The Impact of International Trade with Newly Industrialised Countries on the Wages and Employment of Low-Skilled and High-Skilled Workers in the European Union

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Promotor: Prof. dr. L. Cuyvers

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Preface

I would like to thank my promotor, professor L. Cuyvers, for the support and advice he gave throughout the years while offering me a wide berth to determine the way to deal with the research topic of my doctorate.
I acknowledge the indefatigable support and collaboration of professor G. Rayp (University of Ghent) in most of the theoretical formulation, the boring data collection and the jolly empirical work.
Professor W. Meeusen provided me with useful comments, some unsettling questions and substantial spillovers from my early life work on National Innovation Systems under his supervision.

Many thanks to dr. O. Thas (University of Ghent) and professor P. Willemé for the fun and the support (in that order) with the correction of standard errors in two-step estimation procedures with generated regressands.
I am grateful to professor R.C. Feenstra (University of California, Davis) and professor A. Pagan (The Australian National University, Canberra) for their comments and advice with respect to the correction procedure.

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I would like to thank the members of my jury for their useful comments and suggestions to revalue the results reported in this thesis. Apart from those mentioned before this applies to professor R. Embrechts as the chairmain of the jury, professor F. Abraham (KULeuven), professor J. Hellier (Université de Lille 1-Université de Nantes) and professor R. Ludema (Georgetown University).

At last at last …
I would like to thank my friends and relatives who have put up with my moaning and grousing for years in the hope that it would all end after finishing my Ph.D. I am afraid all hope is in vain as I will surely find other motives to grumble but I promise I will try it over first (stop grumbling that is).

Antwerp, June 2004.

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1. Introduction

"*Now Main Street's whitewashed windows and vacant stores. Seems like there ain't nobody wants to come down here no more. They're closing down the textile mill across the railroad tracks. Foreman says these jobs are going boys and they ain't coming back to your hometown*."

-**Bruce Springsteen** *My Hometown*.

In the last decades of the 20th century the labour market position of low-skilled people appears to have deteriorated substantially in most industrialised countries.
This trend was first noticed in the United States were in the 1980s the skill premium (i.e. the wages of high-skilled workers relative to the wages of low-skilled workers) started to increase dramatically.
In some EU countries, especially in the United Kingdom, wage inequality between high-skilled and low-skilled workers surged as well or stopped decreasing as it did in the previous decades.
However, in a number of EU countries the poor labour market position of low-skilled workers is reflected in high unemployment rates rather than in a rising skill premium.

As in most industrialised countries the relative supply of high-skilled workers generally increases, which other things equal should affect high-skilled workers instead of low-skilled workers, the retrogression of the low-skilled seems to hinge on a common structural shift in relative labour demand.
Cross-country differences in (labour market) institutions are often instanced to elucidate why in countries with relative flexible labour markets wage inequality rises in response to a shift in demand and why in countries with more rigid labour markets unemployment rises.
Remains to examine what exactly caused the structural shift in labour demand in favour of high-skilled workers.

Two main explanations have been put forward: trade with low-skill abundant Newly Industrialised Countries (NIC) and skill-biased technological change (SBTC).

The fact that imports from the NIC were on the rise at about the same time that the labour market position of low-skilled workers in industrialised countries declined did not go unnoticed and North-South trade was soon to be rounded up as a usual suspect.
The public prosecutor could invoke one of the core theorems of the mainstream Heckscher-Ohlin trade theory, i.e. the Stolper-Samuelson theorem, to make out the case against international trade.
The Heckscher-Ohlin theory states that countries can mutually benefit from international trade by specialising in the production of those goods that require relatively much of the production factors that the country is well endowed with, i.e. high-skill abundant countries should specialise in producing skill-intensive goods.
However, the Stolper-Samuelson theorem subjoins that although countries can mutually benefit from international trade, free trade is not neutral in terms of income distribution within countries as it predicts that when a high-skill abundant country starts trading with a low-skill abundant country, the relative wages of low-skilled workers will fall in the first country and rise in the latter.

A number of economists argued that skill-biased technological change is probably a more likely explanation for the structural rise in the demand for high-skilled workers than international trade. They reasoned that investment in new technologies (e.g. computers) raised the average skill level required to perform a job and thereby raised the relative demand for high-skilled workers.

Theoretical arguments do not permit to conclude which of these two explanations is the most important.

Different empirical methodologies have been proposed to test the claim that international trade with Newly Industrialised Countries deteriorated the labour market position of low-skilled workers in industrialised countries.

In the mid-1990s, following the early empirical work, economists seemed to reach a consensus on the limited impact of international trade. Skill-biased technological change ended up in the dock as the more likely culprit.

However, more recently a number of prominent trade economists uttered that the consensus may have been overhasty. Some new empirical methodologies and non-Heckscher-Ohlin theoretical models have been proposed that do not permit to exculpate international trade that easily.

Moreover, most empirical studies considered the situation in the United States. Relatively little research on this issue has been performed on data for EU countries, and if so mostly only for a single country. The substantial differences in institutions, trade flows and specialisation patterns between the United States and most EU countries, but also within the European Union, should warn against the extrapolation of previous results.

In this thesis I give an account of own empirical work on the impact of international trade with Newly Industrialised Countries on the wages and employment of low-skilled and high-skilled workers in the European Union, based on data for a panel of EU countries.

I will focus on the two last decades of the 20th century, as this was the period that imports from NIC became worth mentioning. In the 1980s, the Asian Tigers (Hong Kong, Singapore, South Korea and Taiwan) and the Asian Pussycats (Indonesia, Malaysia, the Philippines and Thailand) were the most active exporters among the emerging economies. After the fall of the *Iron Curtain* and the *Berlin Wall*, Central and Eastern European Countries gradually started to export to EU countries, especially to Germany and Italy.

However, in the 1990s, the export performance of most emerging economies was eclipsed by the dazzling entrance of China.

Whereas in 1990, China's import share in most industrialised countries was negligible, today, China produces a quarter of all TV sets and washing machines worldwide and half of the cameras and copy-machines, with still 500 million peasants- i.e. more than the entire EU population- expected to migrate to urban areas in the next two decades (Forney 2004).

The results of the empirical work that are reported join with and revise the outcome of the project carried out for the European Commission by Cuyvers, Dumont, Rayp, Stevens and Van Den Bulcke (2001 a).

The project was prompted by the general concern for the labour market impact of a further enlargement of the European Union.

I will consider the two main explanations put forward by economists to explain the weakened position of low-skilled workers in industrialised countries though explicitly accounting for their interdependence.

In most of the early empirical work a dichotomy between international trade and technological change seems to have been assumed.

This seems somewhat odd given the general perception of international trade as a mechanism for technology transfer and spillovers and the possibility of trade-induced technological change.

Having pointed out which research topics will be considered I think this may be the appropriate place to present the inevitable list of the topics that will not be assessed.

Though I fully endorse the view of van de Ven (2003) that apart from environmental depletion, the closing of the indecently wide North-South divide is the true challenge of globalisation, I will not consider the impact of trade (liberalisation) on developing countries.

Reviewing the empirical evidence on the impact of trade openness on growth and poverty in developing countries, Dollar and Kraay (2004) concluded that both individual case studies and cross-country growth regressions support the view that globalisation enhances economic growth and on average tends to reduce poverty in developing countries, but Winters (2004) added that the evidence also shows that trade liberalisation alone does not boost growth significantly and that institutions play an important role in translating trade openness into economic growth.

Focusing on the developed countries seems justified, as Krugman (2004) rightly stated that taking seriously the apparent and sometimes rational fears of people in rich countries, with regard to globalisation, should be part of any political strategy to promote free world trade.

As shown by OECD (2001), the growth record of foreign direct investment (FDI) [1] has been far more impressive than the record of international trade in goods or services, in the 1980s and 1990s. This supports the view that capital moves more swiftly than goods and may therefore have a far larger impact on labour markets.

The impact of FDI on wages and employment is not considered in this contribution.
In a twin project for the European Commission Cuyvers, Dumont, Rayp, Stevens and Van Den Bulcke (2001 b) reviewed previous estimations of the impact of foreign direct investment on labour demand and performed own estimations on a panel of EU countries, with respect to investment in Central and Eastern European countries (CEEC). Activities of CEEC affiliates were found to have a significant impact on employment. In addition to the sector component, the component accounting for inter-sector spillover effects, often ignored in previous estimations, is also found to be significant and as substantial as the direct effect.
FDI and international trade are obviously linked. Both are relatively dominated by the activities of multinational firms. UNCTAD (2002: p. 153) estimated the share of international trade involving multinational corporations at about two-thirds for the second half of the 1990s and one-third of world trade would consist of trade among affiliates of the same corporation.
However, foreign outsourcing, i.e. the contracting out to low-wage locations of sliced-up fragments of production processes in high-wage countries, is by many believed to be as important if not more important than FDI.
Given foreign outsourcing implies arms-length transactions as well as equity transactions, a focus on multinational firms and FDI could underrate the impact of this phenomenon.
In most estimations I considered foreign outsourcing, measured as imports of intermediate goods, as an alternative to trade in final goods.

Another potential determinant that is not considered is immigration. As immigrants in industrialised countries tend to be low-skilled, a net inflow of immigrants can be expected to raise the supply of low-skilled workers. All other things equal this will increase the skill premium, or

1 FDI is mostly defined as a participation of at least 10 per cent of ordinary shares in a foreign company.

given sticky wages, increase the unemployment of low-skilled workers. However, available data on relative labour supply in OECD countries suggest that if anything, the relative supply of high-skilled workers increased, which indicates that changes in labour supply cannot explain the weakened position of low-skilled workers, unless official data on labour supply severely underestimate the amount of clandestine low-skilled immigrants.

I will also not consider the possible overall decline in the competitive advantage of high-skill abundant countries in manufacturing activities with respect to low-wage countries that could affect the wages and employment of high-skilled workers and low-skilled workers with no distinction.

How relevant and interesting these issues may be, they are beyond the scope of this thesis.
The main research topic is whether international trade with Newly Industrialised Countries has played a role in the deteriorated labour market position of low-skilled workers in the European Union. Other determinants will be considered to the extent that they could bias the estimates of the impact of international trade and as far as data allows.

This thesis contains two parts.
In part I, including chapters 2 and 3, a rather elaborate though obviously not exhaustive review of the empirical and theoretical literature with respect to the labour market impact of international trade is presented.
The theories are discussed in some detail as they provide the framework for most previous empirical work as well as for own empirical work reported in part II, consisting of chapters 4 up to 6.
The empirical methodologies are extensively described to point out their respective strength and weakness and to show the main differences in theoretical and methodological assumptions. At the end of part I, the overview is used to argue why some estimation procedures have been considered for own empirical work and why other approaches have not.

Part II can however be digested without full reading of the first part, as I refer to the relevant sections in part I as much as possible.

In chapter 2 some stylised facts of recent decades with respect to the evolution of wages and (un)employment of low-skilled and high-skilled workers in EU countries are summarized. Trends in imports from Newly Industrialised Countries (NIC) towards the European Union are also briefly discussed.

The main theoretical models that consider the impact of international trade on labour markets are treated in section 3.1. In section 3.2, I review the empirical work and the different methodological approaches that have been put forward to assess the impact of international trade on income distribution.

Part II presents the results of own empirical work, based on data for a panel of EU countries in the 1980s and 1990s.

In chapter 4, two-step mandated wage regressions are performed to assess whether or not Stolper-Samuelson effects (i.e. the impact of changes in import prices on factor prices) have been significant in the European Union. With this procedure the impact of international trade can be disentangled from the impact of technological change and the indirect impact of international trade, e.g. trade-induced technological change, can be accounted for.

The Stolper-Samuelson theorem is derived under a number of rather restricting limitations. Though the theorem can be shown to be rather robust to relaxing some of these assumptions, perfect competition in labour markets is a necessary condition for the theorem to hold.

Most EU countries are conventially perceived as being characterized by a number of institutional labour market rigidities (e.g. collective bargaining, minimum wages …).

If due to these rigidities wages are not fully flexible, changes in labour demand will not as much affect wages but rather induce unemployment.

Two alternative estimation procedures have been considered to estimate the impact of trade with the NIC on EU labour markets, under the assumption that wages are sticky due to labour market institutions like minimum wages, unemployment benefits or collective bargaining.

Allowing for sticky wages, the demand for low-skilled and high-skilled labour is derived from a flexible cost function in chapter 5. By incorporating external determinants like international trade, the impact of these factors on the demand for production factors can be estimated. The estimated elasticities of labour demand with respect to the external determinants provide an indication of the magnitude of the impact.

In chapter 6, a bargaining framework is adopted, reflecting the fact that in firms, industries or at the country level, unions bargain for wages, employment and/ or working conditions. If unions represent and organize part of the labour supply they may have some power to bargain for the sharing of rents resulting from the market power of firms.

Increased international trade could reduce the bargaining power of unions. Dependent on the bargaining regime and union preferences, the decrease in union power will have a different impact on wages and employment.

A two-step estimation procedure is proposed to infer the impact of international trade on wages and employment, within a union bargaining framework.

In a first step, union power is derived from a production function. The estimated union bargaining power is then, in a second step, regressed on a number of potential determinants (e.g. import penetration). The impact of international trade on wages and employment can then be inferred from the first step indications of the bargaining regime and union preferences.

Most previous studies with respect to the impact of international trade on labour markets in industrialised countries considered a single country, mainly the United States.

Although the relative wages as well as the relative employment of low-skilled workers dropped more dramatically in the United States from the 1980s onwards than in most EU countries, data availability also seems to explain the US dominance in empirical work.

Given the institutional differences between the United States and EU countries, as well as intra-EU heterogeneity, the results of studies that only cover one country cannot simply be carried over to the whole European Union.

As mentioned above, a panel of EU countries has been constructed.

Panel estimations have the advantage that they allow to assess the degree and nature of heterogeneity (asymmetry in shocks or asymmetry in the impact of shocks) across observational units, in casu EU countries.

Panel estimations have the additional advantage that some country-specific changes (e.g. aggregate relative labour supply, changes in the share of non-tradables) can be captured by the country-specific intercepts and are therefore less likely to bias the estimation results.

As geographical distance, differences in factor endowment and technological level undoubtedly matters, more or less homogenous groups of Newly Industrialised Countries have been distinguished.

PART I

2. Whatever Happened?

"*All this happened, more or less. The war parts, anyway, are pretty much true. One guy I knew really* ***was*** *shot in Dresden for taking a teapot that wasn't his. Another guy I knew really* ***did*** *threaten to have his personal enemies killed by hired gunmen after the war. And so on. I've changed all the names*."

-Kurt Vonnegut *Slaughterhouse Five***.**

2.1 Introduction

This section reproduces some stylised facts, more or less, for EU countries in recent decades, with respect to wages and employment broken down by skill level. Trends of imports from Newly Industrialised Countries (NIC) in the European Union will also be discussed.
The data clearly show that EU countries are rather heterogeneous, which should be accounted for in any analysis of the impact of international trade on labour markets in the European Union, both in terms of the possibility of asymmetric shocks or asymmetric effects of common shocks (e.g. due to institutional differences). It also cautions against the extrapolation of results for a single EU country to the whole European Union.

Cuyvers, Dumont and Rayp (2003) Cuyvers, Dumont, Rayp and Stevens (2003) constructed a panel for as many EU countries as possible for the period 1985-1996.
Constructing consistent and continuous time series proved difficult due to structural breaks in data sets, the limited coverage of countries and a large number of missing values in sources of internationally comparable data. Austria, Greece, Ireland, Luxembourg and the Netherlands could not be considered for analysis, lack of sufficient data on some of the necessary variables required for estimation.

A disturbing observation is that the availability, quality and international comparability of data on skills for EU countries appears, in contrast to what one would expect, to be deteriorating (e.g. data on wages for manual and non-manual workers, the only available internationally comparable proxy for wages of low-skilled and high-skilled workers, is no longer provided by EUROSTAT).

This severely undermines empirical work on issues related to skills and the definition of well-considered policies, as the much-needed data are lacking, in sharp contrast with the United States, where highly detailed and freely available data sets incites a stream of empirical work.

2.2 The Rise and Fall of Wages and Employment

“ *SKILL*

Pronunciation: skil

Definition: [n] ability to produce solutions in some problem domain; "the skill of a well-trained boxer"; "the sweet science of pugilism"
[n] an ability that has been acquired by training

Synonyms: accomplishment, acquirement, acquisition, attainment, science

See Also: ability, craft, craftsmanship, horsemanship, literacy, marksmanship, nose, numeracy, oarsmanship, power, salesmanship, seamanship, showmanship, soldiering, soldiership, swordsmanship, virtuosity, workmanship

“ SKILLED WORKER

Definition: [n]

Synonyms: trained worker

See Also: aeronaut, airman, aquanaut, artificer, artisan, aviator, baker, balloonist, bread maker, butcher, calligrapher, calligraphist, coiner, cook, craftsman, crew member, crewman, cutter, dental hygienist, draftsman, draftsperson, draughtsman, dyer, editor, electrician, engraver, fisher, fisherman, fixer, flier, flyer, founder, framer, functionary, funeral director, funeral undertaker, galvaniser, galvanizer, gilder, grip, harpooneer, harpooner, hunter, huntsman, indexer, journeyman, laminator, lens maker, lineman, linesman, lobsterman, lockkeeper, lockman, lockmaster, maintenance man, man, metalworker, military man, military personnel, minter, moneyer, mortician, mounter, oceanaut, official, oilman, optician, painter, perfecter, plaiter, plasterer, plater, power worker, power-station worker, preserver, pressman, printer, projectionist, refiner, refinisher, renovator, repairer, repairman, restorer, riveter, rivetter, router, sailor, service man, serviceman, shearer, skinner, slaughterer, smith, undertaker, worker.”

(**Source**: http://www.hyperdictionary.com/dictionary)

2.2.1 Data on skills

Reliable and detailed data on skills are as hard to obtain as a plain definition.
For a long time, in theories of international trade, capital and homogeneous labour have been considered as the two sole production factors. Only with the apparent deterioration of the labour market position of low-skilled workers in industrialised countries, did skill heterogeneity of labour become an issue for policy-makers and data collectors.

The skill level of workers is obviously a multi-dimensional measure that is difficult to reflect in a single yardstick, as a decent measure of skills should capture basic education and training as well as learning-by-doing and the ability to adapt to a changing environment (Forbes 2001).

Aggregate data on schooling years and schooling quality are available from the Barro-Lee data set. Barro and Lee (1996, 2001) gathered data on the educational attainment, over five-year intervals from 1960 to 1990, for 126 countries. Seven groups of schooling are distinguished, ranging from people without any formal education to people with a degree of higher education.
Data on inputs include number of school days per year and number of school hours per year. Data on outputs (e.g. average scores on internationally comparable tests in reading, mathematics and science) are used to measure schooling quality, though these data are only available for a subset of countries.

In table 2.1 the Barro-Lee data on secondary and higher schooling for the period 1960-1990 are given for four country groups: OECD countries, (formerly) centrally planned economies, countries from East Asia and the Pacific and a group of Latin American and Caribbean countries.

In 1990, the (formerly) centrally planned economies apparently had a higher proportion of their population finishing secondary education and throughout the period 1960-1990 had a higher average of school years than OECD countries. In 1990, in Latin America, relatively more students finished higher education than in East Asia. East Asian and Pacific countries had the largest growth, over the period 1960-1990, in the proportion of their population finishing secondary school and

Latin American countries the highest growth in the proportion finishing higher education but in 1990 both country groups still lagged the (formerly) centrally planned economies and the OECD countries in students finishing secondary and higher schooling.

Table 2.1: Secondary and Higher School Attainment as a Share of the Population

		Education				
		Secondary		Higher		**Mean School years**
Region	**Year**	**Some**	**Full**	**Some**	**Full**	
OECD	1960	0.310	0.116	0.068	0.030	7.05
	1970	0.347	0.116	0.099	0.040	7.58
	1980	0.443	0.227	0.155	0.067	8.76
	1990	0.413	0.153	0.216	0.102	9.02
(Formerly) Centrally planned Economies	1960	0.314	0.109	0.031	0.015	7.54
	1970	0.445	0.145	0.063	0.035	8.58
	1980	0.504	0.117	0.077	0.045	8.95
	1990	0.617	0.209	0.112	0.077	9.98
East Asia and the Pacific	1960	0.085	0.028	0.016	0.008	2.83
	1970	0.130	0.041	0.027	0.012	3.80
	1980	0.218	0.101	0.050	0.022	5.10
	1990	0.248	0.115	0.076	0.035	6.08
Latin America and the Caribbean	1960	0.126	0.041	0.015	0.007	3.26
	1970	0.143	0.050	0.025	0.010	3.82
	1980	0.181	0.056	0.052	0.020	4.46
	1990	0.214	0.074	0.082	0.037	5.24

Source: Barro and Lee (1996: p. 220). The averages per country group are weighted by each country's population aged 15 and over. The shares give the fraction of the population that indicated the given level as its highest attained education level.

At the level of individual sectors (manufacturing or services) time series data on wages and employment by education or skill level are not readily available for many countries and long periods of time, which can probably be explained by the longstanding focus on capital and homogeneous labour as the main production factors. In most studies the distinction between high-skilled and low-skilled workers is proxied by non-production/production, non-operatives/operatives, non-manual/manual or white-collar/blue-collar workers.

In 1995 the OECD asked its member states to provide data on wages and employment for individual industries, broken down by occupation. Data on occupation intrinsically provide more information on skills than data on education. The OECD requested countries to submit data, following the International Standard Classification of Occupation (ISCO 88) developed by the International

Labour Office. The 27 occupational categories reflect different levels of education and abilities required to perform a given job.

There are nine one-digit categories:

1) Legislators, senior officials and managers
2) Professionals (e.g. physical, mathematical and engineering science professionals)
3) Technicians and associate professionals
4) Clerks
5) Service workers, shop and market sales workers
6) Skilled agricultural and fishery workers
7) Craft and related trades workers
8) Plant and machine operators and assemblers
9) Elementary occupations

These nine categories can be aggregated into:

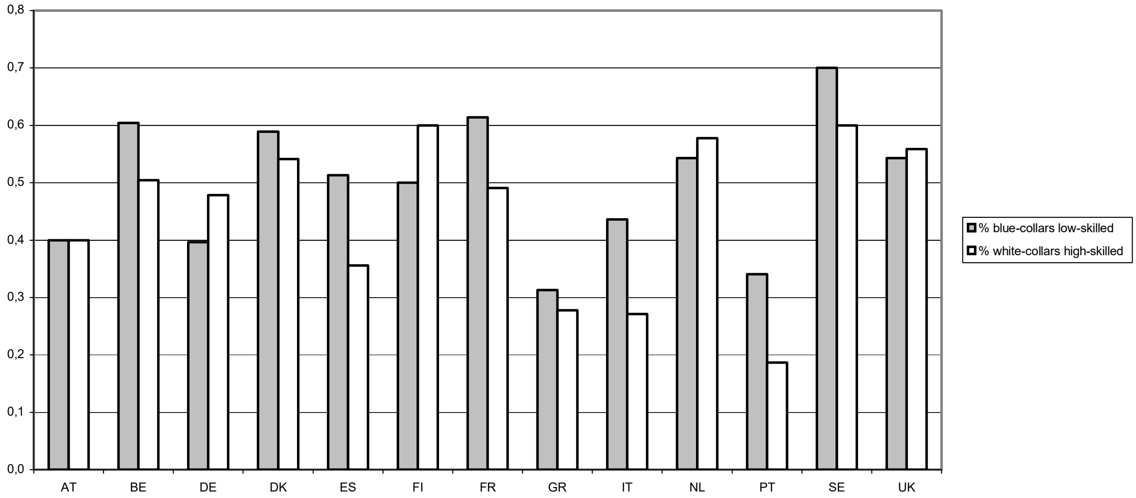
- White-collar high-skilled (WCHS): categories 1 up to 3
- White-collar low-skilled (WCLS): category 4 and 5
- Blue- collar high-skilled (BCHS): category 6 and 7
- Blue-collar low-skilled (BCLS): category 8 and 9

For EU countries, data on employment at industry level, following the ISCO 88 classification are available from 1993 onwards as a result of the Labour Force Surveys, carried out every year in each EU country, applying common methods, definitions and classifications to obtain a reasonable level of international comparability. It provides detailed information on (un)employment at the household level (e.g. ISCO classification of occupation). The OECD found significant differences between countries in the reported number of workers in the nine one-digit ISCO 88 categories, which seem to reflect differences in definitions of occupations and different reclassifications of national data into ISCO 88, especially with respect to category 2 and 3 for white-collar workers and category 6 and 7 for blue-collar workers. The four aggregated groups (WCHS, WCLS, BCHS and BCLS) are considered as reasonable in terms of international comparability (OECD 1998: p. 6).

Classifications based on educational attainment and classifications based on ISCO 88 appear- not too surprisingly- to be positively correlated and using education or occupation to proxy skill results in similar conclusions with regard to skill composition and trends (OECD 1998: pp. 8-9).
In his review of studies on the impact of international trade on wage inequality (see section 3.2.5) Slaughter (2000) concluded that results appear to be rather robust to which measures are used to proxy the skill level.
Burtless (1995) pointed out that in the United States, in the first half of the 1980s, the relative wages of high-skilled workers, when proxied by non-production workers, rose far less substantially than the relative wages of college graduates, an alternative proxy for high-skilled workers.

In figure 2.1, using data from the Labour Force Surveys on employment in 1999, classified by ISCO 88, the share of blue-collar workers that are low-skilled and the share of white-collar workers that are high-skilled is shown for thirteen EU countries.
As mentioned before, the ISCO 88 classification permits to classify workers into high-skilled white-collars, low-skilled white-collars, high-skilled blue-collars and low-skilled blue-collars.

Figure 2.1: Degree of Correct Skill Classification following White-Collar/ Blue-Collar Distinction for Thirteen EU Countries in 1999



Source: Own calculations from Labour Force Survey data (EUROSTAT).

Using these data, the share of white-collar workers that are high-skilled (as assumed when using white-collar workers to proxy high-skilled workers) and the share of blue-collar workers that are low-skilled (as assumed when using blue-collar workers to proxy low-skilled workers) can be computed.

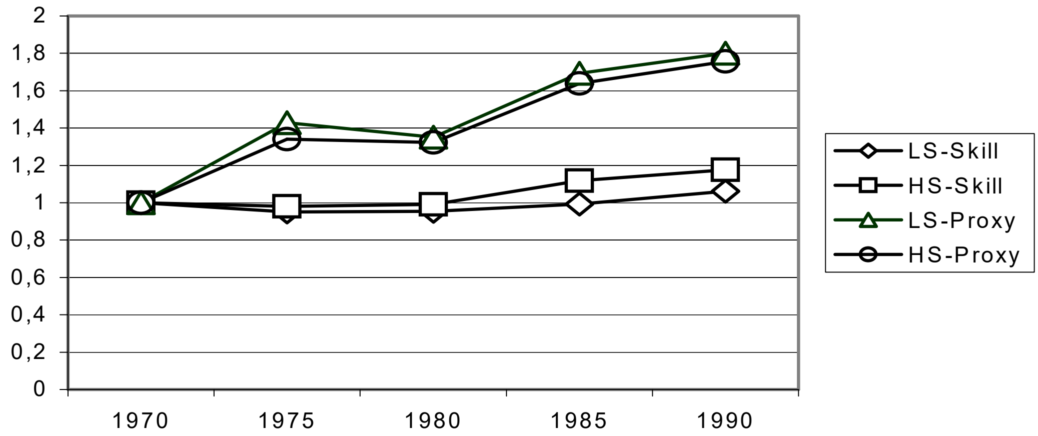
The shares give an indication of the bias of the distinction blue-collar/white-collar workers, when used as a proxy for low-skilled/ high-skilled workers. Data for earlier years reveal a similar pattern. In general, more than 40 per cent of blue-collar workers are reported to be high-skilled and about 50 per cent of white-collar workers are reported to be low-skilled.

Figure 2.2 shows, for Finland[2], the evolution of employment of high-skilled workers relative to low-skilled workers, using the ISCO classification of high-skilled workers (WCHS + BCHS) and low-skilled workers (WCLS + BCLS) and alternatively the proxy distinction white-collar (WCHS + WCLS) and blue-collar (BCHS + BCLS). The ratio of relative employment of high-skilled

2 Finland provided the OECD with the longest time series on employment by ISCO 88.

(white-collar) workers for 1970 is set at one. The ratio is given for low-skill sectors (LS) and high-skill sectors (HS) separately[3].

Figure 2.2: Trend of Relative Employment of High-Skilled Workers according to ISCO 88 (Skill) or White-Collar/ Blue-Collar Distinction (Proxy) in Finland (1970-1990)



Source: Own calculations from data provided by the OECD (DSTI/ EAS division).

Using the white-collar/ blue-collar distinction apparently results in a more substantial increase in the relative employment of high-skilled workers than when the 'actual' skill classification is considered.

A remarkable finding is the extremely close link between the evolution in the ratio in low-skill and high-skill sectors, irrespective of which distinction is used.

Figures 2.1 and 2.2 suggest that the traditional proxies for skills could result in biased conclusions, though the trends are similar. In principle, data using ISCO 88 are more appropriate than most proxy classifications. The reason that proxy measures are used more often is that other data are more readily available.

Whereas most countries provided the OECD with data on employment by ISCO 88 (albeit mostly only for a limited number of years) not a single country responded to the explicit request for wages by occupation level (OECD 1998: p. 4).

3 A median split on the value added shares of production workers is used to distinguish between low-skilled sectors and high-skilled sectors. Using the ratio of high-skilled workers to low-skilled workers gives a similar distinction.

Except for availability there is an important caveat to the ISCO 88 data, especially for EU countries. For the EU these data are gathered from the Labour Force Surveys. As pointed out by OECD (1998) the numbers as well as the ratio high-skilled/ low-skilled workers could be subject to serious measurement error. This is suggested by the fact that the aggregates of ISCO employment taken from the Labour Force Survey data do not match- and often substantially differ from- more reliable data on total employment from the OECD Structural Analysis Industrial (STAN) data. The OECD actually rescaled the data it received, using its own data on total employment at the sector level, assuming that the proportions between the categories reported were reliable.
A quick-and-dirty check suggests that this is not necessarily so.
Given the following identity in each industry *i*:

$$\text{Total wage sum}_i = \text{Wage}_{manual} \,.\, \text{number of operatives}_i + \text{Wage}_{non\text{-}manual} \,.\, \text{number of non-operatives}_i$$

regressing the total wage sum on the number of operatives and the number of non-operatives for a pooled set of industries, the estimated coefficients should be reasonable estimates of the wages of operatives and non-operatives.
For four EU countries (Germany, Finland, Italy and the United Kingdom) the OECD has data on employment by ISCO 88 at the two-digit ISIC industry level for 1985. For the same countries and the same year the UNIDO General Industrial Statistics provide a breakdown of employment at the sector level by operatives and non-operatives, i.e. a proxy for low-skilled and high-skilled workers. The total wage sum for ISIC industries can be taken from the STAN database.
EUROSTAT (NewCronos- Theme 3) provides time series on gross hourly wages of manual workers and monthly wages of non-manual workers at the ISIC sector level for the period 1972-1998.

These have been used to compute yearly wages for manual and non-manual workers. Actual differences across industries in wages of manual and non-manual workers have been accounted for in the regressions. The results are reported in table 2.2.
In a first regression, for each of the four countries, the total wage sum is regressed on the number of blue-collar and white-collar workers, based on data provided by the OECD on employment

broken down by ISCO 88. In a second regression, the total wage sum is regressed on the number of low-skilled and high-skilled workers, again following the ISCO 88 data.

If the ISCO 88 data are anything to go by the latter regression should provide reasonable estimates of the wages of low-skilled and high-skilled workers, which are not available and could therefore be used as an alternative to wages for proxy categories like manual/ non-manual workers.

In the third regression the total wage sum is regressed on the number of operatives and non-operatives from the UNIDO General Industrial Statistics.

For all estimates the 95 per cent confidence intervals are given in square brackets.

The actual wages for manual and non-manual workers from EUROSTAT are also reported as a benchmark for the reliability of the employment data.

The UNIDO data seem to perform best for all four countries. For Finland they provide a perfect fit whereas for Germany and Italy the estimated wages of non-manual workers substantially exceed the wages of manual workers reported by EUROSTAT.

Table 2.2: Estimation of Wages using OECD ISCO 88 Data or UNIDO Data to proxy Skills (1985)

Dependent variable: Total wage sum	
GERMANY	Estimated annual wages
ISCO 88	
Number of blue-collar workers (BCHS + BCLS)	28106 [25263, 30948]
Number of white-collar workers (WCHS +WCLS)	69628 [64674, 74581]
R^2	0.96
Number of low-skilled workers (WCLS + BCLS)	26722 [18844, 34599]
Number of high-skilled workers (WCHS + BCHS)	57229 [50688, 63771]
R^2	0.94
UNIDO	
Number of operatives	31454 [27677, 35231]
Number of non-operatives	53027 [49771, 56283]
R^2	0.95

	Actual annual wages (EUROSTAT)
Manual workers	31408
Non-manual workers	45468

FINLAND	Estimated annual wages
ISCO 88	
Number of blue-collar workers (BCHS + BCLS)	75844 [74428, 77259]
Number of white-collar workers (WCHS +WCLS)	103146 [100412, 105882]
R^2	0.99
Number of low-skilled workers (WCLS + BCLS)	93425 [90712, 96137]
Number of high-skilled workers (WCHS + BCHS)	80242 [78182, 82303]
R^2	1.00
UNIDO	
Number of operatives	61250
Number of non-operatives	133265
R^2	1.00
	Actual annual wages (EUROSTAT)
Manual workers	61250
Non-manual workers	133265

Table 2.2: (continued)

ITALY	Estimated annual wages
ISCO 88	
Number of blue-collar workers (BCHS + BCLS)	13292 [12100, 14485]
Number of white-collar workers (WCHS +WCLS)	62839 [58139, 67539]
R^2	0.95
Number of low-skilled workers (WCLS + BCLS)	37767 [35698, 39837]
Number of high-skilled workers (WCHS + BCHS)	12751 [11514, 13988]
R^2	0.95
UNIDO	
Number of operatives	15397 [14149, 16645]
Number of non-operatives	36846 [34532, 39160]
R^2	0.91

	Actual annual wages (EUROSTAT)
Manual workers	18102
Non-manual workers	23659

UNITED KINGDOM	Estimated annual wages
ISCO 88	
Number of blue-collar workers (BCHS + BCLS)	8340 [8178, 8503]
Number of white-collar workers (WCHS +WCLS)	12169 [11891, 12446]
R^2	1.00
Number of low-skilled workers (WCLS + BCLS)	10639 [10106, 11170]
Number of high-skilled workers (WCHS + BCHS)	9212 [8734, 9690]
R^2	1.00
UNIDO	
Number of operatives	8185 [7733, 8637]
Number of non-operatives	11817 [11301, 12333]
R^2	1.00
	Actual annual wages (EUROSTAT)
Manual workers	6883
Non-manual workers	10500

Source: The total wage sum is taken from the OECD STAN database, data on wages of manual and non-manual workers from EUROSTAT (NewCronos- Theme 3: Earnings).
Employment figures by ISCO 88 are provided by the OECD and employment of operatives and non-operatives are from the UNIDO General Industrial Statistics. Confidence intervals (95 per cent) are given in square brackets.

Using the ISCO 88 data on low-skilled and high-skilled workers provides very unlikely estimates of wages. For three countries estimation results actually suggest that low-skilled workers would have earned more than high-skilled workers in 1985.

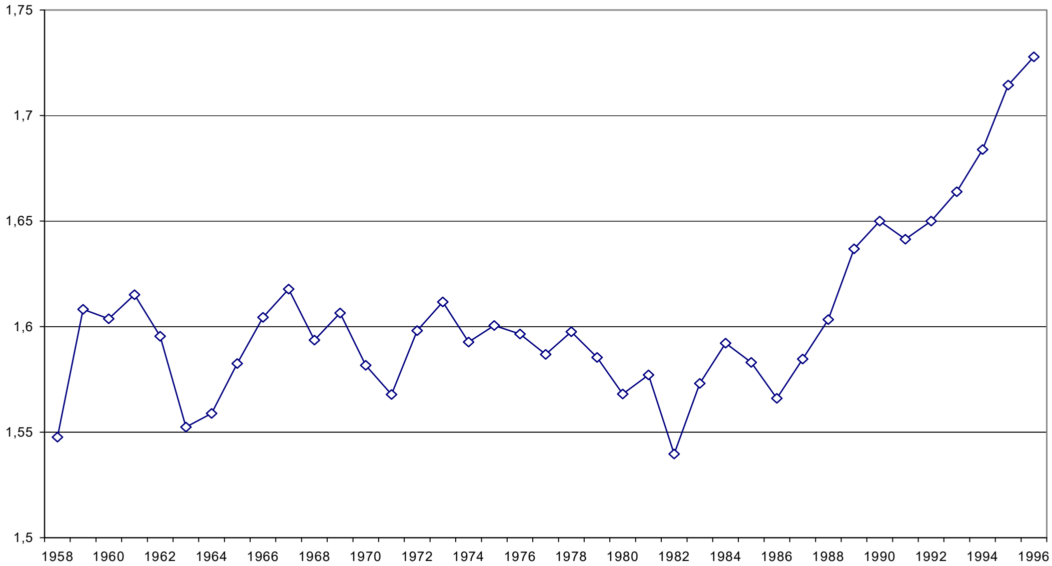
The apparent poor quality of the LFS data is rather problematic, as for the 1990s the Labour Force Survey is the only source for internationally comparable employment data broken down by skills for EU countries, as the UNIDO General Industrial Statistics do not provide data on operatives and non-operatives after 1990.
However, for some EU countries more reliable data for the 1990s are available from country sources or the OECD International Sectoral Database (ISDB), which have been used as much as possible in the estimations in part II.
With respect to data on wages, EUROSTAT no longer provides wages for manual and non-manual workers (for most countries data coverage stops in 1998), which poses a severe problem for future empirical work as this was one of the only sources providing data on wages broken down by skill.

2.2.2 Wage inequality

The earliest studies drawing attention to the weakened labour market position of low-skilled workers appeared in the United States, where in the 1980s wage inequality increased dramatically as can be seen in figure 2.3, which shows the evolution of the relative wages of non-production workers (proxy for high-skilled workers) in the period 1958-1996.
The relative wages are a weighted average of the relative wages in 450 US manufacturing industries using each industry's share in total employment as a weight. Data are taken from the NBER-CES Manufacturing Industry Database.
From a more long-run perspective it should be pointed out that the relative wages of high-skilled workers in the United States had, as in most other industrialised countries, decreased almost continuously for several decades prior to the 1980s (von Tunzelmann and Anderson 2001).

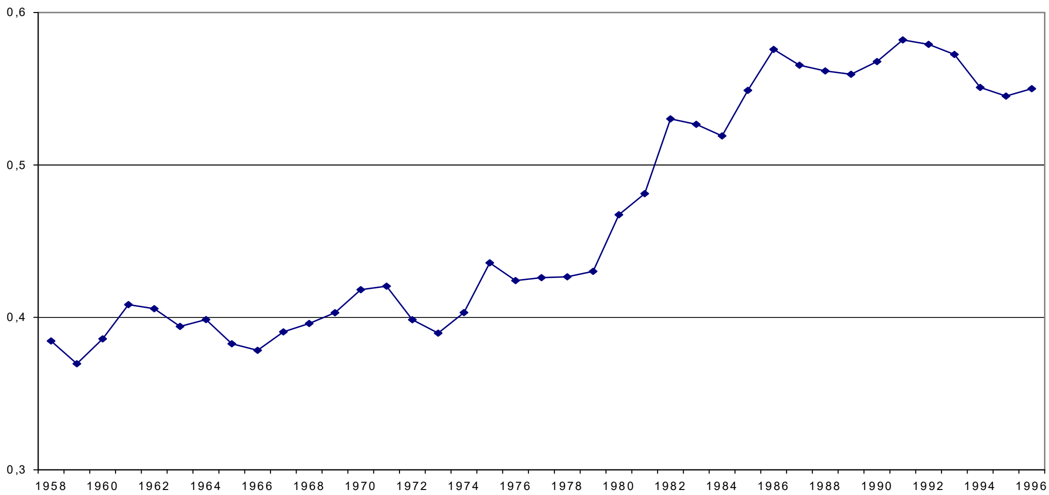
Figure 2.3: The Evolution of the Relative Wages of Non-Production Workers in the United States (1958-1996)

Source: Own calculations from the NBER-CES Manufacturing Industry Database (1958-1996).



As shown in figure 2.4, the relative employment of non-production workers already increased considerably in the 1970s.

Figure 2.4: The Evolution of the Relative Employment of Non-Production Workers in the United States (1958-1996)



Source: Own calculations from the NBER-CES Manufacturing Industry Database (1958-1996).

The relative employment is again a weighted average of relative employment in 450 US manufacturing industries
According to Cline (1997) a strong increase in the relative supply of high-skilled workers dominated any relative labour demand effect in the 1970s, explaining the drop in the skill premium. In the 1980s the relative supply further increased but less spectacularly insofar that the supply effect was dominated by an increased demand for high-skilled workers, resulting in a rising skill premium.

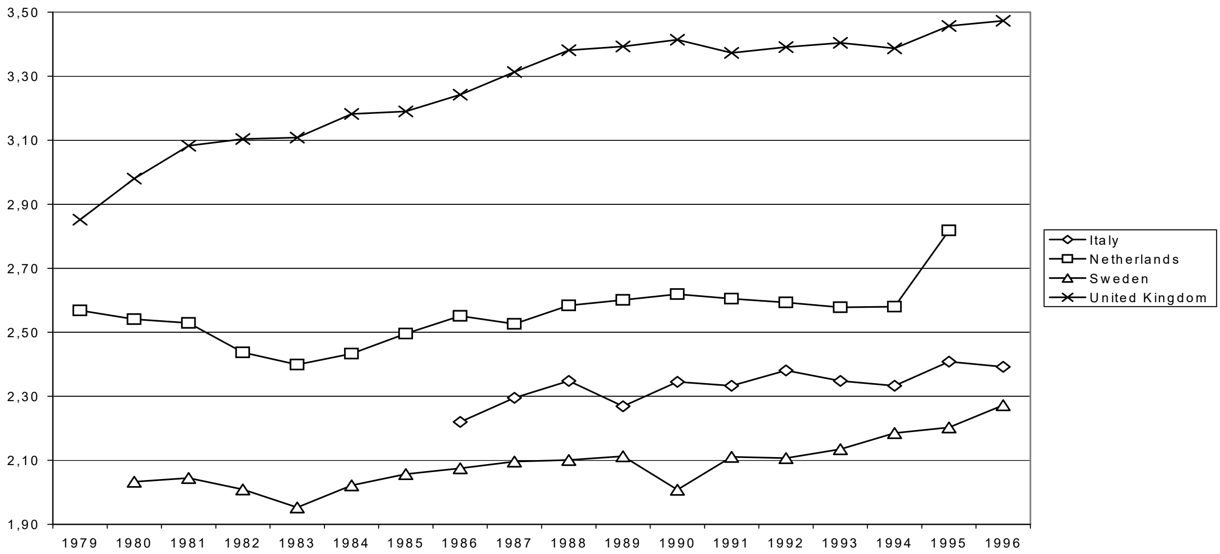
The dramatic increase in earnings inequality that occurred in the United States is not found in most other industrialised countries. As figure 2.5, based on data reported in OECD (1996) shows, in the United Kingdom earnings inequality (measured as the ratio of earnings in the ninth decile relative to earnings in the fifth (median) decile of employees, with employees ranked from lowest to highest earnings (D9/D5)) increased considerably in the period 1979-1996. However, in other EU countries inequality hardly changed or even decreased (Belgium and Germany).

Relating median earnings to earnings of the lowest decile (D5/D1), again shows that inequality increased rather substantially for the United Kingdom and the United States, slightly in France, the Netherlands and Sweden but decreased in Belgium, Denmark, Germany and Finland (OECD 1996: 61-62). As reported in OECD (2003 a) from the mid-1990s wage inequality stabilized in the United Kingdom, increased in Germany, Italy and the Netherlands and decreased in France.
For Europe, Atkinson (1996) found that the Scandinavian countries, Belgium, Germany, Luxembourg and the Netherlands have the lowest income inequality, South-European countries and Ireland have the highest income inequality and France and to a lesser extent the UK occupy an intermediate position.

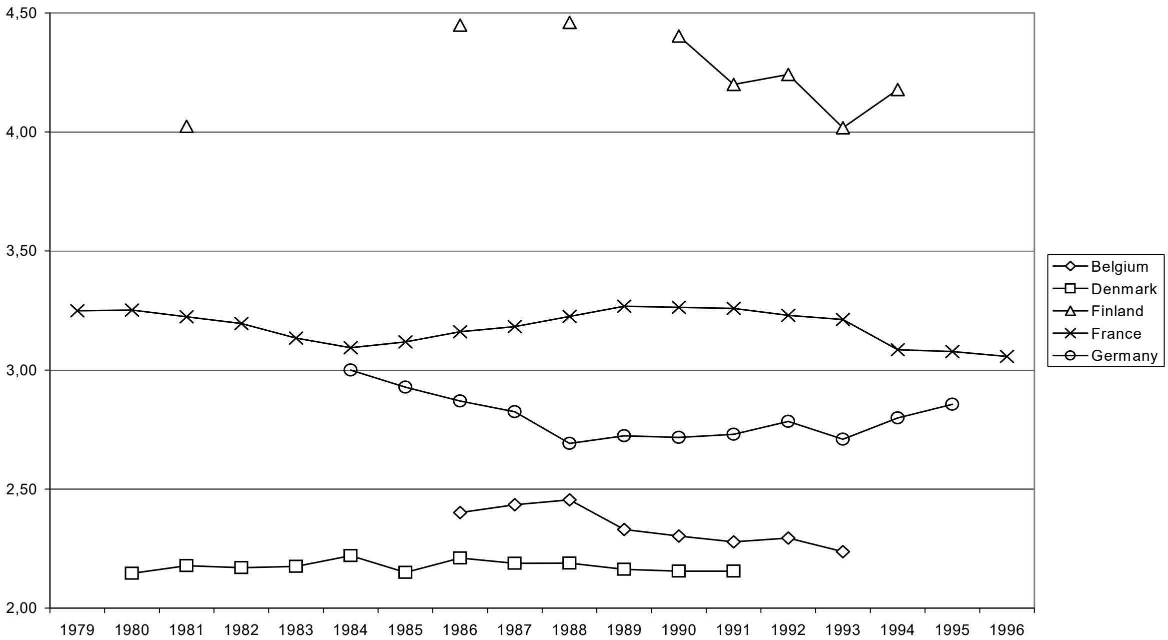
Hellier and Chusseau (2003) reported a sharp increase in the wage gap between the highest and the lowest income decile in the United States and the United Kingdom in the 1980s and the 1990s. In France and Germany this gap, which decreased in the 1960s and 1970s, hardly changed, whereas the Netherlands and Sweden witnessed increased wage inequality though these countries remained relatively egalitarian.

Figure 2.5: Trends in Earnings Inequality in the European Union (1979-1996)

Countries with increased earnings inequality



Countries with relatively stableor decreasing earnings inequality



Note: Data are taken from OECD (1996: table 3.1), more recent data have been provided by Joël Hellier. Earnings inequality is measured as the ratio of earnings of the ninth decile relative to the earnings of the fifth decile (median) of employees with employees ranked from lowest to highest earnings. Dispersion is measured for all employees (male and female) except for the United States for which only male workers are considered.

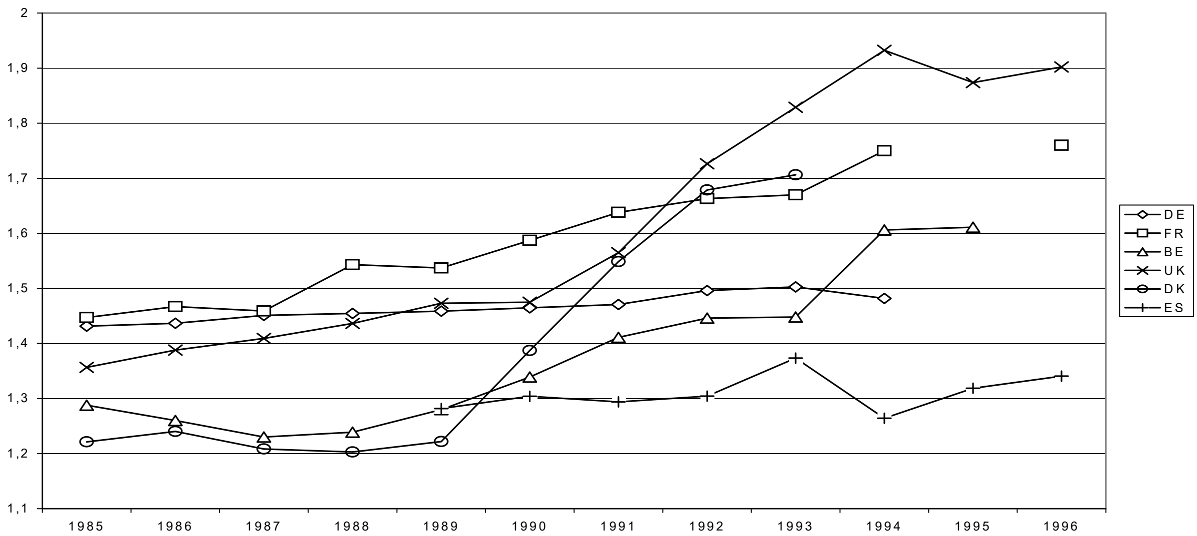
The previous trends concern aggregate earnings inequality.

Figure 2.6 shows the ratio of wages of non-manual workers relative to the wages of manual workers in manufacturing industries for nine EU countries in the period 1985-1996. The ratio is a weighted average of the ratio across industries, with each industry weighted by its share in the total wage sum for all manufacturing industries.
Contrary to figure 2.5, figure 2.6 suggests that wage inequality did not just increase in the United Kingdom, albeit most distinctly in this country, but also in Belgium, France, Denmark and Germany.

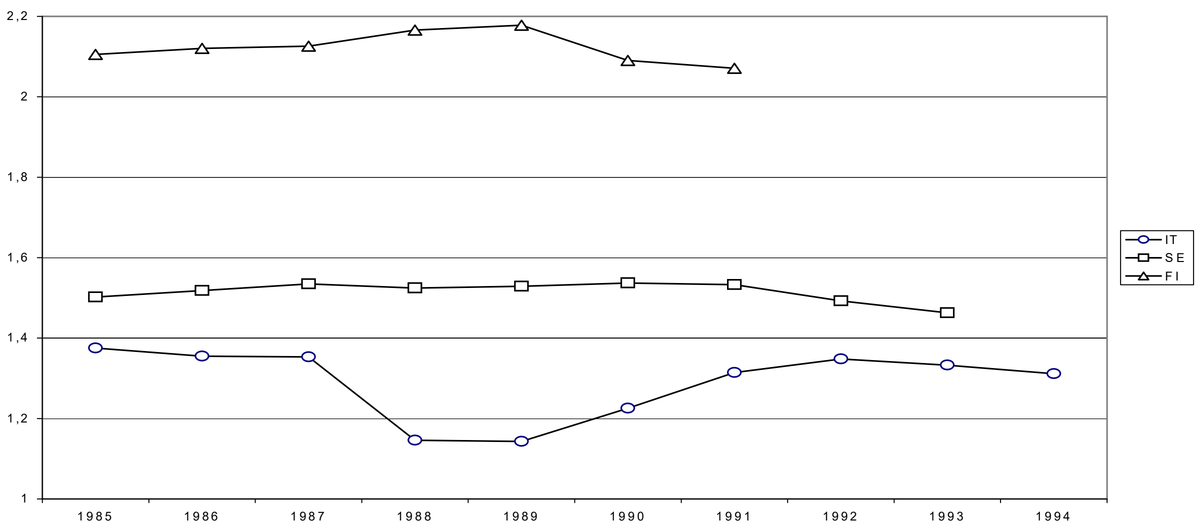
Economists often evoke a trade-off between wage inequality and unemployment to explain the difference between a *moneyless* jobs United States and a *jobless* money European Union (e.g. Krugman 1995 a).
OECD (2003 a: p. 42) granted that some of the policies that it advocated in its 1994 *Jobs Study* to increase employment rates (e.g. activation measures) may have increased wage inequality, as some of these measures simply increase labour supply, mostly of low-skilled people, which without a compensating increase in labour demand will depress wages. Decentralisation of wage bargaining and the reduction of minimum wages may also have gnawed at the wages of low-wage workers whereas revoking employment protection may have encouraged low-pay and low-productivity jobs. Low-paid employment increased considerably in the United States and the United Kingdom in the 1980s and in Italy, the Netherlands and most Central European OECD countries in the 1990s (OECD 2003 a: p.63). The OECD enumerated the potential benefits of labour and product market flexibility in stimulating innovation and productivity growth but found a negative cross-country correlation between employment growth and labour productivity growth in the 1990s, suggesting a trade-off between employment and productivity (OECD 2003 a: p. 42).

Figure 2.6: Trends in the Relative Wages of Non-manual Workers in Nine EU Countries in the Period 1985-1996

Countries with increased relative wages



Countries with stable or decreased relative wages



Source: Own calculations from the UNIDO General Industrial Statistics, Labour Force Survey data (EUROSTAT) and OECD Structural Analysis Industrial (STAN) and International Sectoral database (ISDB).

2.2.3 (Un)employment

Table 2.3 shows the unemployment rates and the ratio of employment to population, broken down by education level for 2001, for a number of OECD countries.
Overall, the unemployment rate of people without a higher secondary education exceeds substantially the unemployment rate of people with a higher education level. The gap in unemployment rates is extremely high in the Czech Republic, Hungary and Poland. In Mexico and South Korea the unemployment rate of persons with little education is reported to be lower than the unemployment rate of the highly educated, although the unemployment rates, especially for Mexico seem rather uninformative, looking at the employment- population ratio. On average, persons not having finished secondary schooling account for half of total unemployment in OECD countries (OECD 2003 a: p. 86)
According to the OECD the weak employment performance of low-skilled workers in the 1990s reflected their lower labour market participation, which as it occurred simultaneously with an increase in aggregate employment opportunities would be consistent with the view that skill-biased technological change and international trade reduced the demand for low-skilled workers (OECD 2003 a: p.29).

Figure 2.7 shows the unemployment rate of people with a secondary education degree relative to the unemployment rate of people with a higher education degree in seven EU countries, comparing the 1992 level to the level of the ratio in 2001.
The ratio increased in Germany and the United Kingdom and less pronounced in France and Italy. It hardly changed in Belgium, slightly decreased in Spain and rather substantially in Denmark.
The increase in Germany and the United Kingdom is remarkable, given the rise in the skill premium in both countries at about the same time.
However, whereas the ratio appears to have increased continuously throughout the period 1992-2001 in Germany, the ratio in the United Kingdom fell from 3.05 in 1992 to 2.55 in 1997, increasing spectacularly after 1997. In France the ratio fell from 2.49 in 1992 to 2.28 in 1997, to increase to

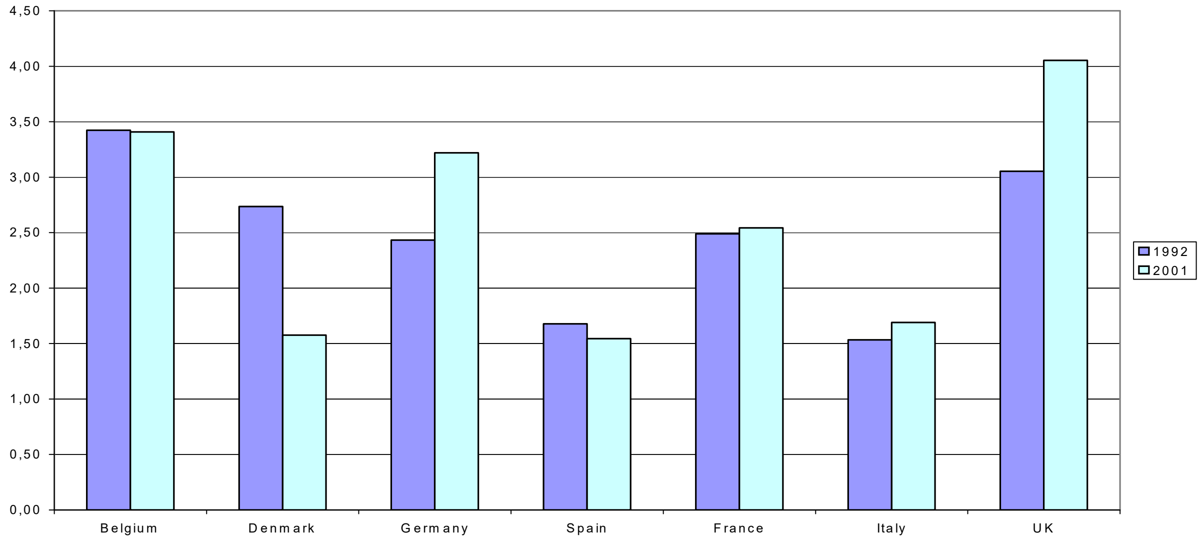
2.54 in 2001. In Belgium the ratio increased between 1992 and 1997 from 3.42 to 3.79. The ratio fell from 2.74 in 1992 to 2.41 in 1997 in Denmark and further fell to 1.58 in 2001.

Table 2.3: Unemployment Rates and Employment/ Population Ratio by Educational Attainment (2001)

		No upper secondary education	Upper secondary education	Higher education
Belgium	Unemployment rates	8.5	5.5	2.7
	Employment/population	49.0	73.9	84.5
Czech Republic	Unemployment rates	19.2	6.2	2.0
	Employment/population	46.7	75.7	87.8
Denmark	Unemployment rates	5.0	3.3	3.2
	Employment/population	61.9	80.7	87.3
Finland	Unemployment rates	11.4	8.5	4.4
	Employment/population	58.2	75.5	85.1
France	Unemployment rates	11.9	6.9	4.8
	Employment/population	57.7	76.5	83.7
Germany	Unemployment rates	13.5	8.2	4.2
	Employment/population	51.8	70.5	83.4
Hungary	Unemployment rates	10.0	4.6	1.2
	Employment/population	36.8	71.9	82.5
Italy	Unemployment rates	9.1	6.8	5.3
	Employment/population	48.8	71.9	81.6
South Korea	Unemployment rates	2.9	3.4	3.3
	Employment/population	67.5	69.4	75.8
Mexico	Unemployment rates	1.4	1.7	2.2
	Employment/population	62.8	64.1	81.5
Poland	Unemployment rates	22.6	15.9	5.0
	Employment/population	41.5	64.8	84.0
Spain	Unemployment rates	10.2	8.4	6.9
	Employment/population	55.0	71.7	80.7
Sweden	Unemployment rates	5.9	4.6	2.6
	Employment/population	68.8	81.9	86.9
United Kingdom	Unemployment rates	7.6	3.9	2.0
	Employment/population	54.0	79.5	88.3
United States	Unemployment rates	8.1	3.8	2.1
	Employment/population	58.4	76.2	84.4

Source: OECD (2003 a: p. 316). The numbers reported are shares of the population between 25 and 64.

Figure 2.7: The Unemployment Rate of People with a Secondary Education Degree relative to People with a Higher Education Degree in Seven EU Countries (1992-2001)



Source: Eurostat New Cronos.

Figure 2.8 shows the trends in relative employment of non-manual workers in the manufacturing industries, in the period 1985-1996, for the panel of nine EU countries.

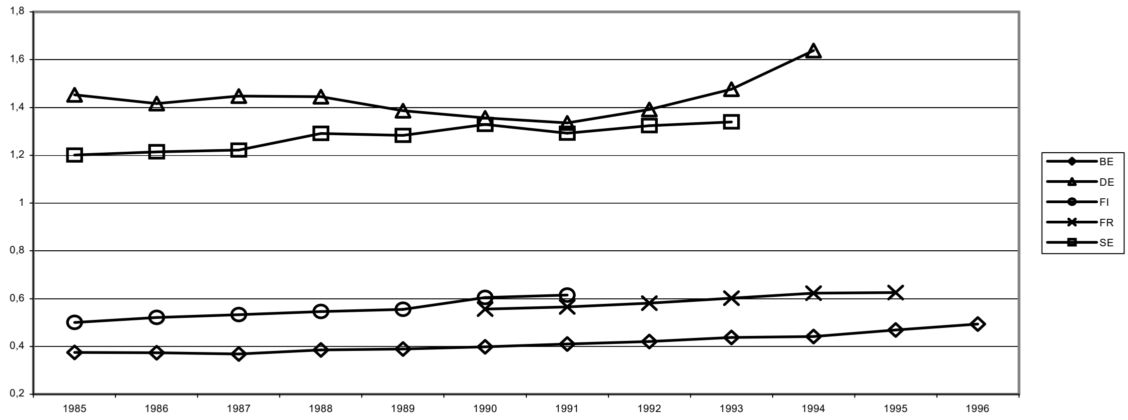
Aggregate relative employment is taken as the weighted average over manufacturing industries, with the industries' share in total manufacturing employment used to weigh.

In three EU countries (Belgium, France and Germany), which according to figure 2.6 witnessed increased relative wages of non-manual workers, relative employment of non-manual workers increased as well though not spectacularly.
In the two countries, which experienced the highest increase in the skill premium relative employment was rather stable (United Kingdom) or even decreased (Denmark).

If anything, figures 2.6, 2.7 and 2.8 clearly show the diverging trends among EU countries in relative wages and employment.

Figure 2.8: Trends in the Relative Employment of Non-Manual Workers in Nine EU Countries in the Period 1985-1996

Countries with increased relative employment



Countries with stable or decreased relative employment

Source: See figure 2.4

The data also show that the simultaneous dramatic increase in relative wages and employment of high-skilled workers, as witnessed in the United States and often considered as evidence of skill-biased technological change is not generally found in the European Union.
However, overall the data show that either in terms of increased wage inequality or employment opportunities the position of low-skilled workers also deteriorated in most EU countries, albeit with exception of the United Kingdom less pronounced than in the United States.

The OECD found indications that, contrary to the general belief, the employment performance of EU countries improved in the 1990s.
The OECD estimated the non-accelerating inflation rate of unemployment (NAIRU), i.e. the equilibrium unemployment rate that can be maintained without endangering price stability for the period 1991-2001 and found that for eight EU countries it actually appears to have decreased, that it did not change much in the United States, Austria and Italy and increased in Germany, Greece, and Finland. They however pointed out some conceptual and empirical caveats of the NAIRU estimation and therefore also considered other indications of labour market performance (OECD 2003 a: pp. 30-31).

The match between vacancies and the unemployed worsened in the 1980s and showed little improvement in most OECD countries in the 1990s indicating a structural mismatch between labour supply and demand (OECD 2003 a: pp. 31-35).

According to the OECD, wage moderation seems a more likely explanation for the decrease in equilibrium unemployment. In most EU countries total labour costs outpaced productivity growth in the 1970s, levelled in the 1980s and lagged productivity growth in the 1990s. The OECD listed a number of institutional factors that influence wage setting, other than those that are also likely to affect the matching between vacancies and the unemployed (e.g. employment protection and unemployment benefits) as the latter did not seem to have improved. Union bargaining is believed to cause wage rigidity and thereby unemployment, a mechanism that may be weakened by co-

ordination (e.g. through centralization at the national level) of the bargaining process across sectors or firms. If unions try too hard to reduce wage inequality between low-skilled and high-skilled workers employers may become reluctant to hire low-skilled workers (OECD 2003 a: p. 36).
Taxes on labour are another obvious determinant of total labour costs. The OECD referred to empirical work on the impact of labour taxes on unemployment by Daveri and Tabellini (2000) and Nickell et al. (2003) which- contrary to previous work by e.g. Layard, Nickell and Jackman (1991)- seemed to show that taxes raise equilibrium unemployment. This effect appears to be smaller in those countries that have co-ordinated wage bargaining. According to the OECD this would suggest that labour taxes have a more substantial negative impact on employment in Belgium, France, Germany, Italy, the Netherlands and Spain and less impact in Finland, Norway and Sweden where wage bargaining is more co-ordinated (OECD 2003 a: p. 37).

Wage moderation seems to have resulted in substantial employment growth in the business sector in the 1990s in most EU countries, in contrast with the sluggish growth in the 1970s and 1980s.
The OECD concluded that there are clear indications of a structural improvement in employment performance in EU countries in the 1990s. Moreover, in most EU countries job growth has been more pronounced in industries that pay relatively well, except in the Netherlands and the United Kingdom where low-paying jobs increased more than medium- or high-paying jobs. At the downside, wage inequality seems to have increased in countries where wage setting became more decentralised and market driven, especially in the United Kingdom. Moreover, some subjective (e.g. workers' perception) and objective (e.g. overtime) measures seem to indicate worsened working conditions (OECD 2003 a: pp. 40-48).

2.3 International Trade with Newly Industrialised Countries

Landesmann, Stehrer, and Leitner (2002) gathered data from the OECD Bilateral Trade database for seven OECD countries (France, Germany, Japan, the Netherlands, Sweden, the United Kingdom and the United States) with respect to a group of trading partners from the *North* (high-wage OECD countries) and trading partners from the *South*, classified into four groups: **Southern**

European countries (Greece, Portugal, Spain and Turkey), **Asian Tigers** (Hong Kong, Singapore, Taiwan and South Korea), **Eastern European transition countries** (Czech Republic, Poland and Hungary) and **Southern developing countries** (Argentina, Brazil, China, India, Indonesia, Malaysia, Mexico, Philippines, Thailand and the rest of the world).
Apparently, import penetration from the *South*, in the EU countries considered, increased mainly in the period 1989-1996, whereas in the United States it increased over both the periods 1980-1988 and 1989-1996. Import penetration from the Asian Tigers occurred during the first sub-period for the United States as well as the EU countries. Landesmann, Stehrer and Leitner stress the integration of the formerly autarkic trade bloc of Central and Eastern European countries, which opened up to trade with the European Union in the 1990s, whereas the Southern European countries had already started integrating in the European Union in the 1980s.
The Southern developing countries mainly increased their imports in the period 1989-1996.

Figure 2.9 shows the evolution of the average import shares of four groups of Newly Industrialised Countries in the period 1990-2000 with respect to nine EU countries. The data were taken from the OECD International Trade by Commodities Statistics (ITCS) and converted into volumes at the ISIC sector level with a concordance table provided by EUROSTAT[4]. The four NIC groups are: **Asian NIC** (Hong Kong, Indonesia, Malaysia, Philippines, South Korea, Singapore and Thailand), **CEEC** (Czech Republic, Hungary and Poland), **Latin** (Argentina, Brazil, Chile and Mexico) and **China.**

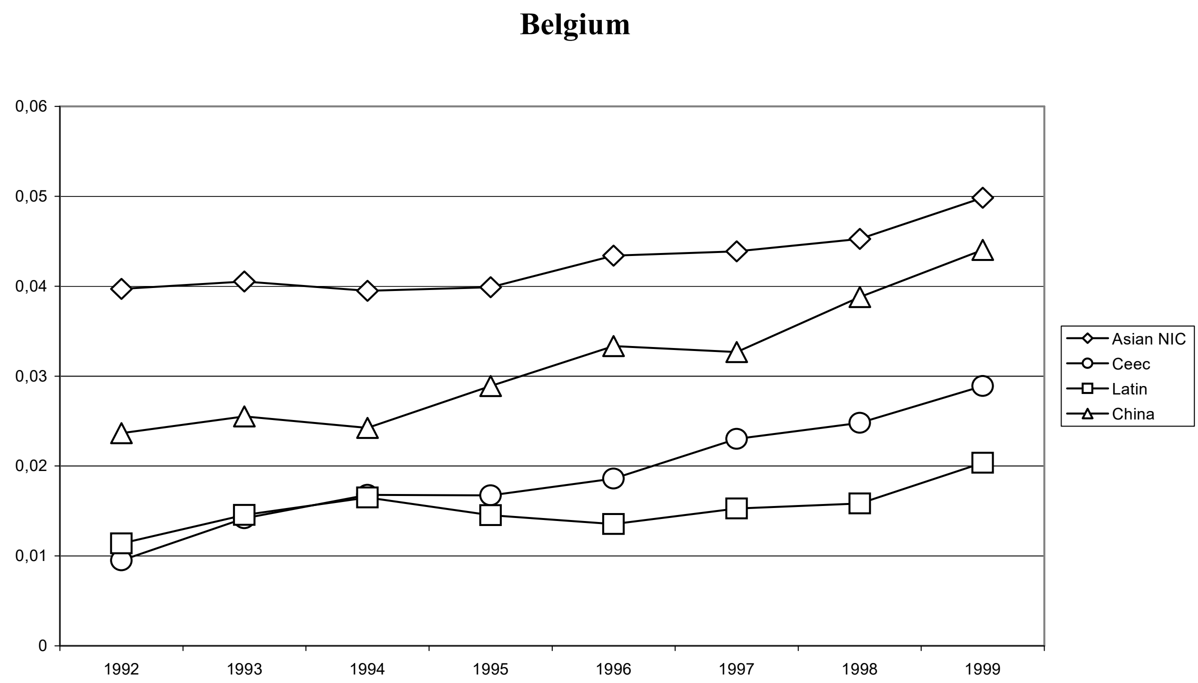
Import penetration from the Asian NIC hardly increased in the 1990s, except in Spain, Sweden and especially the United Kingdom where the import share has risen considerably.

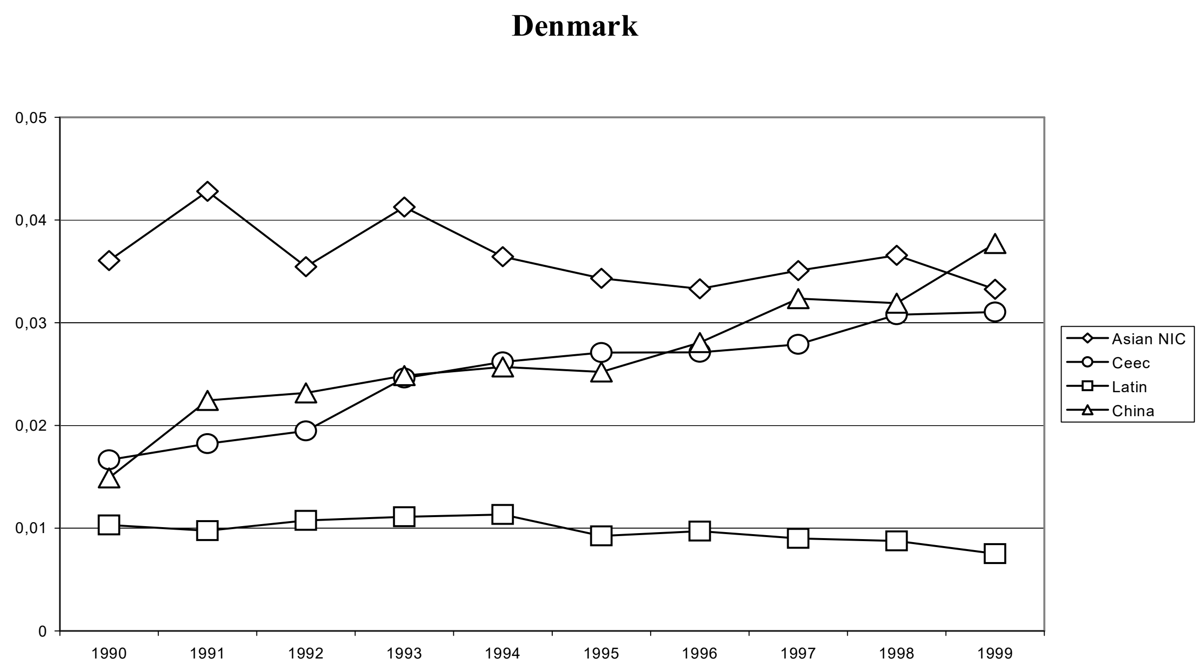
Imports from Central and Eastern European countries increased mainly in those EU countries that are most nearby, i.e. Germany and Italy, but remained quite modest in most other countries.

[4] The ITCS trade statistics of the OECD in general do not include goods in transit or goods that are temporarily admitted or withdrawn in a country (except for goods for inward or outward processing). Import values are expressed in thousands of US dollars and relate to imports c.i.f. (cost, insurance and freight).

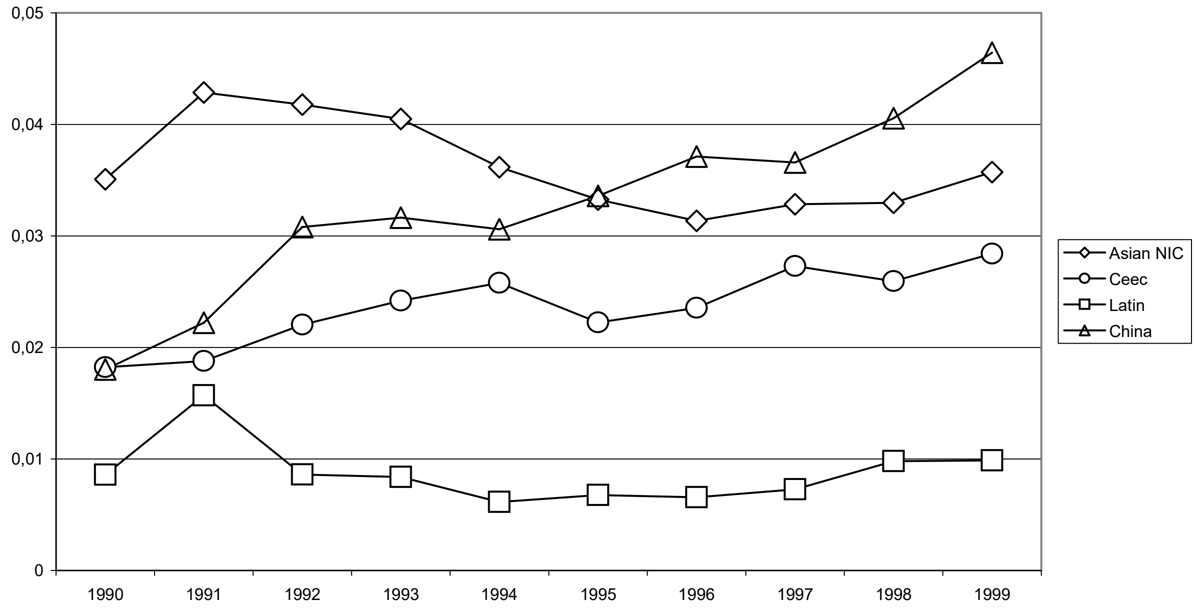
Imports from the Latin-American countries remained at the low initial level throughout the 1990s in all EU countries.

Figure 2.9: Evolution of Import Shares of NIC Groups (1990s)

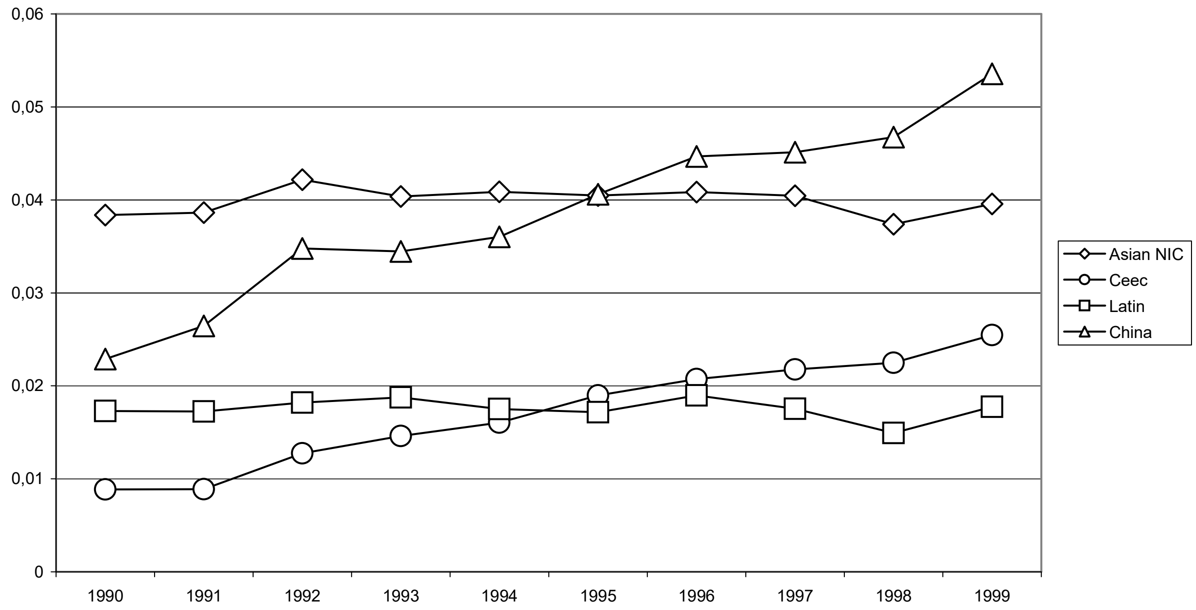




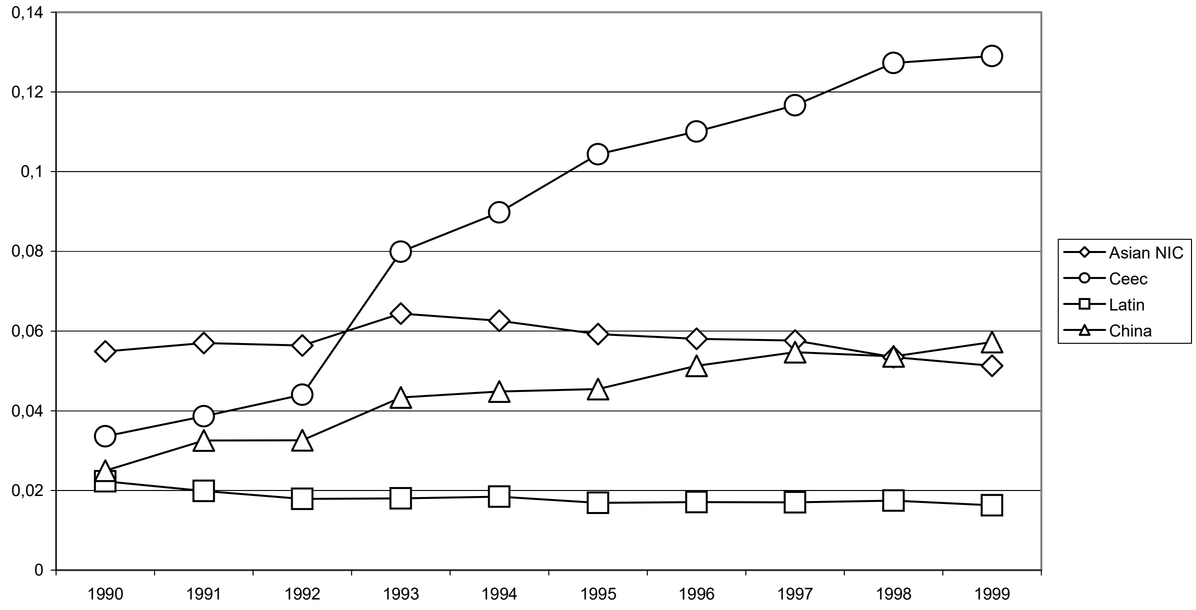
Finland



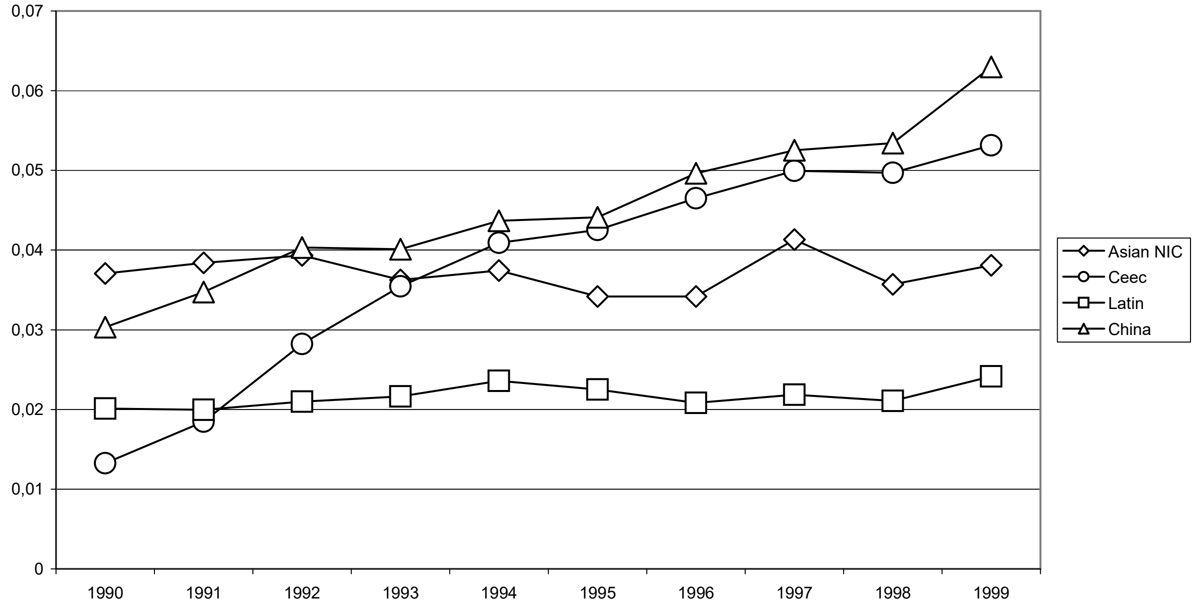
France



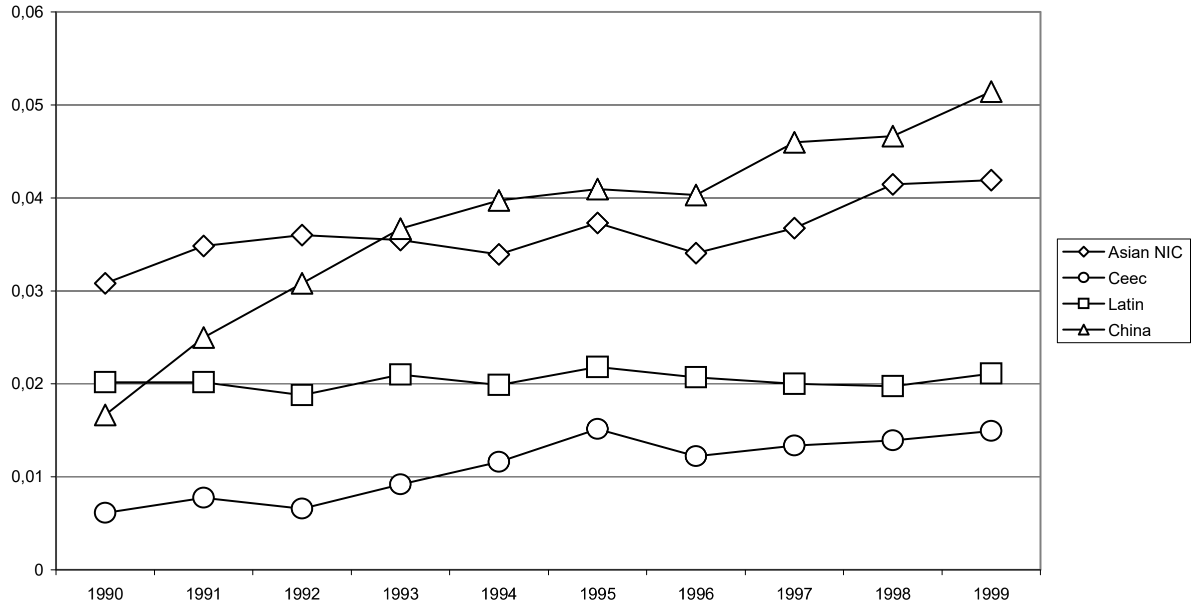
Germany



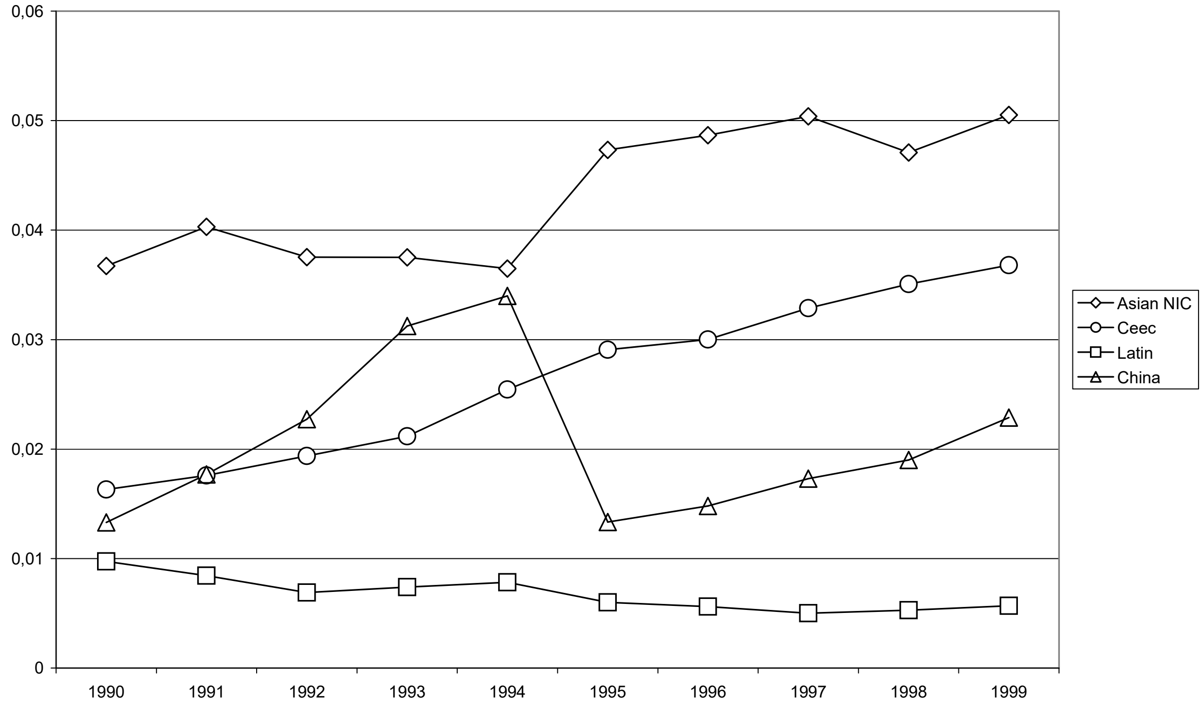
Italy



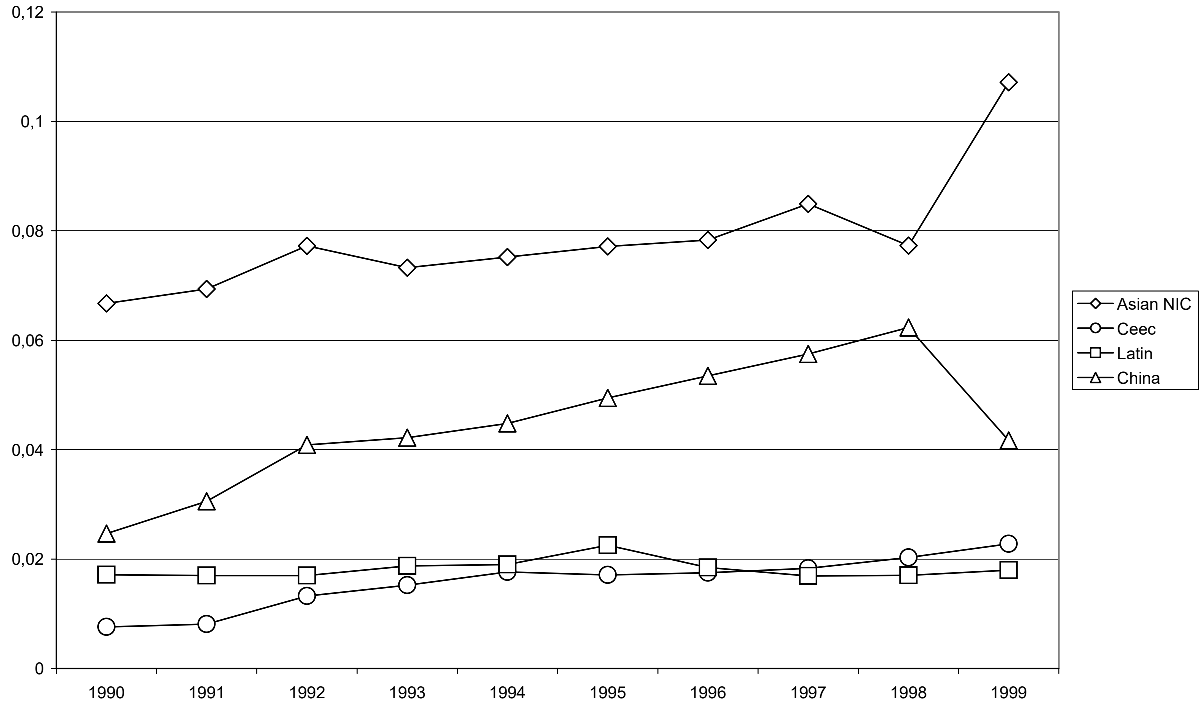
Spain



Sweden



United Kingdom



Source: Own calculations from the OECD International Trade by Commodities Statistics (ITCS).
Asian NIC: Hong Kong, Indonesia, Malaysia, Philippines, South Korea, Singapore and Thailand
CEEC: Czech Republic, Hungary and Poland, **Latin:** Argentina, Brazil, Chile and Mexico.

Imports from China increased dramatically in such a way that the country rushed past the three other NIC groups as main exporter in 2000 in five out of nine EU countries.
By now, China produces a quarter of all TV sets and washing machines in the world and half of the cameras and copy-machines (Forney 2004).

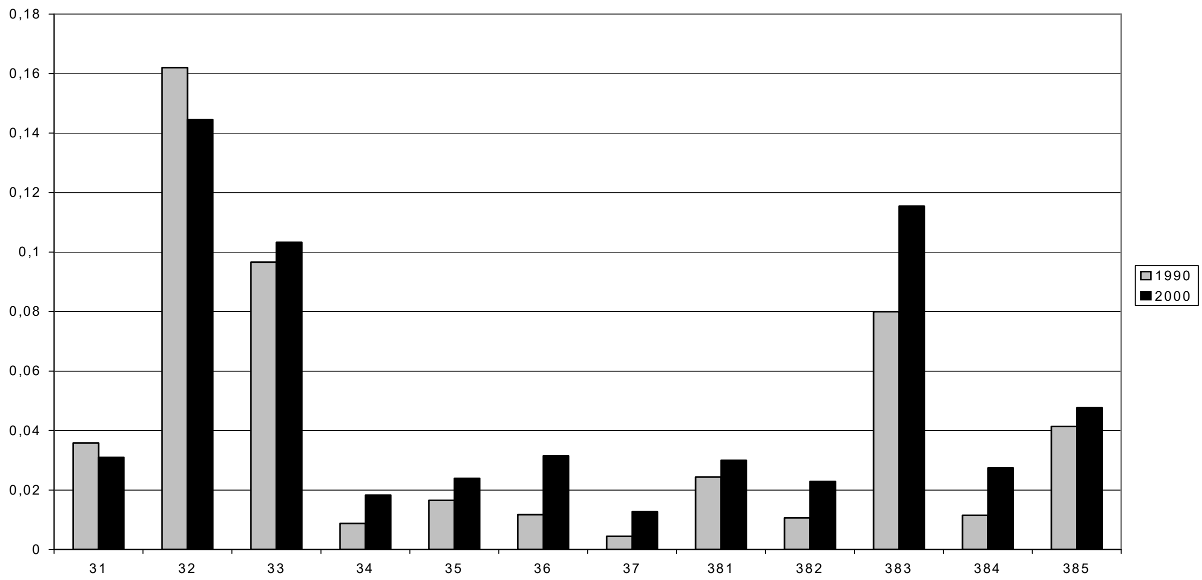
In figure 2.10 the import shares, averaged (not weighted) over the nine EU countries, are given at the two-digit ISIC level (except for ISIC 38 which is broken down at the three-digit level):

- ISIC 31: Food, beverages and tobacco
- ISIC 32: Textiles, footwear and leather
- ISIC 33: Wood, cork and furniture
- ISIC 34: Paper, printing and publishing
- ISIC 35: Chemicals
- ISIC 36: Non-metallic mineral products
- ISIC 37: Basic Metal Industries
- ISIC 381: Fabricated metal products
- ISIC 382: Non-electrical machinery
- ISIC 383: Electrical equipment
- ISIC 384: Transport equipment
- ISIC 385: Precision instruments

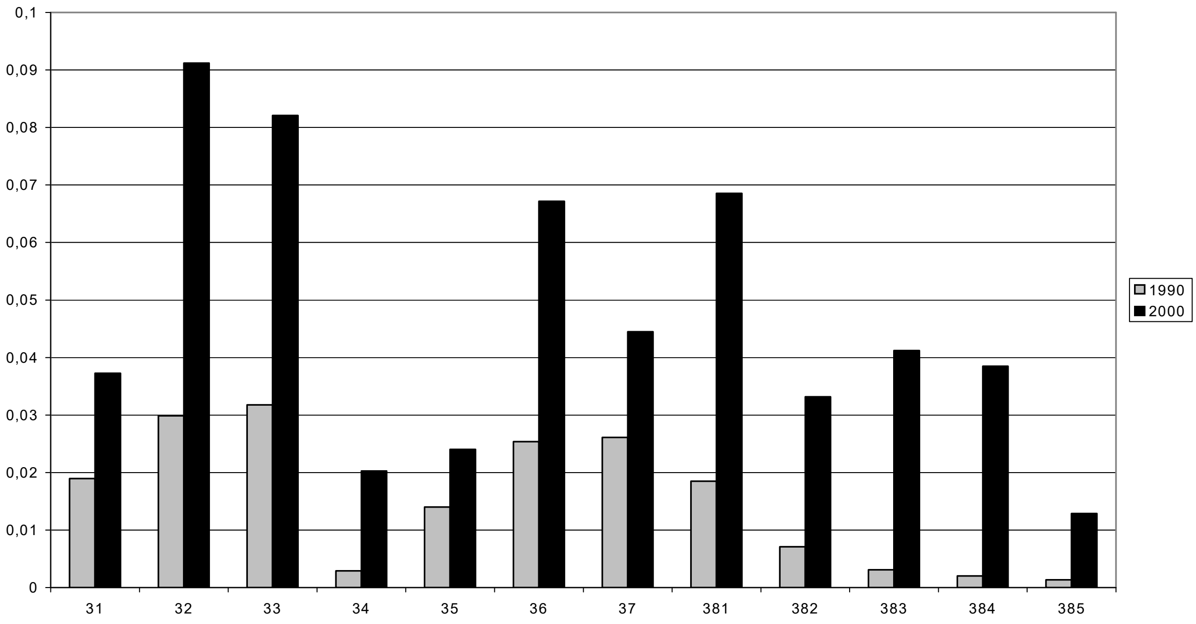
The Asian NIC have high import shares in low-skill intensive industries like *Textiles* (32) and *Wood* (33) but also in the high-skill *Electrical Equipment* (383) sector. The import share of *Textiles* decreased during the 1990s (partially due to fierce competition of China) whereas the import share of *Electrical Equipment* increased. Landesmann, Stehrer and Leitner (2000) found for their group of seven OECD countries that for the Asian Tigers, *Office Machines and Computing* became the top industry in terms of import penetration at the end of the period 1980-1996, whereas *Textiles* dropped from a first place at the beginning to a third place at the end of the period. A substantial part of imports in *Office Machines and Computing* probably reflects the outsourcing of low-skill intensive intermediate inputs by high-wage countries.

Figure 2.10: Evolution of the Average EU Import Shares of NIC Groups in Twelve Manufacturing Industries (1990s)

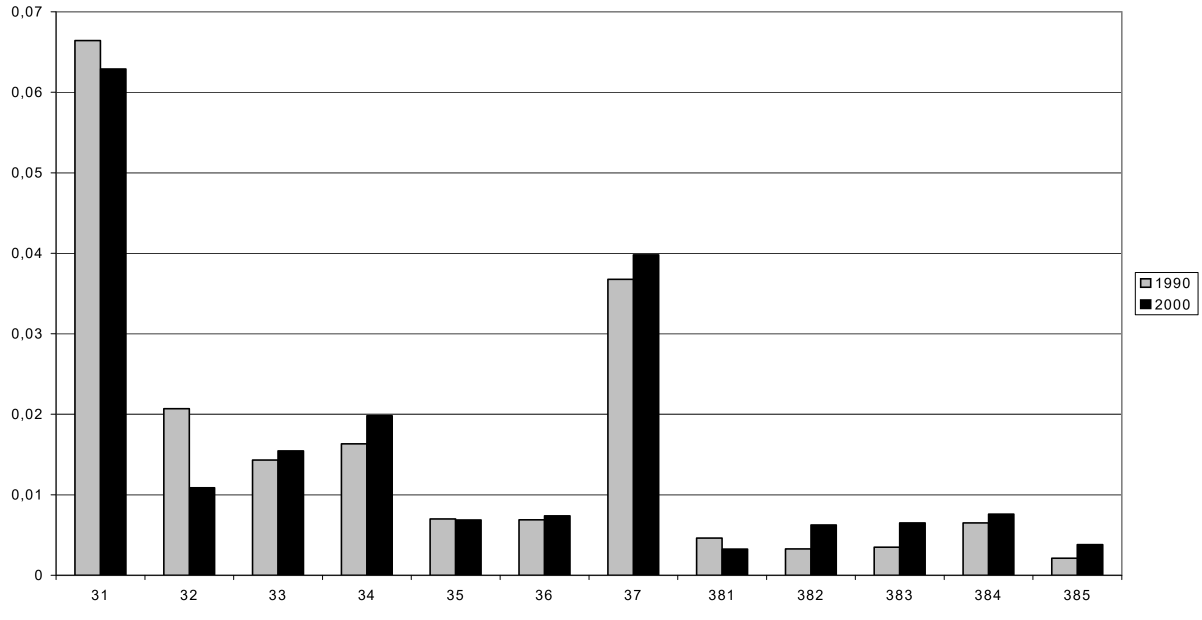
(South-) East Asian NIC



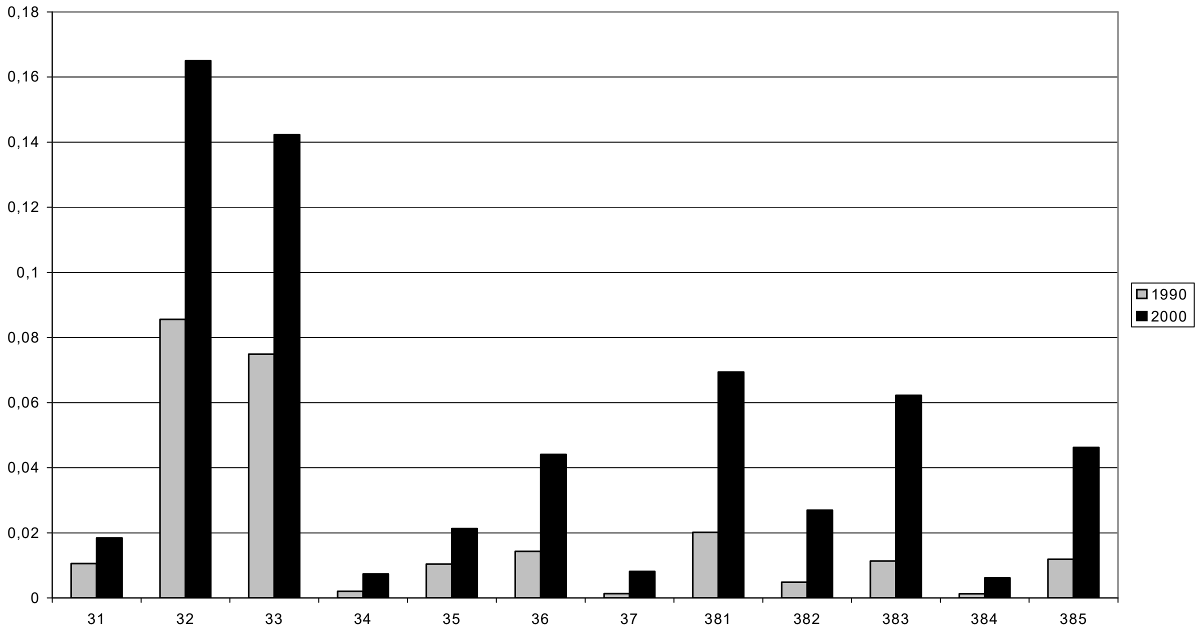
Central and East European NIC



Latin American NIC



China



Source: Own calculations from the OECD International Trade by Commodities Statistics (ITCS).

The Central and Eastern European countries became active exporters to the European Union in the 1990s.
Their main industries are low-skill sectors *Textiles* and *Wood*, medium-low-skill sectors *Non-Metallic Mineral Products* (36), *Basic Metal Industries* (37) and *Fabricated Metal Products* (381) and (medium-) high-skill sectors *Electrical Equipment* and *Transport Equipment* (384).

The Latin American emerging economies have import shares below 2 per cent in all industries except in *Food, Beverages and Tobacco* (31) and *Basic Metal Industries*.

Import shares of China boosted in the 1990s in *Textiles* and *Wood* but also in high-skill industries like *Electrical Equipment* and *Precision Instruments* (385).

The data reveal that import volumes from these countries can hardly be argued to be modest when related to total imports in manufactured goods as e.g. Krugman (1995 a) did with respect to the United States to refute the claim that international trade with emerging economies may have had a substantial impact on wage inequality.
In *textiles* the four NIC groups have a combined import share in the European Union of more than 40 per cent and even in *electrical equipment* the combined import share exceeds 20 per cent[5].
Moreover, Leamer disagreed with Krugman that small import volumes cannot result in a large impact on wages as he stated that in an Heckscher-Ohlin model import prices matter, not import volumes.

Landesmann, Stehrer and Leitner (2002) found that the NIC were not only exporting low-skill goods to the European Union, as would be expected. They considered the share of high-skill white collars workers in total sector employment as a measure of skill intensity and found that the industries with the highest skill intensity experienced high growth of import competition of the NIC, especially from the Southern European countries, the Asian Tigers and the Southern Developing Countries.
Schott (2003) showed that even at a rather detailed aggregation level, product categories tend to be heterogeneous. The importance of some NIC in high-skill sectors could reflect the recent

5 The total share of NIC in *textiles* would be substantially higher if countries like India and Tunesia were also considered.

phenomenon of foreign outsourcing by developed countries of the most labour intensive fragments of production processes towards low-wage countries.

Table 2.4 shows EU average growth of the import shares of the four NIC groups at the sector level and sector skill intensity.
The correlation between skill intensity and share growth is 0.54 (t-value: 2.04) for the Asian NIC, -0.46 (t-value: -1.63) for the Central and Eastern European countries, 0.56 (t-value: 2.11) for the Latin American NIC and -0.30 (t-value: -1.00) for China.

Table 2.4: EU Average Growth of Import Shares of NIC Groups and Skill Intensity at Sector Level (1990-2000)

ISIC	Asian NIC	CEEC	LATIN	China	Skill Intensity
31	-0,5	1,8	-0,4	0,8	0,093
32	-1,7	6,1	-1,0	7,9	0,058
33	0,7	5,0	0,1	6,7	0,084
34	1,0	1,7	0,3	0,5	0,183
35	0,7	1,0	0,0	1,1	0,261
36	2,0	4,2	0,0	3,0	0,104
37	0,8	1,8	0,3	0,7	0,110
381	0,6	5,0	-0,1	4,9	0,132
382	1,2	2,6	0,3	2,2	0,370
383	3,5	3,8	0,3	5,1	0,303
384	1,6	3,6	0,1	0,5	0,261
385	0,6	1,2	0,2	3,4	0,302

Source: Import shares are computed from OECD (2002). Skill intensity (share of white-collar high-skilled workers in total employment) is taken from Landesmann, Stehrer and Leitner (2002). For industries for which skill intensity is given at the three- or four-digit level, an average across sub-sectors is considered.

The correlation between import shares and skill intensity was negative for all NIC groups in 1990 as well as in 2000 but in 2000 the correlation was only significant (at the 5 per cent level) for the Central and East European countries whereas in 1990 it was significant at the 10 per cent level for Latin American NIC and China and at the 5 per cent level for Central and Eastern European countries. The positive correlation between import shares of high-skill OECD countries and skill intensity dropped from 2.51 in the 1990 to 2.01 in 2000.
Whereas the import shares reveal a specialisation of NIC in low-skill sectors, the dynamic pattern supports the finding of Landesmann, Stehrer and Leitner (2002) that a number of NIC started to compete with OECD countries in high-skill sectors in the 1990s. According to Landesmann, Stehrer and Leitner the data for seven OECD countries in the period 1980-1996 clearly show the importance to account for differences between NIC in terms of technological

level and specialisation patterns and to consider non-Heckscher-Ohlin mechanisms to explain the dynamic pattern of North-South trade, e.g. the increasing import penetration of some NIC groups in high-skill intensive sectors.

Apparently, exports of technology-intensive products are growing faster for developing countries than for industrialised countries. In 2000, high-tech exports by developing countries amounted to 450 million dollars, which was more than their exports of primary goods, resource-based goods or low (medium)-tech goods. Though most of these high-tech exports reflect labour-intensive activities like assembling imported components, Singapore, South Korea and Taiwan have moved into complex manufacturing and design, and local content of high-tech manufacturing is growing, e.g. in China (UNCTAD 2002: pp. 145-146).

2.4 Conclusions

The data reported in this chapter suggest the following stylised facts:

- Dramatic increase in the skill premium in the 1980s and a sharp rise in the relative employment of high-skilled workers in the 1970s in the United States.
- Strong increase in overall earnings inequality in the United Kingdom in the 1980s and 1990s and more moderate increase in Italy, the Netherlands and Sweden.
- Stable or even decreasing overall earnings inequality in most other EU countries.
- The relative wages of non-manual workers in manufacturing industries increased in most EU countries in the 1980s and 1990s, most pronounced in the United Kingdom.
- The unemployment rate of people with a low level of education is substantially greater than the unemployment rate of people with a high level of education in most OECD countries. The difference in the unemployment rates further increased in a number of EU countries in the 1990s, especially in Germany and the United Kingdom.
- In the period 1985-1996 the relative employment of non-manual workers in manufacturing industries increased considerably in Germany and moderately in Belgium, Finland, France and Sweden. In other EU countries the relative employment hardly changed or even decreased.
- Import shares from Newly Industrialised Countries have increased in all EU countries. In the 1980s the (South-) East Asian NIC became important importers. In the 1990s the East European countries started to export to EU countries but their performance was

eclipsed by the dramatic rise in imports from China. The NIC increasingly start to export low-skill intensive intermediate inputs in high-skill intensive industries.

The stylised facts for EU countries are more mixed and do not show the clear-cut deterioration of low-skilled workers found in the United States. This should warn against generalizing conclusions for the United States or single EU country studies.
However, overall the facts reveal that either in terms of rising wage inequality or rising unemployment, the labour market position of low-skilled workers also declined in most EU countries

The simultaneity of the deteriorated position of low-skill workers in most industrialised countries and the increased imports from low-skill abundant countries prompted the public prosecutor to round up international trade as a usual suspect for having caused the downslide of low-skilled workers.
Although, apart from the established correlation the prosecutor could rely upon mainstream international trade theories to state his case free trade advocates were soon to take up the defence of international trade by accusing another likely suspect, i.e. skill-biased technological change.
But more on that in the next chapter.

3. What has International Trade got to do with it?

"*Helen: Well! This is the place.*
Jo: And I don't like it.
Helen: When I find somewhere for us to live I have to consider something far more important than your feelings ... the rent. It's all I can afford. [...]

Jo: Tomorrow? What makes you think we're going to live that long? The roof's leaking!
Helen: Is it? No it's not, it's just condensation.
Jo: Was it raining when you took the place?"

- **Shelagh Delaney** *A Taste of Honey*.

As the data in the previous chapter suggest, the relative supply of low-skilled workers decreased in most OECD countries, which all other things equal should have resulted in a fall in the skill premium or relative employment of high-skilled workers. However the stylised facts in the previous chapter also show that the skill premium and/ or unemployment of low-skilled workers actually increased, which is an indication of a structural shift in relative labour demand in favour of high-skilled workers. International trade with low-skill abundant countries and skill-biased technological change (SBTC) have been put forward as the two main potential explanations for such a labour demand shift.
Imports from Newly Industrialised Countries (NIC) became noteworthy in OECD countries at about the same time that the skill premium in the United States and unemployment of low-skilled workers in EU countries started to rise. Although the Stolper-Samuelson theorem provides a theoretical argument for the impact of international trade with low-skill abundant countries on the skill premium many trade economists considered skill-biased technological change as a more important determinant of rising wage inequality.
The Stolper-Samuelson theorem, as one of the four core theorems of the textbook Heckscher-Ohlin model, predicts that if a country that relatively abounds in high-skilled labour opens up to trade with a country that relatively abounds in low-skilled labour, the wages of low-skilled workers will fall in the first and the wages of high-skilled workers will fall in the latter country.

Another core theorem of the Heckscher-Ohlin model, namely the Factor Price Equalization theorem, even takes the point as far as to predict that factor prices will equalize between both countries.
As will be argued in this chapter the Stolper-Samuelson theorem is, in contrast with the Factor Price Equalization theorem, rather robust to relaxing some of the restrictive assumptions of the Heckscher-Ohlin framework and therefore seems a logical starting-point to assess the impact of international trade on income distribution.
The argument of trade economists that skill-biased technological change is an equally valid explanation for a rise in the skill premium in high-skill abundant countries rings true but there are no theoretical reasons to favour one explanation over the other and the assessment of the contribution of both factors is therefore an empirical issue. Any serious empirical assessment should moreover account for the interdependence of international trade and technological change.

The early empirical work did not result in unambiguous conclusions but gradually an academic consensus dawned on the limited role of international trade and the dominant role of SBTC in explaining the deteriorated labour market opportunities of low-skilled workers.
However, more recently some prominent scholars started to question the consensus view by raising some methodological caveats of previous empirical work and by presenting non-Heckscher-Ohlin mechanisms through which international trade may affect the labour market position of low-skilled workers.

The Heckscher-Ohlin assumption that labour markets are perfectly competitive is necessary even for the robust Stolper-Samuelson theorem to hold. Especially for the European Union where labour market institutions like minimum wages, unemployment benefits and collective bargaining are generally perceived to be important this assumption seems somewhat unrealistic. Labour market rigidity is often evoked to explain why in many EU countries wages hardly change but why instead, given the lack of wage flexibility, unemployment increased.
It seems appropriate to acknowledge the importance of labour market institutions in the European Union and to abandon the Heckscher-Ohlin model for some more *European* theoretical models.

Other assumptions like perfect product market competition and no factor (e.g. capital) mobility between countries also fit awkwardly with the world out there and some scholars proposed models that relax these assumptions.
Section 3.1 provides an overview of the main models that have been presented to analyse the impact of international trade on income distribution, which provide the theoretical framework for the empirical work that will be reviewed in section 3.2.

In section 3.1.1, I start with an elaboration of the Heckscher-Ohlin framework and the Stolper-Samuelson theorem as this provides a logical and coherent explanation for the impact of international trade on the rewards of the different production factors.
In the next subsections I discuss some of the more recent non-Heckscher-Ohlin models and mechanisms put forward to explain how international trade could affect wages or employment. These models relax some of the restrictive Heckscher-Ohlin assumptions to account for foreign outsourcing; international capital mobility; imperfect product market competition and labour market institutions that could cause wage rigidity.

In section 3.2, I review the empirical assessment of the impact of international trade with emerging economies on wages and employment in industrialised countries.
The early empirical work focused on some predictions of the Stolper-Samuelson theorem, e.g. that the relative price of low-skill intensive products should have fallen or that skill intensity should have decreased in all industries.
Some of this circumstantial evidence is presented in section 3.2.1.

Decomposition analysis, taken up in section 3.2.2, tested the prediction of the Heckscher-Ohlin model that trade liberalisation results in shifts of employment between rather than within industries. Between-industry employment shifts are ascribed to international trade whereas the within-industry residual is mostly explained by technological factors.

Another strand in the empirical literature are factor content calculations, the results of which are reported in section 3.2.3.
In factor content calculations the impact of international trade is estimated by computing the amount of production factors that are embodied in trade flows and by inferring the number of

jobs lost, or the downward pressure on wages, due to the actual increase in labour supply embodied in net imports.

Following Grossman (1987) some economists have estimated reduced form regressions that consider the impact of international trade on wages and employment, accounting for the labour market interaction between wages and employment.
Some of the results of these reduced form estimations are reported in section 3.2.4.

The mandated wage regression approach, proposed by Leamer (1996 a) and refined by Feenstra and Hanson (1997, 1999) and Haskel and Slaughter (2001), is an instrument to disentangle the impact of international trade from the impact of technological change as well as to estimate the indirect effect of international trade, e.g. trade-induced technological change. Wood (1994) argued that ignoring the latter effect could result in an underestimation of the labour market impact of international trade.
The mandated wage regression procedure and its main results are reviewed in section 3.2.5.

Relaxing the Heckscher-Ohlin assumption of flexible wages the demand for different production factors can be derived from flexible cost functions. Extending these flexible specifications with external determinants that may affect the demand for production factors (e.g. international trade) permits to estimate the elasticity of factor demand with respect to these external variables. The results of estimations within a flexible cost function framework are discussed in section 3.2.6.

In most studies deriving factor demand from flexible cost functions, labour market institutions, though explicitly acknowledged, are not specified. Sticky wages are simply allowed for without considering the specific mechanisms that can explain downward wage rigidity. Collective bargaining is an important characteristic of wage setting in many EU countries. Within a bargaining framework, modelling the bargaining between firms and labour unions, union power can be estimated. If globalisation weakens the bargaining power of unions this will affect wages and employment in unionised sectors.
Section 3.2.7 treats with the results of the relatively rare empirical studies on the impact of international trade on union bargaining power and the inferred impact on wages and employment.

In the final section of the overview of the empirical literature I give an account of the results of some Computable General Equilibrium (CGE) models that allow for a general equilibrium analysis of the interaction between international trade and labour markets, accounting for imperfect product market competition, the role of non-tradables and intermediate goods, international capital mobility and changes in relative factor supply.

In section 3.3, I conclude the first part by arguing, referring to the theoretical and empirical literature, why for the empirical assessment of the impact of trade with the Newly Industrialised Countries on wages and employment in the European Union, some methodologies have been used in part II and why others have not.

3.1 The Theory

In this section I discuss the theoretical models that have been used as a framework for the empirical studies that are reviewed in section 3.2.

I start with the Heckscher-Ohlin (HO) model, as one of its four core theorems, i.e. the Stolper-Samuelson theorem, clearly predicts the impact of trade liberalisation on income distribution. The HO model has been questioned for its lack of empirical relevance and its rather restrictive assumptions though, as discussed in section 3.1.1.4, the Stolper-Samuelson theorem is rather robust to relaxing some of these assumptions. However, the Stolper-Samuelson is not robust to relaxing all the assumptions and some authors considered a number of mechanisms, outside the traditional Heckscher-Ohlin framework, through which international trade may affect wages and employment. These mechanisms are discussed in sections 3.1.2 up to 3.1.6.

3.1.1 Heckscher-Ohlin framework

The Heckscher-Ohlin (HO) model has been the single most popular theoretical framework to elucidate the gains of international trade although many scholars doubt its empirical relevance.

The foundation of the so-called Heckscher-Ohlin model was laid by Heckscher (1919) and Ohlin (1933). Stolper and Samuelson (1941), Samuelson (1948, 1949, 1953), Rybczynski (1955), Jones (1965) and Vanek (1968) made some important contributions to the further elaboration and generalization of the Heckscher-Ohlin model, which is sometimes also referred to as the Heckscher-Ohlin-Samuelson or Heckscher-Ohlin-Vanek model.

The Heckscher-Ohlin framework, and more specific the Stolper-Samuelson theorem, offers a way to predict the impact of international trade on the rewards of different production factors. The Stolper-Samuelson theorem predicts that those factors that a country is relatively well endowed with will benefit from trade liberalisation as they will witness an increase in relative rewards at the expense of the production factors that the country is relatively poorly endowed with. The Stolper-Samuelson theorem therefore provides a logical explanation for the established deteriorated position of low-skilled workers.

3.1.1.1 Two Factors- Two Goods Heckscher-Ohlin Model

The Heckscher-Ohlin model can be schematised in the simplest way with two countries (e.g. OECD and NIC) using two production factors (e.g. high-skilled labour L_{HS} and low-skilled labour L_{LS}) for the production of two goods, with a high-skill intensive good X_{HS} requiring relatively more L_{HS} than a low-skill intensive good X_{LS}. One country (OECD) is assumed to be abundant with high-skilled workers relative to the other country (NIC). Traditionally, the HO model is represented with capital and labour as the two production factors. As the focus in this thesis is on the distinction between low-skilled and high-skilled workers, I will consider the two types of labour in the two factors model. Capital can arguably be considered as a production factor that is immobile between countries whereas this assumption is less exacting for labour. Krugman (1995 b) reasoned that as the share of capital in income hardly changed it is appropriate to focus on low-skilled and high-skilled labour.
Considering just two factors and two goods is convenient for graphical representation and the straightforward derivation of the HO theorems. Later on models with more factors and goods are considered.

There are a number of assumptions underlying the Heckscher-Ohlin model (Francois and Nelson 1998: pp. 1484-1485):

- **Behaviour and institutions:**

  - Rational behaviour by households and firms.
  - Perfect competition.

- **Identical homothetic indifference curves in both countries**
- **Production factors:**

  - Uniform quality.
  - Perfectly mobile between sectors in both countries.
  - Perfectly immobile between both countries.

- **Goods**

- Identical technological opportunities.
- Production functions are linear homogenous (degree one), twice differentiable and strictly concave.

- **Factor intensity**: good X_{LS} is low-skill intensive relative to good X_{HS} for all relevant factor prices (i.e. there is no factor intensity reversal)

- **One country is relatively more endowed with high-skilled labour than the other**

- **International trade is costless**

These assumptions are obviously rather restrictive but allow for a general equilibrium and the derivation of the "core propositions" of the Heckscher-Ohlin model (Jones and Neary 1984: p. 15):

- **Heckscher-Ohlin theorem:** a country will tend to export the good that relatively intensively uses the production factor that it is relatively well endowed with.

- **Factor-price equalization theorem:**

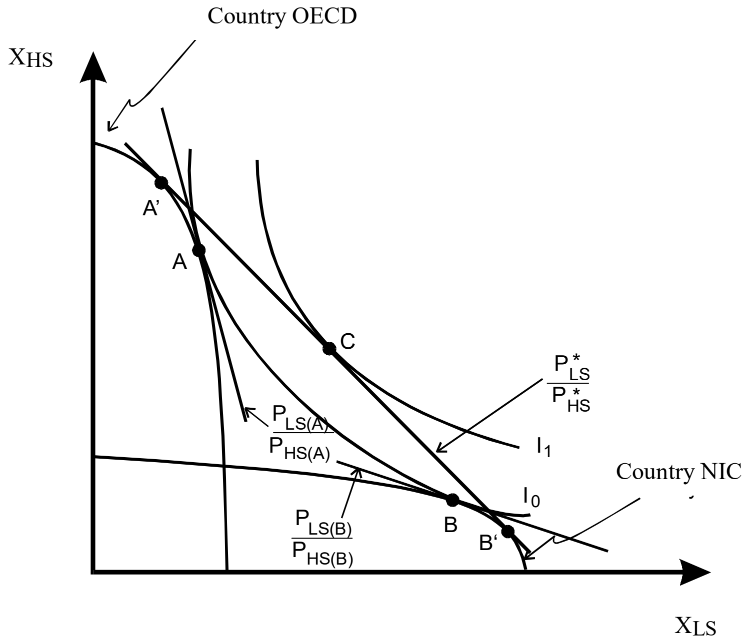
  - global form: international trade will result in equalization of the factor rewards of trade partners.
  - local form: small changes in factor endowment will, at constant goods prices, not affect factor rewards (Leamer and Levinsohn 1995 prefer to call this the Factor Price Insensitivity theorem).

- **Stolper-Samuelson theorem**: an increase in the price of a good will increase (decrease) the reward of the production factor that is relatively intensively (little) used for producing that good.

- **Rybczynski theorem:** An increase in the endowment of a given production factor will, at fixed goods prices, raise (decrease) the production of the good that relatively intensively (little) uses that given production factor.

If country OECD is relatively well endowed with L_{HS} and country NIC with L_{LS}, the opening of the economies to trade will, starting from autarky, result in a shift of production towards X_{HS}, away from production of X_{LS}, in country OECD and an opposite shift in country NIC as shown in figure 3.1.

Figure 3.1: Output and Relative Prices in Country OECD and Country NIC under Autarky and Free Trade



Source: Cuyvers, Dumont and Rayp (2003).

Given the relative abundance with high-skilled workers country OECD can produce relatively much of X_{HS} as reflected by the steep production possibilities curve, whereas the flat possibilities curve of country NIC reflects its comparative advantage in the production of X_{LS}. In autarky, equilibrium is given by the point were one of the consumers indifference curves (i.e. I_0) touches the possibility curves, that is in point A for country OECD and in point B for country NIC.

The line tangent to the possibilities curve and the equilibrium indifference curve is an isovalue line (connecting combinations of both goods that provide the same value), the slope of which reflects the relative price of X_{LS} and given the assumption of perfect competition also reflects

the relative wages of low-skilled workers. In autarky the relative wages of low-skilled workers are higher in country OECD than in country NIC.
If both countries would remove trade barriers, the relative price of X_{LS} will change and determine the terms of trade.

The terms of trade are given as: $Px_{LS\,(NIC)} / Px_{HS\,(NIC)} < P^*x_{LS} / P^*x_{HS} < Px_{LS\,(OECD)} / Px_{HS\,(OECD)}$

Where P^*x_{LS} / P^*x_{HS} is the relative world market price of the low-skill intensive good.
So trade liberalisation results in a drop (rise) in the relative price of the low-skill intensive good in country OECD (NIC). As a result production of X_{LS} falls from A to A' in country OECD but rises from B to B' in country NIC.

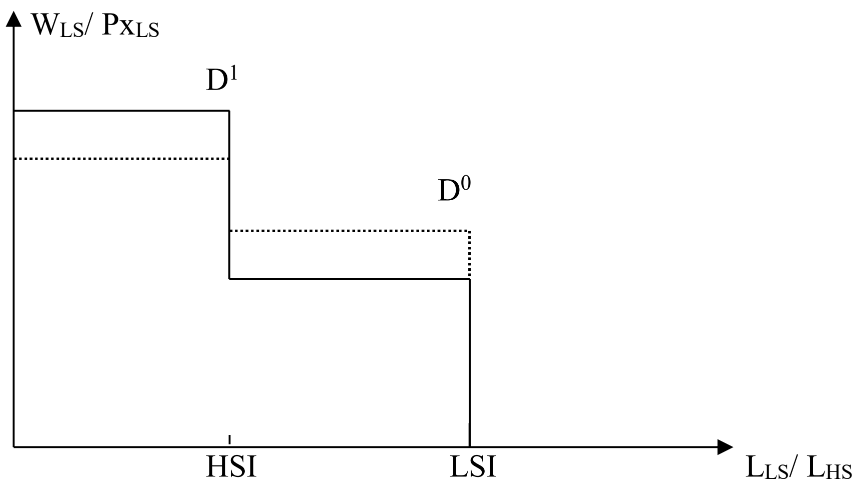
Country OECD now actually produces more of X_{HS} than needed for domestic consumption. It will export the surplus in exchange for the surplus of X_{LS} produced by country NIC.
Before considering the impact of trade liberalisation on income distribution it should be pointed out that figure 3.1 clearly shows the net gains from trade for both countries.
Under free trade both country OECD and country NIC can reach consumption point C, which satisfies I_1, i.e. an indifference level that cannot be obtained under autarky as it exceeds the domestic production possibilities of both countries.

The impact of a decrease in Px_{LS} on the relative demand for low-skilled workers is depicted in figure 3.2. W_{LS}/ Px_{LS} denotes the wage of low-skilled workers relative to the price of the low-skill intensive good and HSI and LSI the relative intensity of low-skilled labour in the production of respectively good X_{HS} and good X_{LS}.

D^0 (dotted line) is the initial relative demand for low-skilled workers and D^1 (full line) the relative labour demand after Px_{LS} decreased (e.g. due to lower import tariffs).
The horizontal part of D^0 and D^1 between HSI and LSI reflects the 'Rybczynski theorem' (or Factor Price Insensitivity theorem), i.e. an increase in the relative supply of low-skilled workers will, given constant goods prices, change the output mix without affecting factor rewards.

A decrease in the price of good X_{LS} will lower real wages of low-skilled workers, reflected in the downward shift of relative demand between HSI and LSI[6].
However, the lower Px_{LS} also implies that the wages of low-skilled labour relative to the price of X_{LS} increases.
Both the wages of low-skilled and high-skilled workers would increase if Px_{LS} decreases for relative labour supply below HSI, in which case the considered country would be fully specialized in producing the high-skill intensive good X_{HS}. If factor endowment between both countries differs to the extent that both would fully specialize, international trade actually benefits all production factors in all countries and there would be no losers.
Leamer (1996 a) suggested that this might be the case for trade between the United States and some Asian NIC. Countries that are abundant in capital and high-skilled labour can focus on higher quality goods. Cheaper imports of non-competing goods from low-skill abundant countries will only raise real wages of both high-skilled and low-skilled workers. This is the 'lifting all boats' argument, i.e. trade with NIC does not necessarily have to affect the position of low-skilled workers in high-skill abundant countries (Leamer 1996 a: p. 10).

Figure 3.2: Relative Demand for Low-Skilled Labour: Impact of a Decrease in the Relative Price of the Low-Skill Intensive Good



Source: Adapted from Leamer (1996 a).

Stolper and Samuelson (1941) have shown that the changes in product prices have a magnified effect on (real) factor rewards (i.e the magnification effect coined by Jones 1965). The Stolper-

6 This is also reflected in figure 3.1 in the decreased slope of the line tangent to the indifference curve in C and to the production possibilities curve of country OECD in point A.

Samuelson theorem clearly states that when both countries have a common cone of diversification (see next paragraph) not all production factors benefit from trade liberalisation. The Stolper-Samuelson theorem can formally be derived from the fact that changes in goods prices should be a weighted average of changes in the prices of production factors (Jones and Neary 1984: pp. 16-17):

$$d\, Px_{LS} / Px_{LS} = \theta_{LS,\, x_{LS}}\, dw_{LS}/w_{LS} + \theta_{HS,\, x_{LS}}\, dw_{HS}/w_{HS} \tag{3.1}$$

$$d\, Px_{HS} / Px_{HS} = \theta_{LS,\, x_{HS}}\, dw_{LS}/w_{LS} + \theta_{HS,\, x_{HS}} dw_{HS}/w_{HS} \tag{3.2}$$

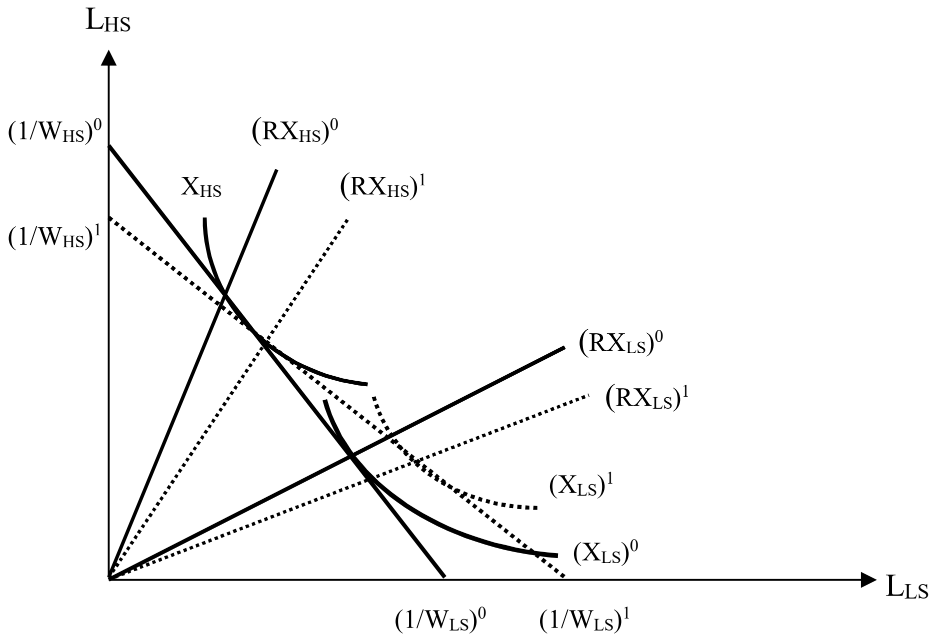
$\theta_{F,\, G}$ denotes the cost share of production factor *F* in the production of good *G*.

If the price of the low-skill intensive good X_{LS} decreases ($d\, Px_{LS} / Px_{LS} < 0$) the system of the two equations (given both goods are produced domestically) implies that the wages of low-skilled workers will decrease ($dw_{LS}/w_{LS} < 0$). Moreover, as the price changes are weighted averages of the wages w_{LS} will fall more substantially than Px_{LS}, i.e. the magnification effect. The Stolper-Samuelson theorem can be depicted in a Lerner-Pearce diagram, as in figure 3.3, which shows the unit isovalue curves of high-skill intensive good X_{HS} and low-skill intensive good X_{LS}. Unit isovalue curves connect the amounts of L_{LS} and L_{HS} that can be combined to produce one unit value of output and are thus respectively given by $1/ Px_{LS}$ for good X_{LS} and $1/ Px_{HS}$ for good X_{HS}. RX_{HS} and RX_{LS} are the rays of factor intensity of the respective goods. The region between these two factor intensity lines is often referred to as the cone of diversification. As long as the relative factor endowment point of a country lies in this cone, both products can be produced with full employment of all production factors. As long as the endowment point does not fall outside the cone, a shift in relative factor endowment will induce a shift in the product mix without affecting the relative factor rewards, as argued in the Rybczynski theorem.

Given the assumption that production factors are mobile between the two sectors, the chosen unit value combinations for both sectors should be tangent to the negatively sloped line of the relative factor rewards. X_{HS} and $(X_{LS})^0$ show an initial equilibrium at factor rewards given by the full negatively sloped line [$(1/W_{HS})^0$ and $(1/W_{LS})^0$].

If the price of the low-skill intensive good decreases, its unit value isoquant ($1/ Px_{LS}$) will shift outwards as it will require more input factors to produce a unit value of X_{LS}. For X_{HS} and $(X_{LS})^1$ to be equilibrium combinations the factor rewards line should be tangent.

Figure 3.3: Lerner-Pearce Diagram of the Stolper-Samuelson Theorem



Source: Adapted from Deardorff (1994 b).

The counter-clockwise turn implies that wages of low-skilled workers will fall and wages of high-skilled workers will increase. The Lerner-Pearce diagram also clearly shows another result of the price decrease of good X_{LS}, namely that both sectors will use relatively more low-skilled workers than initially. The latter conclusion has been brought forward by Lawrence and Slaughter (1993) to refute a Stolper-Samuelson explanation of increased wage inequality in the United States, as in most industries the ratio of high-skilled workers to low-skilled workers actually increased. Cline (1997) showed that by considering shifts in the relative supply of high-skilled workers the fact that production did not become more low-skill intensive does not imply that there may not have been Stolper-Samuelson effects (see also the foreign outsourcing model by Feenstra and Hanson (1996) in section 3.1.3 in which it is shown that skill intensity can actually increase in all countries due to international trade).

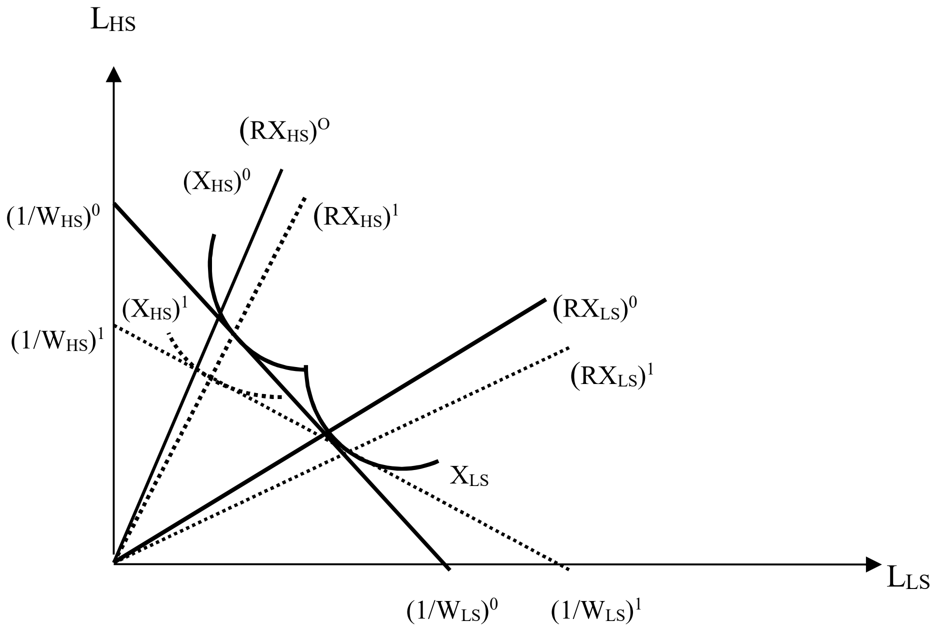
Mussa (1979) showed how the Stolper-Samuelson theorem can be represented (geometrically) in terms of the dual of a production function, i.e. a cost function. A fall in the price of the low-skill intensive good implies a fall in the wages of low-skilled workers to ensure the general equilibrium zero profits condition (assumption of perfect competition).

3.1.1.2 Skill-Biased Technological Change (SBTC)

Within the Heckscher-Ohlin framework as presented in the previous sections it can be shown that technological change may have the same impact on factor rewards as a reduction in international trade barriers.

If, for example, technological progress occurs in the production of X_{HS} (i.e. technological change is sector-biased) a unit value can at given product prices be produced more efficiently using less L_{LS} and L_{HS}. The unit value curve of X_{HS} will shift towards the origin. In figure 3.4 the unit value curve shifts alongside the initial ray of factor intensity $(RX_{HS})^0$, which reflects Hicks-neutral technological progress (i.e. no factor bias). If technological progress is biased in favour of sector X_{HS} the outcome is similar to a price decrease in Px_{LS}.

Figure 3.4: Lerner-Pearce Diagram of Technological Change in the High-Skill Intensive Industry



Source: Adapted from Krugman (1995 a).

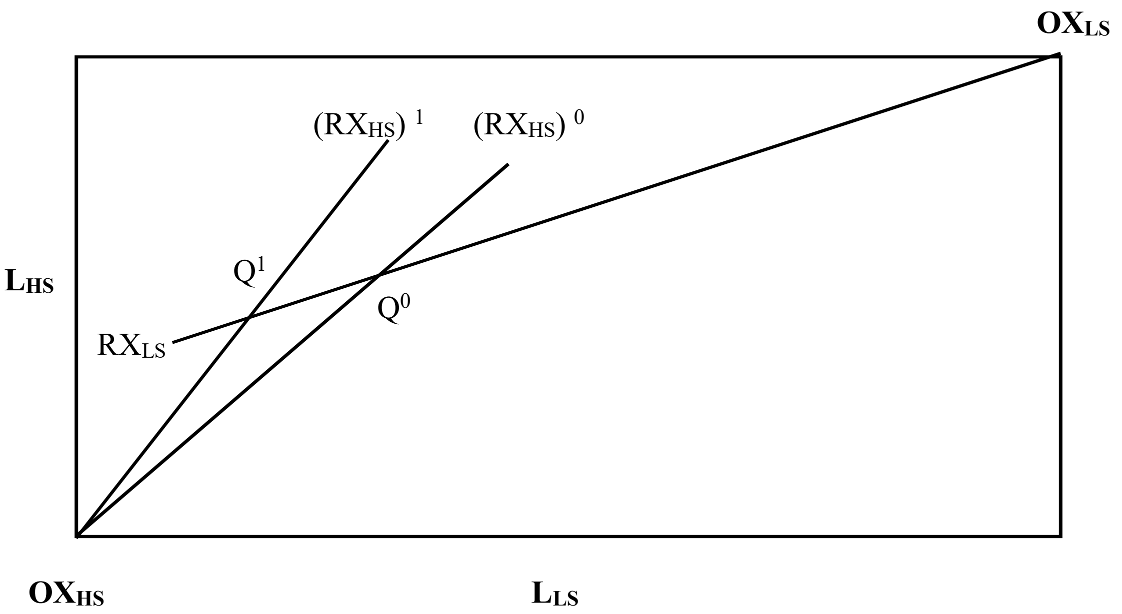
The relative wages of low-skilled workers will fall and production of X_{HS} will use low-skilled labour more intensively. If technological progress would occur in the production of X_{LS} the

relative wage of low-skilled workers would rise. As argued by Leamer (1996 a) the **factor bias** of technological change does not seem to matter, the **sector bias** does.
However, Krugman (1995 a) objected that this assertion depends on the assumption that goods prices are given and technological progress is local. This would be the case if the considered country is too small to affect world prices and if there are no international technology spillovers. Krugman considered both assumptions as unrealistic, especially when considering the United States and the European Union.

If utility is assumed to be Cobb-Douglas with a constant share α spent on good X_{HS} and factor intensity is fixed in both sectors the allocation of production factors can be represented in an Edgeworth box without referring to goods prices or factor rewards as shown in figure 4.5.

Initially Q^0 is the point denoting how much of L_{LS} and L_{HS} is allocated to the production of respectively X_{HS} (from the origin OX_{HS}), respectively X_{LS} (from the origin OX_{LS}).

Figure 3.5: Allocation of Low-Skilled and High-Skilled Labour and the Factor Bias of Technological Change



Source: Adapted from Krugman (1995 a).

As α is the share of total income spent on X_{HS} we have (Krugman 1995 a: p. 15):

$$(w_{HS}/w_{LS}).L_{HS,\,x_{HS}} + L_{LS,\,x_{HS}} = \alpha\, [(w_{HS}/w_{LS}).L_{HS} + L_{LS}] \quad (3.3)$$

and

$$w_{HS}/w_{LS} = (\alpha\, L_{LS} - L_{LS,\,x_{HS}})/(L_{HS,\,x_{HS}} - \alpha\, L_{HS}) \quad (3.4)$$

with $L_{HS,\,x_{HS}}$ ($L_{LS,\,x_{HS}}$) the amount of total high-skilled labour L_{HS} (low-skilled labour L_{LS}) allocated to the production of X_{HS}.

If Hicks-neutral technological progress occurs in the production of X_{HS} (**sector bias**), given constant factor intensity, it follows from (3.4) that the relative wage of high-skilled workers will not change. If however, technological progress in the skill-intensive industry favours high-skilled workers (**factor bias**) and factor intensity increases from $(RX_{HS})^0$ to $(RX_{HS})^1$ allocation shifts from Q^0 to Q^1. As both $L_{LS,\,x_{HS}}$ and $L_{HS,\,x_{HS}}$ are lower at this point it follows from (3.4) that the relative wage of high-skilled workers will rise. Skill-biased technological change in either sector will increase the skill premium. Krugman went on to show that this result did not depend on the assumption of fixed factor intensity. Relaxing the Cobb-Douglas assumption that elasticity of substitution equals one, technological progress in the skill-intensive industry will increase the skill premium. However, if elasticity of substitution is lower than one, the skill premium will decrease.

Krugman concluded that when countries are too large to simply be considered as price-takers or technological spillovers are international, the **factor bias** of technological progress clearly matters for factor rewards whereas the impact of the **sector bias** is ambiguous.

Haskel and Slaughter (2002) argued that Krugman's claim that when product prices are endogenized skill-biased technological change will increase the skill premium irrespective of the sector bias in technological change, does not necessary hold under different assumptions about technology and demand, as shown by Davis (1998 a); Haskel and Slaughter (1998) and Xu (1998) and that in many cases it is the **sector bias** of technological change and not the **factor bias** that matters for the factor rewards.

Moutos (2000) proposed a two-sector model with one sector producing a homogenous good and the other sector a good that can be offered by firms at different quality levels. Low-skilled and high-skilled labour were considered as the two production factors. Higher quality goods require more high-skilled labour than lower quality varieties. Moutos showed that technological change that is uniform across the two sectors as well as Hicks-neutral, i.e. technological change without a sector or a factor bias could raise the skill premium. The main mechanism to explain this finding is the increase in productivity which will raise real income, generating a higher demand for the higher quality varieties and as a result a higher demand for high-skilled workers. If wages are sticky, preventing the skill premium to increase, even skill-neutral technological change may raise the unemployment of low-skilled workers, which Moutos figured could explain the high unemployment rates in the European Union.

In much of the early empirical work, international trade and technological change were apparently considered as mutually exclusive explanations. However, as argued by Wood (1994) international trade may induce technological change. A comprehensive assessment of the impact of international trade should therefore account for this indirect effect.

Acemoglu (1999) presented a theoretical model in which trade induces skill-biased technological change both in skill-abundant and skill-scarce countries, raising wage inequality without necessarily affecting relative product prices. This seems to provide a theoretical underpinning of Wood's argument and fits well with most stylised facts.

Dinopoulos and Segerstrom (1999) showed, in a North-North Trade model with endogenous skill acquisition, how trade liberalisation could result in skill-biased R&D activities that will increase skill intensity in all industries and thereby reduce the relative wages of low-skilled workers.

Chusseau (2002) presented an endogenous growth model in which the impact of North-South trade on R&D activities and technological change in the IT sector is considered, assuming capital-skill complementarity and substitution between capital and low-skilled labour.

In line with other endogenous growth models the impact of international trade is ambiguous. If labour markets are perfectly competitive trade liberalisation with respect to the South will actually slow down R&D activities and productivity, compared to the autarky situation, whereas if minimum wages are imposed North-South trade will increase R&D activities and raise productivity in the North.

Ethier (2002) considered a model in which capital and high-skilled labour are assumed to be complements and low-skilled labour and outsourced activities substitutes. Assuming that

capital utilization is a choice variable allows for endogeneity of skill-biased technological change.
Thoenig and Verdier (2003) presented a dynamic model in which firms can endogenously determine the bias of technological change. If increased openness results in knowledge leakages and spillovers that may strengthen the position of competitors, firms will try to increase the share of tacit knowledge embedded in their production technology to reduce the threat of imitation and technological leapfrogging. The shift towards a higher tacit share is likely to require a larger share of high-skilled workers. As a result, this defensive technological change will be skill-biased and in the model increases wage inequality in both countries considered (Thoenig and Verdier 2003: p. 709).

Another potential link between trade and technology are international technology spillovers.
Grossman and Helpman (1991) considered international trade as an important spillover mechanism. In their endogenous growth model the impact of technology and trade policies will depend upon whether knowledge spillovers are local or global in scope.
Coe and Helpman (1995) and Lichtenberg and Van Pottelsberghe de la Potterie (1996) found evidence of substantial trade-related international R&D spillovers between OECD countries and Coe, Helpman and Hoffmaister (1995) found evidence of substantial trade-related R&D spillovers from industrialised countries to developing countries.

International trade and skill-biased technological change are the two main explanations brought forward to explain the weakened labour market position of low-skilled workers in most industrialised countries. There are no theoretical reasons to favour one over the other so assessing the impact of both explanations is an empirical issue. However, a sound empirical assessment should account for the interdependence between international trade and technological change.

3.1.1.3 M factors- N goods Heckscher-Ohlin model

In the Heckscher-Ohlin model with two production factors and two goods the impact of trade liberalisation on the rewards of the respective production factors is rather straightforwardly framed in the Stolper-Samuelson theorem. If a high-skill abundant country opens up to trade with a low-skill abundant country and factor endowments in both countries are not such that countries fully specialize the wages of low-skilled (high-skilled) workers will fall in the high-skill (low-skill) abundant country. However, in a model with *M* production factors and *N* goods the 'core propositions' are more complicated and less general.

Without any restrictions on the number of production factors and the number of produced goods, Ethier (1984) considered an initial product prices vector p^0 and an ultimate product prices vector p^1, as well as an initial factor rewards vector w^0 and an ultimate factor rewards vector w^1. Given the relationship between product prices and factor rewards $p = w\,A(w)$ with A(w) being the matrix of least-cost factor cost shares it can be shown that:

$$(w^1 - w^0)\,A(w)\,(p^1 - p^0) > 0 \qquad (3.5)$$

The positive correlation between $(w^1 - w^0)\,A(w)$ and $(p^1 - p^0)$ implies that (Ethier 1984: p. 164): "*there is a tendency for changes in relative commodity prices to be accompanied by increases in the rewards of factors employed most intensively by those goods whose prices have relatively risen the most and employed least intensively by those goods whose relative prices have fallen the most*."

In an M x N model the increase in the price of the n-th good will not exceed the proportional increase in the cost:

$$dp_n/p_n = \theta_{1,n}\,dw_1/w_1 + \theta_{2,n}\,dw_2/w_2 + \ldots + \theta_{m,n}\,dw_m/w_m \qquad (3.6)$$

As factor shares ($\theta_{i,n}$ is the share of factor *i* in the cost of producing good *n*) are positive and sum to unity there will be at least one factor for which the rewards will increase more or as much as the price of the *n*-th good.

If we assume this to apply to the m-th production factor and consider the *k*-th good for which the price did not change:

$$0 = dp_k/p_k = \theta_{1,k}\, dw_1/w_1 + \theta_{2,k}\, dw_2/w_2 + ... + \theta_{m,k}\, dw_m/w_m \qquad (3.7)$$

Given that all factor shares are positive and $dw_m/w_m > 0$ this implies that there should be at least one production factor for which the factor reward decreased.
This leads to the *correlation version* of the Stolper-Samuelson theorem defined for M production factors and N goods (Ethier 1984: pp. 165-166):

"*A rise in any single commodity price will cause the reward of* ***some*** *factor to rise in terms of all other goods and to fall in terms of none, and it will cause the reward of* ***some*** *other factor to fall in terms of all goods- provided that the good is initially produced and that every factor which it employs is subsequently also employed elsewhere in the economy*."

3.1.1.4 How Robust is the Stolper-Samuelson Theorem?

The Heckscher-Ohlin model requires a number of strong assumptions. As argued by Jones and Scheinkman (1977) the Factor Price Equalization theorem and to a lesser extent the Heckscher-Ohlin theorem are very sensitive to the HO assumptions, especially with respect to identical technology between countries: ”*If two countries have dissimilar technologies, any basis for an exact equivalence in factor-pricing structure (in the absence of international factor mobility) quite obviously disappears. In similar though less exact fashion, any strong difference in the quality of technologies between countries could outweigh factor endowment differences and upset the Heckscher-Ohlin theorem*.” (Jones and Scheinkman 1977: p. 911).
As shown in the previous section, even under the strong HO assumptions, the theorems derived within a 2 x 2 model need to be relaxed for models that allow for more than two production factors and more than two goods. However relaxing a number of the HO assumptions does not, in contrast with the Factor Price Equalization theorem and the Heckscher-Ohlin theorem, seem to matter too much for the Stolper-Samuelson theorem and the Rybczynski theorem.

The assumption of the HO model that technologies do not differ between countries is often seen as too restrictive and led some scholars to opt for more Ricardian models. Krugman and

Obstfeld (2003), given the perceived lack of empirical support for the HO model, favour a Ricardian explanation of trade with its focus on technological differences and see a more limited role for the Heckscher-Ohlin model in assessing the effects of international trade on income distribution, for which the Ricardian theory is less adequate.
Jones (2000) stated that the Stolper-Samuelson nor the Rybczynski theorem actually require the assumption that technologies are the same between countries but only implies some properties of the inverse technology matrix (reflecting the requirement of input factors per unit output): "*Even though sufficient conditions can thus be stated to prove strong or weak forms of the Stolper-Samuelson theorem (and, by reciprocity, the Rybczynski theorem) in the higher n x n case, the severity of these conditions might suggest that these propositions are best reserved for smaller-dimensional models. This would, in my view, represent a mistake because the essence of the Stolper-Samuelson theorem is that **any** factor of production can have its **real** return enhanced by the indirect means of altering some commodity prices (it may take more than one). All it takes to prove this is that there is no joint production (or not too much) and that there are at least as many commodities as factors of production*." (Jones 2000: p. 26)
Allowing for imperfect competition in the goods markets does not need to be dramatic either for the factor intensity theory, as assuming goods are differentiated by quality and thus can be produced by technologies with different intensities, as in Falvey and Kierzkowski (1987), trade patterns can still be linked to factor endowment.

Hakura (1999) proposed a modified Heckscher-Ohlin model that allows for technological differences between countries and shows that using direct and domestically produced indirect input requirements provides more accurate measures of the production factors that are embodied in international trade in final goods.
Trefler and Zhu (2000) also argued that a modified Heckscher-Ohlin model, despite some significant problems, is useful to think about international differences in technology, as well as to assess the impact of international trade on factor prices, product prices, the composition of output and induced technological change.

Thompson (2002) relaxed some of the conditions with respect to production technology, perfect competition and full employment and concluded that the Stolper-Samuelson link between product prices and factor rewards is rather robust.

Abrego and Edwards (2002) claimed that relaxing the assumptions of the HO model with respect to homogeneity of goods, perfect labour markets and factor immobility, though substantially decreasing the impact generally does not affect the direction of Stolper-Samuelson effects. They however subjoined that when allowing for differentiated goods and complementarity between imports and domestic low-skill intensive goods, even the direction may change and that in a multi-goods model the linkage between trade with developing countries and wages in advanced countries is more indirect and tenuous.

Bowen, Leamer and Sveikauskas (1987) and Harrigan (1997) found indications of persistent technological differences between countries.

Schott (2003) however raised the possibility that the reported findings of cross-country differences in production technologies could be a statistical artefact of within-industry product heterogeneity. The three-digit level *electrical machinery* industry, for example, includes low-end portable radios as well as high-end communications satellites. Reported cross-country differences in technology but also conclusions with respect to the home bias in international trade and non-homotheticity of preferences could therefore be due to unobserved differences in the intra-industry product mix (i.e. different country specialisation).

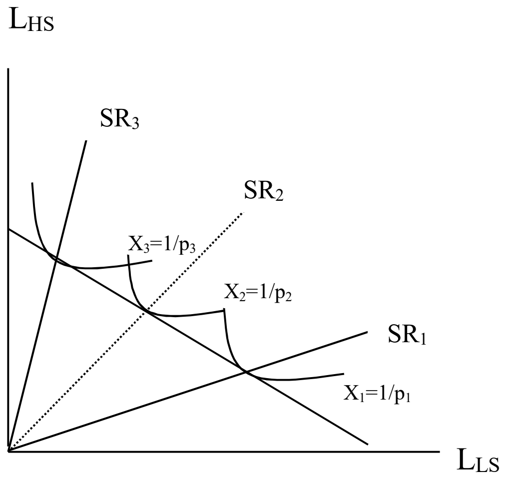
As mentioned before, Jones (2000) argued that the Stolper-Samuelson theorem neither the Rybczynski theorem actually requires the assumption that technologies are the same across countries.

The existence of a single cone of diversification is important for the Stolper-Samuelson theorem to hold in its strict form. If factor endowment between countries is too divergent, i.e. if the endowment point of one of the countries considered falls outside the cone of diversification, formed by the factor intensity lines RX_{LS} and RX_{HS} (see figure 3.3), that country cannot produce both goods and ensure full employment of all production factors. Both countries may specialize in the production of a single good. If this would be the case, trade liberalisation would, as argued by e.g. Bhagwati and Deheija (1994) and Leamer (1996 a) cause a tide that lifts all boats as there would be no competing goods and a decrease in the price of imported goods would unambiguously increase the real rewards of all production factors.

Deardorff (2002) showed that if there are more goods than production factors two kinds of free trade equilibrium could arise.

Considering three goods and two production factors, equilibrium with a single cone of diversification is possible, as shown in figure 3.6[7].

Figure 3.6: Single Cone Free Trade Equilibrium with Three Goods and Two Factors



Source: Adapted from Deardorff (2002).

The skill intensity (price) of the three goods is respectively SR_1 (p_1), SR_2 (p_2) and SR_3 (p_3). The isocost line, determined by the relative wage of low-skilled workers, is tangent to the three unit value isoquants. If the endowment point of a country falls within the cone formed by SR_1 and SR_3 production with full employment of all factors is possible. A country can diversify production within the single cone.

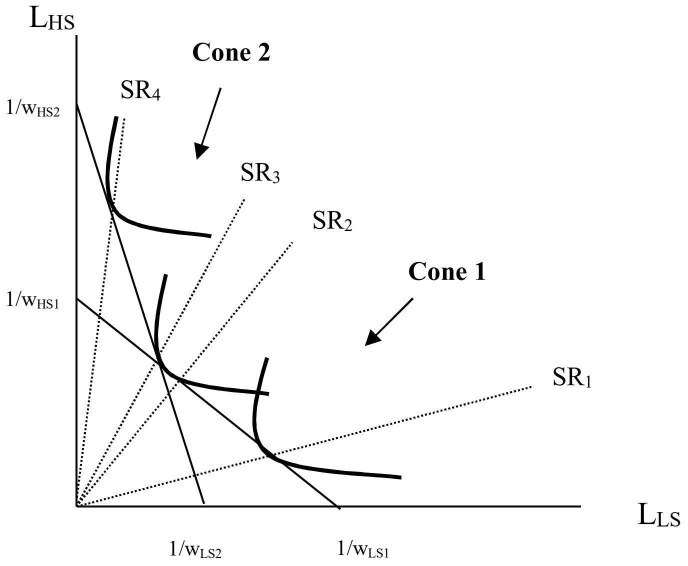
However, the output of the three goods is not fully determined by prices and factor endowment as a country will be indifferent between only producing good 1 and 3 and producing all three goods.

Output will be determined by world demand (Deardorff 2002: p. 3).

The single cone equilibrium is only possible if world market prices are such that the isocost line is tangent to all unit value isoquants. Although market forces may ensure this to happen it cannot be guaranteed. An alternative equilibrium is possible with two cones of diversification, as shown in figure 3.7.

7 Deardorff (2002) considered capital and labour as the two production factors. In line with previous graphical representations low-skilled and high-skilled labour are considered. Accounting for more than two production factors results in multidimensional cones of diversification which obviously would complicate things.

Figure 3.7: Two Cones Free Trade Equilibrium with Three Goods and Two Factors



Source: Adapted from Deardorff (2002).

With the isocost line given by wages w_{LS1} and w_{HS1} a country with its endowment point falling within the cone formed by SR_1 and SR_2 can produce good 1 and 2, employing all workers at the given wages.
With the isocost line given by wages w_{LS2} and w_{HS2} a country with its endowment point falling within the cone formed by SR_3 and SR_4 can produce good 2 and 3, employing all workers at the given wages.

A country with its endowment point outside one of the two cones will produce only one good at relative wages given by the line tangent to the isoquant, at the skill intensity ray running through the endowment point.
Deardorff (2002) considered the model with two cones to be a more appropriate tool than the single cone model to analyse North-South trade, as in a single cone model wages should be equal in developed and developing countries, unless some countries are fully specialized.

Using data for 1990 on some 45 developed and developing countries, Schott (2003) found evidence that the assumption of a single cone of diversification could be rejected in favour of the assumption of two cones of diversification.

Burkett (2000) used data for 58 countries and also found that the hypothesis of a single cone was rejected against the hypothesis of two cones.
The exposition by Deardorff showed that the same good, i.e. the medium high-skill intensive good 2 can be produced with different skill intensity, in different countries. Low-skill abundant countries will employ relatively more low-skilled workers in producing this good than high-skill abundant countries.
This implies that it is difficult to establish whether reported technology gaps between countries are due to differences in technological level or efficiency or whether the differences can actually be explained by common production technologies being used with different skill intensities, given the differences in factor rewards.

The Stolper-Samuelson theorem holds regardless, with respect to trade between countries for which factor endowment falls within the same cone. If a high-skill abundant country does not produce the low-skill intensive good 1, a fall in the price of this good, will unambiguously favour all its factors. Schott (2003) found that few capital abundant countries produced the labour intensive HO aggregate. However, if the high skill abundant country produces the medium high-skill intensive good 2, a fall in the price of this good, e.g. due to falling trade barriers with respect to low-skill abundant countries, would still imply an increase in the skill premium (Deardorff 2002: pp. 4-5). Schott (2003) found that few countries fully specialize and that most of them produce medium labour-intensive goods. This seems to support a North-South Heckscher-Ohlin model with two cones, as depicted in figure 3.7.

I believe to have shown in this section that the Stolper-Samuelson theorem provides a theoretically coherent and rather robust prediction of the impact of international trade on the distribution of income over the production factors and therefore seems a logical starting-point for the empirical assessment of trade with Newly Industrialised Countries on wage inequality in high-skill abundant countries.
A starting-point that is, as some of the restrictive Heckscher-Ohlin assumptions are necessary even for the robust Stolper-Samuelson theorem to hold and clinging to this theorem regardless could result in biased estimates of the labour market impact of international trade. In the next sections a number of theoretical models that relax the most unrealistic Stolper-Samuelson assumptions are presented and the impact of international trade on labour markets within these non-Heckscher-Ohlin models is discussed.

3.1.2 Foreign Outsourcing

When Krugman (1995 b) stressed that the overall volume of North-South trade did not change as dramatically as is sometimes assumed he mentioned a potentially new aspect of international trade: the slicing up of the value added chain, with firms being increasingly able to break up their production process in geographically separated fragments although he subjoined that this was more a general belief than that it could be substantiated by hard statistical evidence.
Srinivasan (1995) believed that Krugman understated the important role of technological progress in decreasing transport and communications costs and thereby in facilitating the slicing up of the value added chain. Feenstra and Hanson (1996) objected that Krugman only considered foreign direct investment flows by multinationals whereas international trade in intermediated inputs increased far more than trade in final goods.
Jones and Kierzkowski (2001) believed that significant cuts in coordination costs allow firms to take advantage of international differences in technologies and factor prices to develop global production networks and suggest that, as the price of international services declines, the need to contain the different production stages within the framework of a multinational organization may have reduced in favour of international arms-length transactions.
UNCTAD (2002: p. 141) concluded that foreign outsourcing is becoming generalized: "*Non-core functions, such as the labour-intensive parts of the production process, the assembly of less sophisticated products, or the logistical organization of product distribution are outsourced to low-cost sites. The contract manufacturing phenomenon epitomizes these outsourcing trends as the complete production process is outsourced. It increases the scale and importance of suppliers' operations, as global value chains are more and more finely sliced into specialized functional and geographical elements*."

In a survey of Belgian firms, 35 percent of the respondents responded to have outsourced activities to firms abroad in the period 1990-1996 whereas only 27 per cent of the responding firms invested in a foreign affiliate (Federal Planning Bureau 2000: p. 242).

Feenstra and Hanson (1996) developed a model of foreign outsourcing[8] which results in a modified version of the Stolper-Samuelson theorem and can explain why wages of high-skilled workers as well as skill intensity of production increased in both high-skill abundant and low-skill abundant countries.

The model assumed a high-skill abundant North and a low-skill abundant South, producing a single manufactured good with a continuum of intermediate inputs indexed by $z \in [0,1]$. A unit of intermediate input z requires $a_{LS}(z)$ of low-skilled labour and $a_{HS}(z)$ of high-skilled labour and capital K(z) which substitutes for labour. Production is modelled with the following Cobb-Douglas function (Feenstra and Hanson 1996: p. 93):

$$Q_i(z) = A_i \left[\min\left\{ \frac{L_{LS}(z)}{a_{LS}(z)}, \frac{L_{HS}(z)}{a_{HS}(z)} \right\} \right]^{\theta} \left[K(z)\right]^{1-\theta} \tag{3.8}$$

A_i is a technology parameter allowed to differ between the North and the South (*i* = N, S) and θ is the share of labour in output. The final good Y is assembled without any costs using the intermediate inputs (Feenstra and Hanson 1996: p. 93):

$$\ln Y = \int_0^1 \alpha(z) \ln Q(z) dz \qquad \text{with} \int_0^1 \alpha(z) dz = 1 \tag{3.9}$$

The endowment and technology in the North and the South differ sufficiently to prevent factor price equalization. The return of capital is assumed to be lower in the relatively capital abundant North which will, given the possibility of international capital flows, result in foreign investment by Northern firms.

8 Apparently there is some competition among scholars to coin the most original term for the phenomenon of firms breaking up their production process and contracting out separable fragments to the most optimal location (country), with the following contestants: (foreign) outsourcing (Katz and Murphy 1991; Feenstra and Hanson 1996; Kohler 2001a; Grossman and Helpman 2002 and Egger and Egger, 2000); slicing up the value added chain (Krugman 1995 b); (international) fragmentation (Deardorf 1998 b; Jones and Kierzkowski 2001; Venables 1999; Arndt and Kierzkowski 2001; Burda and Dluhosch 2001and Kohler 2001b, 2002); intra-product specialization (Arndt 1997); disintegration of the production process (Feenstra 1998); vertical specialization in international trade (Hummels, Rapoport and Yi 1998; Hummels, Ishii and Yi 2001and Strauss-Kahn 2002, 2003); intra-mediate trade (Antweiler and Trefler 2000); global production sharing (Feenstra and Hanson 2001). Without designating a winner I will stick to the term foreign outsourcing throughout this text.

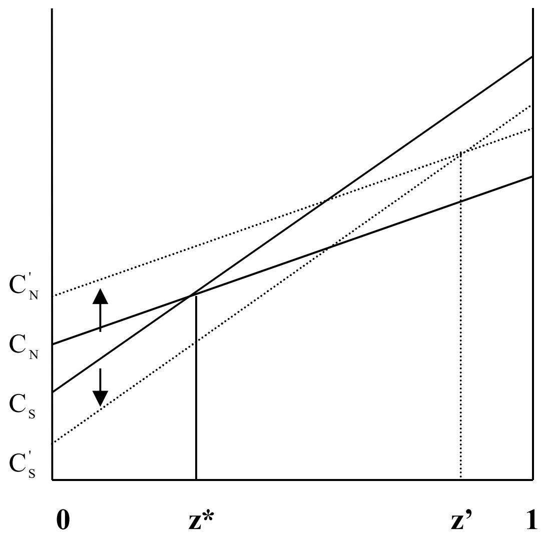
The minimum unit cost of producing $Q_i(z)$ in country *i*, i.e. the dual of the production function (3.8), is given by (Feenstra and Hanson 1996: p. 93):

$$c(w_{LS,i}, w_{HS,i}, r_i; z) = B_i \left[w_{LS,i} a_{LS}(z) + w_{HS,i} a_{HS}(z) \right]^{\theta} r_i^{1-\theta} \quad \text{with } B_i = \frac{1}{\theta^{\theta}(1-\theta)^{1-\theta} A_i} \qquad (3.10)$$

Ranging the intermediate inputs in order of increasing unit costs and assuming the unit costs to be a continuous function of z, the unit costs of respectively the North (C_N) and the South (C_S) can be depicted as in figure 3.8.

As long as both the North and the South produce some intermediate inputs, the C_N and the C_S line should cross at a given z*. The intermediate inputs below z* will then be produced in the South, given its cost advantage, whereas the more high-skill intensive inputs above z* will be produced in the North.

Figure 3.8: Unit Costs of the Continuum of Intermediate Inputs in the North and the South



Source: Adapted from Feenstra and Hanson (1996).

To determine the critical point z* the demand for the production factors can, following Shepard's lemma (e.g. Mas-Colell, Whinston and Green 1995: pp. 140-141) be derived by differentiating (3.10) with respect to factor prices, which for the South results in the following expression for labour demand (Feenstra and Hanson 1996: p. 95):

$$L_{LS,S}\left(\frac{w_{HS,S}}{w_{LS,S}}\right)=\int_0^{z^*} B_S\theta\left[\frac{r_S}{w_{LS,S}a_{LS}(z)+w_{HS,S}a_{HS}(z)}\right]^{1-\theta} a_{LS}Q_S(z)dz \qquad (3.11)$$

$$L_{HS,S}\left(\frac{w_{HS,S}}{w_{LS,S}}\right)=\int_0^{z^*} B_S\theta\left[\frac{r_S}{w_{LS,S}a_{LS}(z)+w_{HS,S}a_{HS}(z)}\right]^{1-\theta} a_{HS}Q_S(z)dz \qquad (3.12)$$

The capital share can be derived from the Cobb-Douglas production function:

$$r_S K_S=\left[w_{LS,S}L_{LS,S}+w_{HS,S}L_{HS,S}\right]\frac{1-\theta}{\theta} \qquad (3.13)$$

Each intermediate input receives a share α (z) of total expenditures.

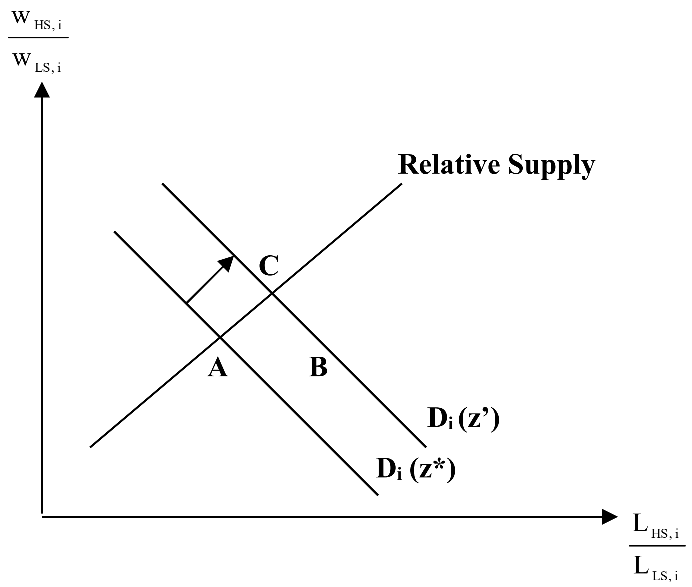
The equilibrium of the model is given by an expression in which C_N is set equal to C_S for z* and the expressions of derived demand for the three production factors in the South and the North (analogous to expressions 3.11-3.13), setting world expenditure equal to the sum of factor payments in the North and the South.

If capital flows from the North to the South (not possible in the Heckscher-Ohlin model), given the lower capital return in the North, the return to capital will increase in the North and decrease in the South. As a result, if wages are fixed, unit costs C_N will increase whereas C_S will decrease as shown in figure 3.8. The critical point will shift from z* to z'. Intermediate inputs between z* and z' will now be produced in the South. The ratio of high-skilled labour relative to low-skilled labour actually increases in both the North and the South inducing increased relative demand for high-skilled workers in both countries, which will tend to increase relative wages of high-skilled workers in both countries.

The eventual labour market equilibrium is shown in figure 3.9.

If capital moves from the North to the South such that the point where C_N and C_S cross increases from z* to z' derived relative demand for high-skilled workers (D_i) increases in both countries. If wages would be fixed, point B would be reached. This is however not an equilibrium on the labour market. Labour market equilibrium implies an increase in the relative wage of high-skilled workers, resulting in equilibrium at point C. Feenstra and Hanson showed that under a stability condition, capital movement from the North to the South (or alternatively technological catch-up of the South) will raise z* even when relative wages of high-skilled workers rise.

Figure 3.9: Relative Supply and Demand of High-Skilled Labour



Source: Adapted from Feenstra and Hanson (1996).

They also derived a modified Stolper-Samuelson theorem which links the relative prices of intermediate inputs to relative wages, i.e. relative prices of inputs produced in the North relative to inputs produced in the South will increase corresponding to the increase in the relative wage of high-skilled workers. It is this modified theorem that leads Feenstra and Hanson to argue that rather than the traditional comparison of domestic and import prices, the price deflators for domestic value added should be compared to import prices, within a given industry or economy-wide (see section 3.2.1).

Deardorff (1998 b) demonstrated that in a world without factor price equalization (due to countries operating in different cones of diversification) outsourcing of a production stage towards a country that requires more resources than in the country of original production may still be worthwhile if there are substantial differences in factor rewards across countries.

According to Deardorff factor prices may actually be driven apart by fragmentation although outsourcing may also result in factor price equalization. The factor deciding which way the wind will blow is the factor intensity of the different production stages and more precisely the difference between factor intensity of the respective sliced up stages of the value added chain and the factor intensity of production in each country before outsourcing occurred. A similar point is made by Venables (1999).

Glass and Saggi (2001) proposed a model of foreign outsourcing, which contrary to the model proposed by Feenstra and Hanson (1996) is driven by differences in technology between countries and not so much by differences in factor endowment. The model is considered by the authors to complement the Feenstra and Hanson model by considering the impact of foreign outsourcing on the rate of innovation.

As foreign outsourcing lowers the marginal cost of production, the increase in profits is assumed to provide a greater incentive for innovation. Whereas outsourcing will depress the relative wages, outsourcing-induced innovation will result in a positive growth effect, which could offset the negative direct impact.

Kohler (2002) argued that theoretical models describing foreign outsourcing and its driving forces are rather stylised with regard to distribution of income over production factors, whereas models focusing on income distribution tend to simplify the forces of foreign outsourcing. He also pointed at the diverging conclusions of different theoretical models on the impact of outsourcing on the position of low-skilled workers. Whereas the framework by Feenstra and Hanson (1996) explains both the decrease in relative wages of low-skilled workers and the increased skill-intensity of production in both high-skill and low-skill abundant countries, other models lead to more ambiguous conclusions as to the impact on low-skilled workers. In Arndt (1997), Venables (1999) and Jones and Kierzkowski (2001) it is shown that under certain conditions foreign outsourcing could actually favour low-skilled workers in high-skill abundant countries that outsource part of their production to low-skill abundant countries.

Kohler (2002) tried to link up the different theoretical principles that have been put forward to model outsourcing by proposing a general equilibrium framework where both Ricardian and Heckscher-Ohlin aspects play a role in determining the impact on factor rewards. The model allows for an arbitrary number of final goods, input factors and production fragments. International factor price differences and differences in technology are the driving forces of foreign outsourcing. The impact on factor rewards depends on the factor intensity of the production stages that remain in the outsourcing country and not on the factor intensity of the stages that are outsourced.

Strauss-Kahn (2002) proposed a model of foreign outsourcing in which, to reflect the situation in continental Europe, wages were assumed fixed. Outsourcing increases relative employment of high-skilled workers in the high-skilled abundant country whereas agglomeration effects, which are also considered in the model, result in a simultaneous impact on employment inequality in both high-skilled abundant and low-skilled abundant countries (i.e. similar to the co-movement of wages in Feenstra and Hanson 1996).

Accounting for the recent phenomenon of foreign outsourcing implies that a strict Heckscher-Ohlin framework has to be vacated.

Feenstra and Hanson (1996) derived a modified Stolper-Samuelson theorem from a model that incorporates foreign outsourcing. Following their model, foreign outsourcing will raise the skill premium in high-skill abundant as well as in low-skill abundant countries and at the same time raise skill intensity in all countries. As will be argued in the overview of the empirical literature this seems more in line with some stylised facts than the predictions derived from a strict Heckscher-Ohlin model.

Some of the other foreign outsourcing models that have been discussed in this section provide more ambiguous predictions with respect to the impact of foreign outsourcing on labour markets. As it seems impossible to decide, on theoretical grounds, what the outcome will be, empirical studies are needed to estimate the net effects of international trade in intermediate goods.

3.1.3 Sachs and Shatz Mechanisms

Following some of the early empirical work, which focused on the implication of the Stolper-Samuelson theorem that trade liberalisation results in a fall in the relative prices of low-skill intensive products in high-skill abundant countries, an implication that did not receive much support from the data (see section 3.2.1), Sachs and Shatz (1996) proposed a number of non-Stolper-Samuelson mechanisms through which international trade can affect wages without changing domestic product prices. They first considered the possibility of international capital mobility (as Feenstra and Hanson 1996). If firms in high-skill abundant countries can relocate their low-skill intensive activities to low-skill abundant countries the relative wage of low-skilled workers can fall even without any change in the relative price of the low-skill intensive goods. They proposed a model with two sectors producing tradables (high-skill intensive X_{HS} and low-skill intensive X_{LS}) and a sector producing non-tradables X_N. The low-skill intensive good is an intermediate good, used in the production of the high-skill intensive final good and can be produced either domestically or in a low-skill abundant country. Capital is assumed to be specific to sector X_{LS} and X_N (i.e. the capital stock of the first cannot be used in the latter and vice versa) and capital is not considered as a direct input in the production of the final good X_{HS}. High-skilled labour L_{HS} is fixed and only used for producing X_{HS} whereas low-skilled labour, fixed as well, is used for producing X_{LS} and X_N. The amount of capital allocated to produce X_{LS} in the low-skill abundant country is considered to be exogenous (determined by the FDI policy of the host country, relative factor prices, tax policy…). If the wages of low-skilled workers are lower in the host country than in the home country, capital will be more profitable in the host country. Under full international capital mobility the low-skill intensive good will no longer be produced domestically. If capital is shifted from the home country to the host country to allow for higher quasi-rents, displaced low-skilled workers in the home country will be forced to look for a job in the non-tradables sector. The wages of low-skilled workers will then be determined by the demand for low-skilled workers in this sector (i.e. equal to the marginal value of L_{LS} in X_N or $W_{L_{LS}} = P_{X_N}\left(\frac{\partial X_N}{\partial L_{LS,N}}\right)$).

As $L_{LS,N}$ increases $\left(\frac{\partial X_N}{\partial L_{LS,N}}\right)$ will fall whereas P_{X_N} will tend to fall given increased output but could increase due to a positive income (demand) effect, which follows from the more profitable production of the intermediate good. If the income effect is smaller than the supply effect, the wages of low-skilled workers in the home country will fall. The price of X_{LS} is determined by the demand for the intermediate good used in the production of X_{HS}, which depends on the input of the intermediate good and the supply of high-skilled workers. As the latter two are assumed to be fixed, the price of the low-skill intensive good will not change whereas the wage of low-skilled workers changes. Assuming that the production of X_{HS} also requires sector-specific capital and L_{HS} can also be used to produce X_{LS} results in the finding that the wage gap between low-skilled and high-skilled workers is determined in the non-tradables sector. If skill intensity in sector X_{LS} is lower than skill intensity in sector X_N the latter sector will become more intensive in low-skilled labour[9]. Low-skilled workers will have to accept a lower relative wage for all displaced low-skilled labour to be absorbed by the non-tradables sector.

Sachs and Shatz then adjusted the model to allow for the domestic low-skill intensive sector to be monopolistic in the absence of international capital mobility. Foreign production of X_{LS} is competitive and determined by the foreign capital stock only. Production of X_{LS} can either occur using a low marginal cost technology or using a high-cost alternative technology at a cost of P*. The monopolistic domestic sector will earn a rent when using the low-cost technology but it cannot set its price higher than P* as this would allow foreign firms to supply X_{LS} using the high-cost technology. Foreign imports can be seen as a competitive fringe of the domestic monopolist.

Now, if the foreign sector increases its production of X_{LS} the domestic monopolist will hold its price at P* and absorb increased imports by reducing domestic production. This will displace (low-skilled) workers from this sector and force them into the non-tradables sector. However, as there is now a negative income effect (monopolist profits decrease due to import competition) the wage of low-skilled workers will unambiguously fall.

Finally, Sachs and Shatz used the framework by Murphy, Shleifer and Vishny (1989) to show another potential mechanism through which international trade could affect relative wages without any change in relative product prices.

In an economy with *N* sectors, goods in sector *j* can be produced either using low-skilled and high-skilled labour ($Q_j = L_{LS,\,j} + L_{HS,\,j}$) or alternatively with a more advanced technology requiring a fixed cost of high-skilled labour to allow production at a lower marginal cost ($Q_j =$

9 Data for the US show that import-competing industries are less high-skill intensive than export-competing industries and the non-tradables sectors are the most high-skill intensive (Sachs and Shatz 1996: p. 30).

$\theta[L_{LS,j} + L_{HS,j}]$ with $\theta>1$). Under the assumption that there is not enough high-skilled labour to allow for the use of the advanced technology in all sectors the scarcity of high-skilled labour will elicit a skill premium[10].

A monopolist owns the advanced technology. Market demand is characterised by a constant-elasticity-of-substitution (CES) utility function (Sachs and Shatz 1996: p. 19):

$$U(C_1, C_2, ..., C_N) = \left[\frac{1}{N}\sum_{j=1}^{N} C_j^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} \quad (3.14)$$

with C_j the consumed quantity of good j and σ the constant elasticity of substitution.

From this the demand for each sector is given as (Sachs and Shatz 1996: p. 22):

$$C_j = \frac{1}{N}\left(\frac{P_j}{P}\right)^{-\sigma}(Y + Y^*) \quad (3.15)$$

Where P is a price index corresponding to (3.14), Y is domestic income and Y* foreign income. Given inelastic demand (i.e. $\sigma < 1$) the monopolist-owner of the advanced technology will set the price as high as possible with the upper limit determined by the possibility of other firms to compete with the low-tech alternative. The monopolist will use the advanced technology as long as market demand is large enough to cover the fixed cost of high-skilled labour. The monopolist can produce for domestic demand but also export to the world market. International trade could make the use of the advanced technology profitable even if it would not be in a closed economy. Potential monopolists will bid for the high-skilled workers so that their wages will increase until pure profits of the advanced technology production are exhausted. Trade liberalisation, when allowing the advanced technology to be used profitably, may thus raise the wage of high-skilled workers without affecting product prices or the wages of low-skilled workers.

3.1.4 Sticky Wages

10 Sachs and Shatz (1996) actually assume that there is just enough high-skilled labour to allow for the use of the advanced technology in just one sector but argue that this assumption is not restrictive and could easily be relaxed.

As mentioned before, an assumption of the Heckscher-Ohlin model, which on empirical grounds seems rather problematic for the European Union, is that labour markets are perfectly competitive, implying that wages are fully flexible. If so, wages will absorb all effects of international trade, safeguarding full employment of all production factors.

If wages on the contrary are sticky, a fall in labour demand shall result in unemployment of some workers.

Labour market rigidity is often evoked to explain the high EU unemployment rates relative to the United States, though as mentioned before the evidence for a clear-cut equity-efficiency trade-off is not overwhelming and for the 1990s the OECD argued that employment performance in a number of EU countries improved, probably as a result of wage moderation.

However, unemployment rates of low-skilled workers are disturbingly high in most EU countries, as in the United States for that matter, as shown in table 2.3 in chapter 2 and labour market institutions undoubtedly explain part of this poor employment performance of workers with little education.

Krugman (1995 b) followed Brecher (1974) in considering a model of downward wage rigidity. He discriminated between a *European* model where international trade with low-wage countries is, given wage rigidity, assumed to affect employment and an *American* model where only wages are affected.

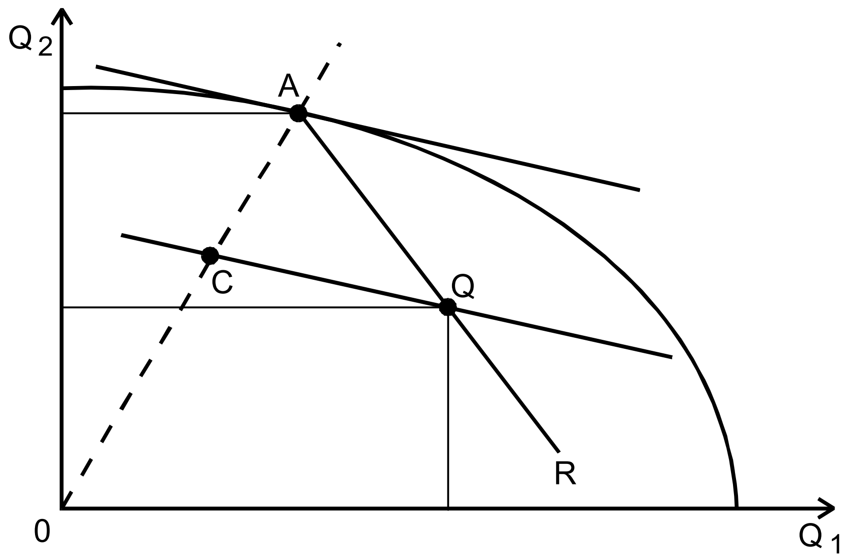
If, starting from autarky, Europe would open up to trade with low-wage countries, the changes in supply and demand and the resulting changes in production and employment are shown in figure 3.10.

True to the notation in the previous sections Q_1 represents the high-skill intensive good X_{HS} and Q_2 the low-skill intensive good X_{LS}.

Initially, the autarky point A shows how much of the high-skill intensive respectively low-skill intensive good is being produced and consumed. The line tangent to the production possibilities curve is the budget line and the line OA is the income expansion path.

As Europe is too large to be considered as a price-taker, imports from low-skill abundant countries will not entirely eliminate production of low-skill intensive goods in Europe. European production of the low-skill intensive good will decrease though, but at constant relative prices, until trade is balanced.

Figure 3.10: Adjustment of Production and Consumption in the *European* Model

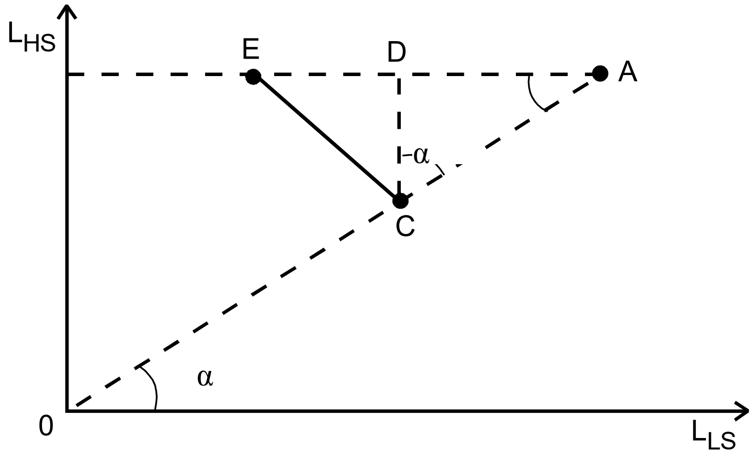


Source: Krugman (1995 b).

Production in Europe slopes down the *Rybczynski* line AR, reflecting the *Rybczynski* theorem, which implies that if the endowment of a production factor falls, the production of the good that relatively intensively requires that given production factor will fall. As relative prices of goods in the European Union are fixed by sticky factor prices, the available endowment of low-skilled workers, at competitive factor prices, can be considered to fall. Following the *Rybczynski* theorem, production will shift from the low-skill intensive good Q_2 to the high-skill intensive good Q_1. Q is the point where trade is in equilibrium at the fixed relative product prices. The lower production level results in an inward shift of the budget line with consumption falling to point C. Krugman argued that previous estimates of the impact of trade on employment ignored this decrease in income and thus in domestic demand, as a result of the fall in employment. Assuming relative wages and relative prices do not change, the total impact can be derived from a look at the factor content.

In figure 3.11 point A represents the autarky point with full employment of low-skilled and high-skilled workers. In autarky the derived demand for factors embodied in production equals supply. However, if income falls, derived demand will shift inwards along the income expansion path OA. The slope of the budget line EC equals the relative wage of high-skilled workers. A-E low-skilled workers are now unemployed. From figure 3.11 it is clear that employment of low-skilled workers in Europe falls by EA, which is more than low-skilled labour embodied in imports (ED).

Figure 3.11: Adjustment of Consumption and Employment in the *European* Model



Source: Adapted from Krugman (1995 b).

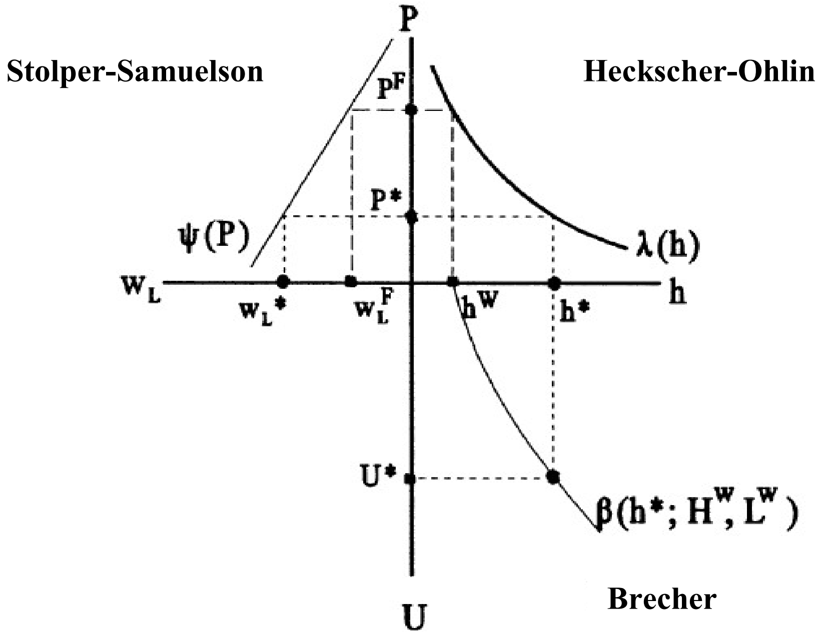
The total employment effect of imports in Europe equals the net imports of low-skilled workers plus a general equilibrium multiplier effect (Krugman 1995 b: p. 354):

Net imports of low-skilled labour (ED) + [Net exports of high-skilled labour (DC) x Ratio of low-skilled labour relative to high-skilled labour in Europe (tg α)]

Krugman did not address the apparent (Keynesian) implication of the *European* model that there are no gains from international trade for countries with sticky wages, as each trade equilibrium point on the *Rybczynski* line AR falls below domestic production possibilities, as clearly shown in figure 3.10.

In Davis (1998 a) the different impact of international trade in countries with flexible labour markets compared to countries with rigid labour markets is concisely reproduced, as in figure 3.12. The Heckscher-Ohlin quadrant maps the relation between the relative world supplyt of high-skilled workers *h* (world supply of high-skilled workers H^W relative to the world supply of low-skilled workers L^W) band the relative price of the high-skill intensive good P.

Figure 3.12: Flexible Wages (Stolper-Samuelson) Versus Rigid Minimum Wages (Brecher)



Source: Davis (1998 a: p. 1617).

The higher the relative world supply of high-skilled workers the lower the price of the high-skill intensive good. The Stolper-Samuelson quadrant reflects the fall in the relative wages of low-skilled workers w_L due to a rise in P. The integration of low-skill abundant countries in the world economy will lower the relative world endowment h and this will lower the wages of low-skilled workers in the previously integrated high-skill abundant countries. If there is however a minimum wage w_L^* which at a given world endowment h^* is above the flexible wage w_L^F the according equilibrium relative goods price should be P*. At this price level the Heckscher-Ohlin relation shows that skill intensity of employment should be h^*, which now shows the employed factors instead of the world endowment. Given the relative world endowment of high-skilled workers h^W the unemployment level will be given by the relation in the Brecher quadrant. With a minimum wage wage w_L^* the unemployment level is U*.

Given the stylised facts, showing that in most EU countries the relative employment of low-skilled workers decreased, rather than their relative wages, in line with the general view that labour market institutions play an important role in the European Union, a model that accounts for sticky wages seems more appropriate than a model like Heckscher-Ohlin which only holds under the restrictive assumption that labour markets are perfectly competitive.

3.1.5 Imperfect Product Market Competition

Neary (2001) believed that the focus on competitive general equilibrium models restricts the impact of foreign competition to decreases in prices or increased imports and ignores the potential impact on mark-ups or profit rates. He considered oligopoly as the market structure that is most in line with stylised facts.

Following Spencer and Brander (1983), he considered a model with a domestic firm involved in a Nash strategic competition game with a foreign firm. In a first stage both firms decide on their investment level, which reduces marginal costs. In the second stage the firms decide on their output level, maximizing their profits, considering investment as a sunken cost.

Investment has a non-strategic motive, i.e. the decrease in marginal costs. In addition there is a strategic motive, as each firm will anticipate the impact of its investment decision on the other firm. A higher level of investment lowers costs and thereby pushes the rival firm down its output reaction function. This implies that there is a strategic incentive to invest above the efficient level (Neary 2001: pp. 11-12).

Neary considered the impact of import quota on the equilibrium, compared to a situation of free trade. As a quota fixes the foreign firm's imports, the strategic motive to (over-) invest disappears.

Sales of the domestic firm will be lower with import quota but the price will be higher and inefficient investment does not occur. Profits may therefore be higher.

Reducing the level of quota will incur strategic investment. As investment in R&D is assumed to require only high-skilled workers and production only low-skilled workers, the more aggressive investment by both firms will favour high-skilled workers. Without changes in wages, skill-biased technological change occurs.

To assess the impact of a reduction in quota if wages change, Neary imposed a number of restrictions (e.g. both countries are identical, there is a continuum of identical sectors and firms produce either for the domestic **or** the foreign market).

Neary argued that the relative wages of high-skilled workers are likely to increase, dampening but not reversing the initial increase in skill intensity but though the main conclusions appear to be robust to relaxing some of the rather restrictive assumptions (e.g. homogenous goods, production only requiring low-skilled workers) he considered the model more as a future research programme than as a full explanation of changes in skill premium in OECD countries due to changes in import quota in oligopolistic markets.

As pointed out by Neary, the model is more likely to apply to international trade between countries with a similar level of development than to trade with Newly Industrialised Countries.

Choudri and Hakura (2001) proposed a general Ricardo-Heckscher-Ohlin model with monopolistic competition. The Ricardian aspect of the model reflects differences in production techniques between countries whereas the monopolistic competition aspect accounts for differentiated goods.

Monopolistic competition is incorporated by using a Dixit-Stiglitz utility function with symmetrically differentiated goods which permits to model the demand in a country for a variety of a good produced in another country, accounting for trade barriers. Ricardian and Heckscher-Ohlin factors are introduced in the model by linking the price ratio to respectively relative productivity and relative factor prices (Choudri and Hakura 2001: p. 5).

Using data from the OECD International Sectoral Database at the two-digit level for France, Germany, Italy, Japan, the United Kingdom and the United States in the period 1970-1990, to test the model, Choudri and Hakura (2001) found indications favouring the integrated model over the more specific nested Ricardian or Heckscher-Ohlin models.

The model is proposed to derive a relation explaining relative exports of two countries to a third country and is not very informative with respect to the impact of international trade on income distribution. Empirical verification moreover requires data on productivity, factor prices and factor use for all country pairs considered in relation to a third trade partner.

A number of Computable General Equilibrium (CGE) models that will be discussed in section 3.2.8, model imperfect competition using a CES utility function, as proposed by Dixit and Stiglitz (1977). The underlying assumption of this utility function is that consumers appreciate variety. For a given income level, an increase in the number of differentiated goods increases consumers' utility. Firms will earn a mark-up that will depend on their market share. As goods within the same industry are not perfect substitutes, the impact of imports will be less substantial than if product markets were fully competitive and goods would be perfect substitutes.

Smith (1999) argued that the Dixit-Stiglitz model accounts for intra-industry trade, which is a generally acknowledged aspect of trade between developed countries that cannot easily be explained by traditional trade theories. He found that even trade between the European Union and developing countries is for a substantial part intra-industry, though he admitted that the three-digit level he considered is probably too aggregated to substantiate this claim.

There may moreover be a qualitative difference between intra-industry trade among developed countries, reflecting the consumers' preference for differentiated goods and increasing returns to scale (e.g. Helpman and Krugman 1985) and North-South intra-industry trade, reflecting the outsourcing by the North, of low-skill intensive fragments of production processes, to the South (see section 3.1.2).

Dinopoulos, Syropoulos and Xu (2002) presented a model of Chamberlinian monopolistic competition between two countries, with endogenous factor supplies (i.e. the supply of high-skilled workers rises with the skill premium). Following Krugman (1979), the Dixit-Stiglitz demand side of the model implies that trade liberalisation will increase the elasticity of demand and, as a result of free entry, force firms to move down along their average cost curves. However, due to internal economies of scale the output as well as total factor productivity of firms will increase.

The authors relaxed the assumption of homotheticity in production and assumed that an increase in output raises the skill intensity of production. If the production function is assumed to be homothetic factor intensity does not depend on firms' output level.

The model predicts that trade liberalisation will result in an increase in the skill premium as well as in an increase in the relative employment of high-skilled workers, an increase in total factor productivity, the output of the representative firm and the number of product varieties.

According to the authors the model is in line with the stylised facts for the United States, where both the relative wages and employment of high-skilled workers appear to have increased in the 1980s.

Most product markets in industrialised countries are unlikely to meet the assumption of perfect competition. New Trade theories explained the phenomenon of intra-industry trade by considering economies of scale and differentiated goods. However, these models seem more attuned to trade between countries with similar relative factor endowment and technological levels than to North-South trade for which differences in factor endowment are probably more important driving forces than consumers' love of variety.

3.1.6 Union Bargaining and International Trade

In the European model proposed by Krugman (1995 b), described in section 3.1.4, sticky wages are explicitly accounted for but the labour market institutions that could cause wage rigidity are not specified.

Considering institutional factors that may explain sticky wages, labour unions will undoubtedly pop up in the minds of many economists.

Agell (1999) instanced the evidence that generous unemployment benefits of long duration and strong but uncoordinated unions generate unemployment but argued that the evidence on the impact of other labour market institutions like job security, minimum wages or the tax wedge on labour income is mixed at best.

Leamer (1999) supposed that most economists associate minimum wages with unemployment as they assume one-dimensional labour contracts that only stipulate wages. However, when considering that working conditions as well as wages are bargained for, minimum wages legislation may be met with adjustments in working conditions (e.g. effort) that guarantee full employment.

Apparently, recent surveys on wage rigidity and laboratory studies of reciprocal behaviour suggest that social norms could cause wage rigidity, independently of legal constraints[11]. Legal reform, therefore, will not always prove to be very effective.

In a contraire view, Agell (1999) reasoned that some labour market rigidities could actually be useful and that globalisation could call forth some rigidities rather than more labour market flexibility, as is commonly expected. His main argument is that as labour markets are instruments of social insurance, increased external risks (e.g. linked to globalisation) will raise the demand for more insurance (Agell 1999: pp. F143-F144). Rodrik (1997) developed a similar argument.

Manning (2004) raised the possibility that the implicit assumption in the efficiency-equality trade-off debate, namely that labour markets are perfectly competitive in the absence of intervention, may be wrong. If it is costly for workers to change jobs, information about job opportunities is not perfect or workers have some non-wage preferences, wage elasticity of the labour supply with respect to an individual firm may not be infinitely elastic as assumed and the labour market could be characterised by monopsony. Manning presented a model in which

11 These findings remind Agell (1999: p. F145) of Keynes (1936) who seemed to explain wage rigidity by aspects of the human psyche rather than by unions or government regulation.

some labour market institutions (minimum wages, unions and unemployment benefits with a job search requirement) actually improve efficiency in monopsonistic labour markets.

If labour unions have some bargaining power with respect to employers, they could claim part of (supernormal) profits, such that workers get paid wages above their marginal product, as a result of which firms will tend to employ less workers. To the extent that unions bargain for supernormal profits, i.e. profits due to imperfect competition in product markets, union bargaining power and product market power may actually be linked. Import penetration is likely to increase product market competition and thereby infringe upon the bargaining position of unions. If moreover firms have an increasingly credible threat to relocate activities abroad through foreign direct investment or outsourcing, union bargaining power may further be weakened. As unions are reported to reduce wage inequality, the negative impact of internationalisation on the bargaining power of unions might be an explanation for increased wage inequality and an improved employment record (as occurred in a number of EU countries in the 1990s, see section 2.1) or rising unemployment if unions become more wage-oriented in response to intensified import penetration as argued by Gaston (1998).

Aidt and Tzannatos (2002) summarized the net benefits of unions as participatory and dispute resolution benefits minus monopoly costs and rent-seeking costs. Whether the net benefits are positive depends on the size of the three terms.

Unions may be beneficial if through consultation and collective agreements they reduce conflicts between workers and employers. Better working conditions could result in lower labour turnover and higher productivity.

If unions can monopolize the labour supply they have a strong position to bargain with firms for supernormal profits, associated with imperfect product markets or government regulations. The monopoly position of unions can result in the passing on of higher wages to product prices or the reallocation of labour to non-unionised sectors due to the increased relative price of labour in unionised sectors.

McDonald and Solow (1981) proposed an efficient bargaining framework, in which unions and firms bargain for both wages and employment.

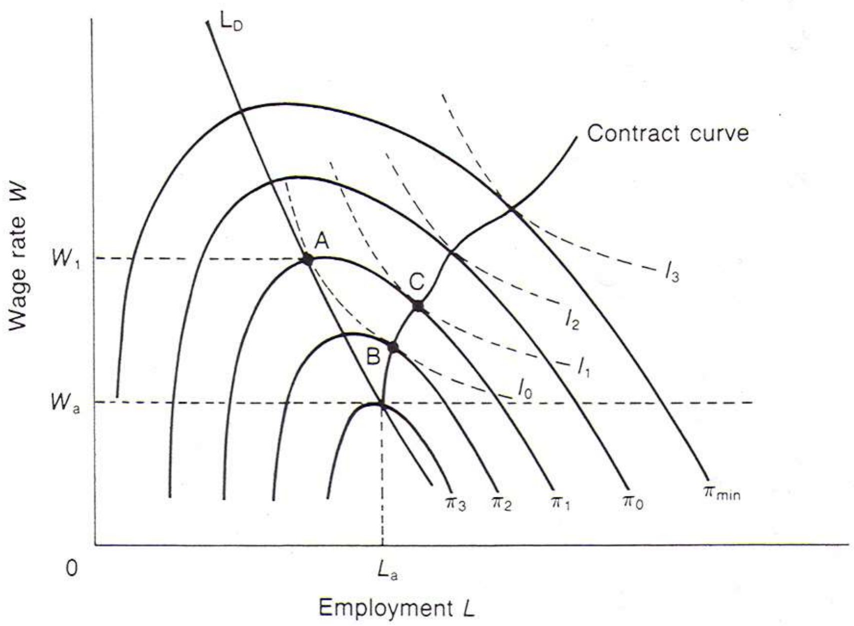
The expected utility function of a union can be represented by (Smith 2003: p. 210):

$U = L\,(U(w_u) - U(w_a))$ (3.16)

where L is the employment level, w_u is the wage obtained by unions and w_a is the outside option for unions (alternative wage).

A family of union indifference curves ($I_3 > I_2 > I_1 > I_0$) and a family of isoprofit curves ($\pi_3 > \pi_2 > \pi_1 > \pi_0$) is represented in figure 3.13. The labour demand curve L_D links the peaks of the isoprofit curves.

Figure 3.13: Labour Demand and the Contract Curve in an Efficient Bargaining Framework



Source: Smith (2003: p. 212).

Point A is an efficient outcome but the firm will prefer a point like B (higher profits) to A whereas a union has no preference of A over B. The union will prefer a point like C (higher utility) to A whereas a firm is indifferent with respect to A and C. Any point between B and C provides a Pareto welfare improvement on point A. The curve connecting the tangency points between the isoprofit curves and the union indifference curves is defined as the contract curve. Except for the intersection of the contract curve with the labour demand curve (where wages equal the lower bound w_a), bargained wages will exceed the marginal product of labour and moreover firms will employ more workers at the negotiated wage level than they would in the absence of unions.

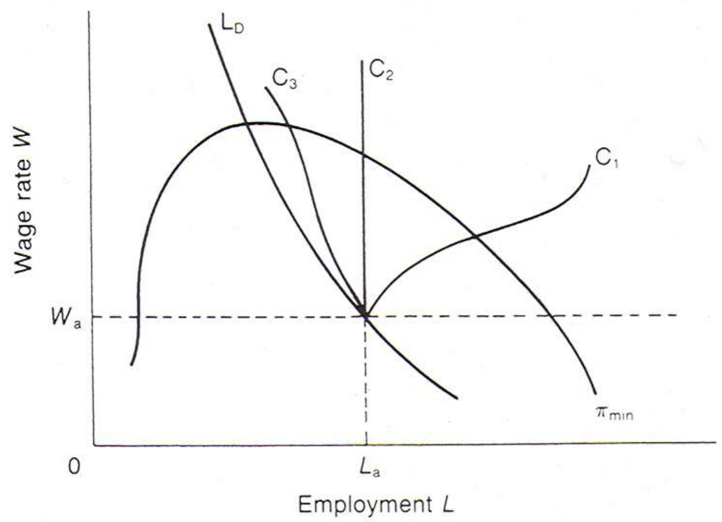
The minimum profit constraint π_{min}, e.g. imposed by shareholders or the capital market, provides the upper bound for negotiation. Efficient bargaining results in an efficient outcome from the perspective of the firm and the union, not from the perspective of allocation, as wages exceed the marginal product of labour (Smith 2003: pp. 211-213).

Unions will try to obtain a wage-employment combination as close to the constraint π_{min} whereas a firm will try to obtain a wage-employment point at which wages are as close to the marginal product of labour as possible. The bargaining strength of the union will determine the outcome.

If unions are only concerned with maximizing the wage mark-up w_u - w_a, rather than an upward sloping contract curve as in figure 3.13, the contract curve would be vertical, as shown by contract curve C_2 in figure 3.14.

Unions will try to bargain for a larger share of the rent, leaving the employment level unaffected. If a union would be wage-oriented, i.e. clearly prefer wages to employment, the contract curve may even be downward sloping as C_3 in figure 3.14.

Figure 3.14: Position of the Contract Curve in an Efficient Bargaining Framework depending on the Degree of the Union's Wage Orientation



Source: Smith (2003: p. 213).

A decrease in union power will shift the bargaining outcome towards L_D. Dependent on the position of the contract curve this will have a different outcome.

If the contract curve is upward sloping, a fall in union bargaining power will result in a fall in wages as well as in employment.

If the contract curve is vertical, a decrease in union power will only affect wages and if the contract curve is downward sloping, wages will fall but employment will actually increase. As pointed out by Smith (2003) the position of the contract curve is an empirical matter that cannot be settled at the theoretical level.
A right-to-manage model is an alternative to the efficient bargaining framework. In this model the firm and the union bargain for the wage level, after which the firm unilaterally determines the employment level. A monopoly union model is a special case of the right-to-manage model in which unions are assumed to set the wages unilaterally, after which the firm sets the employment level unilaterally.
In a right-to-manage framework the firm will take an employment point on its labour demand curve where wages equal the marginal product of labour. In this framework a fall in union bargaining power will unambiguously decrease the wage level and increase the employment level (Smith 2003: p. 214-215).

If firms are forced to share their profits with workers, capital investment and R&D activities may be depressed (Aidt and Tzannatos 2002: pp. 24-25).

Unions can also induce rent-seeking costs, if they push for policies that reduce competition on product markets (as this will increase the supernormal rents) or labour markets (e.g. minimum wages).

Reviewing the evidence from microeconomic studies, Aidt and Tzannatos (2002) concluded that unions are apparently successful in raising the wages of union members or of all workers covered by collective agreements. There is also ample evidence that unions, which dominantly recruit low-paid workers, reduce wage inequality between low-skilled and high-skilled workers (e.g. Freeman 1980; Blau and Kahn 1996; Aidt and Tzannatos 2002 and Card, Lemieux and Riddell 2003). Aidt and Tzannatos argued that this tendency to reduce the skill premium, which at first thought suggests reduced returns to skill acquisition (e.g. Deardorff 1999) may actually increase human capital formation if low-skilled workers are fired due to the increased relative wages and are therefore forced to require skills to find a job. Agell (1999) made a similar point.

Institutional characteristics like union density and the level at which bargaining takes place (firm, sector or national level) are relevant factors that affect the impact of unions on economic performance. Countries characterised by coordinated collective bargaining tend to have lower unemployment rates and a more compressed wage distribution. However, only the latter result is somewhat robust, as the relationship between coordination and economic performance weakens substantially when cross-country differences in policy, institutions and conditions are accounted for (Aidt and Tzannatos 2002: p. 104).

Aidt and Tzannatos also found little evidence in favour of the popular hump hypothesis (i.e. a U-shaped relationship between economic performance and the level of bargaining coordination), which puts that semi-coordinated collective bargaining leads to worse outcomes than both coordinated and uncoordinated collective bargaining.

According to Blanchflower, Oswald and Sanfey (1992) data on US manufacturing industries in the period 1964 to 1985, are consistent with a labour contract framework with risk-averse firms but clearly not consistent with a model of competitive labour markets. This would indicate that even for the United States, the assumption of competitive labour markets is too heroic.

Among the first to consider wage bargaining in an open economy were Lawrence and Lawrence (1985) who considered a monopoly union framework to assess the impact of long-run changes in demand (e.g. due to cheaper imports) on wage differentials.

The utility function for an individual union member can be given as (Lawrence and Lawrence 1985: p. 54):

$$\frac{L}{N}U(w)+\left(1-\frac{L}{N}\right)U(\overline{w}) \tag{3.17}$$

where L denotes the number of union members that are employed and N is the fixed total number of union members. U(w) is the utility of a job in the unionised sector and $U(\overline{w})$ is the utility of receiving the reservation wage $\overline{w}$, i.e. the wage in a less unionised sector or the unemployment benefit. L/N is considered as the probability of a union member to be employed in the given (unionised) sector and 1-L/N the probability that the union member is employed in another sector or benefits some unemployment compensation.

Under the assumption that the utility functions of individual members can be summed the maximization by unions can, following McDonald and Solow (1981), be given as:

$$L\left(U(w)-\overline{U}\right) \tag{3.18}$$

with $\overline{U} = U(\overline{w})$ [12]subject to the aggregate derived labour demand in the industry considered. Lawrence and Lawrence considered a Constant Elasticity of Substitution (CES) function to model production technology and the (inverse) aggregate demand curve of the industry:

$$P = ZY^{-\frac{1}{\beta}} e^{\frac{1}{\beta}V} \qquad Z, \beta > 0 \tag{3.19}$$

where P is the international product price index, Z autonomous demand, Y aggregate demand, β the constant elasticity of demand and V is a stochastic demand shifter.

If foreign firms can produce substitutes for domestic goods at lower costs this would be reflected in a negative value for V. Changes in international competitiveness could also affect demand elasticity β (Lawrence and Lawrence 1985: pp. 54-55).

From the production function, the first-order maximization conditions and the aggregate demand, the demand for labour can be derived (Lawrence and Lawrence 1985: p.55):

$$\log w = A + \frac{1}{\rho}\left(\frac{1}{\sigma} - \frac{1}{\beta}\right)\log\left[\alpha + (1-\alpha)\left(\frac{1-\alpha}{\alpha}\frac{w}{r}\right)^{\rho\sigma}\right] - \beta^{-1}\log L + \beta^{-1}V \tag{3.20}$$

with w and r the rewards of respectively labour and capital, α and ρ are technology parameters from the CES production function and $\sigma = \frac{1}{1-\rho}$ is the elasticity of substitution between labour and capital.

The union is assumed to choose wages (w) and employment (L) such that (3.17) is maximized, equating the elasticity of the gain in utility from employment with respect to the wage rate, with the elasticity of the derived labour demand.

If cheaper imports of substitutes, changes in tastes or a decrease in income shifts domestic product demand inwards, unions will keep wages unchanged. If the rental rate is also considered fixed and capital is mobile or short-lived, labour and capital will be reduced equiproportionally. However, wages and the capital-labour ratio could be affected if the demand shift changes the elasticity of the derived demand.

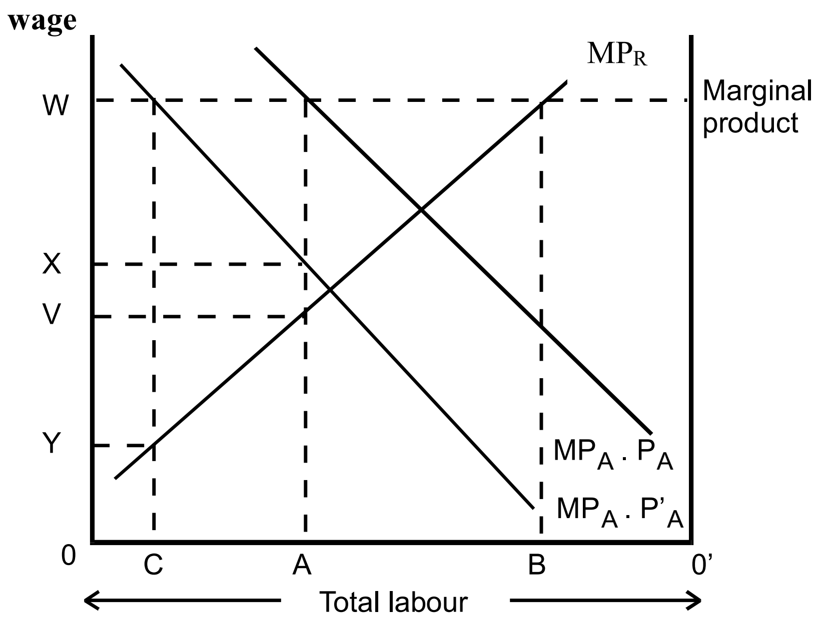
[12] $\overline{U} = D + U(w_u)$ with D the fixed additive disutility of holding a job and w_u the standard of living that would be achievable if a worker is not employed by the firm (e.g. unemployment benefit).

If capital is long-lived and sector-specific (e.g. steel, shipbuilding) it cannot be transferred on the spot and the elasticity of the demand for labour may be low. The impact of a common demand shock thus depends on the nature of the capital stock in a given industry and wages could behave differently, as a result of which inter-industry wage differences could increase (Lawrence and Lawrence 1985: pp. 55-56).
Lawrence and Lawrence considered an extreme case of an industry in which capital is infinitely long-lived and unions are faced with a permanent reduction in demand. As long as revenue is higher than variable costs, firms will continue production but they will no longer invest in new capital. If capital is fixed, as a result of the reduced substitution possibilities between capital and labour, labour demand elasticity will decrease. If the effect of low elasticity of substitution dominates the effect of the downward shift in demand, wages will tend to rise in this "end game", i.e. a situation where unions are aware of the fact that firms no longer consider any new capital investment.
If cheaper imports increase the elasticity of demand β, capital-intensive industries with little possibilities to substitute labour for capital will actually witness an increase in wages. The authors argued that the case of the US steel industry in the period 1970-1984 is in line with the predictions that can be derived from the "end game" framework. They considered the level of protection of the steel industry in the United States as too small to explain the increase in hourly wages by 27 per cent in the 1970s, despite stagnating demand and investment. As plants started to close and demand fell sharply, wages decreased by 12 per cent between 1982 and 1984.

Bhagwati and Deheija (1994) proposed a general equilibrium insider-outsider model to assess the impact of import competition on rents and jobs, bargained for by unions. The economy is assumed to consist of an unionised sector A (e.g. autos) and a rest sector R, which is assumed to be non-unionised and competitive.
The model is graphically depicted in figure 3.15.

The MP lines reflect marginal product. OA is the number of union members (insiders) and AO' the number of non-unionised workers (outsiders), thus OO' is the economy-wide labour supply. Employment in sector A is shown from the origin O and employment in sector R from the origin O'.

Figure 3.15: Impact of Import Competition on Union Rents in an Insider-Outsider Model



Source: Bhagwati and Deheija (1994) .

In sector A, unions will bargain for a wage that ensures that all its OA members (insiders) are employed. If this wage W is legislated as a national minimum wage, employment in sector R will be determined by the point at which the wage equals the marginal product. Unemployment of non-unionised workers (AB) may and probably will occur. To ensure full employment wages in sector R should fall to V (Bhagwati and Deheija 1994: pp.66-67)
Assuming wages in sector R are flexible enough to ensure full employment, Bhagwati and Deheija consider what would happen if the relative price of the good produced by sector A (p_A) would drop, e.g. due to increased import competition.

The marginal product line of sector A will shift inwards and the union will have to accept a drop in the wages, from W to X, if it wants to ensure employment for all its members. Real wages expressed in the price of sector A will remain constant, but expressed in terms of the price in sector R will have decreased. If the fall in trade terms is not expected by the union they will stick to a wage level W, as result of which only OC union members will be employed by sector A. The rest of the union members will have to join the army of workers in sector R, where all O'C workers will be employed at the low wage level Y (Bhagwati and Deheija 1994: pp. 67-68).

Bhagwati and Deheija claimed that the insider-outsider bargaining model is consistent with the situation in the United States, where wages fell and employment hardly changed. Within the model, unions expecting a downward shift in demand, accepting a reduction in wages to ensure full employment, could explain this. As according to the authors, wages did not change much in the European but unemployment increased, they reason that European unions may not have foreseen the drop in demand or did not allow for a market-clearing decrease in wages.

Bhagwati (1995), though clearly favouring a skill-biased technological change explanation of increased wage inequality to a trade competition explanation, pointed out that, within a bargaining framework, employers will gain in bargaining power if they can credibly threaten to relocate production to low-wage countries.
Bluestone and Harrison (1982) apparently already argued that multinational enterprises strategically played off one group of workers against another in a global economy (Gaston 1998: p.3).

Gaston and Nelson (1997) reasoned that as most industrialised countries have fairly similar factor endowment and technology, and witnessed similar (trade) shocks, differences in labour market institutions could explain the established cross-country differences in trends of wage inequality. Two of the countries that witnessed the sharpest increase in wage inequality, i.e. the United Kingdom and the United States, also witnessed a substantial fall in union membership.

Abowd and Lemieux (1993) and Borjas and Ramey (1993) developed a model of bargaining between a union and a firm for the rent that follows from imperfect product market competition, which is modelled by Cournot competition between the domestic employer and a foreign firm. The framework by Borjas and Ramey suggests that import penetration has a larger impact on relative wages in a sector, the more concentrated that sector is, as rents are transferred from low-skilled workers towards foreign producers and these rents are high in concentrated sectors.

Gaston (1998) developed a model that can explain the decentralisation of wage bargaining, which occurred in most OECD countries (e.g. Freeman and Gibbons 1993)[13]. The model also explains why unions will tend to become more wage-oriented in response to increased trade

13 Freeman and Gibbons see the diverging interests of high-skilled and low-skilled workers and private-sector and public-sector unions as the main cause for the decentralisation of wage bargaining.

competition and the threat of relocation towards low-wage countries. Despite risk-neutrality of underlying preferences, unions will prefer contracts that involve higher wages and greater employment risk. Gaston rationalises this result as the outcome of a political economic equilibrium. In response to the threat of firms to outsource production abroad unions adapt their bargaining position.

If unions bargain for wages as well as for employment, the impact on wages and employment depends on the nature of the bargaining process, the bargaining power of the union and union preferences with respect to wages and employment (e.g. McDonald and Solow 1981; Oswald 1985; Holmlund, Løfgren and Engstrøm 1989 and Mezzetti and Dinopoulos 1991). In a right-to-manage framework, with unions and employers only bargaining for wages, a weakening of the union's bargaining strength will result in falling wages and employment could remain constant. In an efficient bargaining setting (where wages and employment are included in the bargaining process), a trade-off between wages and employment reduction will occur provided that the union values wages more than employment. In the opposite situation, one rather expects that wages and employment change synchronically.

Collective bargaining is an important aspect of the wage setting process in many EU countries. As institutional differences between countries are generally considered to explain a considerable part of the differences in labour market performance, a bargaining framework may offer a convenient way to estimate the impact of international trade on wages and employment, by assessing differences in bargaining regimes, union power and union preferences.

Given the empirical evidence that unions tend to recruit low-skilled workers disproportionally, a negative impact of globalisation on union bargaining power could explain the weakened labour market position of low-skilled workers.

The different impact of international trade on wages and employment, depending on the bargaining regime and union preferences, could explain the mixed pattern found for EU countries in chapter 2.

3.2 The Empirics

In a review of the evidence on international trade theory Leamer and Levinsohn (1995) suggested not to take trade theory too seriously but not to treat it too casually either.

The first part of the suggestion follows from the need to understand that no theory should be taken as literally 'true' and that it is debatable to claim to 'test' a given theorem with noisy data. Trade theories should be used to 'estimate' certain relationships within a given theoretical framework that suits the specific research domain. With the second part of their suggestion the authors argued that if empirical results are to be enduring, there should be a clear connection between theory and the data (Leamer and Levinsohn 1995: p. 1-2).

Leamer (1998) contended that empirical work should clearly address the aggregation/ heterogeneity problem. The Heckscher-Ohlin model with two production factors and two goods offers clear-cut predictions. As shown in the theoretical section things become a bit more complicated in models with a higher dimension. Production factors and goods can be aggregated to fit a two goods-two factors model but this would mean aggregating heterogeneous goods and factors.

In this section I review the different empirical methodological approaches that have been used to assess the labour market effects of international trade between high-skill abundant countries and low-skill abundant countries. The underlying assumptions and the theoretical framework as well as the strength and limitations of the different methodologies are discussed and the main results are reported.

The empirical work predominately focused on the United States, whereas for Europe only a relatively small number of single country studies and almost no panel studies have been published. Given the substantial differences between the United States and the European Union as well as intra-EU heterogeneity, the results of previous empirical studies cannot simply be generalized for the whole European Union.

In part II, I report the results of own empirical work for a panel of EU countries. In section 3.3, I use the overview of the empirical literature to justify why in part II some empirical procedures have been used and why others have not.

3.2.1 Circumstantial Evidence

From the discussion in section 3.1.1 it follows that a number of predictions can be derived from the Heckscher-Ohlin model. A high-skill abundant country is expected to witness, as a result of falling trade barriers, an increase in its output (and exports) of skill-intensive goods, a fall in the relative prices of low-skill intensive goods, a fall in the wages of low-skilled workers and an increase in the relative employment of low-skilled workers in all sectors. For the 1980s the first and the third prediction seem to be consistent with data for the United States but the evolution of relative prices has been a much-debated issue. Following the Stolper-Samuelson theorem international trade affects factor rewards through changes in relative goods prices.

Lawrence and Slaughter (1993) and Bhagwati and Dehejia (1994) found little evidence in US data of decreased relative prices of low-skill intensive goods for the 1980s and reasoned that this points at other factors than international trade to explain increased wage inequality. Hall (1994) and Neary (2001) uttered that the finding that high-skill intensive goods have not become more expensive is actually not supportive of any theory of structural change, including skill-biased technological change, as technological change that would have displaced low-skilled workers by using cheaper technology should have decreased relative prices of low-skill intensive goods as well.

As discussed in section 3.1.2, Sachs and Shatz (1996) proposed a number of non-Stolper-Samuelson mechanisms through which North-South trade may affect factor rewards without necessarily affecting relative output prices. Apart from the theoretical argument that lack of evidence on relative price changes does not imply that international trade may not have affected relative wages they diagnosed some shortcomings in the Lawrence and Slaughter (1993) analysis. They first objected that the data Lawrence and Slaughter used only covered some 50 sectors and for even a lower number of sectors the data covered the entire period. The import and export price data were not adjusted for productivity or quality changes. Finally, they pointed at the substantial international trade occurring between affiliates of the same firm. International transfer prices may differ from prices set in arms-length transactions.
Moreover, using data on domestic output prices for 450 US manufacturing industries for the period 1978-1989 and additional data on 410 industries for the period 1989-1995, Sachs and Shatz found rather robust evidence that prices in high-skill intensive industries rose more rapidly than prices in low-skill intensive industries, in line with the Heckscher-Ohlin prediction.

Krueger (1997) using data on 150 US manufacturing industries in the period 1989-1995, also found evidence that prices increased relatively less in industries that use low-skilled workers intensively.

Feenstra and Hanson (1996) derived a modified Stolper-Samuelson theorem within a theoretical model explaining foreign outsourcing (see section 3.1.3), linking prices of intermediate inputs, rather than prices of final goods, to factor prices. They reconsidered the evidence by Lawrence and Slaughter (1993) and found that for the countries they considered (Germany, Japan and the United States) domestic prices did indeed increase more than import prices, as predicted by their modified Stolper-Samuelson theorem.

For 450 US manufacturing industries Leamer (1998) found that correlations between price changes and some industry indicators (e.g. capital per worker, non-production workers' employment share) reveal that price changes did not matter for relative wages in the 1960s, lowered the relative wages of production workers in the 1970 whereas in the 1980s it would have been capital that suffered and all labour groups would have gained though he subjoined that these simple correlations are suggestive at best and argued that multiple regressions on factor shares are needed for more reliable conclusions.

Borjas and Ramey (1994) used data from the US Current Population Surveys for the period 1964-1991 to perform cointegration tests on time series of the average wage differential between college graduates and high school dropouts and the average wage differential between college graduates and high school graduates. Relative wages appeared to contain a stochastic rather than a deterministic trend. First differencing or de-trending the data, as done in most previous studies, will eliminate the informative trend component whereas the relevant issue is precisely to find out what causes the long term persistent change in the relative wages. Cointegration tests as proposed by Engle and Granger (1987) establish whether two non-stationary time series share a common stochastic trend. Borjas and Ramey considered a number of potential determinants that could explain changes in relative wages and tried to find out which of these variables is cointegrated with the time series of relative wages: the ratio of college graduates relative to high school graduates, the unemployment rate, percentage of workers that are not member of a union, percentage of immigrants in the population, female labour participation, R&D intensity, net imports of durables as a percentage of GDP and net exports of durables as a percentage of GDP. Throughout the period 1963-1988 imports of durables seemed to be the variable that most closely concurred with relative wages and to a lesser extent also R&D expenditures per worker. The null hypothesis of non-cointegration with relative wages could only be rejected for net imports as a percentage of GDP.

If anything, the empirical studies that tested some of the predictions of the Stolper-Samuelson theorem mainly by looking at simple correlations provided circumstantial rather than conclusive evidence. Clearly, any serious analysis should account for factors that may interact with predicted *ceteris paribus* relationships. Even if relative wages of low-skilled workers would have increased international trade may still have had a negative impact on these wages. The increase would then only indicate that other determinants of wages probably offset this negative impact.

Moreover, by only considering Stolper-Samuelson effects, these studies ignore the non-Heckscher-Ohlin mechanisms, discussed in section 3.1, through which international trade can affect factor rewards.

3.2.2 Decomposition Analysis

Decomposition analysis provided a seemingly sophisticated instrument to test the Heckscher-Ohlin prediction that international trade results in changes between industries rather than changes within industries.

In the Heckscher-Ohlin model trade liberalisation will shift output from industries where a country has a comparative disadvantage to industries where a country has a comparative advantage. As a result employment in the latter industries will increase and employment in the first industries will fall.

Katz and Murphy (1991) used data from the Current Population Surveys over the period 1963-1987, covering some 1.4 million workers in the United States, to distinguish 64 labour groups, classified by gender, four education levels and eight levels of professional experience. Katz and Murphy decomposed employment shifts into a within-industry and a between-industry component. They claimed that the within-industry shift is mainly explained by skill-biased technological change, changes in prices of non-labour inputs and foreign outsourcing.

On the other hand, they explained the between-industry shift by product demand shifts, sector-biased technological change and international trade.
They found that between-industry demand shifts were substantial for the 1960s, 1970s and the 1980s but too modest to outweigh the downward relative wage pressure of the increase in relative factor supply and therefore argued that the within-industry demand shift should explain the observed rise in the US skill premium in the 1980s, especially as the between-industry demand shift slowed down in the 1980s.

Bound and Johnson (1992) proposed a decomposition of the wage changes of different demographic groups into four components to discriminate between four explanations that have been put forward to explain rising US wage inequality in the 1980s: international trade, union power, technological change and labour supply.

Bound and Johnson found little evidence that labour supply changes, product demand shifts (e.g. due to international trade competition) and unions affected relative wages and claimed that their analysis strongly supported the view that skill-biased technological change and changes in unmeasured labour quality were the dominant explanations for the rising wage inequality by education level in the United States in the 1980s.

Berman, Bound and Griliches (1993) decomposed the aggregate change in the employment share of non-production workers into a within-industry term and a between-industry component.
They considered changes over the business cycles 1959-1973, 1973-1979 and 1979-1987, using data on 450 US manufacturing industries from the Annual Survey of Manufacturing.
Imports and exports only appeared to explain 29 per cent of the between-industry component and only three per cent of the within-industry component for the last period.
Assuming that imports displace production workers but not non-production workers and that imports embody the same amount of production labour and no non-production labour Berman, Bound and Griliches found that imports explained only a small part of the change in the employment share of production workers but also found that foreign outsourcing which appeared to be a an important phenomenon in some individual industries (motor industry and semiconductors) could explain more than 100 per cent of the shift away from production workers. Nonetheless, they argued that foreign outsourcing was too restricted to some specific

industries to explain a large part of the skill upgrading that occurred in US manufacturing in the 1970s and 1980s.

Berman, Bound and Machin (1998) decomposed the employment and wage bill shares of non-production workers for twelve OECD countries for the 1970s and the 1980s. Their results suggested that the finding for the United States of skill-biased technological change as the dominant explanation for skill upgrading seemed to hold for most OECD countries as the within-industry component clearly dominated the between-industry component. OECD (1998) provided similar evidence for OECD countries with more pronounced conclusions if skill groups were proxied by education level rather than by occupation (production/ non-production).

Bernard and Jensen (1997) decomposed the share of non-production workers in total employment or their share in the total wage bill but instead of using industry level data used plant level data from the Annual Survey of Manufactures of the US Census Bureau for the period 1976-1987, covering some 50.000 manufacturing plants.
The data supported the view that an industry level analysis ignores substantial heterogeneity across plants and their results suggested that demand changes across plants, associated with exports, were a major source for rising wage inequality whereas skill-upgrading due to technological change did not appear to be a important determinant of employment shifts across plants.

With Cline (1997: p. 54) I believe that a decomposition analysis, though seemingly providing a meticulous and exhaustive demonstration of the impact of international trade and technological change, is a rather mechanical accounting method, resting on a number of assumptions that are not tested and attributing the entire unexplained residual to technological change. Most industry level data undoubtedly conceal a high degree of intra-industry heterogeneity, which makes decomposing changes into between-industry and within-industry terms rather uninformative. Moreover, when accounting for foreign outsourcing and other mechanisms, international trade can explain within-industry changes as well as between-industry changes.

3.2.3 Factor Content Calculations

Factor content calculations are probably the most controversial empirical methodology to assess the impact of international trade on labour markets.

The main idea is that trade flows embody the production factors required to produce the traded goods and that from this factor content the impact on labour demand (or supply) can be estimated.

Borjas, Freeman and Katz (1991) mapped trade flows into equivalent production factors, using data on the labour input in domestic manufacturing industries in the United States for the 1980s. They focused on the direct labour supply, thus ignoring indirect effects through input-output linkages.

The labour supply equivalent of trade flows of labour group *i* in year *t* is:

$$L_{it} = \sum_{j} \left(\frac{T_{jt}}{Q_{jt}} \right) a_{ij} L_{jt} \tag{3.21}$$

Where L_{it} denotes the total amount of labour group *i* required to produce output and T_{jt}, Q_{jt}, L_{jt} and a_{ij} denote respectively trade flows, output, labour input and the average proportion of workers in the *i*-th group in industry *j*. Borjas, Freeman and Katz considered equation (3.21) in which international trade is assumed to affect production and non-production workers in a similar way but alternatively considered a specification in which imports are assumed to affect production workers only. Using Current Population Surveys data for the period 1964-1988 they divided workers into 64 groups based on gender, four education levels and eight experience levels.

The results suggested that in the 1960s and the 1970s international trade did not affect workers substantially. In the 1980s, when the United States witnessed an increasing trade deficit, trade substantially increased the supply of workers with little education (i.e. high school dropouts). Under the assumption that imported goods reduce employment of production workers more than employment of non-production workers Borjas, Freeman and Katz regressed the change in the employment share of production workers on the change in imports relative to the sum of imports and sales, the change in the ratio of exports to sales and the change in sales. Following the results of these regressions for the period 1960-1985, changes in import ratios reduced the employment share of production workers whereas the change in the export ratio did not seem to have a significant impact.

Estimations suggest that trade as well as immigration altered the relative supply and thereby explain a substantial part of the observed decrease in the relative wages of high school dropouts in the 1980s.

Sachs and Shatz (1994) performed factor content calculations on 51 manufacturing industries, using input-output data from the US Department of Commerce. The results suggested that the rise in imports from developing countries in the period 1978-1990 caused a decrease of 6.2 per cent in production employment and a decrease of 4.3 per cent in non-production employment relative to the 1978 manufacturing employment level. The impact of trade with developed countries on employment was more modest. Aggregating the 51 manufacturing industries into deciles according to skill intensity (production workers' share) furthermore clearly indicated that low-skill intensive industries witnessed the sharpest decline in employment. Employment in the most skill intensive decile of industries increased due to trade.

In the undoubtedly most elaborated and most debated factor content calculations of trade between industrialised and industrialising countries, Wood (1994) stated that previous factor content calculations underrated the impact of North-South trade as in most of these studies imports were assumed to affect low-skilled and high-skilled workers in an equal way whereas he assumed that imports from developing countries were non-competing (i.e. not produced in developed countries anymore)[14]. Using domestic labour input coefficients therefore underestimates the low-skill labour content of imported goods, which will be more low-skill intensive than the goods produced in high-skill abundant countries. Wood recalculated the US factor content estimations by Sachs and Shatz (1994) for a panel of developed countries, using labour input coefficients of developing countries rather than the domestic labour input coefficients of developed countries to estimate the labour content of imports. The results for 1990 suggested that the relative demand for workers with little education decreased by more than 20 per cent whereas the Sachs and Shatz estimate indicated a modest 2 per cent decrease. Wood considered even these estimates to be biased downward as they ignore trade-induced technological change. Accounting for defensive innovation by firms in developed countries doubled the labour content estimates.

14 An implication of Wood's argument that imports from the South are non-competing seems to be that all harm has been done and that further trade liberalisation will have no impact on labour markets in the North but will rather lift all boats, unless Southern countries would catch up with the relative factor endowment or technological level of Northern countries so that they can start to compete in more skill-intensive goods.

As mentioned in section 3.1.1.2, Acemoglu (1999), Dinopoulos and Segerstrom (1999), Chusseau (2002), Ethier (2002) and Thoenig and Verdier (2003) provided a theoretical foundation for Wood's argument of trade-induced technological change.

Lawrence (2000) used data on US manufacturing industries in the period 1978-1989 to estimate the impact of international trade competition on total factor productivity and the skill ratio. Import competition of developing countries appeared to have induced faster TFP growth in US industries though the results were rather sensitive with respect to the specification and estimation procedure and there were indications of a causal relationship between trade competition and technological change that runs in both directions (Lawrence 2000: p. 216).

Burtless (1995) perceived some inconsistency between Wood's argument of non-competing imports and technological change induced by North-South trade. If imports from developing countries would be fully non-competing there would not be much pressure from these imports on firms in developed countries to save on low-skilled workers.

To find out to which extent international trade induced wage inequality Sachs and Shatz (1994) summed up some factors that make this kind of analysis more complicated than plain factor content calculations. First of all, manufacturing employment represents a small share of the total labour force. Labour markets tend to be segmented, not only between manufacturing and non-manufacturing, but even within manufacturing and wages are, in addition to general equilibrium market forces, also determined by rents, union bargaining and disequilibria, which may be enduring. Details on workers and industry characteristics should also be accounted for. Sachs and Shatz reasoned that even if one assumed labour markets were fully integrated, a 10 per cent decrease in the demand for low-skilled workers would only imply a small impact on the economy-wide demand for low-skilled workers and that the observed employment effects of international trade seem too modest to explain the large increase in wage inequality (Sachs and Shatz 1994: p. 33).

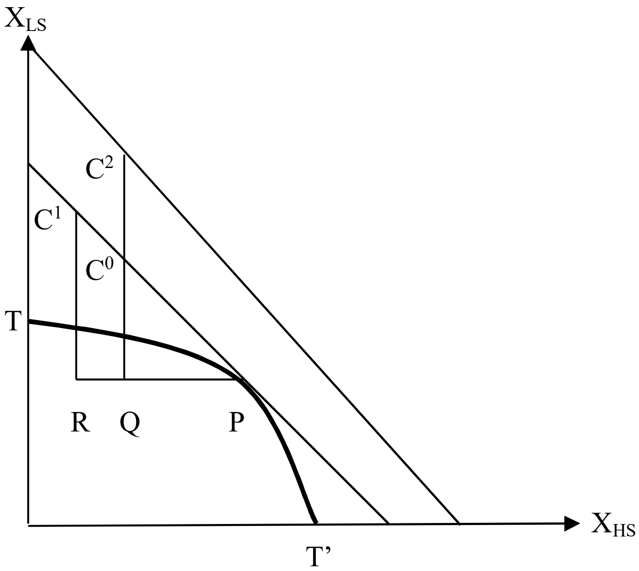
In contrast with most circumstantial evidence and the results of decomposition analysis, a number of factor content calculations suggested a substantial impact of international trade on labour markets, with Wood (1994) claiming that international trade was by far the dominant determinant.

However, the approach has been criticised ardently by some Major-League trade economists for its lack of theoretical justification (e.g. Bhagwati and Dehejia 1994; Deardorff 1994 and Leamer 1996 b).

Bhagwati and Dehejia (1994) showed how factor content calculations may erroneously lead to the conclusion of increased factor content and inferred changes in relative wages. This is shown in figure 3.16.

In a high-skill abundant country, initially, production occurs at P and consumption at C^0. QP of X_{HS} is exported for QC^0 of imports of X_{LS} (i.e. trade is balanced). If a change in taste would shift demand toward C^1 exports will increase to RP and imports to RC^1. Bhagwati and Dehejia argued that factor content calculations would pick up this shift as an increase in the supply of L_{LS} and infer a decrease in the relative wage of low-skilled workers.

Figure 3.16: Factor Content of International Trade



Source: Adapted from Bhagwati and Dehejia (1994).

However relative product prices would not have changed and hence, following the Stolper-Samuelson theorem, relative wages would not have changed. Similarly, if the high-skill abundant country would run a trade deficit by importing C^0C^2 more of X_{LS} than exports allow for, factor content calculations would again erroneously suggest a change in relative wages in spite of constant relative product prices.

Deardorff (1994 a) granted that factor content calculations could be correct but do not establish any causation and are bothersome in that trade is assumed to be exogenous. Coincidence does not imply causation as many exogenous changes, domestic or foreign, may equally have caused the observed changes in trade and wages.

Panagariya examined the assumptions needed to justify the use of the factor content approach: identical elasticities of substitution across all production functions and the utility function; no increasing returns; no non-competing imports; homotheticity of demand and no endogenous response of factor supplies to trade. Although he admitted that the question whether the factor-content calculations are anything to go by cannot be answered unambiguously he argued: "*Personally, I take a skeptical view of the approach: the assumptions required to implement it are much too strong to inspire confidence in the estimates it generates*". (Panagariya 2000: p. 94).

In my view the assumptions required for factor content calculations to be trustworthy are indeed very exigent.

3.2.4 Reduced Form Regressions

Following Grossman (1987), who proposed a model in which the impact of import competition on both wages and employment is estimated under the assumption that production factors are not perfectly mobile across sectors, Revenga (1992) regressed wages and employment on import prices for a panel of US manufacturing industries in the 1980s. Instrumental variables estimation suggests that the appreciation of the dollar, in the period 1980-1985, had a substantial impact on both wages and employment.

Dewatripont, Sapir and Sekkat (1999) estimated the impact of trade between EU countries and developing countries on relative wages and employment but contrary to Revenga distinguished low-skilled workers from high-skilled workers. They used a system of two simultaneous equations, one with the relative employment of low-skilled (manual) workers and one with the relative wages as dependent variable. Data on wages and employment were used to construct a panel of 14 two-digit sectors for Belgium-Luxembourg, Denmark, Germany and the United Kingdom in 1981, 1984 and 1988. The coefficient of import penetration in the relative employment equation is not significant, the coefficient of exports is positive and significant at the 10 per cent level in a specification with sector dummies. The coefficient of imports from developing countries in the relative wage equation was significant at the 5 per cent level when no sector dummies were used and at the 10 per cent level when sector dummies were used. The authors to their own surprise found indications that trade with developing countries would have affected relative wages rather than relative employment whereas the stylised facts show that, on average, for the considered years relative employment changed more considerably than relative wages in the five EU countries.

Oscarsson (2000) modelled the output in a sector producing importable goods by a Cobb-Douglas production function with Hicks-neutral technological change to derive the demand for the production factors. Apart from capital, low-skilled labour (production workers) and high-skilled labour (non-production workers) she also considered energy, assumed to be a traded input with an exogenously determined price. Capital and labour were considered to be imperfectly mobile between sectors, even in the long run.
The output of a sector substitutes imperfectly for the import good. The system of equations results in reduced form equations for the employment and wages of low-skilled and high-skilled workers. The impact of international trade is measured through the price of import goods, including an ad valorem tariff. Import penetration, defined as the imported value relative to sales per sector is also considered. Oscarsson used data on 63 Swedish manufacturing sectors at the four-digit level for the period 1975-1993. Given the small time span the data were pooled, imposing the restriction that elasticities are equal across sectors. Estimation results indicated that decreasing import prices decreased employment of both production and non-production workers but the impact surprisingly was larger for non-production workers. On the other hand, import competition depressed wages of production workers but had no significant impact on wages of non-production workers. The employment effects were larger than the wage effects, which Oscarsson attributed to low wage flexibility and the active labour market policy in Sweden. Technological change appeared to have decreased employment of both labour groups in manufacturing, without any bias, though it had a significant positive impact on the wages of non-production workers and no significant impact on the wages of production workers.

Reduced form regressions are, as granted by Dewatripont, Sapir and Sekkat (1999) not very *structural*. They account for the interaction between labour supply and demand but do not specify the theoretical framework that links international trade to the labour market.

3.2.5 Mandated Wage Regressions

Most of the early empirical studies merely encircled the Stolper-Samuelson theorem and therefore only provided circumstantial rather than decisive evidence on the limited role of international trade in explaining rising wage inequality.

Leamer argued that multiple regressions are needed to provide more reliable conclusions.

Leamer (1996 a) proposed the mandated wage regression procedure, which is as closely linked to the Stolper-Samuelson theorem as possible.

Starting from the Heckscher-Ohlin assumption of perfect competition, which implies that there are no long-run supernormal rents, Leamer considered the zero profits condition for a given industry:

$$p_i = \sum_m w_m a_{mi} \tag{3.22}$$

with p_i the domestic product price in sector *i*, w_m the reward of factor *m* (the same across industries given the assumption of inter-sector factor mobility) and a_{mi} the input of factor *m* per unit of output.

Differentiating (3.22) gives:

$$dp_i = \sum_m \left(w_m da_{mi} + dw_m a_{mi}\right) \tag{3.23}$$

and dividing (3.23) by p_i:

$$\frac{dp_i}{p_i} = \sum_m \left[\frac{w_m da_{mi}}{p_i} + \left(\frac{w_m a_{mi}}{p_i}\right)\left(\frac{dw_m}{w_m}\right)\right] = \sum_m \theta_{mi}\frac{dw_m}{w_m} + \sum_m \theta_{mi}\frac{da_{mi}}{a_{mi}} \tag{3.24}$$

where $\theta_{mi} = w_m a_{mi} / p_i$ denotes the cost share of factor *m* in industry *i*.

As physical input per unit output a_{mi} is given by v_{mi}/ Q_i we know:

$$\frac{da_{mi}}{a_{mi}} = \frac{dv_{mi}}{v_{mi}} - \frac{dQ_i}{Q_i} \tag{3.25}$$

and

$$\frac{dQ_i}{Q_i} - \sum_m \theta_{mi} \frac{dv_{mi}}{v_{mi}} = -\sum_m \theta_{mi} \frac{da_{mi}}{a_{mi}} = TFP_i \tag{3.26}$$

This finally results in the relationship between product price changes, factor rewards changes and total factor productivity (Leamer 1996 a: p. 23):

$$\frac{dp_i}{p_i} = \sum_m \theta_{mi} \frac{dw_m}{w_m} - TFP_i \tag{3.27}$$

or in value-added price changes[15]:

$$\frac{dp_i^{VA}}{p_i^{VA}} = \frac{dp_i}{p_i} - \sum_j \gamma_{ij} \frac{dp_j}{p_j} = \sum_m \theta_{mi} \frac{dw_m}{w_m} - TFP_i \tag{3.28}$$

With γ_{ij} the amount of product *j* used in the production of product *i*.

If the product price changes plus total factor productivity are regressed on the factor cost shares θ_{mi} Leamer reasoned that the estimated coefficient can be interpreted as the change in the factor reward of the respective input factor *m* that is "mandated" by product price changes or technological change in order for the zero profit condition to hold.

Leamer noted that, trusting in equation (3.27), the sector bias of technological change seems to matter, not the factor bias. As mentioned in section 3.1.1.2, Krugman (1995 a) argued that this

[15] Strictly, equation (3.27) only holds for continuous changes. For discrete changes second order effects need to be accounted for, resulting in the following general equilibrium relationship (Leamer 1996 a: p. 24):

$$\frac{dp_i}{p_i} = \sum_m \theta_{mi} \frac{dw_m}{w_m} - TFP_i + \sum_m \left[\left(\frac{a_{mi} w_m}{p_i} \right) \left(\frac{da_{mi}}{a_{mi}} \right) \left(\frac{dw_m}{w_m} \right) \right]$$

Following this equation the factor bias could matter through the second order effects.

view rests upon the assumption that the considered country is small and technological change local.

Leamer allowed for the fact that the considered country could be large or technological spillovers international in scope by considering a pass-through of technological change to product prices.

To disentangle the impact of international trade from the impact of technological change Leamer split equation (3.27) in a "technology" equation and a "globalisation" equation:

$$\frac{dp_i}{p_i}(t) = \sum_m \theta_{mi} \frac{dw_m}{w_m}(t) - TFP_i \tag{3.29}$$

$$\frac{dp_i}{p_i}(g) = \sum_m \theta_{mi} \frac{dw_m}{w_m}(g) \tag{3.30}$$

$\frac{dw_m}{w_m}(t)$ reflects the part of the changes in factor rewards that are "mandated" by changes in domestic product prices due to technological factors and $\frac{dw_m}{w_m}(g)$ reflects the part of the changes in factor rewards that are "mandated" by changes in domestic product prices due to globalisation forces (e.g. import competition of the NIC) . The procedure thus decomposes the link between product prices and factor prices into a component explained by international trade and a component explained by technological change.

Leamer proposed to assume a common pass-through of technological change (λ) to product prices which denotes the portion of product price changes explained by productivity changes:

$$\frac{dp_i}{p_i}(t) = -\lambda TFP_i \tag{3.31}$$

A pass-through close to zero can be expected for a small open economy and local technological change whereas a pass-through close to one would suggest that the country is large enough to affect product prices or that international technology spillovers are substantial.

The factor bias can matter if it induces sector-biased price changes but these induced price changes are not inevitable according to Leamer, if the demand for non-tradables would be very elastic and the workers freed by technological change from tradables production could easily be absorbed by the non-tradables sector without necessitating changes in tradable goods prices.

Considering intermediate inputs the change in value-added prices is given by:

$$\frac{dp_i^{VA}}{p_i^{VA}} = \frac{dp_i}{p_i}(t) - \sum_j \gamma_{ij} \frac{dp_j}{p_j}(t) = -\lambda TFP_i \tag{3.32}$$

In equation (3.32) it is assumed that technological change only affects value-added prices. Leamer granted this to be a strong assumption as it ignores the possibility of technological progress in one sector to have forward and backward (input-output) effects, which may alter the demand for intermediate inputs. For a fully satisfactory analysis a worldwide general equilibrium input-output model is needed. Lack of such a practicable model Leamer's empirical analysis assumes that second-order effects are small, the TFP pass-through is common to all sectors and applies only to value-added prices and that the factor bias in technological change does not induce any sector-biased price changes because the non-tradables sector absorbs the production factors saved in the tradables sector.

The impact of technological change and globalisation can be estimated separately:

$$(1-\lambda)TFP_i = \sum_m \theta_{mi} \frac{dw_m}{w_m}(t) + \varepsilon_i^t \tag{3.33}$$

and

$$\frac{dp_i^{VA}}{p_i^{VA}} + \lambda TFP_i = \sum_m \theta_{mi} \frac{dw_m}{w_m}(g) + \varepsilon_i^g \tag{3.34}$$

Leamer estimated equations (3.33) and (3.34) for 450 US manufacturing industries for the decades 1961-1971, 1971-1981 and 1981-1991.

An additional assumption in applying these regressions is that the rewards of different skill labour groups do not differ across industries. If furthermore each sector's skill intensity were assumed to be constant over time, changes in the distribution of factor rewards across sectors would be explained by changes in the rewards of the different skill groups. Leamer found some indications in the data that these assumptions are not too unworldly. Data on different skill groups would permit for an estimation that does not impose the assumption of fixed skill intensity but Leamer did not trust the usual measures used to proxy skill. He argued, as did Mishel and Bernstein (1994), that the often-used distinction between production and non-production workers is too broad and heterogeneous to be very useful.

Leamer estimated the mandated wage specification, alternating the pass-through to be zero and one. He split labour into high-wage and low-wage labour. The results suggested that the wages of low-wage workers were under pressure from globalisation in the 1970s but globalisation would have mandated an increase in their wages in the two other decades. This finding seems robust to whether the pass-through is set at zero or at one though the other results were more sensitive to the choice of pass-through. If the pass-through was set at zero, high-wage workers appeared to have suffered from globalisation in the 1970s and gained in the 1980s. If the pass-through was set at one this conclusion was reversed. Changes in the wages of high-wage and low-wage workers appeared to be explained dominantly by globalisation and to a lesser extent by technological change, with the share explained by globalisation up to 95 per cent and higher for estimations with the pass-through set at one.
Despite the low trust he had in the production/ non-production workers distinction Leamer also estimated equation (3.33) and (3.34) using this proxy. The results clearly differed from the estimation with the high-wage/ low-wage split and suggested that the "mandated" wages of non-production workers (proxy for high-skilled workers) increased in all three decades and the mandated wages of production workers decreased in the 1970s and the 1980s. Following the zero pass-through estimation the drop in the production workers' wages can be explained by technological change whereas following the full pass-through estimation it would be explained by globalisation. The share of the change in the wages of production and non-production workers that would be explained by globalisation ranged from 19 per cent up to 62 per cent for the zero pass-through estimation and from 55 per cent up to 96 per cent for the full pass-through estimation.

In the analysis of Leamer changes in the supply of production factors do not matter as the Rybczynski theorem (or Factor Price Insensitivity theorem) is assumed to hold, i.e. at given product prices a change in the factor supply will induce a shift in the domestic production mix without affecting factor prices. Labour demand is infinitely elastic. The Rybczysnki theorem strictly only holds if the country considered is too small to affect product prices. Yet, by considering a pass-through of technological change to product prices Leamer did not exclude the possibility that the country is large enough to affect product prices. In this case, factor supply changes matter (Rybczynski 1955). Cline (1997) distrusted an analysis in which a country like the United States is considered as a small country and the developing countries as an infinite world market. Moreover, as the Stolper-Samuelson theorem holds in the long run, the analysis focused on changes over a decade. The shift in factor supplies over such a relatively long period may be large enough to result in an equilibrium point on the downward-sloping part of the relative demand curve, i.e. the part where changes in factor supply do affect factor prices.

Baldwin and Cain (1997) pointed at the lack of good measures of exogenous technological change and the fact that the components of the TFP measure are endogenous to the price setting process. They therefore argued against the use of technology measures in price regressions and considered the following regression equation (Baldwin and Cain 1997: p. 13):

$$\frac{dp_i}{p_i} = \sum_m \theta_{mi} \frac{dw_m}{w_m} \tag{3.35}$$

Equation (3.35) only holds under unchanged technological conditions.
Baldwin and Cain granted that rather strong assumptions are required for this equation to be a well-specified regression (e.g. unchanged constant returns-to-scale technology) but argued that the equation can be useful to test some of the hypotheses within the Heckscher-Ohlin model.

Lack of good measures of exogenous technological change, Baldwin and Cain proposed to infer from the theoretical model, biases in the regression coefficients of the factor shares, by accounting for assumed domestic technological changes. They considered three additional variables: the economy-wide output of high-skill intensive industries relative to the output of low-skill intensive industries; the within-industry ratio of high-skilled workers relative to low-skilled workers and the economy-wide trade surplus relative to domestic consumption.

Baldwin and Cain compared theoretical assumptions with stylised facts about relative product prices, relative output, relative employment and relative wages to infer which theoretical explanation is most consistent with empirical facts.

Table 3.1 summarizes the theoretical assumptions on the impact of changes in relative supply, increased import competition and technological change in a two-factors (low-skilled labour L_{LS} and high-skilled labour L_{HS}) and two-goods (high-skill intensive good X_{HS} and low-skill intensive good X_{LS}) in which a skill-abundant country is considered to be large enough to affect its terms of trade.

Table 3.1: Effects in a Two-Factors and Two-Goods Heckscher-Ohlin Model for a Large Skill-Abundant Country

	$\frac{P_{X_{HS}}}{P_{X_{LS}}}$		$\frac{Q_{X_{HS}}}{Q_{X_{LS}}}$		$\frac{L_{HS}}{L_{LS}}(\text{coef})$		$\frac{W_{HS}}{W_{LS}}$	
	Fixed labour coefficients	Factor substitution	Fixed labour coefficients	Factor substitution	Fixed labour coefficients	Factor substitution	Fixed labour coefficients	Factor substitution
Increase in relative supply L_{HS} / L_{LS}	-	-	+	+/-	0	+	-	-
Increase in import competition in X_{LS}	+	+	0	+	0	-	+	+
SBTC in both sectors	+	+	-	-/+	+	+/-	+	+
Neutral technological change in X_{HS}	-	-	+	+/-	0	-/+	+/-	+/-

Source: Baldwin and Cain (1997).

The table considers the impact on the relative price of the high-skill intensive good (first column), on relative output (second column), the coefficient of high-skilled to low-skilled labour in production (third column) and the relative wages of high-skilled workers (last column), assuming either that relative factor intensity is fixed or alternatively that factor substitution is possible.

As table 3.1 shows, if factor substitution is possible, the impact of trade competition is observationally equivalent to the impact of skill-biased technological change (as explained in section 3.1.1.2). The fact that skill intensity actually appears to have increased in most sectors has often been considered to support the view that skill-biased technological change is probably the dominant explanation, as the predicted impact on skill intensity discriminates between import competition and SBTC, as shown in the third column.

The regression results of Baldwin and Cain for US industries were, for the period 1963-1973, apparently consistent with the explanation of an increase in the relative supply of high-skilled workers decreasing the wage gap.

For the 1980s and the 1990s the observed increase in the wage gap between highly educated and less-educated workers did seem to be explained by skill-biased technological change rather than by import competition although estimation results suggested that the decrease in the wages of workers with less than 12 years of education could have been caused by an increase in import competition.

Feenstra and Hanson (1997, 1999) have shown that a mandated wage regression provides consistent estimates given two conditions. The first condition is that the dual measure of total factor productivity is used and the second that there is no correlation between industry-specific factor rewards and industry-specific factor shares. Given the high correlation between primal and dual measures of total factor productivity the last condition is the most crucial. If the latter condition is not met the regression will have an omitted variable bias. The omitted variable bias can however be measured using available data and the mandated wage regression can therefore account for this bias. Feenstra and Hanson proposed a two-step expansion of the mandated wage regression procedure proposed by Leamer (1996 a).

Feenstra and Hanson considered the value added price regression equation (3.30) derived by Leamer (1996 a). If a dual TFP measure (log change in product prices minus cost-shares weighted change in factor rewards) is used this equation will hold as an identity. Given the duality between production functions and cost functions, the more often used primal TFP measure (growth of value-added minus weighted average growth of input factors) is theoretically equal to the dual TFP measure and Feenstra and Hanson (1999: p. 910) found for the United States in the period 1979-1990, the correlation between both measures to be 0.99 so that using a primal TFP instead of a dual TFP will have a negligible effect.

To obtain a regression equation rather than an identity, Feenstra and Hanson assume that wages are random variables over industries with a mean, over all industries, of ω_m.
If this mean is introduced in (3.28) to replace dw_m/w_m there will be a residual term e_i which will equal the average deviation of industry-specific wages from the cross-sector average (Feenstra and Hanson 1999: p. 910-911)[16]:

$$\frac{dp_i^{VA}}{p_i^{VA}} = \sum_m \theta_{mi}\omega_m - TFP_i + \sum_m \theta_{mi}\left(\frac{dw_{mi}}{w_{mi}} - \omega_m\right) \tag{3.36}$$

Feenstra and Hanson argued that the last term in (3.36) is usually treated as a residual in price regressions although data are available to measure this term. As main source for inter-industry wage differentials the authors considered variation in the quality of production factors. With the residual term measured, effective TFP is defined as TFP minus this residual term:

$$ETFP_i = TFP_i - \sum_m \theta_{mi}\left(\frac{dw_{mi}}{w_{mi}} - \omega_m\right) \tag{3.37}$$

This can be used in equation (3.36):

$$\frac{dp_i^{VA}}{p_i^{VA}} = \sum_m \theta_{mi}\omega_m - ETFP_i \tag{3.38}$$

Equation (3.38) is now an identity and regression will result in estimates of ω_m equal to the actual changes in factor rewards. To turn this identity into a useful estimation of the impact of international trade and technological change on factor rewards, Feenstra and Hanson proposed to estimate the impact of possible determinants of product price changes and technological change by regressing value-added price changes, respectively effective TFP, on a set of structural variables (Feenstra and Hanson 1999: pp. 915-916):

16 θ_{mi} is the average cost share over the period taken as the begin of period plus the end of period value, divided by two.

$$\frac{dp_i^{VA}}{p_i^{VA}} = \lambda ETFP_i + \alpha' dZ_i + \varepsilon_i^p \tag{3.39}$$

$$ETFP_i = \tau' dZ_i + \varepsilon_i^T \tag{3.40}$$

Z_i is the vector of structural variables and λ the TFP pass-through. The total impact of the structural variables on price changes and technological change is then estimated by Feenstra and Hanson, combining (3.39) and (3.40) in the following first-step regression:

$$\frac{dp_i^{VA}}{p_i^{VA}} + ETFP_i = \gamma' dZ_i + \varepsilon_i^{p+T} \tag{3.41}$$

With $\gamma = (1+\lambda)\tau + \alpha$ and $\varepsilon_i^{p+T} = (1+\lambda)\varepsilon_i^T + \varepsilon_i^p$.

Feenstra and Hanson considered each $\hat{\gamma}_k' dZ_{ik}$ as the part of the change in value-added prices and technological change that can be explained by the change in the *k*-th structural variable of the vector Z_i. Each of these K components, generated by multiplying the estimated first-step estimates with the respective *k*-th structural variable is regressed separately in the second step on the cost shares of the production factors:

$$\hat{\gamma}_k dZ_{ik} = \sum_m \theta_{mi} \omega_m^K + \varepsilon_i^K \tag{3.42}$$

The estimated second-step coefficients $\hat{\omega}_m^K$ are then interpreted as the change in the reward of input factor *m* explained by the *k*-th structural determinant.

Feenstra and Hanson showed that by allowing, in equation (3.39), the structural variables to affect value-added price changes over and above the impact of structural variables on TFP in equation (3.40), it is possible to discriminate between the factor bias and the sector bias of technological progress (see Krugman-Leamer debate in section 3.1.1.2).

Assuming Cobb-Douglas preferences, Hicks-neutral technological progress in any given industry would result in offsetting price changes and factor rewards would not be affected (see section 3.1.1.2). In equation (3.39) the pass-though estimate should then be close to –1 and the estimates of α close to zero, at least for those structural variables that are unlikely to have a direct impact on product price changes. If technological progress is biased in favour of high-skilled workers, as pointed out in section 3.1.1.2, Krugman (1995 a) showed that the relative wage of high-skilled workers would increase whereas the impact of the sector bias depends on whether elasticity of substitution equals one or is below one[17]. The factor bias will induce a change in product prices above the offsetting price change due to technological progress and so even under full pass-through (λ = -1) the estimates of α need not equal zero in estimating equation (3.39). For those variables that may have a direct impact on product price changes as well as on technological change the estimates of α will give the combined effect of the direct impact and the factor bias. Feenstra and Hanson (1997, 1999) stressed the difference between their approach and Leamer (1996 a) who did not consider any additional structural variables as he assumed that only the sector bias mattered.

Feenstra and Hanson applied the proposed two-step mandated regression on 450 US manufacturing industries for the period 1979-1990. They used the distinction production/ non-production to proxy low-skilled/ high-skilled workers, acknowledging the problem with this proxy but referring to evidence by Berman, Bound and Griliches (1993) and Sachs and Shatz (1994) that using this proxy results in similar trends as using skill groups. They considered high-tech capital, respectively computer equipment relative to total capital and computer investment relative to total investment as structural variables as well as variables reflecting the degree of foreign outsourcing, with outsourcing defined as imported intermediate inputs relative to total intermediates (see section 3.1.2). They distinguished foreign outsourcing in the narrow sense (intermediate inputs imported from the same two-digit industry) from foreign outsourcing in the broad sense (all imported non-energy intermediate inputs). They first estimated equation (3.39) and found a significant estimate of –1.01 for the TFP pass-through. They pointed out that as effective TFP is, by construction, correlated with value-added price changes the OLS will be biased toward –1. An instrumental variable estimation, which in principle could deal with the endogeneity problem, is hindered by a lack of valid instruments, as the best candidate instruments are the structural variables, which are however correlated with value-added price changes. A test of over-identifying restrictions indeed suggests that the

17 Feenstra and Hanson (1999: p. 919) quoted the more general relationship between factor-biased technological change and factor rewards changes proposed by e.g. Xu (1998) but these studies do not provide a convenient closed form solution to specify the impact of the factor bias on product price changes.

structural variables are poor instruments. To resolve the problem of a consistent estimate of the pass-through coefficient Feenstra and Hanson (1997, 1999) estimated the reduced form equation (3.41). The estimated coefficients of this first-step are then used to generate the dependent variables in (3.42). As the regressands in the second-step regressions are generated from first-step estimates the standard errors of the second-step regressions need to be corrected for additional variance resulting from the use of generated regressands. In the appendix to Feenstra and Hanson (1997) a correction procedure was proposed, which has been applied in Feenstra and Hanson (1997, 1999). Unfortunately, the proposed correction does not warrant positive variance and as a result standard errors cannot always be computed. Dumont, Rayp, Thas and Willemé (2003) have shown that this correction procedure suffers from a negative bias and thus tends to overestimate the significance of the second-step coefficient estimates.

The estimates of Feenstra and Hanson (1999) suggested that foreign outsourcing could explain 15 per cent and the computer share 35 per cent of the increase in the relative wages of non-production workers. However, using some alternative measures for the high-tech share and the computer share results in a higher estimate of the contribution of foreign outsourcing and a lower- in some cases even insignificant- contribution of the computer and high-tech shares.

Haskel and Slaughter (2001) applied a two-step mandated wage regression to a panel of 135 UK industries in the period 1973-1986. They considered a large set of structural variables using data on effective tariff protection, transportation costs, import prices for three country groups and industry concentration for the price regression and data on innovativeness, industry concentration, union density, computer use and relative foreign prices for the TFP regression. They used the manual/ non-manual distinction to proxy low-skilled/ high-skilled workers and estimated separately the first-step price regression and the first-step TFP regression but did not consider a TFP pass-through in the price regression[18]. The first-step estimates were then used to generate the structural variables' respective contribution to product price changes and productivity growth, used as the dependent variables in the second-step estimation. The second-step TFP regressions indicated that the change in domestic product prices relative to product prices in Newly Industrialised Countries mandated a significant increase in the relative wages of high-skilled workers in the 1970s. By considering foreign product price changes, Haskel and

18 They did estimate a first-step price regression with TFP as a regressor and estimated the pass-through to be –0.62 but as its mandated impact was not significant they concluded that productivity growth did not affect factor rewards through price changes.

Slaughter accounted for the possibility of trade-induced technological change, for which they found evidence. The impact of computers was not found to be significant.
In the first-step price regression, changes in OECD prices and NIC prices significantly affected UK product prices, as did tariffs and transportation costs. The second-step regressions for the determinants of value-added price changes showed for the 1980s that price changes of OECD countries, price changes of non-OECD countries, price changes of NIC and changes in effective tariffs all increased wage inequality but only the impact of OECD prices and tariff changes were significant.
Haskel and Slaughter also estimated one-step mandated wage regressions (i.e. price changes and TFP considered exogenous), which would be more appropriate if the United Kingdom can be assumed to be a small open economy. These estimations suggested that international trade had been the dominant explanation of rising UK wage inequality.
So the results seem to incriminate international trade more substantially under the small open economy assumption, which seems reasonable for the United Kingdom. However, as pointed out by Feenstra and Hanson (1999), assuming productivity growth as exogenous does not only imply that one assumes the considered country to be small but also that technological change is a local phenomenon, an assumption that somehow seems less realistic.
Haskel and Slaughter (2003) performed two-step mandated wage regressions for some 425 US manufacturing industries, using data on tariffs and transportation costs but failed to find much evidence of a significant impact of falling tariffs and transportation costs on wage inequality in the 1970s or 1980s.

Cuyvers, Dumont, Rayp and Stevens (2003) and Cuyvers, Dumont and Rayp (2003) applying the two-step mandated wage estimation procedure to a panel of nine EU countries for the period 1985-1996 also found little evidence of Stolper-Samuelson effects. Import competition of (South-) East Asian NIC significantly induced technological progress but this effect somewhat surprisingly appeared to have mandated a decrease in the relative wages of non-production workers.

Slaughter (2000) pointed out that although he considered the mandated wage procedure to be a major improvement over earlier empirical methodologies there were still a number of caveats in answering the key question of how much international trade has contributed to rising wage inequality.

Results of product-price studies appear to be rather sensitive to the number of industries that are considered. The Stolper-Samuelson theorem applies to the overall economy so normally all industries should be considered in the empirical analysis. However, if one wants to assess the impact of international trade on price changes, limiting the sample to industries that produce tradable goods could be justified (Slaughter 2000: p. 152).
The results of product-price studies also seem to be relatively sensitive to whether regressions are weighted (e.g. Leamer 1996 a; Feenstra and Hanson 1997 and Baldwin and Cain 1997) or not and to the period that is considered but rather robust to the level of data aggregation or measures used to proxy the skill level (Slaughter 2000: pp. 156-158).

As mentioned in section 3.1.1.4, the Stolper-Samuelson theorem is rather robust to relaxing a number of restrictive assumptions of the Heckscher-Ohlin model (e.g. no technological differences across countries) and the correlation version of the theorem proposed by Ethier (1984) seems a logical starting-point for the empirical assessment of the impact of trade with low-skill abundant countries on the skill premium in high-skill abundant countries, within a multidimensional economy (i.e. many products and more than two production factors).
The two-step mandated wage regression procedure is more closely linked to the Stolper-Samuelson theorem than most previous empirical methodologies and the multiple regression feature yields less circumstantial conclusions and permits to test the significance of the estimated effects. It moreover provides a convenient way to discriminate between the two main explanations for rising wage inequality, i.e. international trade and skill-biased technological change while accounting for the likely interdependence (e.g. trade-induced technological change).
There are obviously also a number of limitations to this approach. With respect to the European Union, the assumption that labour markets are perfectly competitive, necessary even for the robust Stolper-Samuelson theorem to hold, does not readily mix with the common belief that labour market institutions play an important role in wage setting and probably cause some degree of wage stickiness in many EU countries. In this respect the Heckscher-Ohlin model does not seem to be very *European*.

3.2.6 Flexible Cost Functions

Concluding the previous section I argued that the Heckscher-Ohlin model assumption that all factor rewards are fully flexible does not really ring true for most EU countries. If wages are fully flexible, i.e. adjust to market-clearing levels, full employment of all production factors is guaranteed. However, if wages are sticky a fall in the relative demand for low-skilled workers will not raise the skill premium but rather result in unemployment. As shown by Krugman (1995 b) the fall in employment implies an additional negative general equilibrium multiplier effect (see section 3.1.4).

Flexible cost functions allow deriving the demand for production factors as well as estimating the impact of external determinants, like international trade, on the demand for production factors without imposing the assumption that wages are flexible. The estimated elasticity of factor demand gives an indication of the extent of the changes in wages or employment.
A cost function models the cost-minimizing behaviour of firms. The most popular flexible cost functions are the duals of the transcendental logarithmic or translog production function (TL) and the generalized Leontief production function (GL) proposed respectively by Christensen, Jorgensen and Lau (1971, 1973) and Diewert (1971)[19].

Translog cost function (TL):

$$\ln C = \alpha_0 + \sum_{i=1}^{I} \alpha_i \ln p_i + \beta \ln X + \tfrac{1}{2} \sum_{i=1}^{I} \sum_{j=1}^{J} \alpha_{ij} \ln p_i \ln p_j + \sum_{i=1}^{I} \chi_{iX} \ln p_i \ln X \qquad (3.43)$$

Generalized Leontief cost function (GL):

19 Barnett, Lee and Wolfe (1985) defined a functional form as flexible if it can attain arbitrary level and first- and second-order derivatives at a predetermined single point. Most flexible forms are second-order approximations: the translog and generalized Leontief functions are second-order Taylor expansions of respectively a Cobb-Douglas and a Leontief function. Following the duality theorem of linear programming, a concave homogenous of degree one production function can be mapped into a unique concave homogenous of degree one cost function (e.g. Chipman 2001).

$$C = \alpha_0 + \sum_{i=1}^{I} \alpha_i p_i^{1/2} + \beta\ X^{1/2} + \tfrac{1}{2} \sum_{i=1}^{I} \sum_{j=1}^{J} \alpha_{ij} p_i^{1/2} p_j^{1/2} + \sum_{i=1}^{I} \chi_{iX} p_i^{1/2} X^{1/2} \quad (3.44)$$

C denotes costs, p_i the price of the *i*-th input factor and X the output.

Berman, Bound and Griliches (1993) used a translog cost function to estimate the impact of computer investment and R&D activities on the wage bill share of non-production workers in the United States in the period 1979-1987. Feenstra and Hanson (2001) advocated the inclusion of any structural variable that may shift the production function and hence affect costs.

For a TL specification this leads to the following extension (Feenstra and Hanson 2001: p. 19):

$$\ln C = \alpha_0 + \sum_{i=1} \alpha_i \ln p_i + \sum_{k=1} \beta_k \ln X_k + \frac{1}{2} \sum_{i=1} \sum_{j=1} \alpha_{ij} \ln p_i \ln p_j + \sum_{i=1} \sum_{k=1} \chi_{ik} \ln p_i \ln X_k + \frac{1}{2} \sum_{k=1} \sum_{l=1} \chi_{kl} \ln X_k \ln X_l \quad (3.45)$$

X_k denotes the output as well as fixed inputs (i.e. in a short-run function with quasi fixed inputs) and the shift parameters.

Following Shepard's lemma (e.g. Mas-Colell, Whinston and Green 1995: pp. 140-141), if ln *C* is the minimal total cost of production, the cost minimizing cost share of input factor *i* can be obtained by differentiating the cost function with respect to the given factor's price:

$$S_i = \frac{\partial \ln C}{\partial \ln p_i} = \alpha_i + \sum_j \alpha_{ij} \ln p_j + \sum_k \chi_{ik} \ln X_k \quad (3.46)$$

This results in a system of equations. Singularity of the covariance matrix of the residuals can be resolved by dropping the I-th cost share equation (Greene 2000: p. 642). If one considers non-production (high-skilled) and production (low-skilled) labour as the two flexible input factors and capital K as an input factor that is fixed in the short run, there is only one equation left. If the same cost function is assumed to hold across sectors, the change of the cost share can be estimated by pooling the data. Considering the equation for the wage bill share of skilled labour the regression in differences is given as:

$$\Delta S_{hs,j}=\alpha_{hs}+\alpha_{hs,ls}\Delta\ln\left(\frac{w_{hs,j}}{w_{ls,j}}\right)+\chi_{hs,k}\Delta\ln K_j+\chi_{hs,q}\Delta\ln Q_j+\sum_l \chi_{hs,l}\Delta\ln z_{l,j}+\varepsilon_j \quad (3.47)$$

Where $z_{l,j}$ are the external variables for industry *j* that may affect the demand for production factors. Berman, Bound and Griliches (1993) argued that it is not plausible to assume relative wages are exogenous. Assuming that quality-adjusted relative wages do not vary across sectors the term will be constant. Dropping relative wages from the regression will then only affect the constant term. Feenstra and Hanson (2001) dropped relative wages as well. They used data for 447 US manufacturing sectors for the period 1979-1990 and considered the equation for the wage bill share of non-production workers. They considered the following structural variables: shipments (output proxy), ratio of capital to shipments, foreign outsourcing (imported intermediate inputs as a share of total materials purchases), shares of computers and other high-tech capital in the total capital stock and the investment shares of computers. Foreign outsourcing is found to explain 15 to 24 per cent of the increase in the non-production workers' wage bill share. Feenstra and Hanson (1996) found that the import share explained 15 to 33 per cent of the increased non-production share for the period 1979-1987. The impact of computers and other high-tech capital depended on whether the share in capital or in total investment is used. For the first measure the technology variables explained 8 to 13 per cent of the increased wage bill share, using the latter measure they explained 31 per cent.

Anderton and Brenton (1999) estimated a share equation for high-skilled workers (proxied as non-manual workers) with pooled data for 11 four-digit sectors (six textiles sectors and five non-electrical machinery sectors) for the period 1970-1986 in the UK. They also dropped relative wages from the regression specification and proxied foreign outsourcing by the import share, distinguishing between imports from industrialised countries and imports from NIC and developing countries. R&D expenditures were used to proxy technological change. In addition they also estimated an equation using the employment share of non-manual workers rather than the wage bill share as dependent variable. They acknowledged this to be somewhat problematic from a theoretical point of view, as it cannot straightforwardly be derived from a cost function but considered this specification to be insightful from an empirical point of view. Imports from industrialised countries did not seem to have affected the wage bill share or the employment share of non-manual workers. Imports from NIC and developing countries, on the contrary, significantly increased the demand for non-manual workers. R&D expenditures also increased the demand for non-manual workers but the coefficient is not significant in any specification.

Anderton, Brenton and Oscarsson (2002) performed similar estimations as Anderton and Brenton (1999) for Sweden, using data on 41 four-digit manufacturing sectors for the period 1975-1993. In addition to R&D expenditures they alternatively considered patenting as a proxy for technological change. Outsourcing is again proxied by import shares and non-OECD countries are considered separately from OECD countries (excluding those countries that became member after 1994). Following the estimation results, imports from low-wage countries could explain up to 25 per cent of the increase in the wage bill share and 15 per cent of the increase in the employment share of skilled (non-production) workers in Sweden. However, technological change accounted for more than 50 per cent of increased inequality.

Like Anderton and Brenton (1999), Strauss-Kahn (2003) used an equation with the change in the employment share of low-skilled workers as the dependent variable as she reasoned that for France this is probably more appropriate given relative wages have been relatively stable. If wages are not flexible, a decrease in relative labour demand could result in decreased employment rather than in decreased wages. She used data on some 50 French sectors for the period 1977-1993. Foreign outsourcing (vertical specialisation in her terms) was defined as the ratio of imported inputs over output, distinguishing between imports from OECD and non-OECD countries. Controlling for the possible endogeneity of output by performing an instrumental variable estimation using the lagged value of output as instrument, foreign outsourcing is found to explain 11 to 15 per cent of the decreased employment share of low-skilled workers in the period 1977-1985 and 25 per cent for the period 1985-1993. Strauss-Kahn concluded that the bulk of the change is presumably explained by skill-biased technological change though she did not consider any technology variable in her estimations.

Egger and Egger (2000) estimated the impact of foreign outsourcing from Austria towards Eastern Europe and the former Soviet Union for the period 1990-1998. For the estimation of the impact of outsourcing on relative employment they used data on 20 Austrian manufacturing sectors. They regressed the relative employment of high-skilled workers on relative wages, export openness, imports (imports of intermediated goods excluded) from Eastern countries, the capital output ratio and foreign outsourcing. Contrary to the aforementioned studies, Egger and Egger performed the regression in levels rather than in first differences and did not drop relative wages from the specification. They accounted for the endogeneity of relative wages and foreign outsourcing. The degree of unionisation of a sector relative to the economy-wide unionisation rate, the price-cost margin, median sector firm size, variables reflecting tariff barriers and non-tariff barriers and unit labour costs in Eastern economies were used as instruments. Tests of the relevance and validity of the instruments suggested that ignoring the possible endogeneity of outsourcing might result in an underestimation of its impact on relative employment. Outsourcing towards Eastern countries seemed to explain about 25 per cent of the increase in relative employment of high-skilled workers in Austria. The levels estimations by Egger and Egger yield suspiciously high R^2 values, which could indicate that the use of (non-stationary) time series in levels instead of first-differences results in spurious correlation.

Morrison and Siegel (1997) extended the generalized Leontief function to account for exogenous factors that may affect the cost function and thereby shift the demand for production factors. Morrison Paul and Siegel (2001) considered high-tech capital, R&D investment and (domestic) outsourcing as potential external determinants. The interest of the external factors lies in their overall impact on industries, which as Morrison Paul and Siegel raised joins with endogenous growth theories (e.g. Romer 1986 and Grossman and Helpman 1991) in stressing the importance of spillovers and other sources of increasing returns.

An extended GL cost function can be written as (Morrison Paul and Siegel 2001):

$$C = X\left[\sum_i \sum_j \alpha_{ij} p_i^{1/2} p_j^{1/2} + \sum_i \sum_m \delta_{im} p_i s_m^{1/2} + \sum_i p_i \sum_m \sum_n \gamma_{mn} s_m^{1/2} s_n^{1/2}\right] \tag{3.48}$$

The variables s denote output (X) and the external determinants. Applying Shepard's lemma, the demand for the i-th input factor can be obtained by differentiating (3.48) with respect to its own price:

$$D_i = \partial C / \partial p_i \tag{3.49}$$

Log-differentiating the demand for an input factor given in equation (3.49) with respect to the n-th element of vector S gives the elasticity of demand for that factor with respect to the considered external factor:

$$\varepsilon_{D_i S_n} = \partial \ln D_i / \partial \ln S_n \qquad (3.50)$$

Applying the extended GL cost function to data on US manufacturing sectors in the period 1959-1989, Morrison Paul and Siegel found that technological change could explain the largest fraction of changes in the demand for different labour groups (classified by education level). Somewhat surprisingly the negative impact of technological change and international trade on the demand for workers with a high school degree is larger than the impact on the demand for workers without a high school degree. Technological change (proxied by computerization) seemed to be biased in favour of college graduates. Outsourcing (proxied by the cost share of purchased services) decreased the demand for all labour groups but more substantially for workers with little education. The authors found evidence that international trade stimulated computerization, arguing that this indirect effect of trade needs to be accounted for.

The demand for production factors can rather straightforwardly be derived from flexible cost functions. When extending these functions with external determinants, the elasticity of factor demand with respect to the external factors can be estimated. The restrictive Stolper-Samuelson assumption of perfectly competitive labour markets does not need to be imposed. If international trade with Newly Industrialised Countries would reduce the demand for low-skilled workers in high-skill abundant countries and wages are not flexible, unemployment of low-skilled workers seems likely. The magnitude of the impact can be inferred from the estimated labour demand elasticity. Though lacking the well-established coherent framework of a perfect competition theory, accounting for downward wage rigidity seems appropriate for most EU countries when assessing the labour market impact of international trade.

3.2.7 Bargaining Models

In section 3.1.6 it was mentioned that collective bargaining is generally considered to be an important labour market institution in many EU countries, often evoked to explain the relative wage stickiness and high unemployment rates, compared to the United States. As empirical evidence indicates that strong unions are successful in reducing wage inequality, the suppression of the skill premium could account for the high unemployment rates of low-skilled workers.

When accounting for downward wage rigidity a union bargaining framework clearly specifies the labour market mechanism through which international trade could affect wages and employment.

As pointed out in section 3.1.6, Lawrence and Lawrence (1985) were among the first to consider the impact of import competition within a bargaining framework.

Gaston and Trefler (1995), adopting an efficient bargaining framework (i.e. bargaining for wages as well as for employment) combined micro data on individuals' characteristics and earnings with data on trade flows, tariffs and non-tariff trade barriers for the United States in 1983.

In a first step they regressed the wage level of an individual i in industry j on individual characteristics H_i and sector dummies D_j (Gaston and Trefler 1995: p. 8):

$$\log(W_{ij}) = H_i\beta_H + D_j W_j^* + \varepsilon_{ij} \tag{3.51}$$

W_j^* is considered as an estimate for the inter-industry wage differential (wage premium) in industry *j*.

In a second step the estimated wage premium is regressed on a vector of international trade (protection) factors P_j and a vector of domestic factors X_j, reflecting union bargaining power, product market concentration and the outside options for the firm and the union (Gaston and Trefler 1995: p. 9):

$$W_j^* = P_j\beta_P + X_j\beta_X + \delta_j \tag{3.52}$$

They used imports from, and employment of, majority-owned foreign affiliates of US firms to proxy foreign outsourcing, which they considered as a measure for the bargaining power of a firm. If no agreement is reached a firm will lose the rents from the firm-specific capital investment. The outside option for the firm is therefore considered by Gaston and Trefler to be negatively related to the capital/labour ratio and the profit rate. As to the outside option for the union, i.e. the alternative wage, they considered a number of different measures like the union/non-union wage differential and the lowest wage decile, with a preference for the latter. Estimation results suggested that the union wage premium is more sensitive to import competition than to export success.

The authors found little support for the endogeneity of trade protection or the endogeneity of trade flows.

They argued that as unions can negotiate low wages in return for employment guarantees, union and non-union responses to trade and trade protection could differ fundamentally.

Magnani and Prentice (2003) provided evidence of falling union membership in most OECD countries. Import penetration appeared to be a significant though minor determinant of union membership in the United States for the period 1973-1994. Skill-biased technological change (SBTC) is found to be even less important in explaining falling union membership. The latter result conflicts with the claim by Acemoglu, Aghion and Violante (2001) that SBTC caused falling union membership, especially in the United States and the United Kingdom, as they believed that SBTC increased the outside option of high-skilled workers and undermined the coalition between low-skilled and high-skilled workers.

Kramarz (2003) matched firm level data with individual worker level data for the 1980s. At the firm level he considered data from the French Customs administration for the period 1986-1992 on imports by countries of origin and by product. At the level of individuals, data from the DADS-EDP (Echantillon Démographique Permanent) were used, providing detailed information on the characteristics of a sample of individuals.

Following Blanchflower, Oswald and Sanfey (1992) and Abowd and Lemieux (1993), Kramarz considered an efficient bargaining game between the firm and workers:

$$\max_{w,l} (1-\theta)\ln[\pi-\pi_0(I)]+\theta \ln(w-w_0)l \tag{3.53}$$

θ is the bargaining power of workers, and π_0 and w_0 denote the threat point of respectively the firm and workers. I is the level of a firm's imports. As Blanchflower, Oswald and Sanfey (1992), Kramarz equated w_0 to the wage available from temporary work in case of a breakdown in the bargaining. $\pi_0(I)$ was considered to be the profit that a firm can generate in the absence of a bargaining agreement by employing temporary workers.
The bargained wage in this model will be (Kramarz 2003: p. 7):

$$w = w_0 + \theta \frac{\pi^0 - \pi_0(I)}{l} \tag{3.54}$$

with w_0 the competitive wage level (i.e. equal to the marginal product of labour) and π^0 the profit evaluated at w_0. Kramarz assumed that inputs imported from abroad or the relocation of some fragments of the production process will have to be announced in advance. This provides workers with hold-up opportunities. Malcomson (1997) stated that turnover costs or firm-specific investments could imply rents to continue a relationship. These rents can be bargained for between the firm and workers. The hold-up opportunity could result in under-investment by the firm. Malcomson (1997: p. 1954) believed that with turnover costs, sticky wages and wages that respond asymmetrically to upward and downward shocks may actually be efficient responses, given well-defined labour contracts, and do not necessarily indicate inefficiencies in labour markets.
In the model by Kramarz (2003) the hold-up opportunities due to the fact that firms have to decide on imports before the bargaining game starts results in the level of bargained wages being higher the higher a firm's imports are.
The impact of imports on the bargained wage is however not unambiguously positive as w_0, apart from a component that reflects the unconditional opportunity cost of time, also consists of an industry-specific component that depends on the demand for labour, which will decrease if imports can substitute for domestic labour. This second component of w_0 therefore depends negatively on the level of imports in the given industry. The sign of the impact of imports on wages is an empirical matter, i.e. to assess whether the hold-up effect dominates the substitution effect or the other way around.
This is reflected in the equation that is estimated by Kramarz:

$$w = w_0 + \theta \frac{\pi^a - \pi_0(I)}{l} - \theta w_0(\bar{I}) \qquad (3.55)$$

π^a is the quasi-rents evaluated at the alternative wage of workers w^a and $\bar{I}$ the industry level of imports.

Kramarz found evidence for both the hold-up effect (i.e. firm's own imports appear to protect employees) and the substitution effect (i.e. wages are lower the higher the level of imports in the industry) but the net effect seemed to be negative for most workers.

The hold-up effect was especially important for highly educated workers. Somewhat surprisingly the highly educated workers also appeared to be affected the most by the substitution effect.

Kramarz distinguished imports from Europe, other OECD countries, low-wage countries close to France (Maghreb and Eastern European countries) and low-wage countries far away from France (China, India, NIC). The origin of imports, as well as distance, seemed to matter though the latter especially for highly educated workers.

Estimating the impact of international trade on wages and employment within a union bargaining framework seems an appropriate way to account for a labour market institution that is generally acknowledged to play an important role in wage setting and employment growth in many EU countries.

Institutional differences could explain why the development of relative wages and employment differs between EU countries. A common shock, e.g. increased trade with NIC, can have a different labour market impact depending on the bargaining regime and union preferences.

3.2.8 Computable General Equilibrium Models

Krugman (1995 b) argued that Computable General Equilibrium (CGE) models permit a complete general equilibrium analysis of the interaction between labour market developments in high-wage countries and import competition from low-wage countries.

He therefore proposed a miniature computable general equilibrium model, which he admitted to be too simplified to deliver anything else than glorified back-of-the-envelope estimates. He considered an OECD economy producing and consuming a low-skill intensive good X_{LS} and a high-skill intensive good X_{HS}. Since the income share of capital hardly changed he only considered low-skilled labour L_{LS} and high-skilled labour L_{HS}. The production of both goods requires both production factors. Constant returns to scale are assumed under the assumption that economies of scale are not important in explaining North-South trade. Product markets were assumed to be perfectly competitive.

To make the model practicable Krugman borrowed some parameter estimates from previous studies (e.g. relative wages of high-skilled workers and skill intensity of the high-skill intensive sector from Wood 1994).

However, before taking on the CGE model he used World Bank estimates of North-South trade to compute the total employment effect of imports from low-skill abundant countries under the assumption of sticky wages, i.e. the European model treated in section 3.1.4, where the total employment effect can be estimated from the factor content of international trade, combined with a general equilibrium multiplier effect accounting for the income effect due to falling employment. Krugman found a considerable total employment effect (1.43 per cent fall in employment) though he added that this estimate still falls short of the actual decline in employment in Europe. Moreover the estimates depend on the assumption that wages are fully rigid, which even for Europe seems unlikely. He therefore also considered an American model, under the assumption of flexible wages, resulting in a CGE model. Production and utility functions were assumed to be Cobb-Douglas.

With this model one can see what, starting from autarky, the emergence of trade with low-skill abundant countries on relative wages in the OECD would be. Krugman found that a 3 per cent rise in the relative wage of high-skilled workers would imply that trade with NIC accounted for 2.2 per cent of OECD output, i.e. larger than the actual share at the time. For elasticity of substitution below one the estimate for the impact of trade on wages would be higher. Krugman claimed that the exercise, despite the stylised and simplified model, could explain why studies focusing on changes in product prices generally failed to find much indications of Stolper-Samuelson effects, as the change in product prices associated with the actual growth of trade with NIC is likely to fall within the boundaries of measurement error and can therefore not be filtered from the noise in data.

Following Krugman (1995 b) several economists proposed more elaborate CGE models, introducing aspects like imperfect product market competition (differentiated goods, increasing returns to scale), sectors of non-tradables and skill-biased technological change (e.g. Lawrence and Evans 1996; Cline 1997; Minford, Riley and Nowell 1997; Cortes and Jean 1998; Nahuis 1998 and Smith 1999).
Except for Nahuis (1998) these CGE studies did not provide much evidence of a substantial impact of North-South trade on labour markets in the industrialised countries.

Panagariya and Dutta-Gupta (2003) questioned CGE modelling for its black box aspect, making it difficult to pinpoint where the results come from. They point out that authors often cannot explain their own results intuitively and when pressed to do so provide uninformative answers. Neary (2001) judged the assumption of monopolistic competition, used in many CGE models, as patently unrealistic as the assumption of perfect competition, as both share the assumption of an infinitely elastic supply of atomistic firms that face no entry or exit barriers and do not engage in strategic behaviour. He stated that most markets are characterised by oligopoly and believed that the large number of difficulties that arise when modelling oligopoly in general equilibrium explains why it has not been pursued frequently, in contrast with the flurry of general equilibrium monopolistic competition models.

In my view Krugman justifiably questioned the reliability of some empirical studies that provided a partial rather than a general equilibrium analysis of the interactions between international trade and labour market developments. However, given the rather large number of other restrictive assumptions that have to be imposed for CGE models to be practicable they often appear to be very *specific* rather than *general*. A large number of model parameters, if not imposed, are 'borrowed' from econometric estimation, the significance of the computed effects cannot be tested and the variables considered in the model, though subject to measurement error, are required to explain all variance, i.e. there is no residual variance.

Table 3.2: Summary of the Main Empirical Studies on the Impact of International Trade on Wages and Employment broken by Skill Level

Authors	Theoretical framework	Data	Results
Decomposition analysis			
Katz and Murphy (1991)	Heckscher-Ohlin prediction that employment will shift between rather than within industries.	US Current Population Surveys (1963-1987)	Between-industry employment shift in 1980s too modest to explain rising skill premium. The within-industry shift is therefore considered more important. The authors attribute the within-industry shift to skill-biased technological change (SBTC).
Berman, Bound and Griliches (1993)	"	US Annual Survey of Manufacturing (1959-1987)	Imports explain a small part of the changes in the employment share of production workers. In some industries (semiconductors and motor industry) foreign outsourcing explains a very substantial part of the shift away from production workers.
Bernd and Jensen (1997)	"	Plant level data from Annual Survey of Manufactures -US Census Bureau (1967-1987)	Demand shifts across plants, associated with exports, are an important source for rising wage inequality. Skill-upgrading does not seem to be an important determinant of employment shifts across plants.
Berman, Bound and Machin (1998)	"	Data on twelve OECD countries (1970s and 1980s)	Within-industry shifts dominate between-industry shifts in employment and wage bill shares of non-production workers, which the authors explain by SBTC.
Factor content studies			
Borjas, Freeman and Katz (1991)	Trade flows embody the production factors used to produce the traded goods. The factor content is used to estimate the impact of international trade on relative factor demand.	US Current Population Surveys (1964-1988)	International trade and immigration affected relative labour supply and explain a large part of the changes in the relative wages of high school dropouts in the 1980s.
Sachs and Shatz (1994)	"	Input-output data from US Department of Commerce (1978-1990)	Imports from developing countries caused a decrease of 6.2 per cent in the employment of production workers and a decrease of 4.3 per cent in the employment of non-production workers. Low-skill intensive industries witnessed the sharpest decrease in employment.
Wood (1994)	Net factor content with assumption of non-competing imports and trade-induced technological change.	UN, OECD and national sources	For 1990 international trade is estimated to have decreased the demand for workers with little education by 20 per cent and more.

Reduced Form Regressions

Dewatripont, Sapir and Sekkat (1999)	**Impact of international trade on wages and employment, relaxing the assumption that production factors are perfectly mobile across sectors.**	**Data for 14 two-digit sectors in Belgium-Luxembourg, Denmark, Germany and the United Kingdom (1981, 1984 and 1988).**	**Results suggest that trade with developing countries affected relative wages of manual (low-skilled workers) rather than relative employment in the five EU countries considered.**
Oscarsson (2000)	**Cobb-Douglas function with assumption of Hicks-neutral technological change.**	**Four-digit sector level data for 63 Swedish manufacturing industries (1975-1993).**	**Import price competition decreased employment of production workers as well as employment of non-production workers. Impact on the latter surprisingly higher. Imports depressed the wages of production workers, not those of non-production workers but wage effects are smaller than employment effects.**

Mandated Wage Regressions

Leamer (1996)	**Stolper-Samuelson theorem linking changes in import prices to changes in factor prices, under the long-run zero profits assumption. The pass-through of productivity changes to domestic product prices is accounted for.**	**NBER productivity database 450 four-digit SIC industries US (1961-1991)**	**In the 1970s product price changes explain a very large part of the decrease in the wages of low-wage workers. In the 1980s estimations suggest that the wages of high-wage workers actually decreased primarily due to product price changes (if pass-through is complete) or technological change (if pass-through is set to zero). Using the distinction non-production/ production the wages of production workers are estimated to have decreased both in the 1970s and the 1980s due to product price changes (if pass-through is complete) or technological change (if pass-through is set to zero).**
Baldwin and Cain (1997)	**Heckscher-Ohlin with varying types of technological change**	**Bureau of Economic Analysis (BEA) input-output data Bureau of Labor Statistics NBER productivity database 79 two-digit industries US (1968-1991)**	**For the period 1967-1973 the increased supply of well-educated workers explains large part of the decreased wage inequality. For the period 1979-1991 increased imports cannot explain increased wage inequality, except for the group with less than 11 years of education. Technological change with an apparent factor bias and a sector bias in favour of well-educated workers may have been the dominant force of increased wage inequality during the latter period.**
Feenstra and Hanson (1999)	**The proposed two-step mandated wage regression procedure accounts for large country effects and permits to discriminate between the factor bias and the sector bias of technological change.**	**NBER productivity database-Bureau of Labor Statistics 450 four-digit SIC industries US (1958-1991)**	**Computer investment explains, depending on the specification, 35 per cent up to 75 per cent and foreign outsourcing 15 per cent up to 40 per cent of the increase in the relative wages of non-production workers.**

Haskel and Slaughter (2001)	"	Manufacturing data- Census of production UK (1958-1986)	Under the small country assumption international trade explains rising wage inequality in the UK in the 1980s more than technology does. If price changes and TFP changes are considered as endogenous, changes in OECD prices and UK tariffs significantly increased relative wages of high-skilled workers. Changes in import prices from NIC significantly affected TFP growth but not relative wages.
Cuyvers, Dumont and Rayp (2003)	"	Unido- Labour Force Survey data nine EU countries (1985-1996)	Little evidence of significant Stolper-Samuelson. Import competition of South-East Asian NIC significantly induced technological change, but this effect surprisingly seems to have favoured low-skilled workers.

Flexible Cost Functions

Feenstra and Hanson (1996, 2001)	Labour demand derived from a translog cost function reflecting the cost minimizing behaviour of firms. Exogenous factors (e.g. import competition) incorporated.	US manufacturing industries (1979-1990)	Foreign outsourcing explains 15 up to 24 per cent of the increase in the wage bill share of non-production workers. In the period 1979-1987 the import share explains 15 up to 33 per cent of the wage bill share of non-production workers.
Anderton and Brenton (1999)	"	Eleven four-digit sectors UK (1970-1986)	Imports of NIC significantly increased the demand for non-manual workers.
Egger and Egger (2000)	"	20 manufacturing industries Austria (1990-1998)	Outsourcing towards East European countries explains 25 per cent of the increased relative employment of high-skilled workers.
Anderton, Brenton and Oscarsson (2002)	"	41 four-digit manufacturing industries Sweden (1975-1993)	Imports from low-wage countries explain up to 25 per cent of the increase in the wage bill share and up to 15 per cent of the increase in the employment share of non-production workers.
Strauss-Kahn (2003)	"	50 French manufacturing industries (1977-1993)	Foreign outsourcing explains 11 up to 15 per cent of the decreased employment share of low-skilled workers in the period 1977-1985 and up to 25 per cent in the period 1985-1993.
Morrison Paul and Siegel (2001)	Extended generalized Leontief cost function	US manufacturing industries 1959-1989	Impact of technological change on the relative demand for high-skilled workers higher than impact of international trade but indications of trade-induced technological change.

Bargaining models

Gaston and Trefler (1995)	**Efficient bargaining framework (unions and firms bargain for wages and employment)**	**Data on individuals' characteristics and earnings US (1983)**	**The union wage premium is more sensitive to import competition than to export performance.**
Kramarz (2003)	**Efficient bargaining framework with outside option of firms depending on the opportunity to relocate or outsource activities abroad.**	**French Customs firm level data- Data on individuals (1986-1992)**	**Impact of imports on bargaining position of high-skilled workers surprisingly higher than impact on low-skilled workers. Origin of imports matters, especially for high-skilled workers.**

Computable General Equilibrium (CGE) models

Krugman (1995 b)	**Miniature CGE model with high-skill intensive and low-skill intensive sector.**	**World bank data**	**Small negative impact of trade with NIC on the relative wages of low-skilled workers.**
Lawrence and Evans (1996)	**CGE model with two production factors and three sectors (e.g. non-tradables).**	**US manufacturing industries (1990)**	**Small impact of international trade in the past inferred from simulation of a future substantial increase in international trade.**
Cline (1997)	**Trade and Income Distribution Equilibrium (TIDE) model. Thirteen regions considered (e.g. US, EU, Asian Tigers).**	**Five sectors (1973, 1984 and 1994 benchmark years)**	**Stolper-Samuelson effects are diluted due to the large size of the non-tradables sector and the home bias in consumption and production.**
Minford, Riley and Nowell (1997)	**North-South CGE model based on Heckscher-Ohlin, expanded to account for evolving factor and product properties.**	**OECD/non-OECD (1970-1990)**	**About 40 per cent of the decrease in employment of low-skilled workers in the North (OECD) can be explained by technology (60 per cent) and trade (40 per cent). The same proportion between technology and trade holds for explaining the decrease in relative wages and the rising unemployment of low-skilled workers. The substantial impact of technology and trade was counterbalanced by a rise in the supply of high-skilled workers and productivity growth.**
Cortes and Jean (1998)	**North-South CGE model with imperfect product market competition (Armington) and capital-skill complementarity.**	**Thirteen sectors (e.g. services) CHELEM trade data International input-output data**	**Import competition of emerging economies can explain a non-negligible but small part of the rise in wage inequality in the EU.**
Nahuis (1998)	**Worldscan model. Heckscher-Ohlin model, combined with a Solow model of economic growth.**	**Bilateral trade and input-output data (1990 benchmark year)**	**Results suggest that international trade with developing countries explains about half of the increased wage inequality in the 1980s.**
Smith (1999)	**CGE model with imperfect product market competition (Dixit-Stiglitz) and capital assumed perfectly mobile internationally.**	**64 three-digit sectors for eleven EU countries (1991 benchmark year)**	**Not much evidence that EU trade with developing countries can explain substantial part of EU unemployment.**

3.3 General Conclusions part I

In the 1980s, the skill premium and the relative employment of high-skilled workers started to increase dramatically in the United States. Data for the European Union provide a mixed image of the evolution of wage inequality, with a sharp increase in the United Kingdom and a moderate increase in a number of other EU countries but also stable if not declining inequality in some EU countries. In a number of EU countries unemployment of low-skilled workers rose considerably in this period. Overall the stylised facts show a deterioration of the labour market position of low-skilled workers in most industrialised countries.

International trade with Newly Industrialised Countries (NIC) increased at about the same time that the labour market position of the low-skilled started to deteriorate. Among academics the traditional Heckscher-Ohlin model and more specific the Stolper-Samuelson theorem was considered as a relevant theoretical framework to assess the impact of trade between developed and developing countries on income distribution.

The Stolper-Samuelson theorem predicts that if a high-skill abundant country opens up to trade with a low-skill abundant country, the fall in the relative price of low-skill intensive goods will shift production from the low-skill intensive sector(s) to high-skill intensive sectors. As the latter have a higher ratio of high-skilled to low-skilled workers, general equilibrium with full employment can only be ensured if the wages of low-skilled workers fall, allowing for the substitution of low-skilled workers for high-skilled workers.

In chapter 3 I elaborated the Heckscher-Ohlin model and argued that the Stolper-Samuelson theorem is relatively robust to relaxing some of the restrictive Heckscher-Ohlin assumptions (e.g. no technological differences between countries). The theorem therefore seems a logical benchmark for the empirical assessment of the impact of trade with Newly Industrialised Countries on wage inequality in high-skill abundant countries.

The assumption that labour markets are perfectly competitive is however necessary even for the Stolper-Samuelson theorem to hold and seems rather unrealistic, especially for the European Union, given the common belief of downward wage rigidity in many EU countries.

I therefore also discussed some more *European* models that allow for sticky wages in general or consider specific labour market institutions like collective bargaining that play an important role in wage setting in the European Union.

In section 3.1 some theoretical mechanisms that account for a labour market impact of international trade outside the Heckscher-Ohlin framework have been presented.
Foreign outsourcing, i.e. the contracting out to low-wage countries of labour-intensive fragments of production processes in high-wage countries, is widely seen as an increasingly important aspect of globalisation and models that focus on this phenomenon predict an impact on labour markets though the predictions are more ambiguous than the predictions of the Heckscher-Ohlin model.

In section 3.2 I reviewed the empirical work on the link between international trade and labour market developments.

Most of the early empirical work, which mainly considered the situation in the United States, tested some of the predictions of the Stolper-Samuelson theorem, e.g. the link between prices of imported goods and domestic goods. The empirical tests did not seem to provide much evidence of considerable Stolper-Samuelson effects. The increase in skill intensity in most industries was seen as evidence that skill-biased technological change (SBTC) was a more likely determinant as the Heckscher-Ohlin model actually predicts a fall in skill intensity in high-skill abundant countries.
The results of decomposition analysis, which overall indicated that, in contrast with the Heckscher-Ohlin prediction, employment shifted within industries rather than between industries was trotted out as additional incriminating evidence against SBTC, further discharging international trade.

However, some of the non-Stolper-Samuelson theoretical models that were presented in section 3.1 predict an impact of international trade on wages without necessarily affecting relative product prices and allow for within-industry changes due to international trade as much as for between-industry shifts.

A number of factor content calculations, which inferred the impact of international trade on jobs or wages from the assumed amount of production factors embodied in trade flows, provided substantial estimates of the impact of North-South trade but were harshly criticised for lacking any appreciable theoretical justification.

The mandated wage regression procedure was a distinct methodological improvement as it was more closely linked to the Stolper-Samuelson than any previous method and moreover permitted to discern the impact of international trade from the impact of skill-biased technological change, accounting for the interlinkage.
Estimations for the United States suggested that Stolper-Samuelson effects were significant and relatively substantial but for EU countries generally no significant effects were found.

If some of the early empirical work was waved aside for lack of a clear theoretical framework, the mandated wage procedure has, on the contrary, been charged for obstinately clinging to the Heckscher-Ohlin model in spite of some rather restrictive assumptions.

Relaxing the Stolper-Samuelson assumption that wages are fully flexible, the impact of international trade and technological change on the demand for production factors can be derived from extended flexible cost functions, modelling the cost-minimizing behaviour of firms. The estimated elasticity of labour demand gives an indication of the impact of international trade on wages or- if wages are sticky- on employment.
Most flexible cost function estimations suggested a significant impact of trade with the Newly Industrialised Countries on wages and/ or employment.

A union bargaining framework specifies a labour market institution, i.e. collective bargaining, believed to be important in wage setting in the European Union. If international trade weakens the bargaining position of unions, wages and employment will be affected in a way that depends on the bargaining regime and union preferences. The rare estimations using a bargaining framework found an impact of trade on wages and employment.

Krugman, arguing that most previous empirical work only provided a partial analysis of the interaction of labour market developments and international trade, proposed a miniature Computable General Equilibrium (CGE) model.
More elaborated CGE models have since been proposed, incorporating sectors of non-tradables and intermediate inputs, differentiated goods, increasing returns to scale, capital mobility, technological catch-up and relative factor supply.

The results of CGE modelling are clearly sensitive to the specific structure that is imposed but, with some exceptions, suggested a rather limited role of North-South trade in labour market development.
Summing up, the methodological assessment of how much international trade with Newly Industrialised Countries affected wages and employment in industrialised countries has been refined considerably since the early empirical work.
Though the mid-1990s consensus view that international trade only played a limited role in the rise in the skill premium or in the high unemployment rates of low-skilled workers was overhasty it seems only fair to say that more recent empirical studies overall failed to find overwhelming evidence that international trade has been the dominant determinant of labour market developments.
However, most of the empirical work focused on the United States, to some extent explained by data availability, whereas for the European Union only a relatively small number of single country studies have been carried out.
As stylised facts for the United States differ from those in most EU countries, conclusions of US-based work cannot simply be carried over to the European Union.
Intra-EU heterogeneity also warns for the generalization of the results for single EU countries.

In part II, I report the results of own empirical work for a panel of EU countries.
Having reviewed the theoretical and empirical literature I would now like to justify why some methodologies have been considered and why others have not.

My main premise for the empirical work is a very distinct preference for multiple regressions, as these allow to test, within a well-defined theoretical framework, a number of hypotheses and thereby, in my view, seem to join in the recommendation of Leamer and Levinsohn (1995) not to take trade theory too seriously, nor to treat it too casually.
Panel data regressions moreover allow to account and test for the degree of heterogeneity across countries.
By only considering simple correlations or mechanically decomposing employment and wage shifts much of the early empirical studies provided circumstantial evidence, at best.
Given the relatively high level of industry aggregation of the available data for EU countries, a decomposition of overall shifts into within-industry and between-industry shifts does not seem

very informative. Moreover, a number of non-Heckscher-Ohlin theoretical models clearly allow for international trade to induce within-industry shifts as much as between-industry shifts.

Though Krugman tried to rehabilitate the factor content calculations, vilified by many trade economists for their lack of theoretical justification, I fully endorse the view of Panagariya (2000) that the assumptions required to implement these calculations are much too strong to inspire confidence in the estimates they generate.

The first empirical methodology that is considered in part II is the two-step mandated wage regression procedure, which given its close link to the well-established Stolper-Samuelson theorem seems a logical starting-point for the assessment of the impact of international trade on wage inequality. The procedure moreover discriminates between the impact of the two main explanations put forward to explain rising wage inequality, i.e. international trade and skill-biased technological change, explicitly accounting for the interlinkage between both. The possible indirect impact of international trade has been ignored in most of the early studies despite the general perception of trade as an important spillover channel or as a stimulus for defensive innovation.

The mandated wage regression procedure and its results for a panel of nine EU countries is reported in chapter 4.

One of the Heckscher-Ohlin assumptions that is necessary even for the robust Stolper-Samuelson theorem to hold, namely that labour markets are perfectly competitive, is rather problematic for the European Union given the general belief that labour market institutions intervene with wage setting in many EU countries. If wages are not fully flexible, a fall in the relative demand for low-skilled workers could result in unemployment.

There is no generally accepted comprehensive general equilibrium framework to assess the impact of international trade under the assumption of labour market rigidity.

Therefore two alternative approaches have been used in part II.

First, in chapter 5, following the *European* model proposed by Krugman (1995 b), elasticity of the demand for low-skilled and high-skilled workers with respect to international trade and other external determinants is estimated using extended flexible cost functions. If trade lowers

relative labour demand but wages are sticky, the elasticity estimates provide an indication of how much unemployment of low-skilled workers could be explained by international trade.
The *European* model allows for sticky wages but does not really specify what might cause wages to be sticky.
Therefore, a relatively novel two-step estimation procedure that considers the important role that unions are assumed to play in European labour markets is proposed in chapter 6.
There is ample empirical evidence that strong labour unions are successful at confining wage inequality. If globalisation weakens the strength of unions this could explain the rise in wage inequality or unemployment of low-skilled workers.
In the first step of the proposed procedure, bargaining power is estimated for five EU countries, using firm-level data. At the same time, hypotheses with respect to the bargaining regime and union preferences can be tested. In a second step the estimated bargaining power is regressed on international trade and other potential determinants of union bargaining power.
If international trade is found to weaken the bargaining position of labour unions, the first-step results with respect to the bargaining regime and union preferences can be invoked to infer the impact of international trade on wages and employment.

I would like to believe that the combination of the three empirical procedures yields methodologically sound and relatively robust conclusions with respect to the impact of international trade with Newly Industrialised Countries, on wages and employment of low-skilled and high-skilled workers in the European Union.

Somehow I am inclined to conclude part I here, hopping to part II, but I am afraid that this will elicit the question why didn't you … do some CGE modelling?
Though I agree with Krugman that a general equilibrium analysis of the interactions between international trade and labour market developments is called for I consider most of the CGE models as very specific and restrictive.

My main objection is that CGE models torture the elected variables, afflicted with measurement error, until there is no residual variance left.
The results of panel data estimations, though obviously also affected by measurement errors and omitted variables, partially absorb these deficiencies by capturing them in the **error** term or in the country-specific intercepts.

Somehow I am inclined to conclude part I here. The chances are that this will elicit the question why didn't you ... but anyhow concluding part I is just what I am going to do now.

PART II

4. Two-Step Mandated Wage Panel Regressions

""*A rise in any single commodity price will cause the reward of* ***some*** *factor to rise in terms of all other goods and to fall in terms of none, and it will cause the reward of* ***some*** *other factor to fall in terms of all goods- provided that the good is initially produced and that every factor which it employs is subsequently also employed elsewhere in the economy*."

Ethier (1984: pp. 165-166).

4.1 Introduction

In this chapter the results of two-step mandated wage regressions for a panel of EU countries are reported. The methodology has already been discussed extensively in section 3.2.5 but some additional methodological and econometric issues will be dealt with.
As argued by Slaughter (2000) the mandated wage regression procedure comes closer than simple consistency checks to testing the *correlation version* of the Stolper-Samuelson theorem (see quote of Ethier 1984) which he considered the most suited version of the theorem to assess increased wage inequality.
The Stolper-Samuelson theorem implies two predictions linking changes in import prices to changes in factor prices:

- Changes in domestic product prices will be positively correlated with changes in import prices.
- Changes in factor prices will be positively correlated with changes in the relative domestic prices of those goods that relatively require much of the given production factor.

The first correlation is estimated in the first step and the second correlation in the second step of the two-step procedure.
For a large economy or countries with substantial international technology spillovers an additional prediction is given:

- Changes in total factor productivity will be negatively correlated with changes in domestic product prices.

This prediction can be tested with the estimation of the TFP pass-through in the first step product price regression

Leamer (1996 a: pp. 25-26) justified the mandated wage approach as a second best to a world-wide general equilibrium input-output model, which given the lack of data is not within reach. The procedure has the additional advantage that it permits to disentangle the impact of international trade from the impact of technological change (i.e. the main alternative explanation for increased wage inequality), while explicitly accounting for the interlinkage between both explanations (e.g. trade-induced technological change, trade-related spillovers).

The results discussed in this chapter are to a large extent based on Cuyvers, Dumont and Rayp (2003) with extensions with respect to foreign outsourcing, an update of the data set and some alternative specifications and robustness tests.

In most mandated wage estimations a single country is considered (e.g. the United States in Leamer 1996 a, Baldwin and Cain 1997 and Feenstra and Hanson 1999 and the United Kingdom in Haskel and Slaughter 2001). Given the general view of substantial institutional differences between the United States, the United Kingdom and continental EU countries and the high degree of intra-EU heterogeneity that became apparent from the stylised facts reported in chapter 2, the results for single countries cannot simply be carried over to all EU countries. Performing panel estimations, the impact of international trade on wage inequality can be established, accounting for the degree of heterogeneity among EU countries, to find out whether international trade with Newly Industrialised Countries (NIC) affected EU countries in an asymmetric way (e.g. due to differences in skill abundance, specialisation patterns, trade flows or labour market institutions).

Previous mandated wage estimations considered a single aggregate NIC group. However, Newly Industrialised Countries from (South-) East Asia, Central and Eastern Europe and Latin America are unlikely to be similar with regard to skill-abundance, technological level, transportation and communication costs and even import tariffs (regulated in regional trade agreements with the European Union) and can therefore questionably be merged into a single group of homogenous countries. A geographical breakdown of the Newly Industrialised Countries can account for intra-NIC heterogeneity.

As explained in section 3.2.5, the pass-through of total factor productivity to domestic product prices reflects the impact of the country considered on world market prices (i.e. country size) or the extent to which technological change spills over between countries. The two-step mandated wage procedure proposed by Feenstra and Hanson (1999) permits the estimation of the pass-through rather than arbitrarily fixing it at a given level as in Leamer (1996 a). Feenstra and Hanson (1999) used data on outsourcing, computer equipment and other high-tech capital and Haskel and Slaughter (2001) data on innovation counts, industry concentration, union density, computer use and foreign prices to construct independent variables for the TFP regression.

Using domestic and foreign R&D stocks as structural determinants, Cuyvers, Dumont, Rayp and Stevens (2003) and Cuyvers, Dumont and Rayp (2003) accounted for the role of R&D spillovers.

As mentioned in section 3.1.1.2, Grossman and Helpman (1991) perceived international trade as an important spillover mechanism though they explicitly considered the possibility that free trade can actually slow down economic growth in some countries. In their endogenous growth model the impact of technology and trade policies will depend upon whether knowledge spillovers are local or global in scope.

Analysis of competing products and contacts with clients are two channels for learning through trade that are frequently mentioned in a survey of innovative firms. Exporters appear to learn from their foreign buyers and importers from their foreign suppliers (MacGarvie 2003).

Coe and Helpman (1995) and Lichtenberg and Van Pottelsberghe de la Potterie (1996) found evidence of substantial trade-related international R&D spillovers between OECD countries and Coe, Helpman and Hoffmaister (1995) considering 77 developing countries in the period 1971-1990, found evidence of substantial trade-related R&D spillovers from industrialised countries to the developing countries.

The impact of international spillovers provides an alternative mechanism for defensive innovation, induced by import price competition, raised by Wood (1994).

Both indirect effects of international trade need not have the same sign and the latter effect is likely to be more factor-biased.

Incorporating spillovers will improve the econometric specification and hence the estimation of the direct and indirect effect of international trade on wages. Large international spillovers would point at the pervasiveness of technological change, which should be reflected in a large TFP pass-through, even for small countries as the latter are often found to be the most important

beneficiaries of international knowledge spillovers (e.g. Coe and Helpman 1995; Dumont and Tsakanikas 2001, 2004).
In the following section I will describe the data sources that were used to construct the panel of EU countries. In section 4.3 some issues regarding the estimation procedure are discussed and the estimation results are reported.

4.2. Data[20]

The panel that has been constructed reflects a trade-off between the need to consider manufacturing industries at a sufficiently low level of sector aggregation- to account for sector heterogeneity- and the objective to cover a reasonable number of EU countries. For a small number of EU countries data are available on most variables to perform estimations at a more disaggregated level but this would not add much insight to previous single country studies. Data were gathered for the period 1985-1996, later extended with more recent data for the second half of the 1990s. For each variable the data sources and some of their limitations are listed below:

- **Wages**

For the wages of low-skilled and high-skilled workers it was necessary to proxy low-skilled workers by manual workers (operatives) and high-skilled workers by non-manual workers (non-operatives) (see section 2.1 on the appropriateness of this proxy). The *Harmonized Gross Earnings* data from EUROSTAT (NewCronos) provide hourly wages of manual workers and monthly wages of non-manual workers. For the period 1985-91 the UNIDO General Industrial Statistics give the wage sum of operatives and the number of operatives, which allows for a straightforward way of computing monthly wages of operatives. From 1992 onwards, monthly wages of manuals were computed with the wage sum of manual workers (total wage sum minus the wage sum of non-manual workers (NewCronos) and the rescaled number of manual workers, taken from the European Union Labour Force Survey (LFS) database. Data on wages following the International Standard Classification of Occupation (ISCO- see section 2.2.1) are not provided by EUROSTAT, which makes it impossible to estimate a mandated wage

20 The data description is to a large extent based on Cuyvers, Dumont and Rayp (2003).

regression for high-skilled and low-skilled workers. Given that the LFS data are open to suspicion (see section 2.1), whenever available more reliable national data were used or data from the OECD International Sectoral Database (ISDB).
For Belgium social security data on the number of manual and non-manual workers are provided by the National Office for Social Security (RSZ) for the entire period.
For Sweden, Eva Oscarsson from the Department of Economics at the University of Stockholm kindly provided data on employment and wages for the period 1970-1993, as used in e.g. Oscarsson (2000).

- **Labour shares**

UNIDO data on the wage sum of operatives are available for Denmark, Finland, Germany, Italy, Spain and the United Kingdom though not always for all years. The breakdown by operatives/ non-operatives is no longer provided by UNIDO after 1991. From 1992 onwards, albeit only from 1993 onwards for most countries, the Labour Force Surveys provide information on the number of white-collar and blue-collar workers. As mentioned in section 2.2.1, the LFS data do not match the official OECD data on total employment. The OECD adjusted the data to the Structural Analysis industrial (STAN) database or OECD National Accounts data (OECD 1998: p.5). As the LFS data are the results of surveys, the OECD STAN data on total employment can be considered to be more reliable and were therefore used to rescale the ISCO numbers, following the white-collar/ blue-collar ratio of LFS.
The value added share of labour was taken from STAN.
The value added share of non-manuals was computed using the monthly wages of non-manuals and the rescaled numbers of white-collar workers. From this the value added shares of manuals were computed. In general this led to intuitively acceptable results, except for Italy. For Italy, data on the number of hours worked by operatives were taken from the OECD Industrial Survey results, which for Italy is given only for 1992-1994. The number of hours worked by operatives (i.e. blue-collar workers in the ISCO classification), the gross hourly wages of manuals from NewCronos and the total wage sum from OECD STAN permitted to compute the value added share of manuals. The results appeared to be more reliable. For a number of countries UNIDO and LFS data overlap for one or two years. This permitted for these countries to smooth the time series on value added shares, which sometimes showed substantial breaks at the partition

year of both distinct data sources. The smoothed time series are used in alternative estimations to test the robustness of the results.

- **Domestic prices**

Domestic prices at the sector level were computed from the OECD STAN data on sector value added in current prices and value added in constant prices.

- **Unit value import prices**

Unit value import prices were computed at the sector level. Data on bilateral imports were taken from the OECD International Trade by Commodities Statistics (ITCS) and aggregated into seven geographical groups of trade partners: high-skill EU countries (Austria, Belgium-Luxembourg, Denmark, Finland, France, Germany, Italy, the Netherlands, Sweden and the United Kingdom); low-wage EU countries (Ireland, Greece, Portugal and Spain); non-EU OECD countries (Australia, Japan, New Zealand, Norway and the United States); Asian Tigers (Hong Kong, South Korea and Singapore); Asian Pussycats (Indonesia, Malaysia, the Philippines and Thailand); Central and Eastern European emerging economies (Czech Republic, Hungary and Poland) and Latin American NIC (Argentina, Brazil, Chile and Mexico).
As ITCS data are given for Standard International Trade Classification (SITC) commodity classes and the estimation is done for International Standard Industrial Classification (ISIC) sectors, the data had to be converted from SITC to ISIC, using correspondence tables from the RAMON EUROSTAT classifications server (http://europa.eu.int/comm/eurostat/ramon).

Freeman and Revenga (1999) pointed out that unit value prices are a ‘mishmash’ of aggregate prices of commodities. However, they found that sectors that experienced increased import penetration showed relative price declines, which suggests that imports price changes are good proxies for import pressure. A caveat of unit value price changes that is often put forward is that as it concerns aggregates, the changes might reflect a change of the commodity mix rather than a change of commodity prices. To preclude this possibility unit value prices were computed, following the shift-share approach, keeping the commodity structure fixed. Using a shift-share approach changes in unit value prices can be decomposed into three components. A first component measures the part due to changes in the commodity mix, keeping commodity prices fixed at their begin of period values. A second component measures the part of unit value price changes that can be explained by changes in commodity prices, keeping the commodity mix fixed at its begin structure. Finally, the interaction component measures the changes of the commodity mix *and* commodity prices. The second component is considered as a measure for unit value price changes.

Given the measurement problem with import prices, import volumes have been considered as an alternative measure for import competition.

- **Total Factor Productivity**

Total factor productivity (TFP) was taken from the OECD International Sectoral Database (ISDB). For those countries for which ISDB did not provide data on TFP it was computed from data on gross fixed capital formation and employment (STAN/ ISDB) using the formula given in OECD (1994):

$$TFP = \frac{VA / ET^{w} GCS^{1-w}}{TFP_0}$$

VA: Value added

ET: Total employment

GCS: Gross capital stock

w: Value added share of labour (standardized at 70 per cent for all sectors and countries)

TFP_0: Total factor productivity in reference year (1985)

In OECD (1994) total factor productivity was computed, using a Cobb-Douglas production function, as output growth minus the weighted growth of input factors (i.e. capital and labour) with the value added shares of the production factors taken as the weights. The OECD considered a standardized labour share of 70 per cent for all sectors and countries, which is said to be close to the actual measured labour shares in most sectors and countries. The use of actual labour shares is considered to be unreliable as inspection of the data seems to suggest that measured differences reflect differences in the coverage of individual categories of data rather than actual differences in factor shares (OECD 1994: appendix 5).

TFP is considered as a proxy for technological change. The appendix to this chapter contains a note on the appropriateness of TFP as a measure for technological change.

- **R&D stock**

Haskel and Slaughter (1999) used innovation counts as a determinant of total factor productivity. This information is not available for enough EU countries to be used. Instead R&D stocks are used. National R&D stocks are computed from data on R&D expenditures provided by the OECD Analytical Business Enterprise Research and Development (ANBERD) database, completed with BERD data. The 1973 stock was taken as the initial stock and computed with the formula given by Coe and Helpman (1995). For each sector, three R&D stocks were computed: the national R&D stock of the given sector; the total national R&D stock (minus the sector R&D stock) to estimate national inter-sector spillovers and a foreign R&D stock which was weighted according to the procedure proposed by Lichtenberg and van Pottelsberghe de la Potterie (1996). As it concerns sector R&D stocks the foreign R&D stocks were weighted by total imports over the GDP of the exporting country times the share of the sector in the national output.

- **Concentration**

To control for the effects of imperfect competition on price setting, the share of the four largest firms in the output of a given sector (C4) was computed, using firm level data from the Amadeus database (provided by Bureau Van Dijk) and data on sector output from STAN. To correct for errors due to the use of consolidated data, an alternative measure of concentration, using STAN data, was also computed.

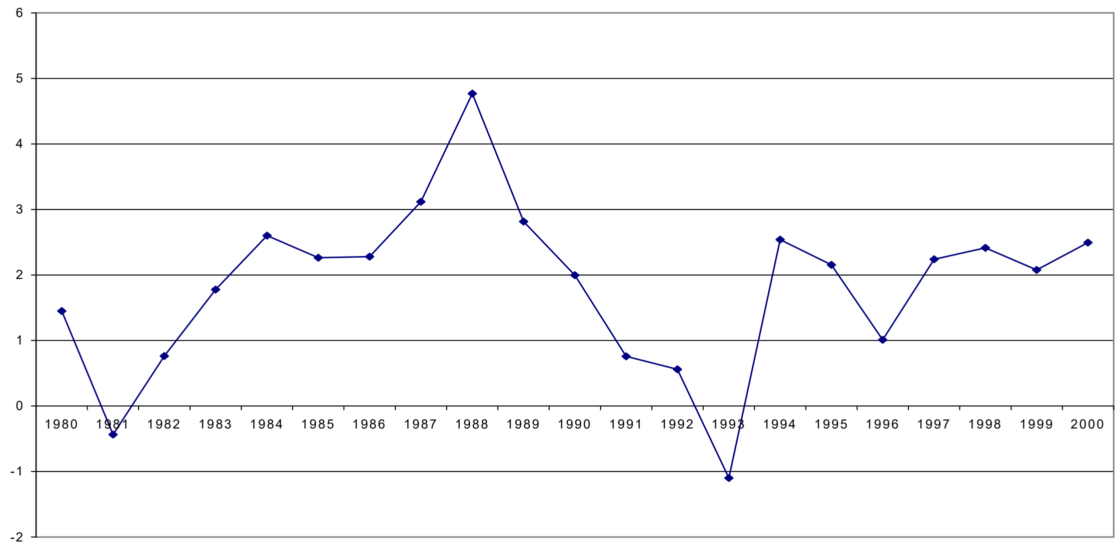
- **Capital/labour ratio**

As an alternative control variable for imperfect competition the capital/labour ratio was computed from OECD STAN data. The capital/labour ratio is a measure of capital intensity and thus can be seen as a proxy for returns to scale and entry barriers, i.e. it is more difficult for a new firm to enter an industry that is capital-intensive and for a given market size a high investment level implies a small number of viable firms.

In European Communities (2003) a positive correlation between market concentration and capital intensity (measured by the capital/labour ratio) is found.

The initial data set covers the period 1985-1995. From figure 4.1, which shows average EU growth of real GDP per capita, taken from the Penn World Tables 6.1, it can be seen that 1985 and 1995 are very similar points in the business cycle[21]. This is convenient as mandated wage regressions consider changes over long time periods and business cycle effects can be important, e.g. the cyclical nature of factor utilisation not accounted for in traditional TFP estimates (Larsen, Neiss and Shortall 2002).

Figure 4.1: Average Real GDP per Capita Growth in the European Union (1980-2000)



Source: Own calculations from data in Heston, Summers and Aten (2002).

The Central and Eastern European countries and China only became active exporters in the 1990s, as shown in section 2.2. Extending the data set for more recent years proved even more difficult than the construction for the period 1985-1995. EUROSTAT no longer provides data on wages at the sector level, broken down by manual and non-manual workers and for most countries 1998 is the most recent year for which this breakdown is available. For the 1990s, the Labour Force Survey data on employment by ISCO 88 are the only source for internationally comparable data on employment by skill level. In section 2.1, I argued that the reliability of these data could be questioned. For the most recent years in the 1990s, data on total factor productivity are difficult to find as well, for a number of EU countries in the panel.

21 Peiró (2004) found indications for seven EU countries, in the period 1957-1998, that business cycles are not asymmetric.

For the 1990s data on China were added to account for the emergence of this country as an important exporter to developed countries.

4.3 Estimation Procedure and Results

A panel of nine EU countries (Belgium, Denmark, Finland, France, Germany, Italy, Spain, Sweden and the United Kingdom) and twelve sectors [*Food, drink & tobacco* (ISIC 31), *Textiles, footwear & leather* (ISIC 32), *Wood, cork & furniture* (ISIC 33), *Paper, printing & publishing* (ISIC 34), *Chemicals* (ISIC 35), *Non-metallic mineral products* (ISIC 36), *Basic Metal Industries* (ISIC 37), *Fabricated metal products* (ISIC 381), *Non-electrical machinery* (ISIC 382), *Electrical equipment* (ISIC 383), *Transport equipment* (ISIC 384) and *Precision instruments* (ISIC 385)] has been constructed.

As discussed in section 3.2.5, a two-step mandated wage estimation consists in regressing, in a first step, domestic price changes and total factor productivity on structural determinants. The estimated impact of each determinant (computed as the variable multiplied by its estimated coefficient) is then, in the second step, regressed on the value added shares of the different production factors. The estimated coefficients of the factor shares are then considered as an estimate of the changes in the rewards of the respective production factors, *mandated* by the structural determinants.

4.3.1 First Step Estimation

The first step specification, with all seven countries groups distinguished, for the domestic price regression and the TFP regression are given as (cf. equations 3.36 and 3.37 in section 3.2.5):

$$\begin{aligned}\Delta \log p_{i,dom} = \alpha_{0,i} + \alpha_{euh}\Delta \log p_{i,euh} + \alpha_{eul}\Delta \log p_{i,eul} + \alpha_{oere}\Delta \log p_{i,oere} + \alpha_{ash}\Delta \log p_{i,ash} \\ + \alpha_{asl}\Delta \log p_{i,asl} + \alpha_{cee}\Delta \log p_{i,cee} + \alpha_{lat}\Delta \log p_{i,lat} + \alpha_{tfp} \log TFP_i + \varepsilon_{i,pr}\end{aligned} \quad (4.1)$$

$$\begin{aligned}\log TFP_i = \beta_{i,0} + \beta_{srd}\,\Delta \log SRD_i + \beta_{ns}\,\Delta \log NSRD_i + \beta_{for}\,\Delta \log FRD_i + \\ \frac{1}{p_{dom,i,85}}\begin{pmatrix}\beta_{euh}\Delta \log p_{euh,i} + \beta_{eul}\Delta \log p_{eul,i} + \beta_{oere}\Delta \log p_{oere,i} + \beta_{ash}\Delta \log p_{ash,i} \\ + \beta_{asl}\Delta \log p_{asl,i} + \beta_{cee}\Delta \log p_{cee,i} + \beta_{lat}\Delta \log p_{lat,i}\end{pmatrix} + \varepsilon_{i,tc}\end{aligned} \quad (4.2)$$

Where $\Delta \log p_{i,dom}$ denotes the change in domestic product prices of sector *i* over a period of time. Considering changes over a relatively long period is justified as Stolper-Samuelson effects bear upon the long run.

I performed panel unit roots tests using the TSP panunit procedure[22]. This procedure runs the unit roots tests proposed by Im, Pesaran and Shin (1997), which allow for some of the individual time series to have unit roots in the alternative hypothesis. The tests suggest that none of the time series of the variables are stationary in the levels. Considering first differences, the null hypothesis of unit roots could not always be rejected, indicating that even after differencing the time series are not stationary. The tests seem to indicate that there is actually no long-run cointegration relationship between the variables considered in levels nor in first differences.

However, as pointed out by Baltagi and Kao (2000) these tests critically rely on the length of the time series for observational units being large and Breitung (2000) showed that the tests by Im, Pesaran and Shin (1997), as well as other panel unit roots tests, tend to have a very low power, i.e. small probability that a false null hypothesis is rejected. Baltagi and Kao (2000) concluded their overview of the econometrics of non-stationary panels by pointing out that although several issues have been resolved, a large number of issues remain unresolved. Considering changes in variables over a long time period reduces the probability of spurious correlation at the expense of dropping information on short- and medium-run effects.

Import price changes are considered for the seven distinct country groups: the high-skill EU countries ($\Delta \log p_{euh}$), the low-wage EU countries ($\Delta \log p_{eul}$), the non-EU OECD countries ($\Delta \log p_{oere}$), the Asian Tigers ($\Delta \log p_{ash}$), the Asian Pussycats ($\Delta \log p_{asl}$), Central and Eastern European NIC ($\Delta \log p_{cee}$) and the Latin American NIC ($\Delta \log p_{lat}$): see section 4.2 (unit value import prices) for an enumeration of the countries in these seven country groups. TFP denotes total factor productivity and SRD, NSRD and FRD are respectively the domestic sector, the domestic inter-sector and the foreign R&D stocks.

The impact of international trade competition on technological change is accounted for by considering import price changes relative to the domestic price level in the base period (i.e. $1/p_{dom, I, 85}$) in the first step TFP regression.

22 Unit roots tests assess the stationarity of time series. If a variable is generated by a non-stationary process, the characteristic equation will have a root equal to 1. Testing the hypothesis of a unit root is therefore a test of stationarity. Regressions with non-stationary variables may provide spurious results, i.e. results driven by the underlying time trend rather than by a *true* relationship between the variables.

The descriptive statistics of the variables in the first step price and TFP regressions are given in table 4.1.

Table 4.1: Descriptive Statistics of Variables in First Step Regressions

	Mean	Standard Deviation	Minimum	Maximum
$\Delta \log p_{i,dom}$	0.32	0.25	-0.74	1.42
$\Delta \log p_{i,euh}$	0.37	0.35	-1.47	1.33
$\Delta \log p_{i,eul}$	0.42	0.27	-0.40	0.93
$\Delta \log p_{i,oere}$	0.40	0.30	-0.33	1.40
$\Delta \log p_{i,ash}$	0.44	0.38	-0.72	1.43
$\Delta \log p_{i,asl}$	0.09	0.50	-1.33	1.35
$\Delta \log p_{i,cee}$	0.55	0.56	-4.13	1.49
$\Delta \log p_{i,lat}$	0.32	0.30	-0.55	1.29
$\log TFP_i$	0.18	0.24	-0.30	1.32
$\Delta \log SRD_i$	0.61	0.55	-0.29	3.16
$\Delta \log NSRD_i$	0.68	0.46	-0.30	2.17
$\Delta \log FRD_i$	0.44	0.24	-0.11	0.90

In table 4.2 the correlation matrix for the variables in the first step price regressions is given. As the reported correlations are simple correlations one should not read too much into it.

Table 4.2: Correlation Matrix of Variables in First Step Price Regressions

	$\Delta \log p_{i,dom}$	$\Delta \log p_{i,euh}$	$\Delta \log p_{i,eul}$	$\Delta \log p_{i,oere}$	$\Delta \log p_{i,ash}$	$\Delta \log p_{i,asl}$	$\Delta \log p_{i,cee}$	$\Delta \log p_{i,lat}$	$\log TFP_i$
$\Delta \log p_{i,dom}$	1.00								
$\Delta \log p_{i,euh}$	-0.24	1.00							
$\Delta \log p_{i,eul}$	0.19	0.00	1.00						
$\Delta \log p_{i,oere}$	-0.36	0.02	0.19	1.00					
$\Delta \log p_{i,ash}$	0.21	0.05	0.18	0.08	1.00				
$\Delta \log p_{i,asl}$	-0.03	-0.12	0.12	0.21	0.09	1.00			
$\Delta \log p_{i,cee}$	0.03	0.16	0.04	0.14	0.15	-0.10	1.00		
$\Delta \log p_{i,lat}$	-0.02	0.05	-0.04	0.12	0.18	-0.03	0.02	1.00	
$\log TFP_i$	-0.68	0.29	-0.02	0.32	-0.17	-0.02	-0.19	0.02	1.00

Only import price changes of the low-wage EU countries and the Asian Tigers appear to be positively correlated with domestic price changes. Total factor productivity is highly correlated with domestic price changes. Import price changes from the high-skill countries (*euh* and *oere*), i.e. the most important sources of knowledge spillovers for most EU countries, are positively correlated with total factor productivity. Correlation between the import price changes is fairly low, which supports the distinction between the countries groups considered and does not warrant aggregation of country groups because of potential multicollinearity.

In table 4.3 the correlation matrix for the variables in the first step TFP regressions is given. All price changes of the NIC groups are negatively correlated with total factor productivity, which could be an indication of import competition inducing technological change, though it should again be pointed out that the matrix reports simple rather than partial correlations. All R&D stocks are positively correlated with total factor productivity.

Table 4.3: Correlation Matrix of Variables in First Step TFP Regressions

	$\log TFP_i$	$\Delta \log SRD_i$	$\Delta \log NSRD_i$	$\Delta \log FRD_i$	$\Delta \log p_{euh,i}$	$\Delta \log p_{eul,i}$	$\Delta \log p_{oere,i}$	$\Delta \log p_{ash,i}$	$\Delta \log p_{asl,i}$	$\Delta \log p_{cee,i}$	$\Delta \log p_{lat,i}$
$\log TFP_i$	1.00										
$\Delta \log SRD_i$	0.17	1.00									
$\Delta \log NSRD_i$	0.01	0.22	1.00								
$\Delta \log FRD_i$	0.07	0.21	0.01	1.00							
$\Delta \log p_{euh,i}$	0.18	0.01	0.04	-0.02	1.00						
$\Delta \log p_{eul,i}$	-0.15	-0.31	-0.05	0.04	0.11	1.00					
$\Delta \log p_{oere,i}$	0.18	-0.04	0.02	0.12	-0.06	0.18	1.00				
$\Delta \log p_{ash,i}$	-0.26	-0.14	-0.16	-0.11	0.11	0.32	0.02	1.00			
$\Delta \log p_{asl,i}$	-0.07	0.23	0.13	0.04	-0.10	0.11	0.19	0.08	1.00		
$\Delta \log p_{cee,i}$	-0.31	-0.15	-0.08	-0.11	0.16	0.15	0.10	0.29	-0.05	1.00	
$\Delta \log p_{lat,i}$	-0.11	0.01	-0.11	0.03	0.06	0.02	0.05	0.31	0.05	0.16	1.00

Note: The changes in import prices are divided by the domestic price level in 1985, as indicated in equation 4.2.

With a panel estimation the heterogeneity between observational units (e.g. countries) with respect to the relationship between variables can be tested. Differences between units can be captured in the intercept and/or the slope of the regression. If units are homogenous, a specification with a common intercept and common slopes (i.e. a plain Ordinary Least Squares (OLS) estimation on pooled data) will fit the data well. A fixed effects or least squares dummy variables (LSDV) specification assumes that differences between units can be captured in unit-specific intercepts, given common slopes. Rejection of both a common intercept and common slopes points at a high degree of heterogeneity.

F-tests can be used to test the null hypothesis that a specification is more appropriate than a given alternative specification.

Three F-tests will be reported. For the first F-test, the null hypothesis is that a pooled OLS specification (common intercept and slopes) fits the data well, compared to a specification with country-specific intercepts and slopes. The second F-test compares a fixed effects specification (country-specific intercepts but common slopes) to a specification with country-specific intercepts and slopes, whereas the last F-test is a consistency check.

The results of the first step price regression for the period 1985-1995 are given in table 4.4.

In the first column the results are given for a specification with a TFP pass-through.

Only for imports from low-wage EU countries and the Asian Tigers a positive correlation between import price changes and domestic product prices is found, as expected from the *correlation version* of Stolper-Samuelson theorem. Only for the first country group this effect is statistically significant.

Table 4.4: First Step Price Regression (1985-1995)

Dependent variable : $\Delta\log p_{i,dom}$			
$\Delta\log p_{i,euh}$	-0.04	(-0.72)	-0.16 (-2.10) **
$\Delta\log p_{i,eul}$	0.18	(2.22) **	0.23 (2.56) **
$\Delta\log p_{i,oere}$	-0.09	(-1.38)	-0.34 (-2.73) ***
$\Delta\log p_{i,ash}$	0.05	(1.14)	0.14 (2.46) **
$\Delta\log p_{i,asl}$	-0.02	(-0.65)	0.01 (0.11)
$\Delta\log p_{i,cee}$	-0.01	(-0.73)	0.02 (1.11)
$\Delta\log p_{i,lat}$	0.03	(0.48)	0.06 (0.87)
log TFP_i	-0.77	(-7.96) ***	
$R^2_{adjusted}$	0.57		0.25
F-test: common intercept and slopes versus country-specific intercepts and slopes (p-values in brackets)	1.39 [0.20]		1.66 [0.05] **
F-test: common slopes versus country-specific intercepts and slopes, given country-specific intercepts (p-values in brackets)	1.18 [0.35]		1.64 [0.06]*
F-test: common intercept versus country-specific intercepts, given common slopes (p-values in brackets)	2.71 [0.01] **		1.34 [0.23]

Note: The table reports the results of a fixed effects estimation. White heteroskedastic-consistent t-statistics in brackets. *- **-** denotes significance at respectively 10%- 5% and 1 % level.

The pass-through of total factor productivity is highly significant and clearly dominates the impact of import price competition[23].

The results of the estimation of a specification without a TFP pass-through as e.g. Baldwin and Cain (1997) and Haskel and Slaughter (2001), are reported in the second column

This specification seems to suffer from an omitted variable bias. Subject to the caveat of the omitted variable bias, results suggest a significant positive correlation for the Asian Tigers (*ash*) and a significant negative correlation for the high-wage EU countries (*euh*) and the high-skill OECD countries (*oere*). The pass-through of total factor productivity, be it because of the size of EU countries or because of international knowledge spillovers, clearly needs to be considered.

For the specification with a TFP pass-through, a pooled OLS estimation (i.e. assuming common intercepts and common slopes for all EU countries) is not rejected, suggesting that there is actually not much heterogeneity between the EU countries considered, with respect to the impact of international trade competition on domestic price changes. The table however reports the results of the fixed effects estimation (i.e. with common slopes but country-specific intercepts) as this performs better in terms of goodness-of-fit, indicating some level heterogeneity.

Slaughter (2000) pointed out that the results of mandated wage regressions are found to be rather sensitive to whether observations are weighted or not. Leamer (1996 a) reported results for weighted mandated wage regressions with the average employment of each sector used to weigh. Using value added to weigh apparently gives similar results but both are "*entirely*" different from the unreported results of un-weighted regressions (Leamer 1996 a: p. 29). Baldwin and Cain (1997) using employment and output as weights also found substantially different results with respect to un-weighted regressions.

Slaughter (2000) argued that according to the logic of the Stolper-Samuelson theorem, all sectors should be weighed equally as the link between product prices and factor rewards depends on the existence of sectors, not on their size. Given the assumption of perfect factor

23 A specification with common slopes for all countries is rejected in favour of a specification with common slopes for all variables except for the TFP pass-through. The country-specific slopes of the TFP pass-through show no straightforward relation with country size. The results of a specification with country-specific TFP pass-throughs do not alter the main conclusions of the first- and second-step estimations.

mobility, changes in product prices in a given sector will, irrespective of sector size, affect factor prices in all sectors. Therefore Slaughter reasoned that weighing the observations requires empirical justification. Baldwin and Cain (1997) weighed industries by size as they believed data for small sectors were of poor quality. Another reason could be that smaller sectors are residual product categories (Slaughter 2000: p. 156).

In table 4.5 the results of weighted fixed effects regressions are reported. Sectors are alternatively weighted by employment, the wage sum and value added.

The main difference is that for all three alternative weights the coefficient of price competition of the high-wage EU countries is significant, as in the un-weighted first step regression without a TFP pass-through.

The conclusions of the un-weighted two-step estimation are not affected by weighing the observations (i.e. the second step results of weighted regressions do not differ in terms of significance from the results of un-weighted regressions).

Table 4.5: Weighted First Step Price Regression (1985-1995)

Dependent variable : $\Delta\log p_{i,dom}$ (weight)	Employment	Wage Sum	Value Added
$\Delta\log p_{i,euh}$	-0.15 (-2.31) **	-0.20 (-3.19) ***	-0.19 (-3.00) ***
$\Delta\log p_{i,eul}$	0.14 (2.49) **	0.14 (2.64) ***	0.12 (2.23) **
$\Delta\log p_{i,oere}$	-0.04 (-0.83)	-0.06 (-1.17)	-0.05 (-91)
$\Delta\log p_{i,ash}$	0.00 (0.01)	0.01 (0.31)	-0.01 (-0.22)
$\Delta\log p_{i,asl}$	-0.02 (-0.69)	-0.03 (-0.93)	-0.03 (-0.98)
$\Delta\log p_{i,cee}$	-0.01 (-0.24)	-0.00 (-0.03)	-0.00 (-0.02)
$\Delta\log p_{i,lat}$	0.02 (0.43)	0.04 (0.72)	0.03 (0.31)
log TFP_i	-0.68 (-7.30) ***	-0.67 (-7.67) ***	-0.63 (-6.90) ***
$\mathbf{R^2_{adjusted}}$	0.52	0.55	0.53

Note: The table reports the results of a fixed effects estimation with observations weighted respectively by the sector share of total employment (first column), the share of the total wage sum (second column) and the share of total value added (third column). White heteroskedastic -consistent t-statistics are given in brackets. *- **-** denotes significance at respectively 10%, 5% and 1 % level.

Moreover, given the rather high two-digit industry level, the two empirical arguments for weighted regressions mentioned by Slaughter (2000) do not seem very clinching. Therefore, the results of weighted regressions are no longer reported hereafter.

As mentioned in section 3.2.5, Feenstra and Hanson (1999) pointed out that by assuming wages are the same across sectors, which is clearly not supported by the data, the mandated wage regression could suffer from an omitted variable bias.

They proposed to use effective total factor productivity, defined as the difference between TFP and a residual term, reflecting the factor share-weighted difference between industry-specific wages and the mean across sectors for the respective production factors (see equation 3.39 in section 3.2.5). Table 4.6 reports the results of the first step price regression with effective TFP rather than plain TFP as right-hand side variable.

The results do not differ substantially from those with plain TFP, except that the negative coefficient of import price changes of the high-skill OECD countries (*oere*) is now significant. Although the specification with effective TFP is purported to remove an omitted variable bias, the R^2 is lower than in the specification with plain TFP.

Table 4.6: First Step Price Regression with Effective TFP (1985-1995)

Dependent variable : $\Delta\log p_{i,dom}$		
$\Delta\log p_{i,euh}$	-0.08	(-1.25)
$\Delta\log p_{i,eul}$	0.19	(2.23) **
$\Delta\log p_{i,oere}$	-0.16	(-2.03)**
$\Delta\log p_{i,ash}$	0.05	(0.97)
$\Delta\log p_{i,asl}$	0.01	(0.04)
$\Delta\log p_{i,cee}$	-0.01	(-0.75)
$\Delta\log p_{i,lat}$	0.04	(0.48)
$ETFP_i$	-0.63	(-6.87) ***
$\mathbf{R^2_{adjusted}}$	0.50	
F-test: common intercept and slopes versus country-specific intercepts and slopes (p-values in brackets)	1.30 [0.26]	
F-test: common slopes versus country- specific slopes, given country specific intercepts (p-values in brackets)	1.21 [0.32]	
F-test: common intercept versus country- specific intercepts, given common slopes (p-values in brackets)	1.70 [0.11]	

Note: See table 4.4

The Stolper-Samuelson theorem assumes perfect competition on product and labour markets. Haskel and Slaughter (2001) referred to the imperfect competition modelling of international trade in Helpman and Krugman (1985). Helpman and Krugman argued that economies of scale provide additional gains from trade, which, if large enough, could outdo the Stolper-Samuelson corrosion of the scarce factors' income. The scarce production factors will not lose from trade if trade partners are similar with respect to relative factor endowment and economies of scale are important. In a market with differentiated goods- invoking the Contestable Markets theory proposed by Baumol, Panzar and Willig (1982)- firms will enter until profits are zero, so a market which is not perfectly competitive does not need to be inconsistent with the zero-profits assumption, as pointed out by Haskel and Slaughter (2001). The more dissimilar countries are in terms of factor endowment, the smaller elasticity of substitution between the differentiated goods has to be for the scarce factor not to suffer from international trade (Helpman and Krugman 1985: pp. 194-195).

As the main focus in this research is on the impact of EU trade with Newly Industrialised Countries, which will be relatively dissimilar from EU countries, the bias due to imperfect competition is probably not that important. Moreover, models that incorporate imperfect competition, if they have any explicit implication for income distribution at all, are very difficult if not impossible to use empirically, given the lack of data.

However, in the two-step mandated wage procedure it is feasible to account for the impact of imperfect competition in the goods markets by including proxy variables reflecting market structure. Market power of domestic firms could, to some extent, shield domestic firms from import competition and thus reduce the link between import price changes and domestic product price changes, which can be incorporated in the econometric specification as follows:

$$\begin{aligned}\Delta \log p_{i,dom} = \alpha_{0,i} &+ \Delta \log p_{i,euh}\left(\alpha_{euh} + \alpha_{IC,euh} * IC\right) + \Delta \log p_{i,eul}\left(\alpha_{eul} + \alpha_{IC,eul} * IC\right) \\ &+ \Delta \log p_{i,oere}\left(\alpha_{oere} + \alpha_{IC,oere} * IC\right) + \Delta \log p_{i,ash}\left(\alpha_{ash} + \alpha_{IC,ash} * IC\right) \\ &+ \Delta \log p_{i,asl}\left(\alpha_{asl} + \alpha_{IC,asl} * IC\right) + \log p_{i,cee}\left(\alpha_{cee} + \alpha_{IC,cee} * IC\right) \\ &+ \Delta \log p_{i,lat}\left(\alpha_{lat} + \alpha_{IC,lat} * IC\right) + \alpha_{tfp} \log TFP_i + \varepsilon_{i,pr}\end{aligned} \quad (4.3)$$

IC is a proxy for industry concentration. If market power does indeed dampen the impact of import competition, the respective coefficients of the interaction between import prices and the

IC variable should be significant and negative, which can be tested using an F-test of the hypothesis that $\alpha_{IC, i}$ (i = euh, eul, oere, ash, asl, cee, lat) are jointly zero.

In table 4.7 the results of a first step price regression with variables reflecting market structure are shown.

Table 4.7: First Step Price Regression with Variables reflecting Imperfect Product Market Competition (1985-1995)

	IC = C4a		IC = C4b		IC = K/L	
$\Delta\log p_{i,euh}$	-0.05	(-0.48)	-0.11	(-1.33)	0.04	(0.43)
$\Delta\log p_{i,eul}$	-0.06	(-0.47)	0.12	(1.08)	0.11	(0.95)
$\Delta\log p_{i,oere}$	0.24	(1.97) *	0.07	(0.60)	-0.03	(-0.18)
$\Delta\log p_{i,ash}$	-0.14	(-1.55)	0.01	(0.07)	0.03	(0.39)
$\Delta\log p_{i,asl}$	-0.06	(-0.85)	-0.08	(-1.37)	-0.03	(-0.48)
$\Delta\log p_{i,cee}$	0.06	(0.60)	-0.01	(-0.04)	-0.09	(-1.61)
$\Delta\log p_{i,lat}$	-0.02	(-0.23)	-0.03	(-0.29)	-0.12	(-0.86)
IC * $\Delta\log p_{i,euh}$	0.11	(0.29)	0.26	(1.00)	-0.00	(-0.76)
IC * $\Delta\log p_{i,eul}$	0.64	(1.86) *	0.11	(0.36)	0.00	(0.16)
IC * $\Delta\log p_{i,oere}$	-1.13	(-2.27) **	-0.77	(-1.42)	0.00	(0.00)
IC * $\Delta\log p_{i,ash}$	0.55	(2.09) **	0.11	(0.58)	0.00	(0.52)
IC * $\Delta\log p_{i,asl}$	0.19	(0.81)	0.22	(0.98)	0.00	(0.36)
IC * $\Delta\log p_{i,cee}$	-0.20	(-0.63)	-0.02	(-0.10)	0.00	(1.30)
IC * $\Delta\log p_{i,lat}$	0.10	(0.38)	0.27	(0.78)	0.00	(1.02)
$\Delta\log TFP_i$	-0.65	(-6.52) ***	-0.74	(-7.46) ***	-0.85	(-7.47) ***
$R^2_{adjusted}$	0.63		0.58		0.58	
F-test $\alpha_{IC, i} = 0$	3.67	(0.00)	1.39	(0.22)	1.60	(0.14)

Note: See table 4.4. The reported F-statistic tests the null hypothesis that all pass-through variables are jointly zero.

In the first column the IC variable is the share of the cumulative turnover of the four largest companies in the sector turnover (C4a), given by the STAN or ISDB sector aggregate. In the second column it is the share of the cumulative turnover of the four largest companies in the sector turnover (C4b), computed from the Amadeus database, which was the source for the company turnover figures (see data description in section 4.2) and in the last column the capital-labour (K/L) ratio, taken from STAN or ISDB, is considered as a proxy for industry concentration.

The hypothesis that the $\alpha_{IC, i}$ are jointly zero cannot be rejected for two out of the three proxies of market structure. The first proxy (C4a), for which the null hypothesis is rejected, is of all IC proxies most likely to suffer from measurement error as it combines data from two sources

(firm level Amadeus data and sector level ISDB-STAN data) and does not correct for the consolidation of the company figures that are used for the computation of the cumulative output of the four largest companies.
The evidence of a dampening effect of market power therefore is far from convincing. For import price changes from (South-) East Asian NIC and the low-wage EU countries the first column actually suggests a reinforcing of the impact due to market power. A specification with the market power proxy variables included (alternatively) as simple right-hand side variables, as Haskel and Slaughter (2001) did for the United Kingdom with a concentration measure (C5), results in a significant coefficient for K/L only.

Overall the alternative first step price regressions only provide evidence for the prediction of a positive correlation between import prices and domestic product prices with respect to imports from the low-wage EU countries. The correlation between import prices of the Asian Tigers and domestic product prices in the EU is also found to be positive in most specifications but is in most cases not significant.

The results of the first step TFP regression are shown in table 4.8.

Table 4.8: First Step TFP Regression (1985-1995)

Dependent variable: log TFP_i	
Δ log SRD_i	0.02 (0.37)
Δ log $NSRD_i$	0.01 (0.11)
Δ log FRD_i	0.24 (2.32) **
(Δ log $p_{euh,i}$) /$p_{dom,i,85}$	0.16 (2.26) **
(Δ log $p_{eul,i}$) /$p_{dom,i,85}$	-0.11 (-1.35)
(Δ log $p_{oere,i}$) /$p_{dom,i,85}$	0.24 (3.13) ***
(Δ log $p_{ash,i}$) /$p_{dom,i,85}$	-0.13 (-2.57) **
(Δ log $p_{asl,i}$) / $p_{dom,i,85}$	-0.02 (-0.51)
(Δ log $p_{cee,i}$)/ $p_{dom,i,85}$	-0.09 (-1.86) *
(Δ log $p_{lat,i}$)/ $p_{dom,i,85}$	-0.05 (-0.74)
$\mathbf{R^2_{adjusted}}$	0.34
F-test: common intercept and slopes versus country specific intercepts and slopes (p-values in brackets)	1.21 [0.37]
F-test: common slopes versus country specific slopes, given country specific intercepts (p-values in brackets)	0.97 [0.56]
F-test: common intercept versus country specific intercepts, given common slopes (p-values in brackets)	3.31 [0.00] ***

Note: See table 4.4

As in previous studies (e.g. Coe and Helpman 1995, Lichtenberg and van Pottelsberghe de la Potterie 1996) trade-related international R&D spillovers are found to be significant. International trade is clearly an important spillover channel. In the estimations only North-North spillovers are considered. Coe, Helpman and Hoffmaister (1995) found evidence of substantial technology spillovers from the North to the South. From a dynamic perspective these spillovers could be an important determinant of import competition of the emerging economies if they allow these countries to close the technology gap.

This would imply that import prices are not necessarily exogenous. However, a validity of instruments test (GMM estimation) suggests that import prices are not endogenous. The closing of the technology gap is not necessarily reflected in falling product prices but could also be reflected in a shift in the comparative advantage of the NIC towards more skill-intensive goods.

With respect to trade-induced technological change, i.e. technology activities induced in the North due to import competition from the South, changes in import prices of high-skill countries (*euh* and *oere*) seems to have had a negative impact on technological change (i.e. the lower import prices the lower TFP) whereas import price competition from the low-wage countries and NIC appears to have induced technological change and with respect to the Asian Tigers significantly.

The coefficients of the import prices are higher than the coefficients in the first step price regressions and are for more country groups found to be significant.

These findings support the view that international trade can have a substantial impact on technological change, be it as a spillover mechanism or as a stimulus for productivity improving activities.

Import competition from the NICs appears to have affected EU countries through induced technological effects rather than through a direct Stolper-Samuelson relation between import prices and domestic product prices.

This in line with previous studies in which little support is found for Stolper-Samuelson effects as well as with some of the studies which indicate significant effects of trade-induced technological change and international technology spillovers.

In a similar way as for the first step price regression import prices of the different country groups can be interacted with variables reflecting market structure in the first step TFP regression. The results of this estimation for the three alternative proxies of industry concentration can be found in table 4.9.

Overall, the results do not convincingly show a substantial impact of market power on the link between import competition and technological change.

Table 4.9: First Step TFP Regression with Variables reflecting Imperfect Product Market Competition (1985-1995)

	IC = C4a	IC = C4b	IC = K/L
Δ log SRD_i	0.04 (0.94)	0.01 (0.15)	0.03 (0.69)
Δ log $NSRD_i$	0.02 (0.25)	0.02 (0.15)	-0.02 (-0.17)
Δ log FRD_i	0.14 (1.15)	0.24 (1.89) *	0.24 (2.01) **
(Δ log $p_{euh,i}$) /$p_{dom,i,85}$	0.06 (0.43)	0.22 (2.14) **	0.15 (1.10)
(Δ log $p_{eul,i}$) /$p_{dom,i,85}$	-0.19 (-1.30)	-0.18 (-1.35)	-0.38 (-2.56) **
(Δ log $p_{oere,i}$) /$p_{dom,i,85}$	0.02 (0.16)	0.26 (2.13) **	0.48 (2.41) **
(Δ log $p_{ash,i}$) /$p_{dom,i,85}$	0.08 (0.56)	-0.10 (-0.91)	-0.02 (-0.21)
(Δ log $p_{asl,i}$) / $p_{dom,i,85}$	-0.06 (-0.67)	0.00 (0.03)	-0.08 (-0.98)
(Δ log $p_{cee,i}$)/ $p_{dom,i,85}$	-0.13 (-0.99)	-0.12 (-1.37)	-0.13 (-1.39)
(Δ log $p_{lat,i}$)/ $p_{dom,I,85}$	0.06 (0.47)	-0.02 (-0.17)	-0.24 (-1.46)
IC *(Δ log $p_{euh,i}$) /$p_{dom,i,85}$	0.24 (0.55)	-0.27 (-0.86)	-0.00 (-0.06)
IC *(Δ log $p_{eul,i}$) /$p_{dom,i,85}$	0.37 (0.80)	0.26 (0.68)	0.00 (2.17) **
IC *(Δ log $p_{oere,i}$) /$p_{dom,i,85}$	0.61 (1.28)	-0.06 (-0.20)	-0.00 (-1.38)
IC *(Δ log $p_{ash,i}$) /$p_{dom,i,85}$	-0.58 (-1.30)	-0.15 (-0.58)	-0.00 (-1.46)
IC *(Δ log $p_{asl,I}$) / $p_{dom,i,85}$	0.06 (0.26)	-0.10 (-0.56)	0.00 (1.61)
IC *(Δ log $p_{cee,i}$)/ $p_{dom,i,85}$	0.14 (0.36)	0.13 (0.52)	0.00 (0.53)
IC *(Δ log $p_{lat,I}$)/ $p_{dom,I,85}$	-0.39 (-0.78)	-0.08 (-0.30)	0.00 (0.90)
$\mathbf{R^2_{adjusted}}$	0.35	0.29	0.39
F-test $\alpha_{IC,i} = 0$	1.35 (0.24)	0.22 (0.98)	2.49 (0.02) **

Note: See table 4.7.

Feenstra and Hanson (1999) did not estimate the price and TFP regression separately but combined domestic price and TFP changes as the dependent variable in a single first step specification (i.e. equation 3.43 in section 3.2.5) and considered the estimated coefficients multiplied by the respective right-hand side variables as the part of the change in domestic prices **and** TFP that can be explained by changes in the structural determinants.

They argued that considering the price and TFP regressions separately will result in a bias of the TFP pass-through toward –1 (they actually estimate the pass-through to be –1.01), given the fact that TFP and value added prices will be correlated by construction.

Instrumental variables estimation, which could be used to obtain consistent estimates of the pass-through, is not obvious as the variables that could be used as instruments (i.e. the structural determinants) for TFP are very likely to be correlated with value added price changes. Feenstra and Hanson regressed domestic price changes on effective TFP using the structural determinants as instruments. A test of over-identifying restrictions did indeed suggest the poor validity of these variables as instruments[24].

Feenstra and Hanson therefore preferred a combined estimation that did not contain the TFP pass-through. Although they rightly pointed out the potential endogeneity bias, their bypass implies that the sector-bias and the factor bias of technological change cannot be disentangled and that the impact of the structural determinants on domestic prices and TFP get mingled. Haskel and Slaughter (2001), in their main mandated wage specification for the United Kingdom estimated the first step price and TFP regressions separately, without a TFP pass-through in the price regression. As a robustness test they estimated a price regression with a pass-through and found a significant estimate of - 0.62 (t-value= -11.50) but it did not seem to have mandated a significant rise in wage inequality in the United Kingdom in the 1970s nor in the 1980s.

Table 4.10: First Step Regression with Domestic Price Changes and (E)TFP as the Combined Dependent Variable (1985-1995)

Dependent variable:	$\Delta\log p_{i,dom}$+ log TFP_i	$\Delta\log p_{i,dom}$+ $ETFP_i$
$\Delta\log p_{i,euh}$	0.00 (0.01)	-0.02 (-0.46)
$\Delta\log p_{i,eul}$	0.12 (1.80) *	0.14 (1.91) *
$\Delta\log p_{i,oere}$	-0.03 (-0.55)	0.07 (-1.22)
$\Delta\log p_{i,ash}$	-0.03 (-0.73)	-0.08 (-1.77) *
$\Delta\log p_{i,asl}$	0.00 (0.10)	0.03 (0.78)
$\Delta\log p_{i,cee}$	-0.02 (-1.12)	-0.03 (-1.82) *
$\Delta\log p_{i,lat}$	0.04 (0.67)	0.06 (1.02)
Δ log SRD_i	-0.05 (-1.68) *	-0.03 (-0.83)
Δ log $NSRD_i$	0.33 (4.33) ***	0.41 (4.57) ***
Δ log FRD_i	0.04 (0.46)	0.10 (1.16)

24 A GMM estimation of the first step price regression with R&D stocks used as instruments for TFP provides no significant coefficients. The test of over-identifying restrictions is not rejected which would indicate that the R&D variables are good instruments. The test also suggest that import prices can be considered as exogenous as these have been used in the GMM estimation as their own instruments.

$R^2_{adjusted}$	0.47	0.45
F-test: common intercept and slopes versus country-specific intercepts and slopes (p-values in brackets)	2.40 [0.04] **	4.46 [0.00] ***
F-test: common slopes versus country-specific slopes, given country specific intercepts (p-values in brackets)	1.37 [0.27]	2.66 [0.03]**
F-test: common intercept versus country-specific intercepts, given common slopes (p-values in brackets)	8.74 [0.00] ***	8.33 [0.00] ***

Note: The table reports the results of the reduced form specification 3.43 in section 3.2.5. White heteroskedastic -consistent t-statistics are given in brackets. *- **-** denotes significance at respectively 10%, 5% and 1 % level.

The first column in table 4.10 gives the results of the estimation with domestic price changes plus plain TFP, as dependent variable, and the second column the results when domestic prices plus effective TFP, which is the specification Feenstra and Hanson (1999) considered, is used.

4.3.2 Second Step Estimation

In the second step, the estimated contribution of each structural determinant $\hat{\alpha}_j z_{i,j}$ is regressed on the value added factor shares, in order to estimate its contribution to the change in wage inequality between high- and low-skilled workers:

$$\hat{\alpha}_j z_{i,j} = V_{HS,i}\Delta \log w_{HS} + V_{LS,i}\Delta \log w_{LS} + V_{K,i}\Delta \log w_K + \varepsilon_{i,j} \quad (j = euh, eul, oere, ash, asl, cee, lat) \tag{4.4}$$

The variables $V_{f,i}$ represent the value added shares of factor f (high-skilled labour HS, low-skilled labour LS and capital K) in sector i. Following Leamer (1996 a) $\Delta\log w_f$ are the parameters to be estimated in this specification, reflecting the wages changes *mandated* by trade-induced price changes. Taking account of the fact that factor shares sum to one ($V_{K,i}$= 1 $V_{HS,i} + V_{LS,i}$) equation (4.4) can be written as (Lücke 1998):

$$\hat{\alpha}_j z_{i,j} = \Delta \log w_K + V_{HS,i}(\Delta \log w_{HS} - \Delta \log w_K) + V_{LS,i}(\Delta \log w_{LS} - \Delta \log w_K) + \varepsilon_{i,j} \tag{4.5}$$

The coefficient estimate of $V_{f,i}$ indicates to what extent the remuneration of factor f diverged from that of capital. A comparison of the estimated coefficients of $V_{HS,i}$ and $V_{LS,i}$ gives an indication of the change in wage inequality between high-skilled and low-skilled workers in the period considered.

The relationship between domestic product price changes, total factor productivity and changes in factor rewards, as given in equation (3.29) in section 3.2.5, is derived by differentiating the zero profit condition in continuous time. For empirical purposes, data availability obviously only allows for discrete time changes. For the latter, the interaction effect between the changes in factor input requirements ($\Delta \log a_{ji}$) and the changes in factor rewards have to be accounted for, as pointed out by Leamer (1996 a). The discrete time equivalent of (3.29) is:

$$\Delta \log p_i = \sum_j V_{ji} \Delta \log w_j \left(1 + \Delta \log a_{ji}\right) - TFP_i \tag{4.6}$$

Estimation of the discrete time changes specification (4.5) could be biased due to the omitted variable if the changes in factor input requirements are not accounted for. If the residuals of (4.5) are regressed on the interaction terms of the value added shares and the unit factor input requirement changes, F-tests on the significance of these residuals can be regarded as a test of the importance of the omitted variable bias. These F-tests are, in addition to the three panel F-tests, reported in tables 4. 11 and 4.12 which show the results of the second step regressions.

A final econometric consideration concerns the nature of the left-hand side variables in the second step specifications. As observed by Slaughter (2000) mandated wage regressions might strike as somewhat odd, as the exogenous variables (i.e. the structural determinants) are used as regressand rather than as regressor whereas the dependent variables (i.e. changes in factor rewards) are the coefficients to be estimated. This follows from the fact that the technology matrix, reflecting the cost shares of production factors, cannot be inverted if the number of sectors (goods) does not equal the number of factors and therefore no system of equations with the changes in factor rewards as left-hand side variables can be obtained.

A more fundamental observation is that the left-hand side variables are, rather than *true* variables, generated using the coefficients estimated in the first step.

Feenstra and Hanson (1997) pointed out that the standard errors of the second step estimates should be corrected to account for additional variance due to the use of the first step estimates. They proposed a procedure to recover the *true* variances. However, their correction method

does not warrant positive variances, as a result of which in a number of cases standard errors cannot be determined (e.g. Feenstra and Hanson 1997, 1999 and Haskel and Slaughter 2001).
Dumont, Rayp, Thas and Willemé (2003) showed that the correction procedure proposed by Feenstra and Hanson (1997) suffers from a negative bias, which can be substantial in small samples. They proposed a procedure that guarantees positive variances. The estimates of the second step regressions have been corrected using this procedure. The proposed alternative correction, which can be derived rather straightforwardly by applying the method of moments procedure proposed by Newey (1984) is given in the statistical appendix to this chapter.
In table 4.11 the results of the second step price regression are shown, using the estimates reported in the first column of table 4.4.

The F-tests show that a plain OLS specification (i.e. common intercept and slopes) is rejected in five out of seven cases, in particular for trade with the EU and non-EU OECD countries and the Asian Tigers[25].
The F-test on the last row test the importance of the omitted variable bias due to the use of discrete time changes as explained above. The bias does not appear to be important.
As shown in equation (4.5) the change in capital return ($\Delta \log w_K$) is the intercept estimated in the econometric specification. For the determinants for which a fixed effects specification is not rejected this intercept is country-specific and therefore not reported in table 4.11.
Overall, the direct influence of trade liberalisation on income distribution in the European Union seems limited.

Only when allowing for a 10 per cent error level, trade with the Asian Tigers can be said to have *mandated* a profit-clearing increase in the relative wages of high-skilled workers by 9 per cent.

Apparently, increased trade with the Asian Pussycats, the Central and Eastern European countries nor the Latin-American emerging economies seems to have affected wage inequality. The significant impact of import prices of the Southern European countries (*eul*) on domestic

25 The F-statistics only test for the specification in the second step conditional regression. The variance of the first step estimated coefficients does not affect the F-statistic. Changing the value of the constant coefficient in the dependent variable results in the variation of the sum squared residuals by the same multiplicative factor for both the restricted and the unrestricted specification, which appears both in the nominator and the denominator of the F-statistic and can therefore be divided away.

prices, found in the first step regression, does not seem to carry over in changes in factor rewards.

Table 4.12 reports the results of the second step TFP regression. For the estimation of the impact on wages of the R&D determinants (e.g. the significant international R&D spillovers) both a plain OLS and a fixed effects specification are rejected, suggesting substantial heterogeneity.

Table 4.11: Second Step Price Regression (1985-1995)

Dependent variable:	$\alpha_{euh}\Delta p_{euh}$	$\alpha_{eul}\Delta p_{eul}$	$\alpha_{oere}\Delta p_{oere}$	$\alpha_{ash}\Delta p_{ash}$	$\alpha_{asl}\Delta p_{asl}$	$\alpha_{cee}\Delta p_{cee}$
Δ log w_{HS} - Δ log w_K	-0.00 (-0.20)	-0.09 (-1.12)	-0.10 (-1.62)	0.09 (1.83)*	0.01 (0.29)	0.02 (0.80)
Δ log w_{LS} - Δ log w_K	-0.01 (-0.35)	0.02 (0.21)	-0.04 (-0.91)	-0.00 (-0.10)	0.00 (0.28)	0.01 (0.78)
Δ log w_K	F.E.	F.E.	F.E.	F.E.	-0.01 (-0.12)	0.00 (0.06)
R^2	0.21	0.23	0.22	0.26	0.02	0.03
F-test: common intercept and slopes versus country-specific intercepts and slopes (p-values in brackets)	2.31 (0.00)***	1.55 (0.08)*	1.52 (0.09)*	1.39 (0.14)	1.21 (0.26)	0.97 (0.52)
F-test: common slopes versus country-specific slopes, given country specific intercepts (p-values in brackets)	1.16 (0.32)	0.91 (0.56)	0.88 (0.59)	0.65 (0.83)	1.30 (0.22)	0.80 (0.69)
F-test: common intercept versus country-specific intercepts, given common slopes (p-values in brackets)	4.48 (0.00)***	2.86 (0.01)***	2.84 (0.00)***	3.04 (0.00)***	0.97 (0.46)	1.35 (0.23)
F-test on zero slopes of $V_{ji}\,\Delta\log a_{ji}$	1.49 (0.23)	1.31 (0.28)	0.16 (0.85)	0.40 (0.67)	0.27 (0.77)	0.17 (0.84)

Note: White heteroskedastic-consistent t-statistics in brackets, corrected with the formula A-14 derived in the statistical appendix. *-**-*** denotes significance at respectively 10%-5 % and 1%. F.E.: fixed effects (i.e. country-specific intercepts). For the estimation with respect to Latin American countries, both a plain OLS and a fixed effects specification are rejected.

Table 4.12: Second Step TFP Regression (1985-1995)

Determinant	M_{euh}	M_{eul}	M_{oere}	M_{ash}	M_{asl}	M_{cee}	M_{latin}
Δ log w_{HS} - Δ log w_K	-0 00 (-0.03)	0.04 (0.69)	0.16 (1.85) *	-0.23 (-2.81) **	0.01 (0.39)	-0.08 (-1.40)	-0.01 (-0.51)
Δ log w_{LS} - Δ log w_K	0.06 (0.87)	-0.01 (-0.16)	0.12 (1.72) *	0.01 (0.12)	0.01 (0.49)	-0.06 (-1.34)	-0.01 (-0.53)
Δ log w_K	F.E.	F.E.	F.E.	F.E.	-0.01 (-1.56)	-0.00 (-0.07)	-0.01 (-0.54)
R^2	0.32	0.19	0.19	0.26	0.01	0.04	0.02
F-test: common intercept and slopes versus country specific intercepts and slopes (p-values in brackets)	2.25 (0.00)***	1.44 (0.12)	1.16 (0.30)	1.28 (0.20)	1.26 (0.22)	1.26 (0.22)	1.17 (0.30)
F-test: common slopes versus country specific slopes, given country specific intercepts (p-values in brackets)	0.89 (0.58)	1.09 (0.38)	0.69 (0.79)	0.54 (0.92)	1.44 (0.15)	0.92 (0.55)	1.43 (0.15)
F-test: common intercept versus country specific intercepts, given common slopes (p-values in brackets)	5.06 (0.10)*	2.10 (0.04)**	2.20 (0.03)**	3.00 (0.01)***	0.85 (0.56)	1.97 (0.06) *	0.60 (0.78)
F-test on zero slopes of V_{ji} Δlog $a_{j\,i}$ (p-values in brackets)	0.21 (0.81)	1.59 (0.21)	0.04 (0.97)	1.10 (0.44)	1.21 (0.30)	0.35 (0.71)	3.63 (0.03)**

Note: Meuh, Meul, Moere, Mash, Masl, Mcee and Mlatin denote the part of TFP that can be explained by changes in import prices (relative to the domestic price level in 1985), as estimated in the first step TFP regression reported in table 4.8. White heteroskedastic-consistent t-statistics in brackets are corrected with the formula A-14 derived in the statistical appendix. *-**-*** denotes significance at respectively 10 %- 5 % and 1%. F.E.: fixed effects (i.e. country-specific intercepts).

Import competition of non-EU OECD countries (*oere*), allowing for a 10 per cent error level, induced changes in total factor productivity that were favourable to both low-skilled and high-skilled workers with a bias towards the latter. Import competition of the Asian Tigers appears to have induced technological change, biased against high-skilled workers.
This somewhat surprising result lends some support to the theoretical model by Acemoglu (2002), in which labour market institutions in Europe are assumed to stimulate investment in technologies that increase the productivity of low-skilled workers.

In table 4.13 the results of the first step price regression, using the extended data set, for the period 1990-1996 and 1990-1998 are reported. As shown in figure 4.1 in section 4.2 the years 1990 and 1996 appear to be at the same point in the business cycle though growth in 1996 was substantially lower than in 1990. Economic growth after 1993 behaved somewhat different from the pattern in the period 1980-1993, as GDP per capita did not grow as fast and as long after the 1993 through than it did after the 1981 through but rather started to oscillate around two per cent up till 2000.

Table 4.13: First Step Price Regression (1990-1998)

Dependent variable : $\Delta \log p_{i,dom}$	**1990-1996**	**1990-1998**
$\Delta \log p_{i,euh}$	0.002 (0.08)	0.04 (0.45)
$\Delta \log p_{i,eul}$	0.01 (0.40)	-0.06 (-1.00)
$\Delta \log p_{i,oere}$	-0.05 (-2.08) **	-0.09 (-1.49)
$\Delta \log p_{i,as}$	-0.01 (-0.52)	-0.06 (-1.52)
$\Delta \log p_{i,china}$	0.01 (0.46)	-0.04 (-1.15)
$\Delta \log p_{i,cee}$	-0.003 (-0.13)	-0.02 (-0.54)
$\Delta \log p_{i,lat}$	-0.06 (-1.65)	0.03 (0.56)
log TFP_i	-0.77 (-5.80) ***	-0.29 (-2.40)***
Number of observations	95	43
$\mathbf{R^2_{adjusted}}$	0.59	0.26
F-test: common intercept and slopes versus country-specific intercepts and slopes. (p-values in brackets)	1.77 [0.07]*	0.92 [0.65]
F-test: common slopes versus country-specific intercepts and slopes, given country-specific intercepts. (p-values in brackets)	1.28 [0.26]	0.73 [0.73]
F-test: common intercept versus country-specific intercepts, given common slopes (p-values in brackets)	4.77 [0.00] ***	2.95 [0.04] **

Note: The table reports the results of a fixed effects estimation. White heteroskedastic-consistent t-statistics in brackets. *- **-** denotes significance at respectively 10%- 5% and 1 % level.

In 1998, GDP per capita growth was closer to the 1990 level, but whereas 1990 was a point at the downhill of the business cycle, 1998 appears to be a point at the moderate plateau-like uplift. The data set with an update for the years 1997 and 1998 has more missing values and is probably flawed by more substantial measurement error.
For both the period 1990-1996 and 1990-1998 unit value import prices have, in addition to the previously groups considered, been computed for China as this country became a mayor exporter in the 1990s as pointed out in section 2.3.

Specification tests for the period 1990-1998 indeed suggest that the updated data may be of poor quality. For the period 1990-1996 the results are rather similar with the results for the period 1985-1995, especially with respect to the TFP pass-through. The positive correlation between import prices of the Southern European EU countries (*eul*) and domestic prices is no longer significant whereas the negative correlation of import prices of the high-skilled OECD countries (*oere*) is now significant. The coefficient for China has the expected positive sign but is not significant. The second step estimations give no significant coefficients.

To test the robustness of the previous results, a number of sensitivity checks have been performed. For the first and the second step, regressions have been estimated by alternatively omitting one of the nine EU countries. All estimations have been carried out, weighing the observations by shares in employment, the wage sum and value added and with effective total factor productivity as suggested by Feenstra and Hanson (1999). In addition to the country-specific intercepts sector dummies have been used in alternative estimations. All estimations have been replicated with the proxy variables for market power (e.g. C4). Instead of using unit value import prices, which are sensitive to measurement error, import volumes have been used as a proxy for import competition. For those cases for which a plain OLS specification has not been rejected the second step estimations have been performed using the first step OLS estimates. Following the results of a Hausman test, a random effects specification (i.e. a specification in which the country-specific intercepts are assumed to be distributed randomly across countries) could not always be rejected in favour of a fixed effects specification. If so, the two-step estimation has also been performed with a random effects specification.
The original data, as well as the data smoothed to account for the structural breaks in the data sets have been used alternatively. Instead of using the variables for 1985 and 1995 as the begin and end point, averages for the years 1984-1986 and 1994-1996 were considered to compute

the differences for the period 1985-1995. As an alternative to using the begin-of-period value for the factor shares (e.g. Leamer 1996 a), the average factor shares over the period have been considered (Feenstra and Hanson 1999 and Haskel and Slaughter 2001). For total factor productivity the original data, using a standardized labour share of 70 per cent, as well as estimates using actual labour shares have been considered.

Though the results appear to be rather sensitive to alternative specifications, the conclusion that there is little evidence to support substantial Stolper-Samuelson effects for EU countries, in the period considered, is consistently confirmed. The indication of technological change induced by trade with Asian Tigers, as found in table 4.12, is not always supported by other estimations, even at the 10 per cent error level.

4.4 Mandated Wage Estimation with Foreign Outsourcing

Although the mandated wage procedure is developed as a tool to estimate Stolper-Samuelson effects (i.e. the impact of changes in import prices on wage inequality through changes in domestic prices), Feenstra and Hanson (1999) did not consider import prices but variables reflecting foreign outsourcing as determinants of domestic price changes and TFP.
In the model proposed by Feenstra and Hanson (see section 3.1.2), foreign outsourcing will actually increase the domestic prices of intermediate inputs as these will become more skill-intensive, after the production of less skill-intensive inputs have been outsourced to low-skill abundant countries. They defined a modified Stolper-Samuelson theorem linking relative prices of intermediate inputs to relative wages. In their empirical work they considered volumes of imported intermediate inputs, derived from input-output tables. They defined foreign outsourcing as (Feenstra and Hanson 1999: p. 924):

$$\sum_{j}\left[\text{input purchases of good } j \text{ by industry } i\right].\left[\frac{\text{imports of good j}}{\text{consumption of good j}}\right] \qquad (4.7)$$

If all non-energy intermediate inputs (i.e. inputs from all manufacturing industries j) are considered, (4.7) gives a *broad* measure of foreign outsourcing whereas if only those intermediate inputs from the same two-digit industry are considered Feenstra and Hanson defined the measure as foreign outsourcing in the *narrow* sense.

As pointed out in section 3.1.2, whereas Feenstra and Hanson concluded that foreign outsourcing harms low-skilled workers, other theoretical models have more ambiguous conclusions as to the impact on the position of low-skilled workers.

To estimate the impact of foreign outsourcing on wage inequality in the European Union the dataset used for the previous mandated wage regressions was extended with data from the OECD Input-Output database. At present the OECD data cover the period 1973-1990 but the OECD is in the process of updating the database. The database contains separate matrices of flows of imported intermediate inputs. For Belgium the input-output data of the Federal Planning Bureau were used. Bilateral import shares were considered to decompose flows of imported intermediate inputs into flows imported from six country groups: Central- and Eastern European emerging economies, (South-) East Asian Newly Industrialised Countries, Latin-American Newly Industrialised Countries, low-wage EU countries, high-wage EU countries and non-EU OECD countries (see section 4.2 for a detailed list of the countries considered). There were sufficient data to construct all necessary variables for Belgium, Denmark, France, Germany and the United Kingdom for the period 1985-1995. The flow matrices of imported intermediate inputs of 1990 are used as no more recent data were available.

Table 4.14 shows the results of the first step price regression, with foreign outsourcing variables as determinants.

The first column reports the results of a specification in which plain TFP is used and which considers foreign outsourcing in the *narrow* sense (i.e. intra-sector).

For an estimation at the two-digit sector level this measure of outsourcing seems more appropriate than using the broader definition. In the second column effective TFP is used instead of plain TFP and in the final column a specification with plain TFP and variables reflecting foreign outsourcing in the *broad* sense.

None of the outsourcing variables appears to have had a significant impact on domestic prices in the period considered. The TFP pass-through is again highly significant and very close to the estimate reported in table 4.4.

Table 4.14: First Step Price Regression- Foreign Outsourcing (1985-1995)

Dependent variable: $\Delta \ln p^{VA}$	Narrow (TFP)	Narrow (ETFP)	Broad (TFP)
Independent variables:			
High-wage EU Countries	-0.32 (-0.36)	-0.35 (-0.38)	0.02 (0.02)
Low-wage EU countries	-1.53 (-0.23)	-1.68 (-0.23)	0.08 (0.02)
Non-EU OECD	-0.21 (-0.06)	-0.15 (-0.04)	-0.78 (-0.45)
(South-) East Asia	-0.11 (-0.97)	-0.13 (-1.08)	-0.12 (-1.43)
Central and Eastern Europe	0.04 (0.47)	0.5 (0.56)	0.03 (0.43)
Latin America	0.02 (0.13)	0.07 (0.56)	0.30 (0.26)
(E)TFP	-0.75 (-9.38) ***	-0.72 (-8.98) ***	-0.76 (-8.35) ***
$R^2_{adjusted}$	0.66	0.65	0.66
F-test: common intercept and slopes versus country-specific intercepts and slopes (p-values in brackets)	1.16 (0.37)	1.13 (0.39)	1.10 (0.43)
F-test: common slopes versus country-specific slopes, given country specific intercepts (p-values in brackets)	0.55 (0.93)	0.53 (0.94)	0.52 (0.94)
F-test: common intercept versus country-specific intercepts, given common slopes (p-values in brackets)	7.44 (0.00)***	7.32 (0.00)***	7.19 (0.00) ***

Note: The dependent variable is the change in domestic value added prices. All variables are changes over the period 1985-1995, except for France for which changes over the period 1990-1996 have been rescaled (omitting France gives similar results). The table reports results of fixed effects estimations. The first column reports results for a specification with plain total factor productivity and variables reflecting outsourcing in the narrow sense, the second column reports a specification with narrow outsourcing and effective TFP and the last column reports the results of a plain TFP specification with outsourcing in the broad sense. White heteroskedastic-consistent t-values are reported in brackets. ***- **-* denotes significance at respectively 1%-5% and 10% level.

In table 4.15 the results of the first step TFP regression, with outsourcing variables in the narrow sense, are reported.

As in the first step price regression with import prices as determinants, international R&D spillovers are found to be significant as is the negative sign of the (South-) East Asian NIC trade variable. However, where the negative sign in table 4.8 is supportive of trade-induced technological change (i.e. decreasing import prices increase TFP) a negative sign in a specification with outsourcing variables as determinants does not seem to support the model by Feenstra and Hanson (1996) as in this model it is assumed that low-skill activities will be transferred abroad, thus lifting the domestic skill level. Foreign outsourcing with (South-) East Asian NIC actually would have decreased TFP.

The second step mandated wage regressions with foreign outsourcing variables do not result in any significant coefficient.

Table 4.15: First Step TFP Regression- Foreign Outsourcing (1985-1996)

Dependent variable:	TFP
Independent variables:	
Domestic R&D stock (intra-sector)	0.08 (0.86)
Domestic R&D stock (inter-sector)	-0.08 (-0.58)
Foreign R&D stock	0.25 (2.42) **
High-wage EU Countries	-0.55 (-0.23)
Low-wage EU countries	10.58 (-1.57)
non-EU OECD	-5.25 (-1.25)
(South-) East Asia	-0.35 (-3.44) ***
Central and Eastern Europe	-0.22 (-0.71)
Latin America	-0.18 (-0.30)
$\mathbf{R^2_{adjusted}}$	0.11
F-test: common intercept and slopes versus country-specific intercepts and slopes. (p-values in brackets)	1.91 (0.10) *
F-test: common slopes versus country-specific slopes, given country specific intercept. (p-values in brackets)	1.75 (0.14)
F-test: common intercept versus country-specific intercepts, given common slopes. (p-values in brackets)	2.09 (0.10)*

Note: The table reports results of a fixed effects estimations with foreign outsourcing in the narrow sense as determinant. White heteroskedastic-consistent t-values in brackets. ***- **-* denotes significance at respectively 1%-5% and 10% level.

4.5 Conclusions

The two-step mandated wage regression procedure, proposed by Feenstra and Hanson (1999) and Haskel and Slaughter (2001), is a convenient tool to disentangle the impact of international trade on wage inequality from the impact of technological change, accounting for the potential indirect impact of international trade, i.e. technological change induced by international trade or trade-related R&D spillovers. The procedure sets off with the zero profit condition of perfect competition to derive a relationship between changes in domestic product prices, total factor productivity (TFP) and changes in factor rewards.

In a first step estimation, the changes in product prices and TFP are regressed on a number of potential determinants like import prices.

In a second step the estimated contributions of the exogenous determinants are regressed on factor shares. The estimated coefficients in the second step provide an estimate of the changes in factor rewards that were *mandated* by the changes in domestic product prices, caused by the respective determinants.

The procedure is closely linked to the Stolper-Samuelson theorem, which states that changes in import prices will, through their impact on domestic product prices, cause changes in factor rewards.

Two-step mandated wage estimations for a panel of nine EU countries, in the period 1985-1998, provide little support for Stolper-Samuelson effects of international trade with Newly Industrialised Countries (NIC). If there is some evidence that import competition of low-wage EU countries affected domestic product prices in the period 1985-1995 this effect does not seem to have carried over in factor price changes. Import competition of the Asian Tigers increased the relative wages of high-skilled workers in the European Union, as expected, but this effect is only significant at the 10 per cent error level and it is moreover not consistently confirmed in alternative specifications.

The impact of technological change on factor prices, through R&D activities, is rather country-specific and the panel estimations do not provide evidence of skill-biased technological change having caused a common drop in the relative wages of low-skilled workers.

International trade-related knowledge spillovers are, in line with previous studies, consistently found to be significant. In addition, import price competition of the Asian Tigers appears to have caused technological change which decreased the relative wages of high-skilled workers, i.e. seems to point at technological change biased in favour of low-skilled workers though the latter result is not very robust.

As foreign R&D activities appear to affect technological change to a larger extent than domestic R&D activities, which undoubtedly have an important role in reinforcing a country's technological absorptive capacity, the indirect impact of international trade may be quite substantial and clearly needs to be accounted for.

The evidence of trade-related North-South spillovers (e.g. Coe, Helpman and Hoffmaister 1995) moreover shows that international trade may help Southern countries to raise their technological level, thereby inducing Northern countries to invest in R&D activities to maintain their technological lead.

International trade and technological change are clearly intertwined and the exclusive focus on either one to explain changes in the labour market does not seem warranted.

The lack of evidence of the impact of import price changes of Newly Industrialised Countries in the European Union is probably not that surprising given the mixed evidence of changes in wage inequality and the institutional differences between EU countries. It does however not imply that international trade did not have any labour market impact. The assumption of perfect labour markets, which contrary to most other assumptions of the Heckscher-Ohlin model is essential for the Stolper-Samuelson theorem to hold, is probably too heroic.

In the next two chapters this assumption is relaxed, allowing for unemployment to arise due to a fall in labour demand, if wages are sticky.

Appendix: Note on TFP as a Proxy for Technological Change

Leamer (1996 a) pointed out that the mandated wage regression procedure in which the pass-through of total factor productivity, i.e. the part of productivity changes that are passed on to product prices, is pegged down at a certain value works in the opposite direction of most previous studies. In these studies (e.g. Bound and Johnson 1992, Berman, Bound and Griliches 1993: see section 3.2.2) the impact of globalisation was first estimated and the residual was entirely attributed to technological change, whereas Leamer first considered the impact of technological change and then attributed the residual to globalisation.

Lack of a worldwide general equilibrium input-output model Leamer assumed that all sectors have the same rate of technological pass-through.

Feenstra and Hanson (1999) estimated the pass-through in the first step price regression but given the indications of an endogeneity bias preferred a reduced form specification of the price and TFP regression.

Haskel and Slaughter (2001) also estimated the TFP pass-through but, similar to Baldwin and Cain (1997), preferred a specification of the first step price regression without TFP.

Haskel and Slaughter argued that skill-biased technological change could be considered as a part of TFP.

Assuming a CES production function:

$$Y = A\left[\left(\lambda_{HS}L_{HS}\right)^{1-\frac{1}{\sigma}} + \left(\lambda_{LS}L_{LS}\right)^{1-\frac{1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} \qquad \text{(A 4.1)}$$

with Y denoting output, A an Hicks-neutral technological parameter, λ_{HS} and λ_{LS} the skill-biased technology parameters of respectively high-skilled labour L_{HS} and low-skilled labour L_{LS} and σ elasticity of substitution, TFP is given as (Haskel and Slaughter 2001: p. 167):

$$\Delta \ln TFP = \Delta \ln A + V_{HS}\, \Delta \ln \lambda_{HS} + V_{LS}\, \Delta \ln \lambda_{LS} \qquad \text{(A 4.2)}$$

with V_{HS} and V_{LS} the wage bill shares of respectively high-skilled labour and low-skilled labour. Haskel and Slaughter quoted Johnson and Stafford (1998) who reasoned that skill-biased technological change (SBTC) does not necessarily raise TFP. Moreover, extensive SBTC, i.e.

technological change that increases the productivity of high-skilled workers but reduces productivity of low-skilled workers could actually raise costs.

Though Haskel and Slaughter considered a CES production function to point out that SBTC may be part of total factor productivity they computed TFP in the usual way as output changes minus the share-weighted changes in input factors. This is the traditional Cobb-Douglas based TFP measure as a proxy for disembodied (i.e. skill-neutral) technological change.

Haskel and Slaughter (2002) estimated the sector bias of SBTC. They derived the relative demand for high-skilled labour from (A 4.1), assuming constant returns to scale (i.e. $\lambda_{LS} = 1 - \lambda_{HS}$):

$$\frac{L_{HS}}{L_{LS}} = \left(\frac{\lambda_{HS}}{1-\lambda_{HS}}\right)^{\sigma}\left(\frac{w_{HS}}{w_{LS}}\right)^{-\sigma} \qquad \text{(A 4.3)}$$

Multiplying both terms with the relative wages of high-skilled workers ($\frac{w_{HS}}{w_{LS}}$) and adding capital (assumed quasi-fixed) provided Haskel and Slaughter with the following empirical specification (Haskel and Slaughter 2002: p. 1767):

$$\Delta\omega_k = a_0 + a_1 \Delta \log\left(\frac{w_{HS}}{w_{LS}}\right)_k + a_2 \Delta \log\left(\frac{K}{Y}\right)_k + \varepsilon_k \qquad \text{(A 4.4)}$$

where ω_k denotes the share of non-production workers (proxy for high-skilled workers) in the total wage bill in sector k and K/Y the capital output ratio.

The authors argued that by estimating this specification on pooled sectors $a_0 + \varepsilon_k$ is an estimate of skill-biased technological change in sector k but also considered a number of alternative estimates for SBTC (e.g. by excluding relative wages from the specification). The sector bias of SBTC is then estimated by regressing the estimate of SBTC on the begin-of-period skill intensity (Haskel and Slaughter 2002: p. 1768):

$$SBTC_k = \alpha + \beta_{bias}\left(\frac{L_{HS}}{L_{LS}}\right)_k + u_k \qquad \text{(A 4.5)}$$

The coefficient β_{bias} is the estimate of Haskel and Slaughter for the sector bias of SBTC.

Using UNIDO data for ten OECD countries they found indications of a significant sector bias in SBTC in the 1970s and the 1980s. In countries that witnessed a decrease in the skill premium SBTC appears to have been concentrated in low-skill intensive sectors, whereas in countries that witnessed increased wage inequality, SBTC seems to have been concentrated in high-skill intensive sectors[26]. Haskel and Slaughter concluded that the sector bias of skill-biased technological change could help to explain changes in the skill premium.

In table A 4.1 the sector bias of SBTC is estimated following the two-step procedure proposed by Haskel and Slaughter (2002) for six EU countries in the period 1985-1995. Two alternative estimates of skill-biased technological change are considered: SBTC1 is the estimate of (a_0 + ε_k) from estimating equation (A 4.4) and SBTC2 is the residual of estimation of this equation when relative wages are dropped.

In line with the positive estimate for the sector bias for Denmark, Portugal and the United Kingdom, found by Haskel and Slaughter for the 1980s, the sector bias estimate is positive for these countries in the period 1985-1995 though the coefficient for Denmark and Portugal is only significant for the second alternative estimate of skill-biased technological change and for the United Kingdom it is not significant at all. The evidence of a sector bias does not seem very strong for the six EU countries considered.

Table A 4.1: The Sector Bias of Skill-Biased Technological Change in Six EU Countries (1985-1995)

	SBTC1	SBTC2
Belgium	0.003 (0.09)	-0.05 (-1.13)
Germany	-0.01 (-1.17)	-0.01 (-0.98)
Italy	0.01 (0.12)	0.02 (0.15)
United Kingdom	0.02 (0.42)	0.07 (1.52)
Denmark	0.01 (0.22)	0.11 (1.93) *
Portugal	0.77 (1.58)	0.90 (1.98) **

Note: The sector bias of SBTC is estimated following the two-step procedure proposed by Haskel and Slaughter (2002). The t-values reported in brackets have been corrected using the procedure proposed by Dumont, Rayp, Thas and Willemé (2003) to account for additional variance due to the use of generated regressands. SBTC1 is the estimate of skill-biased technological change (a_0 + ε_k) from estimating equation (A 4.4). SBTC2 is the residual of estimation of equation (A 4.4) excluding relative wages.

26 As the dependent variable in the second step estimation is an estimated rather than a true variable, Haskel and Slaughter (2002) applied the correction procedure proposed by Feenstra and Hanson (1997). Dumont, Rayp, Thas and Willemé (2003) showed that this procedure suffers from a bias and replicated the estimates of the sector bias of SBTC for the United Kingdom and the United States. Though the conclusions by Haskel and Slaughter generally hold, the t-values differ substantially.

In his biography of Total Factor Productivity, Hulten (2000) argued that identifying the Hicks-neutral factor (i.e. the traditional TFP measure) of a production function with technological change is generally inappropriate. The main reason is that the shift parameter only reflects productivity increases that are costless. Technological progress that results from R&D activities will not be captured by TFP unless it is considered as an input factor of its own right as in some endogenous growth models. Another reason is that changes in the organization of production or worker effort will shift the production function as well.
If input factors do not instantaneously adjust to their desired demand levels, TFP provides a biased estimate of technological change (Nadiri and Prucha 1999).

Primal Total Factor Productivity is traditionally, starting from a production function:

$$Y_t = A_t F(K_t , L_t) \quad \text{(A 4.6)}$$

computed as the change in the Hicks-neutral parameter A_t, or the difference between real output growth and the growth rates of input factors (in this example capital K and labour L) weighted by their respective output elasticities (Hulten 2000: p. 10):

$$dTFP = \frac{\dot{A}_t}{A_t} = \frac{\dot{Y}_t}{Y_t} - \varepsilon_{YK} \frac{\dot{K}_t}{K_t} - \varepsilon_{YL} \frac{\dot{L}_t}{L_t} \quad \text{(A 4.7)}$$

As the output elasticities are not directly observable, production factors are assumed to be competitively paid the value of their marginal product, such that factor income shares can replace the elasticities. The TFP measure as a residual is a *measure of our ignorance* as phrased by Abramovitz (1956). The residual, apart from technological and organizational innovation, also captures measurement error, omitted variables, aggregation bias and other model specification errors. The latter unwanted components of *TFP as residual* might cancel if randomly distributed, which is however not guaranteed
The assumption of constant returns to scale is strictly only necessary when the return to capital is estimated as a residual. If some independent measure of the return to capital could be used, the TFP measure would not imply constant returns to scale.
As shown by Hall (1988), the assumption of perfect competition is a necessary assumption for the TFP measure to be unbiased (Hulten 2000: pp. 10-12).

With respect to the nature of technological change, the TFP measure as the change in the Hicks parameter only holds insofar that innovation increases the marginal productivity of all production factors equally, i.e. technological change is Hicks-neutral (no factor bias).
Innovation affecting the production factors in a distinct way can be modelled by a *factor-augmentation* production function (Hulten 2000: p. 13):

$$Y_t = F(a_t K_t , b_t L_t) \qquad \text{(A 4.8)}$$

This results in the following TFP measure as the factor share weighted average of the rates of factor augmentation:

$$dTFP = s_t^K \frac{\dot{a}_t}{a_t} + s_t^L \frac{\dot{b}_t}{b_t} \qquad \text{(A 4.9)}$$

If the rates of factor augmentation of the production factors differ, technological change is Hicks-biased.
As changes in the income shares of the production factors will change TFP, even if the underlying factor-augmentation does not change, the TFP measure cannot simply be identified with technological change (Hulten 2000: p. 13).

Equation (A 4.7) can be considered as a growth rate of a Divisia index, which allows for a continuous-time formulation, using discrete-time data. However, the index is only unique if there is a production function for which the partial derivatives equal the prices that are used to compute the index. Moreover, the necessary production function exists only under very restrictive assumptions, e.g. that all units (plants, firms) have identical functions up to some constant multiplier (Hulten 2000: p. 14).

Jorgenson and Griliches (1967) argued that in order to avoid the aggregation bias due to changes in the composition of inputs, capital and labour should be decomposed (e.g. long-lived versus short-lived capital stock, workers with different educational level).
Inklaar et al. (2003) decomposed physical capital into a ICT component (software, computers and communications equipment) and a non-ICT component (equipment, structures and vehicles) and labour into a volume component (hours worked) and a component measuring labour quality, based on data by skill category. The procedure involved aggregation of two-

digit sectors and only the United States and four EU countries (France, Germany, the Netherlands and the United Kingdom) were considered, as few countries appear to provide data on prices of computers and semiconductors needed to compute deflators that account for the increase in quality of ICT goods.

Instead of computing TFP as a residual, a function specification representing the production technology could be estimated econometrically, accounting for imperfect competition, non-constant returns to scale and factor-biased technological change.
However, the results of these estimations have often been questioned for their robustness and sufficient data are needed for unrestricted specifications. As the production factors are the right-hand side variables these regressions may moreover suffer from endogeneity bias.
Nadiri and Prucha (1999) argued that a dynamic factor demand model has the advantage over a static factor demand model (i.e. the one underlying traditional TFP measurement) that it does not impose a priori that all production factors are in long-run equilibrium.
This approach requires an extensive data set and poses considerable estimation challenges.
Estimation of a dynamic factor demand model for the electrical machinery industry in the United States, in the period 1960-1980, suggested that the traditional TFP estimate is three times larger than the estimate of pure technological change as estimated with the econometric model[27]. The difference is explained by substantial scale effects and adjustment costs that seem to account for 21 per cent of TFP growth. The residual following the econometric approach is small, i.e. about 1.5 % of TFP growth (Nadiri and Prucha 1999: p. 60).
Nadiri and Prucha concluded that although dynamic factor demand models are rather challenging in terms of complexity and data requirements, they provide an important instrument to measure technological change properly, accounting for the adjustment of factor demands and the impact of exogenous variables.

As capital is often considered as a quasi-fixed input factor, i.e. it does not adjust instantaneously, throughs in the business cycle will often be characterized by low levels of capital utilization, as a result of which the residual computed with capital stock data will

27 According to Hulten (2000), as part of capital accumulation will be induced by TFP growth, i.e. by increasing investment, this part should be counted along with TFP as technological innovation.

fluctuate procyclically along with capacity utilization, obscuring actual productivity changes (Hulten 2000: p. 29).

Hulten considered New Growth Theory, with its focus on imperfect competition, increasing returns to scale, spillovers and endogeneity of innovation as a driving force in the recent shift from traditional non-parametric growth accounting towards econometric modeling.

New Growth Theorists do not consider technological change as an exogenously determined residual but as the result of an endogenous deliberate investment process. However, innovation may appear as an increase in productivity but also as an increase in quality of existing products (i.e. the quality ladder argument of Grossman and Helpman 1991) or the introduction of new products. The latter forms of innovation are not covered by the TFP measure though they could be incorporated by measuring output in efficiency units, reflecting the marginal rate of substitution between old and new goods. The problem with the efficiency approach is its subjective nature (Hulten 2000: pp. 28-40).

From the foregoing it should be clear that Total Factor Productivity, measured as a residual, cannot simply be equated to technological change. Procedures that could correct the TFP measure for other factors than technological change have their own drawbacks and require large data sets.

For the conclusions of the mandated wage regressions, the different TFP components are not that relevant, as the aggregate TFP measure permits to discriminate between the impact of international trade and the impact of the different factors captured by TFP growth. It should only warn against equating the impact of TFP growth to the impact of technological change and thus overestimating the impact of technological change.

Statistical Appendix

This appendix is taken from Dumont, Rayp, Thas and Willemé (2003), in which the variance of the second step estimates in two-step estimations, corrected for the fact that the regressand in the second step is a generated variable, is derived using the method of moments procedure proposed by Newey (1984). In the paper it is shown why the procedure proposed by Feenstra and Hanson (1997) suffers from a bias and a more elaborate derivation of the corrected variance is proposed.

The properties of the method of moments estimator of the asymptotic covariance matrix have been studied by Hansen (1982). Newey (1984) and Pagan (1986) have applied Hansen's results in two-step regression models.
The two equations to be estimated in the generated regressand problem are:

$$y= Z\beta + \delta \qquad \text{(A-1)}$$

$$Z\beta= X\omega+\varepsilon \qquad \text{(A-2)}$$

Where the estimated β from the first step ($\hat{\beta}$) is used to estimate the second regression equation parameters (ω)[28].
A method of moments estimator uses moment conditions to estimate the parameters of a model. An Ordinary Least Squares (OLS) estimator is a specific method of moments estimator which uses the assumption of the classical linear regression model that the independent variables should not be correlated with the disturbance term (i.e. covariance is zero), which is another way of saying that the expected value of the disturbance term, conditional upon the observations of the independent variables should be zero.
The (OLS) moment conditions of (A-1) and (A-2):

$$E[g(Z, \beta)] = 0 \qquad \text{(A-3)}$$

28 It should be noted that the generated regressand problem is not strictly identical to the generated regressor problems considered by Newey and Pagan since the generated variables from the first step estimates enter the second step equation as the dependent rather than as the independent variables. This distinction does not affect the results obtained.

$$E[\mathrm{h}(\mathrm{X}, \omega, \hat{\beta})] = 0 \qquad \text{(A-4)}$$

for this problem are:

$$E[\mathrm{Z}'(\mathrm{y} - \mathrm{Z}\beta)] = 0 \qquad \text{(A-5)}$$

$$E[\mathrm{X}'(\mathrm{Z}\hat{\beta} - \mathrm{X}\omega)] = 0 \qquad \text{(A-6)}$$

i.e. the covariance of the vector of independent variables and the distrurbance term is zero.

Defining:

$$G_\beta = E\left[\frac{\partial g(Z,\beta)}{\partial \beta}\right] \qquad \text{(A-7)}$$

$$H_\beta = E\left[\frac{\partial h(X,\omega,\hat{\beta})}{\partial \beta}\right] \qquad \text{(A-8)}$$

$$H_\omega = E\left[\frac{\partial h(X,\omega,\hat{\beta})}{\partial \omega}\right] \qquad \text{(A-9)}$$

$$V_{gg} = E\left[g(Z,\beta).g(Z,\beta)'\right] \qquad \text{(A-10)}$$

$$V_{gh} = E\left[g(Z,\beta).h(X,\omega,\hat{\beta})'\right] \qquad \text{(A-11)}$$

$$V_{hh} = E\left[h(X,\omega,\hat{\beta}).h(X,\omega,\hat{\beta})'\right] \qquad \text{(A-12)}$$

The moment condition of the second step equation (A-2) depends upon the specific first-step estimate of β. The derivative of the second-step moment condition with respect to β can be computed and should be accounted for, given the conditionality.

(Hansen 1982) showed that a consistent estimator of the asymptotic covariance matrix of ω, i.e. the vector of parameters in the second step is $F^{-1}V\,F^{-1'}$ with:

$$F = \begin{bmatrix} G_\beta & 0 \\ H_\beta & H_\omega \end{bmatrix}$$

and

$$V = \begin{bmatrix} V_{gg} & V_{gh} \\ V_{hg} & V_{hh} \end{bmatrix}$$

The square matrices F and V have been partitioned as in Newey (1984). Applying these results gives:

$$F = \begin{bmatrix} -Z'Z & 0 \\ X'Z & -X'X \end{bmatrix}$$

$$V = \begin{bmatrix} \sigma_\delta^2 Z'Z & 0 \\ 0 & \sigma_\delta^2 X'X \end{bmatrix}$$

with $V_{gh} = V_{hg} = 0$ under the assumption of independence between δ and ε.

The corrected covariance matrix for the second step coefficients is given by (Newey 1984):

$$\Omega_\omega = H_\omega^{-1} V_{hh} H_\omega^{-1'} + H_\omega^{-1} H_\beta \left[G_\beta^{-1} V_{gg} G_\beta^{-1'} \right] H_\beta^{'} H_\omega^{-1'} \qquad \text{(A-13)}$$

Inserting the appropriate sub-matrices of F and V, yields:

$$\mathrm{Var}(\hat{\omega}) = (X'X)^{-1} \left[X' \hat{\sigma}_\varepsilon^2 X + X'Z\hat{\Omega}_\beta Z'X \right] (X'X)^{-1} \qquad \text{(A-14)}$$

which is the equation for the unbiased corrected variance.

5. Sticky Wages and Labour Demand

"*A lack of desire to spend money becomes a symptom of disease that requires expensive medication*."

- Jonathan Frantzen *The Corrections*.

5.1 Introduction

The results of the two-step mandated wage regressions reported in the previous chapter suggest a limited impact of international trade with the Newly Industrialised Countries on income distribution in the European Union, in the 1980s and the 1990s.

One of the fundamental assumptions in the Heckscher-Ohlin framework is that labour markets are perfectly competitive. If this assumption holds, wages, being fully flexible will adjust to market-clearing levels, guaranteeing full employment of all production factors. The Stolper-Samuelson theorem to which the mandated wage regression procedure adheres is, as argued in section 3.1.1.4, more than the other core theorems of the Heckscher-Ohlin model robust to relaxing some of the restrictive HO assumptions. However, the theorem is indissolubly linked to the assumption of perfectly competitive labour markets. If wages are sticky, full employment of the relatively scarce production factor is no longer ascertained as raised by e.g. Brecher (1974) and Krugman (1995 b) (see section 3.1.4).

The sticky wage model of international trade proposed by Krugman (1995 b) implies three basic predictions regarding the influence of trade on employment:

- Full employment of the relatively abundant factor and a decline in the demand for the relatively scarce production factor at the aggregate level, i.e. an increase in relative demand for the relatively abundant production factor.

- An increase in the demand for the relatively abundant as well as the relatively scarce production factor in sectors in which the country has a comparative advantage.
- A decline in the demand for the relatively abundant as well as the relatively scarce production factor in sectors in which the country has a comparative disadvantage.

As shown in section 3.2.6, the demand for production factors can be derived from a flexible cost function, which characterizes the cost-minimizing behaviour of firms. Extending the flexible cost function with external factors, the elasticity of production factors (e.g. low-skilled and high-skilled labour) with respect to international trade can be estimated.

In this section the assumption that wages are fully flexible, which as pointed out by Blanchflower, Oswald and Sanfey (1992) even for the United States does not seem to be supported by the data, is abandoned.
In section 5.2 a flexible cost function framework is considered to estimate the impact of EU trade with Newly Industrialised Countries on the demand for low-skilled and high-skilled workers. If wages are sticky changes in labour demand will affect employment rather than wages, which implies that North-South trade could have caused unemployment among low-skilled workers rather than wage inequality. This section draws extensively upon Cuyvers, Dumont, Rayp and Stevens (2003) and Cuyvers, Dumont and Rayp (2004).

5.2 Flexible Cost Functions

Flexible function specifications impose as little restrictions as possible (e.g. with respect to the substitution between the production factors or returns to scale).
Barnett, Lee and Wolfe (1985: p. 6) defined a function as flexible if it can attain arbitrary level and first- (second-) order derivatives at a predetermined single point. Most flexible functions are second-order expansions of known first-order functional forms. In section 3.2.6 the two most popular flexible cost function specifications, i.e. the translog and the generalized Leontief, have been discussed.
The generalized Leontief specification has the advantage over a translog specification that it allows for a closed form solution of the long-run equilibrium, i.e. where account is taken of the quasi-fixity of certain production factors due to adjustment costs.
In section 3.2.6, the extended generalized Leontief cost function proposed by Morrison and Siegel (1997) has been elaborated. In an extended cost function, external factors, i.e. factors not

explicitly under control of the firm, which can affect the cost-output relationship, are considered. The impact of import competition is most often thought of in terms of international rivalry in a given industry. Increased competition of foreign competitors will reduce the market share (output) of domestic firms. The domestic demand for production factors will fall and result in falling wages or falling employment if wages are not flexible. Including import competition as an external factor accounts for its impact on the cost-output relationship and permits to estimate its impact on the derived demand for production factors.

In this section an extended generalized Leontief cost function is considered with three production factors: low-skilled labour (LS), high-skilled labour (HS) and capital (K).

The demand for input factors, as well as the elasticity of factor demand with respect to external factors, can be derived as shown by equations (3.48)-(3.50) in section 3.2.6.

For the empirical implementation a more convenient expression for factor demand is obtained by dividing (3.49) by Y, which yields an input-output equation for high-skilled labour, low-skilled labour and capital:

$$\frac{X_{HS}}{Y} = \frac{\partial C}{\partial w_{HS}}\frac{1}{Y} = \sum_{j=HS,LS,K} \alpha_{HS,j}\left(\frac{w_j}{w_{HS}}\right)^{0.5} + \sum_m \delta_{HS,m} s_m^{0.5} + \sum_m \sum_n \gamma_{mn} s_m^{0.5} s_n^{0.5} \tag{5.1}$$

$$\frac{X_{LS}}{Y} = \frac{\partial C}{\partial w_{LS}}\frac{1}{Y} = \sum_{j=HS,LS,K} \alpha_{LS,j}\left(\frac{w_j}{w_{LS}}\right)^{0.5} + \sum_m \delta_{LS,m} s_m^{0.5} + \sum_m \sum_n \gamma_{mn} s_m^{0.5} s_n^{0.5} \tag{5.2}$$

$$\frac{X_{K}}{Y} = \frac{\partial C}{\partial w_{K}}\frac{1}{Y} = \sum_{j=HS,LS,K} \alpha_{K,j}\left(\frac{w_j}{w_{K}}\right)^{0.5} + \sum_m \delta_{K,m} s_m^{0.5} + \sum_m \sum_n \gamma_{mn} s_m^{0.5} s_n^{0.5} \tag{5.3}$$

From these three equations, the elasticity of the demand for production factors with respect to the input prices can be derived:

$$\varepsilon_{ij} = \frac{\partial \ln X_i}{\partial \ln w_j} = \frac{\partial X_i}{\partial w_j}\frac{w_j}{X_i} \quad \text{with i and j : HS, LS, K} \tag{5.4}$$

The sensitivity of the demand for high- and low-skilled labour with respect to the exogenous parameters can be expressed as[29]:

$$\varepsilon_{im} = \frac{\partial \ln X_i}{\partial \ln s_m} = \frac{\partial X_i}{\partial s_m}\frac{s_m}{X_i} \qquad \text{with } s_m = (m_{OEHW}, m_{EULW}, m_{NIC}, tech) \qquad (5.5)$$

Import competition and technological change will be used as external factors that may affect costs and the demand for production factors.

A panel of ten EU countries and twelve ISIC sectors is constructed for the period 1985-1995[30]. The data sources for the variables used in these estimations have been described in section 4.2, except for the price of capital, which was not required for the mandated wage estimations but is necessary for flexible cost function estimations.

In Berndt and Hesse (1986) the price of capital is calculated as:

$$P_{Ki,t} = q_{i,t}*(r_t + \delta_i) \qquad (5.6)$$

Where $q_{i,t}$ denotes the investment deflator of the *i*-th type capital (e.g. capital in sector i) in year t, r_t is the long-term government bond yield and δ_i the depreciation rate of the *i*-th type of capital.

Data on long-term government bond yields were taken from the IMF International Financial Statistics. The same source contains data on fixed capital consumption from which depreciation rates can be computed. Unfortunately this information is given for few countries, sectors and years. Rather than using the sector depreciation rate for just a couple of observations and disregarding it for most observations only r_t has been considered.

For $q_{i,t}$ sector-specific deflators were computed from the value added data given in the OECD Structural Analysis industrial (STAN) database.

As in the sticky wage model (see section 3.1.4) sector factor demand is linked to the trade *volume* at the *aggregate* level, import competition is measured as the national average of sector imports relative to GDP.

29 If at least one input factor were quasi-fixed in the short-run these expressions would apply to the short-run. Long-run elasticity would follow from the equilibrium value of the quasi-fixed inputs, obtained by equating the price of the quasi-fixed input and its shadow value. They can be calculated by determining the short-run elasticity and adding the associated long-run adjustment. The latter comprises the effect of a change in the exogenous variable on the equilibrium stock of the fixed input factor and the effect of the latter on factor input demand. See also Morrison (1988).

30 The nine countries included in the two-step mandated wage regressions reported in chapter 4, and Portugal.

Grouping more or less homogenous countries, in terms of factor endowment, product specialisation and differences in natural or legal trade barriers, again differentiates trade partners. Technological change is proxied by the knowledge capital stock, i.e. cumulative (discounted and depreciated) R&D expenditures[31]. Iterative three-stages least squares was used to estimate the system of equations (5.1) up to (5.3) for the twelve individual ISIC sectors at the EU level, i.e. for all countries included. Lagged values of the variables were used as instruments.

Table 5.1 gives the elasticity estimates of respectively high-skilled labour and low-skilled labour, derived from the estimation of the system of factor demand equations.

High-wage OECD countries (*oehw*), low-wage EU countries (*eulw*) and NIC (*nic*) are considered as distinct groups[32]. Elasticity has been evaluated at the means[33] and the ANALYZ procedure in TSP has been used to compute standard errors, as elasticities are combinations of parameter estimates for which the "delta method" has to be used (which the ANALYZ procedure performs).
For all estimates, own price elasticity has the right sign and in most sectors significantly so. In addition, cross price elasticity is positive with respect to at least one production factor, which implies that input factors are never all complements.

The cross elasticity estimates provide little evidence for capital-skill complementarity.
If anything, cross elasticity estimates suggest that low-skilled and high-skilled labour are complements whereas both appear to be substitutes for capital.
Frondel and Schmidt (2003) listed some caveats with respect to capital-skill complementarity (CSC), which is supported in some studies but clearly rejected in other studies. Frondel and Schmidt showed how, using a static translog specification as in most studies on CSC, the conclusions strongly depend on the cost share of capital and they argue that a static translog specification is a questionable basis to address the CSC issue. They defined relative capital-

31 Inter-sector and foreign knowledge stocks were not included in order to limit the loss of degrees of freedom in this framework were each variable, its square and all its cross-products enter the specification. Estimation with foreign R&D stocks gives similar results as with domestic R&D stocks.

32 See section 4.2 for details on country groups.

33 Anderson and Thursby (1986) show that for a translog demand model only elasticities evaluated on the means of actual cost shares are likely to satisfy a normal distribution.

skill complementarity as the case where the elasticity of the demand for high-skilled labour with respect to the return to capital, when not negative, is smaller than the elasticity of low-skilled labour. According to this criterion high-skilled labour and capital are relative complements in six industries.

International trade is clearly found to affect the demand for high-skilled and low-skilled labour in a significant way. EU trade with high-wage OECD countries apparently decreased the demand for high-skilled workers and increased the demand for low-skilled workers.

Table 5.1: Estimated Elasticity of the Demand for Labour at Sector Level (1985-1996)

High-skilled labour

	$\varepsilon_{HS,wHS}$	$\varepsilon_{HS,wLS}$	$\varepsilon_{HS,wK}$	$\varepsilon_{HS,Moehw}$	$\varepsilon_{HS,Meulw}$	$\varepsilon_{HS,Mnic}$	$\varepsilon_{HS,RDS}$
ISIC 31	-0.25 ***	-0.19 ***	0.44 ***	-0.35 ***	-0.31 *	0.48 ***	0.34 ***
ISIC 32	-0.93 ***	-0.01	0.94 ***	-0.84 ***	-1.46 ***	1.72 ***	0.24 ***
ISIC 33	-0.58 ***	-0.32 ***	0.90 ***	-1.21 ***	-0.92 ***	1.24 ***	0.37 ***
ISIC 34	-0.47 ***	0.09 **	0.37 ***	-0.51 ***	-0.74 ***	0.81 ***	0.10 ***
ISIC 35	-0.10	-0.17 ***	0.27 ***	-0.28 ***	-0.57 ***	0.58 ***	0.08 ***
ISIC 36	-0.43 *	-0.03	0.46 ***	-0.35 ***	-0.67 ***	0.96 ***	0.06
ISIC 37	-0.23 **	-0.06	0.30 ***	-0.50 ***	-0.62 **	0.83 ***	0.10
ISIC 381	-0.17	-0.14	0.31	0.22	-0.26	-0.07	0.13
ISIC 382	-0.07	-0.40 *	0.46 **	-0.29 ***	-0.36 *	0.26	-0.06
ISIC 383	-0.64 ***	$-1.49\ 10^{-3}$	0.65 ***	-0.60 ***	-0.54 ***	1.05 ***	0.39 ***
ISIC 384	-0.51 ***	0.06	0.46 ***	0.16	-0.59 ***	1.15 ***	0.65 ***
ISIC 385	-0.15	-0.04	0.19 ***	-0.59 ***	-0.47 ***	0.67 ***	0.19 ***

Low-skilled labour

	$\varepsilon_{LS,wHS}$	$\varepsilon_{LS,wLS}$	$\varepsilon_{LS,wK}$	$\varepsilon_{LS,Moehw}$	$\varepsilon_{LS,Meulw}$	$\varepsilon_{LS,Mnic}$	$\varepsilon_{LS,RDS}$
ISIC 31	-0.20 ***	-0.27 ***	0.47 ***	0.33 ***	-0.36 ***	-0.05	0.29 ***
ISIC 32	$-6.62\ 10^{-3}$	-0.39 ***	0.40 ***	0.22 ***	-0.24 ***	-0.19 ***	$-6.60\ 10^{-3}$
ISIC 33	-0.24 ***	-0.43 ***	0.67 ***	-0.17 *	-0.25 ***	0.23 **	$-5.93\ 10^{-3}$
ISIC 34	0.11 **	-0.42 ***	0.30 **	0.109	-0.59 ***	0.07	0.02
ISIC 35	-0.31 ***	-0.61 ***	0.92 ***	0.49 ***	-0.95 ***	0.33 **	0.22 **
ISIC 36	-0.02	-0.35 ***	0.37 ***	0.43 ***	-0.08	-0.24 ***	0.11 ***
ISIC 37	-0.08	-0.36 ***	0.43 ***	0.36 **	-0.54 *	0.42 **	0.05
ISIC 381	-0.11	-0.31 ***	0.42 ***	0.68 ***	0.17 **	-0.53 ***	-0.34 ***

ISIC 382	-0.44 *	-0.24 ***	0.68 ***	$-4.10\ 10^{-3}$	-0.36 ***	0.21	-0.27 ***
ISIC 383	$-2.11\ 10^{-3}$	-0.43 ***	0.44 ***	0.01	-0.23 *	-0.03	0.47 ***
ISIC 384	0.05	-0.35 ***	0.29 ***	0.98 ***	-0.18 *	0.37 ***	0.45 ***
ISIC 385	-0.09	-1.09 ***	1.17 ***	-0.19	-0.47 **	0.13	0.54 ***

Note: *- **- *** denotes an error level of respectively 10%- 5% and 1%.

This is in line with the expectation that similar high-skill abundant countries compete in high-skill intensive activities. Increased OECD competition is therefore more likely to affect the position of high-skilled workers.

Trade with the so-called low-wage EU countries depressed the demand for both skill groups. For this country group too the high-skilled workers seem to have been affected more than low-skilled workers.
Three countries in this joined the European Union (Portugal and Spain) or had only been a member for a short time (Greece) at the beginning of the period considered. Apparently, integrating these relatively low-skill abundant countries in the European Union had a negative impact on labour demand in general in the other EU countries.

Import competition of the NIC group had a significant positive impact on the demand for high-skilled workers in ten out of twelve sectors considered and a significant negative impact on the demand for low-skilled workers in three sectors. The Newly Industrialised Countries significantly increased the demand for low-skilled workers in four sectors but comparing with the estimates for high-skilled labour the relative demand for low-skilled workers seems to have dropped in all sectors due to imports from the NIC.
In the *textiles* industry, i.e. a sector that is generally viewed as vulnerable to competition from low-wage countries, imports from the NIC had a very considerable positive impact on the demand for high-skilled workers and a significant negative impact on the demand for low-skilled workers. Moreover, R&D activities in this industry were apparently biased in favour of high-skilled workers. In response to the fierce competition of low-wage NIC, textiles firms in the European Union focused on the high-tech end of the market, investing in R&D and technological innovation. Both the direct impact of NIC competition, i.e. shifting the comparative advantage of high-skill abundant countries to more skill intensive textiles activities

and the possible indirect impact through induced R&D activities are considerable and raised the average skill intensity of the shrinking textiles industry in most EU countries.

R&D activities were apparently also significantly biased against low-skilled workers in the sectors *fabricated metal products* and *non-electrical machinery*. In the first sector imports from the NIC significantly reduced the demand for low-skilled workers.

Though the impact of NIC competition seems to have been most outspoken for the *textiles* industry the positive impact on the demand for high-skilled workers is substantial in many other sectors considered.

In most industries R&D activities appear to increase significantly the (relative) demand for high-skilled workers

The significant positive impact of trade with the Newly Industrialised Countries on the relative demand for high-skilled labour seems to support the first prediction of a sticky wage model, i.e. an overall decline in the demand for the relatively scarce production factor.

However, the impact of imports from NIC, as the impact of the other country groups for that matter, seems rather homogenous across sectors. Demand for low-skilled workers seems to have been affected in a similar way, irrespective of the skill intensity of the sector. So the sticky wage model prediction of an overall increase (decrease) in labour demand in high-skill (low-skill) intensive sectors is not supported by the data.

This could be an indication of foreign outsourcing, where in all sectors the low-skill intensive fragments of the production process are vulnerable to being relocated or outsourced to low-wage countries.

In table 5.2, elasticity estimates for the entire manufacturing industry, i.e. pooling data over industries, are reported.

Table 5.2: Estimated Elasticity of the Demand for Labour at Manufacturing Industry Level (1985-1996)

	High-skilled labour	Low-skilled labour
Wages high-skilled workers	-0.48 (-8.38) ***	-0.12 (-2.44) **
Wages low-skilled workers	-0.12 (-2.44) **	-0.59 (-12.00) ***
Return to capital	0.60 (17.2) ***	0.70 (11.1) ***
Trade high-wage OECD	-0.80 (-13.30) ***	0.08 (1.28)

Trade low-wage EU	-0.69 (-10.3) ***	-0.38 (-5.22) ***
Trade NIC	1.26 (18.2) ***	0.37 (5.20) ***
R&D stock	0.09 (6.90) ***	-0.12 (-6.36) ***

Note: **- *** denotes an error level of respectively 5% and 1%.

The results confirm the general results of the estimations at sector level.
Trade with the non-NIC OECD countries decreased the absolute and relative demand for high-skilled workers and NIC trade increased the demand for both low-skilled and high-skilled workers but decreased the relative demand for low-skilled workers.
The skill-bias in technological activities is more outspoken and significant.

When using Generalized Method of Moments (GMM)[34] to estimate the system of equations, a Sargan test on over-identifying restrictions is systematically rejected, suggesting that the instruments used are not valid. When using lags of four years the Sargan test is no longer rejected but most coefficients become insignificant. Griliches and Mairesse (1995: p. 12) argued that lagged variables are often poor instruments without much power and concluded that whereas GMM estimations could alleviate the endogeneity bias by reducing the variance in the variables used to identify the relevant coefficients, other misspecification problems could start to overwhelm the remaining signal in the data. They questioned the incredible low coefficients in estimations of production functions that try to account for endogeneity or omitted variables biases, such as differencing the data.
Blundell, Bond and Windmeijer (2000: p. 86) found that the Sargan test tends to over-reject in small samples. Bowsher (2002) also instanced the poor quality of the Sargan test of over-identifying restrictions in samples of the size that are commonly encountered in econometric analysis.

34 GMM is a generalization of the method of moments procedure. A system of equations that has more moment restrictions than parameters (i.e. overdetermined) is estimated. A test of over-identifying restrictions provides an indication of the validity of the instruments used, as the assumption of zero correlation between the instruments and the error terms is used to construct moment restrictions in a GMM estimation of a system of equations (Greene 2000: pp.474-488).

Rather than assuming that all production factors can be adjusted instantaneously to their optimal levels, which especially for capital is questionable, the model has been re-estimated, taking account of adjustment costs (time) for capital, i.e. not imposing an instantaneous shift to a new equilibrium. Morrison Paul and Siegel (2001) also considered a specification with capital as a quasi-fixed production factor. This long-run estimation implies that the equilibrium value of the quasi-fixed input (i.e. capital) is equated to its shadow value (i.e. the reduction in variable costs following a unit increase in the quasi-fixed input factor). Long-run elasticity is computed by adding the associated long-run adjustment to the short-run elasticity where the long-run adjustment reflects the effect of a change in an exogenous variable on the equilibrium stock of the fixed production factor and the effect of the latter on factor input demand (e.g. Morrison 1988).
This estimation gives similar results and does not alter the overall conclusions.

An extended version of the model, in which the national average imports to GDP ratio, broken down by region (i.e. South–East Asia, Latin-America and the Central and Eastern European Countries) instead of the (average) imports to GDP ratio for the aggregate NIC group has also been estimated.
High-skilled and low-skilled labour demand elasticity for trade with (South-) East Asia closely mirrors the global pattern, but a rather diverging pattern for trade with Latin America and the Central and Eastern European Countries is found. Whereas increased trade with (South-) East Asia would have a positive effect on the relative demand for high-skilled workers in most sectors, increased trade with the two other NIC regions would have the opposite effect. Estimation with China included for the 1990s, suggests that imports from China decreased the demand for low-skilled as well as high-skilled workers, but surprisingly affected the latter more substantially.

Slaughter (2001) tested the claim by Rodrik (1997) that labour demand may have become more elastic due to increased import competition. Higher elasticity will result in a more volatile response of wages or employment to exogenous shocks in labour demand and will shift the bargaining power for supernormal rents in favour of the firm. Slaughter estimated the demand for production and non-production labour. Lack of sufficient data at the firm level he used data from the NBER Productivity database for 450 manufacturing industries, covering the period

1958-1991. The results suggested that the demand for production workers became increasingly more elastic throughout the period considered. The demand for non-production workers, on the other hand, did not appear to have become more elastic.
When controlling for time, Slaughter did not find a substantial impact of trade variables on the elasticity of the demand for production workers and concluded that a large part of the changes in labour demand elasticity remains unexplained.

To find out whether for the panel of EU countries there are indications that the elasticity of the demand for low-skilled and high-skilled workers increased over time, elasticity has been estimated for the periods 1985-1992 and 1989-1996. There are not sufficient data for reliable estimation of labour demand elasticity for each single year. These periods were considered as they resulted in convergence of the iterative three-stages least squares estimation.
In table 5.3 elasticity estimates for the period 1985-1992 and in table 5.4 the estimates for the period 1989-1996 are reported. In contrast with Slaughter's findings for the United States,

Table 5.3: Estimated Elasticity of the Demand for Labour at Sector Level (1985-1992)

High-skilled labour

	$\varepsilon_{HS,wHS}$	$\varepsilon_{HS,wLS}$	$\varepsilon_{HS,wK}$	$\varepsilon_{HS,Moehw}$	$\varepsilon_{HS,Meulw}$	$\varepsilon_{HS,Mnic}$	$\varepsilon_{HS,RDS}$
ISIC 31	-0.04	-0.07	0.10	-0.28 ***	-0.80 ***	0.92 ***	0.13 **
ISIC 32	-0.88 ***	-0.08	0.95 ***	-0.48 ***	-1.80 ***	2.10 ***	0.20 ***
ISIC 33	-0.87 ***	-0.14	1.01 ***	-0.72 ***	-3.37 ***	3.42 ***	-0.04
ISIC 34	-0.43 ***	0.22 ***	0.21 ***	-0.32 ***	-0.21	0.29 *	0.01
ISIC 35	-0.24 ***	$-0.8.\ 10^{-3}$	0.24 ***	-0.04	-0.98 ***	0.79 ***	0.28 ***
ISIC 36	-0.56 ***	0.28 ***	0.28 ***	-0.40 ***	-1.43 ***	1.70 ***	0.38 ***
ISIC 37	-0.51 ***	0.17 ***	0.34 ***	-0.53 ***	-0.94 ***	1.2 ***	0.03
ISIC 381	-0.68 ***	0.14 *	0.55 ***	-0.26 ***	-1.07 ***	1.12 ***	0.32 ***
ISIC 382	-0.30	0.06	0.24	-0.10	-1.03 ***	0.95 ***	0.04
ISIC 383	-0.95 ***	0.16 ***	0.78 ***	-0.50 ***	-0.61 ***	1.20 ***	0.11
ISIC 384	-0.31 ***	0.19 ***	0.12	0.50 ***	-1.11 ***	0.74 ***	0.44 ***
ISIC 385	-0.69 ***	0.53 ***	0.16 ***	-0.50 ***	-1.03 ***	1.24 ***	0.31 ***

Low-skilled labour

	$\varepsilon_{LS,wHS}$	$\varepsilon_{LS,wLS}$	$\varepsilon_{LS,wK}$	$\varepsilon_{LS,Moehw}$	$\varepsilon_{LS,Meulw}$	$\varepsilon_{LS,Mnic}$	$\varepsilon_{LS,RDS}$
ISIC 31	-0.07	-0.13 **	0.19 ***	0.35 ***	-0.62 ***	0.16	0.15 ***
ISIC 32	-0.04	-0.25 **	0.29 ***	0.27 ***	-0.05	-0.33 ***	-0.03
ISIC 33	-0.11	-0.76 ***	0.87 ***	0.04	-1.65 ***	1.42 ***	-0.16 *
ISIC 34	0.26 ***	-0.29 ***	0.02 ***	0.17 ***	0.36 ***	-0.79 ***	-0.07 *
ISIC 35	$-2.\ 10^{-2}$	-0.38 ***	0.38 ***	0.70 ***	-0.47 ***	-0.13	0.08
ISIC 36	0.23 ***	-0.26 ***	0.03	-0.35 **	-0.03	-0.21 **	0.23 ***
ISIC 37	0.23 ***	-0.47 ***	0.24 ***	-0.36 **	-0.22	0.57	-0.22
ISIC 381	0.12 *	-0.43 ***	0.31 ***	0.42 ***	0.28 ***	-0.34 ***	-0.26 ***
ISIC 382	0.07	-0.43 ***	0.36 ***	0.25 ***	-0.09	-0.09	-0.13
ISIC 383	0.25 ***	-0.61 ***	0.36 ***	0.11	0.39 *	-0.40	-0.02
ISIC 384	0.19 ***	-0.15 **	-0.04	1.23 ***	-0.45 *	-0.12	0.22 ***
ISIC 385	1.14 ***	-1.57	0.42 ***	-0.31 *	-0.54 ***	-0.54 ***	0.39 ***

Note: *- **- *** denotes an error level of respectively 10%- 5% and 1%.

Table 5.4: Estimated Elasticity of the Demand for Labour at Sector Level (1989-1996)

High-skilled labour

	$\varepsilon_{HS,wHS}$	$\varepsilon_{HS,wLS}$	$\varepsilon_{HS,wK}$	$\varepsilon_{HS,Moehw}$	$\varepsilon_{HS,Meulw}$	$\varepsilon_{HS,Mnic}$	$\varepsilon_{HS,RDS}$
ISIC 31	-0.17	-0.22 ***	0.39 ***	-0.98 ***	0.30 **	0.93 ***	$0.2.10^{-2}$
ISIC 32	-2.34 ***	0.65 **	1.69 ***	-0.63 ***	-0.49 **	1.93 ***	0.09
ISIC 33	-0.36 ***	-0.24 ***	0.61 ***	-0.71 ***	-0.52 **	1.17 ***	0.28 ***
ISIC 34	-0.61 ***	0.13 ***	0.48 ***	-0.51 ***	-0.24	0.58 ***	0.16 ***
ISIC 35	-0.31 ***	-0.12 *	0.42 ***	-0.51 ***	-0.34 ***	0.91 ***	0.14
ISIC 36	-1.00 ***	0.06	0.94 ***	-0.05	-0.50 ***	0.98 ***	0.24
ISIC 37	-0.75 ***	-0.11 *	0.87 ***	-0.32	-0.42 *	1.04 ***	0.21
ISIC 381	-0.64 ***	0.13	0.51 ***	-0.11	-0.25	0.97 ***	0.40 ***
ISIC 382	-0.74 ***	-0.01	0.75 ***	0.17	-0.32	0.29	0.27 **
ISIC 383	-0.99 ***	-0.04	1.03 ***	-0.46 *	-0.61 **	1.49 ***	0.10
ISIC 384	-0.49 ***	-0.03	0.52 ***	-0.24	-0.21	0.73 ***	0.29 **
ISIC 385	-0.43 ***	0.05	0.39 ***	-0.92 ***	-0.40 ***	0.94 ***	0.52 ***

Low-skilled labour

	$\varepsilon_{LS,wHS}$	$\varepsilon_{LS,wLS}$	$\varepsilon_{LS,wK}$	$\varepsilon_{LS,Moehw}$	$\varepsilon_{LS,Meulw}$	$\varepsilon_{LS,Mnic}$	$\varepsilon_{LS,RDS}$
ISIC 31	-0.21 ***	-0.25 ***	0.46 ***	-0.09	0.02	0.25	0.12
ISIC 32	0.32 **	-0.47 ***	0.16 ***	0.28 ***	0.23 ***	-0.38	-0.16 ***
ISIC 33	-0.17 ***	-0.35 ***	0.52 ***	0.28 **	-0.14	0.11 ****	-0.10
ISIC 34	0.16 ***	-0.16 ***	$0.5.10^{-2}$	0.20 *	-0.16	-0.06	-0.02
ISIC 35	-0.20 *	-0.60 ***	0.80 ***	0.42	-0.64 ***	0.26	0.57 **
ISIC 36	0.05	-0.16 **	0.11 ***	0.65 ***	0.11 ***	-0.31 *	0.14
ISIC 37	-0.13 *	-0.31 ***	0.44 ***	0.41	-0.34	0.42 **	0.27
ISIC 381	0.09	-0.22 ***	0.13 **	0.42 ***	0.30	-0.07	-0.27 ***
ISIC 382	-0.01	-0.12	0.14	0.20	-0.04	0.28	-0.32 **
ISIC 383	-0.05	-0.34 ***	0.40 ***	0.16	-0.33	0.41	0.01
ISIC 384	-0.03	-0.02	0.06	0.56 **	0.14	0.11	0.13
ISIC 385	0.09	-0.47	0.38 **	-0.26	-0.28	0.38 **	0.68 ***

Note: See table 5.2.

overall, the estimates for the two periods suggest that if anything, it is the elasticity of the demand for high-skilled workers that has become more elastic.
Only in three sectors (*food, drink and tobacco; textiles, footwear and leather* and *chemicals*) did the elasticity of the demand for low-skilled workers increase whereas the elasticity of the demand for high-skilled workers appears to have increased in nine out of the twelve sectors considered.

Data for France and Spain only cover the period 1990-1996. This could bias the estimates for the two sub-periods. An estimation of elasticity for the two periods, omitting France and Spain in both sub-periods gives rather similar results and does not change the main conclusions.

The estimation of the extended model is used to compute the average factor demand elasticity for the period 1985-1996[35]. When multiplying the estimate for the elasticity by the cumulative percentage change of the imports to GDP ratio by region and the basic period employment level of high- and low-skilled labour, the sector effect on the demand of high-skilled and low-skilled labour of increased international trade can be estimated.

Aggregating the latter over all sectors and NIC regions results in an estimation of the aggregate impact of North-South trade on the demand for high-skilled and low-skilled workers. The results are reported in table 5.5.
Relative demand for low-skilled workers seems to have decreased in all EU countries considered, in line with the predictions of the sticky wage model. Aggregating the estimated change in the demand for low-skilled labour at the national level, results in an estimated cumulative fall of 3.6 per cent of relative demand due to increased trade with the Newly Industrialised Countries, between 1985 and 1996.

This is somewhat higher though of comparable impact than the value reported by Krugman (1995 b) for the OECD as a whole[36].

35 In the case of France and Spain 1990-1996.

36 The negative effect on labour demand from import competition found for the United Kingdom, is in line with the findings of Greenaway, Hine and Wright (1999). The negative effect reported for Sweden by Oscarsson (2000) is not confirmed.

Table 5.5: The Impact of Import Competition from the Newly Industrialised Countries on the Demand for High-skilled (HS) and Low-Skilled (LS) Workers

(annual percentage change in labour demand 1985-1996)

Country	ΔHS/HS	ΔLS/LS
Germany	1.5%	0.4%
France*	0.3%	-0.6%
Italy	0.2%	0.0%
Belgium	2.2%	-1.1%
United Kingdom	0.8%	-1.1%
Denmark	2.0%	0.4%
Sweden	1.1%	0.1%
Finland	1.7%	-1.4%

Note: The annual percentage change in employment over the period 1985-1996 is given, except for * for which the average over the period 1990-1996 is given.

5.3 The Choice of the Cost Function Specification

Using the well-known KLEM database of US manufacturing industries in the period 1947-1971, Berndt and Khaled (1979) rejected models that are close to the translog specification, as they failed to satisfy the regularity (e.g. concavity) conditions that are expected of a well-behaving function[37]. Berndt and Wood (1982) and Diewert and Wales (1987) found that imposing concavity on a translog form substantially reduces the goodness of fit.

Barnett (1985) and Barnett, Lee and Wolfe (1985) have shown that both a generalized Leontief (GL) function and the translog (TL) function tend to violate regularity conditions within the data region. The GL function has good regional properties when substitution is low and the TL function has good regional properties when elasticity of substitution is close to one. This is not entirely surprising given that the GL function is a second-order Taylor series expansion of a Leontief function for which elasticity of substitution equals zero and the TL function is a second-order Taylor series expansion of a Cobb-Douglas function for which elasticity of substitution equals one (Barnett, Lee and Wolfe 1985: p. 4). Adding this to the finding by Caves and Christensen (1980) that the performance of both functional forms deteriorates rapidly as elasticity moves away from their respective specific values of global well-behaviour Barnett, Lee and Wolfe (1985: pp. 4-5) concluded: "*As a result, neither model is attractive when little*

37 The usual properties required from a cost function are that it is non-decreasing in the factor prices, that the function is homogenous of degree one as well as concave and continuous in the factor prices.

prior knowledge exists about the relevant elasticities, and the selection between models requires very strong prior knowledge about elasticities."

They proposed to use second-order Laurent expansions of the TL and GL functions as Monte Carlo simulations show that these functional forms perform better, especially for time series.

A Laurent expansion results in the following expressions:

Laurent translog cost function (LTL):

$$\ln C = \alpha_0 + \sum_{i=1}^{I} \alpha_i \ln p_i + \beta \ln X + \tfrac{1}{2} \sum_{i=1}^{I} \sum_{j=1}^{J} \alpha_{ij} \ln p_i \ln p_j + \sum_{i=1}^{I} \chi_{iX} \ln p_i \ln X$$
$$- \tfrac{1}{2} \sum_{i=1}^{I} \sum_{j \neq i}^{J} \zeta_{ij} \frac{1}{\ln p_i} \frac{1}{\ln p_j} - \sum_{i=1}^{I} \psi_{iX} \frac{1}{\ln p_i} \frac{1}{\ln X} \quad (5.7)$$

Laurent generalized Leontief cost function (LGL):

$$C = \alpha_0 + \sum_{i=1}^{I} \alpha_i p_i^{0.5} + \beta X^{0.5} + \tfrac{1}{2} \sum_{i=1}^{I} \sum_{j=1}^{J} \alpha_{ij} p_i^{0.5} p_j^{0.5} + \sum_{i=1}^{I} \chi_{iX} p_i^{0.5} X^{0.5}$$
$$- \tfrac{1}{2} \sum_{i=1}^{I} \sum_{j \neq i}^{J} \zeta_{ij} \frac{1}{p_i^{0.5}} \frac{1}{p_j^{0.5}} - \sum_{i=1}^{I} \psi_{iX} \frac{1}{p_i^{0.5}} \frac{1}{X^{0.5}} \quad (5.8)$$

The remainder term of a Laurent expansion is the sum of two terms which by definition always move in opposite directions and therefore varies more smoothly than the remainder term of a Taylor series expansion, which is close to zero at the centre of approximation but rapidly increases outside the radius of convergence (Barnett, Lee and Wolfe 1985: p. 9). A minflex Laurent function is obtained by imposing, on a full second-order Laurent expansion, the minimality property, which states that functions should have just enough parametric freedom to satisfy the definition of a flexible functional form. Minimality is obtained by imposing $\alpha_{ij} . \zeta_{ij} = \chi_{iX} . \psi_{iX} = 0$ for all i-j combinations (Barnett 1985: pp. 35-38).

Laurent flexible functional forms have not been applied frequently in empirical work.

Le Compte and Smith (1990) compared the results of the estimation of a translog cost function to the results of a minflex Laurent translog cost function estimation for the US savings and loans industry. When using the latter functional form the hypothesis of constant returns to scale could not be rejected, contrary to when a traditional translog function was used.

More recently Giannakas, Tran and Tzouvelekas (2003) compared a number of production function forms, nested within a generalized quadratic Box-Cox model (e.g. GL and TL) with a minflex LTL and a minflex LGL production function specification in an estimation of technical efficiency in 125 Greek olive growing farms. The functional forms nested within the generalized quadratic Box-Cox model can be tested against the Box-Cox specification with likelihood ratio tests and against one another with the likelihood dominance criterion proposed by Pollak and Wales (1991). As the minflex Laurent functional forms are not nested within the generalized quadratic Box-Cox, Giannakas, Tran and Tzouvelekas used the non-nested hypothesis tests developed by MacKinnon, White and Davidson (1983) to discriminate pair-wise between the different non-nested functional forms. The non-nested hypothesis tests strongly favoured the minflex LTL and LGL functional forms over the generalized quadratic Box-Cox function, which in its turn is favoured over any of its considered nested functional forms, including the traditional TL and GL forms. The minflex Laurent functional forms are superior to the Box-Cox functional forms but both Laurent functions fit the data comparably well and it is therefore not possible to favour one over the other.

Given the aforementioned caveats of the traditional GL and TL specifications, the alternative minflex Laurent (LTL and LGL) specifications have been estimated to assess the sensitivity of the elasticity estimates with respect to the choice of function specification and to find out whether tests allow to favour one specification over another.
The elasticity estimates, reported in tables 5.1-5.4, indicate that labour demand has been affected in most industries in a similar way. The results seem to be supportive of a sticky wage model, albeit a model of foreign outsourcing, i.e. where the low-skill intensive activities in all industries are outsourced to low-skill abundant countries. Therefore the estimations have been performed with data on foreign outsourcing (see section 4.4)[38] with the estimation using the final goods trade variables as a robustness check.

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38 Given the high level of aggregation, only foreign outsourcing in the narrow sense (see section 4.4) has been considered.

The translog cost (TL and LTL) functions appear to perform very bad on the data set (e.g. significant wrongly signed own price elasticity and often a failure to converge). This seems in line with previous results. Berndt and Wood (1982) found, for US manufacturing industries in the period 1948-1971, that imposing global concavity conditions on a TL cost function ensured that the cost function was well-behaved but resulted in poor goodness of fit and suggested that the trade-off between conditions of well-behaviour and goodness of fit could be less severe for other functional forms like the generalized Leontief (Berndt and Wood 1982: p. 219). Overall, the GL cost functions appear to be well behaved even without imposing restrictions.

For each industry considered, both an extended GL specification (Morrison and Siegel 1997) and an extended minflex LGL specification are considered. J-tests, proposed by Davidson and MacKinnon (1981) are used to discriminate between both specifications.

They considered two non-nested model specifications:

$$H_1: y = x(\alpha) + \varepsilon_1 \quad (5.9)$$

$$H_2: y = z(\beta) + \varepsilon_2 \quad (5.10)$$

With α and β the respective parameter vectors.

The two models are artificially nested within a compound model:

$$H_C: y = (1-\delta)\, x(\alpha) + \delta\, z(\beta) + \varepsilon \quad (5.11)$$

As generally δ, α and β are not identifiable, Davidson and MacKinnon proposed a J-test in which β (i.e. the parameter vector of the hypothesis specification that is not tested) is replaced by its least squares estimate $\hat{\beta}$. They showed that if hypothesis H_1 holds, the t-statistic of $\hat{\delta}$ will be asymptotically standard normally distributed. To test hypothesis H_2, α is replaced by its least squares estimate $\hat{\alpha}$ in (5.11). The pair of non-nested hypotheses tests can have four outcomes (Davidson and MacKinnon 1993: p. 383):

- H_1 is rejected but H_2 not ➔ H_2 preferred model
- H_2 is rejected but H_1 not ➔ H_1 preferred model
- H_1 and H_2 both rejected ➔ H_1 nor H_2 satisfactory specification
- H_1 nor H_2 rejected ➔ Both specifications are similar (or data set is not very informative)

Table 5.6 shows the results of elasticity measures derived from the GL and LGL specification for each individual industry, estimated for the panel of five EU countries for which input-output data allowed to construct the outsourcing variables.
As before, elasticity has been evaluated at the means and the ANALYZ procedure in TSP has been used to compute standard errors.

For all industries, except for high-skilled labour in ISIC 35 (*chemicals*) and ISIC 385 (*precision instruments*) own price elasticity of input factors has the right sign and is mostly highly significant.
The results of the J-tests show that in eight out of the twelve industries considered the traditional GL specification is rejected whereas a Laurent GL specification is not, albeit in five industries GL is only rejected at the 10 per cent level.

Only in two industries (ISIC 34: *paper, printing and publishing* and ISIC 37: *basic metal industries*) GL is clearly preferred to LGL. For ISIC 35 both a GL and a LGL specification are rejected and for ISIC 383 (*electrical equipment*) the J-test is inconclusive.

Given the rather substantial differences in estimated elasticity, in some cases even with contradictory conclusions, the choice of functional form seems to matter. Moreover, the appropriate functional form appears to be industry specific.

Trusting in the results of the preferred specification, the positive estimates of $\varepsilon_{LS,\, whs}$ suggest that low-skilled and high-skilled labour are substitutes in nine industries and significantly so in five industries. This is in contrast with the estimates reported in table 5.1.
However, the main difference does not appear to be the specification, as the results of the estimation using a traditional generalized Leontief specification suggest substitution between low-skilled and high-skilled workers as well.
The difference therefore seems to be explained more by the use of foreign outsourcing variables as external determinants.

Table 5.6: Elasticities from Generalized Leontief (GL) and Minflex Laurent Generalized Leontief (LGL) Cost Function Specification (1985-1996)

	ISIC 31		ISIC 32		ISIC 33		ISIC 34	
	GL	LGL	GL	LGL	GL	LGL	GL	LGL
$\varepsilon_{LS,wls}$	-0.89 (-5.88) ***	-0.58 (-4.13) ***	-1.00 (-5.69) ***	-1.01 (-5.58) ***	-0.43 (-4.30) ***	-0.43 (-4.46) ***	-1.27 (-15.1) ***	-0.44 (-5.57) ***
$\varepsilon_{HS,whs}$	-0.61 (-6.89) ***	-0.45 (-4.72) ***	-1.11 (-5.36) ***	-1.25 (-4.30) ***	-0.41 (-5.92) ***	-0.27 (-4.15) ***	-1.04 (-8.05) ***	-0.78 (-7.83) ***
$\varepsilon_{K,wk}$	-0.16 (-5.58) ***	-0.11 (-6.89) ***	-0.24 (-6.22) ***	-0.08 (-3.48) ***	-0.08 (-3.48) ***	-0.03 (-1.29)	-0.44 (-7.93) ***	-0.22 (-7.44) ***
$\varepsilon_{LS,whs}$	0.17 (1.86) *	0.11 (1.36)	0.19 (1.06)	0.15 (0.82)	0.21 (2.79) ***	0.27 (4.07) ***	-0.22 (-2.44) **	-0.03 (-0.35)
$\varepsilon_{LS,wk}$	0.72 (5.71) ***	0.47 (5.40) ***	0.81 (9.17) ***	0.86 (8.71) ***	0.22 (3.10) ***	0.15 (2.13) **	1.49 (9.63) ***	-0.16 (-3.34) ***
$\varepsilon_{HS,wk}$	0.47 (4.08) ***	-0.12 (-4.40) ***	0.90 (4.39) ***	0.77 (3.67) ***	0.21 (2.35) **	0.00 (.02)	1.19 (6.59) ***	0.80 (9.17) ***
$\varepsilon_{LS,oehw}$	0.69 (2.41) **	1.06 (4.51) ***	0.08 (0.45)	0.21 (1.04)	0.45 (6.63) ***	0.48 (7.80) ***	0.24 (1.34)	0.24 (1.83) *
$\varepsilon_{HS,oehw}$	-0.58 (-1.86) *	-0.14 (-0.58)	-1.30 (-5.24) ***	-1.12 (-4.09) ***	-0.23 (-2.90) ***	-0.23 (-2.69) ***	-0.67 (-4.00) ***	-0.41 (-2.68) ***
$\varepsilon_{LS,eulw}$	-1.93 (-7.73) ***	-1.34 (-5.91) ***	0.01 (0.04)	-0.12 (-0.45)	-0.42 (-5.20) ***	-0.36 (-4.24) ***	-0.77 (-3.04) ***	-0.18 (-1.05)
$\varepsilon_{HS,eulw}$	-1.12 (-4.81) ***	-0.38 (-1.51)	0.28 (0.75)	0.12 (0.32)	-0.31 (-2.76) ***	-0.15 (-1.19)	0.07 (0.29)	-0.05 (-0.19)
$\varepsilon_{LS,nic}$	0.92 (3.64) ***	0.60 (2.97) ***	-0.30 (-2.00) **	-0.13 (-0.92)	0.69 (5.85) ***	0.68 (5.88) ***	0.92 (4.74) ***	-0.12 (-0.96)
$\varepsilon_{HS,nic}$	0.87 (4.20) ***	0.71 (3.80) ***	0.48 (2.02) **	0.85 (3.91) ***	0.92 (4.97) ***	0.92 (4.18) ***	1.22 (6.30) ***	0.39 (1.94) *
$\varepsilon_{LS,rds}$	0.63 (3.13) ***	0.57 (3.45) ***	-0.43 (-2.69) ***	-0.33 (-2.15) **	0.09 (1.30)	0.14 (2.27) **	-0.02 (-0.09)	-1.67 (-1.12)
$\varepsilon_{HS,rds}$	0.36 (1.69) *	0.23 (1.38)	-0.72 (-3.11) ***	-0.61 (-2.56) ***	0.44 (6.21) ***	0.48 (6.36) ***	-0.44 (-2.70) ***	-0.10 (-0.54)
P-test	GL vs. LGL	LGL vs. GL	GL vs. LGL	LGL vs. GL	GL vs. LGL	LGL vs. GL	GL vs. LGL	LGL vs. GL
	1.82 *	0.89	1.91 *	0.85	2.87 ***	1.21	-1.49	4.79 ***

Table 5.6: Continued

	ISIC 35		ISIC 36		ISIC 37		ISIC 381	
	GL	LGL	GL	LGL	GL	LGL	GL	LGL
$\varepsilon_{LS,wls}$	-0.36 (-1.44)	-0.20 (-0.99)	-0.30 (-3.10) ***	0.03 (0.28)	-0.45 (-3.54) ***	-0.54 (-5.93) ***	-0.26 (-2.54) **	-0.22 (-2.05) **
$\varepsilon_{HS,whs}$	.08 (0.59)	0.38 (3.96) ***	-0.58 (-4.78) ***	-0.51 (-5.65) ***	-0.36 (-4.39) ***	-0.41 (-6.01) ***	-0.24 (-2.50) **	-0.23 (-1.68) *
$\varepsilon_{K,wk}$	-0.01 (-0.25)	0.07 (3.13) ***	-0.06 (-4.69) ***	0.01 (0.76)	-0.04 (-3.87) ***	0.04 (1.58)	-0.04 (-0.82)	-0.07 (-1.36)
$\varepsilon_{LS,whs}$	0.01 (0.07)	0.22 (1.17)	-0.01 (-0.14)	0.29 (3.86) ***	0.14 (1.04)	-0.30 (-4.51) ***	0.16 (1.36)	0.12 (0.99)
$\varepsilon_{LS,wk}$	0.35 (3.43) ***	0.01 (0.25)	0.32 (3.30) ***	0.11 (2.81) ***	0.31 (4.10) ***	-0.36 (-1.91) ***	0.10 (0.95)	0.10 (0.89)
$\varepsilon_{HS,wk}$	-0.08 (-0.58)	-0.46 (-3.54) ***	0.59 (4.74) ***	0.21 (2.95) ***	0.10 (1.04)	-0.21 (-1.29)	0.09 (0.65)	0.22 (1.23)
$\varepsilon_{LS,oehw}$	1.09 (6.68) ***	1.30 (6.42) ***	0.35 (2.37) **	0.48 (1.75) *	0.60 (3.07) ***	0.43 (1.41)	0.68 (8.09) ***	0.78 (7.95) ***
$\varepsilon_{HS,oehw}$	0.56 (2.03) **	0.71 (2.28) **	-0.46 (-3.29) ***	-0.17 (-0.56)	-0.31 (-2.29) **	-0.50 (-2.67) ***	0.11 (0.86)	0.30 (2.32)
$\varepsilon_{LS,eulw}$	-0.38 (-1.67) *	-0.38 (-1.31)	-1.76 (-6.13) ***	-3.35 (-6.75) ***	-0.48 (-1.47)	0.48 (0.57)	-0.23 (-1.74) *	-0.31 (-2.33) **
$\varepsilon_{HS,eulw}$	-0.82 (-1.88) *	-0.84 (-1.71) *	-1.94 (-6.04) ***	-4.14 (-7.06) ***	-0.53 (-1.66) *	0.24 (0.58)	-0.39 (-2.12) **	-0.57 (-3.26) ***
$\varepsilon_{LS,nic}$	0.33 (1.83) *	0.03 (0.13)	1.64 (7.01) ***	2.75 (6.87) ***	0.08 (0.29)	0.52 (0.78)	-0.06 (-0.40)	0.02 (014)
$\varepsilon_{HS,nic}$	0.01 (0.02)	-0.20 (-0.64)	2.44 (12.00) ***	4.15 (9.55) ***	-0.09 (-0.39)	0.30 (1.04)	0.06 (0.32)	0.15 (0.62)
$\varepsilon_{LS,rds}$	0.39 (1.60)	0.80 (2.41) **	1.66 (6.95) ***	3.10 (9.02) ***	-0.30 (-1.62)	-1.71 (-2.95) ***	0.20 (2.51) **	0.35 (3.49) ***
$\varepsilon_{HS,rds}$	1.08 (2.41) **	1.38 (2.93) ***	1.52 (4.62) ***	3.21 (6.80) ***	0.22 (1.21)	-0.94 (-3.71) ***	0.89 (6.91) ***	1.16 (5.45) ***
P-test	GL vs. LGL	LGL vs. GL	GL vs. LGL	LGL vs. GL	GL vs. LGL	LGL vs. GL	GL vs. LGL	LGL vs. GL
	-2.03 **	2.56 ***	2.49 **	0.78	-1.45	4.57 ***	2.75 ***	0.44

Table 5.6: Continued

	ISIC 382		ISIC 383		ISIC 384		ISIC 385	
	GL	LGL	GL	LGL	GL	LGL	GL	LGL
$\varepsilon_{LS,wls}$	-0.61(-3.77) ***	-0.02 (-0.23)	-0.05 (-1.03)	0.01 (0.02)	-1.16 (-4.70) ***	-1.25 (-4.97) ***	0.40 (2.27) **	0.19 (1.11)
$\varepsilon_{HS,whs}$	-0.66 (-7.63) ***	-0.46 (-7.05) ***	-0.40 (-6.91) ***	-0.27 (-4.29) ***	-0.72 (-4.99) ***	-0.81 (-5.41) ***	0.26 (2.55) **	0.39 (2.34) **
$\varepsilon_{K,wk}$	-0.08 (-4.82) ***	-0.08 (-3.51) ***	-0.19 (-9.50) ***	-0.27 (-8.37) ***	-0.14 (-6.88) ***	-0.15 (-5.43) ***	-.09 (-2.89) ***	-0.05 (-1.85) *
$\varepsilon_{LS,whs}$	0.39 (2.93) ***	0.01 (0.15)	-0.21 (-6.18) ***	-0.28 (-6.27) ***	0.51 (2.81) ***	0.55 (2.94) ***	-1.07 (-6.36) ***	0.29 (4.77) ***
$\varepsilon_{LS,wk}$	0.22 (2.49) **	0.04 (0.30)	0.26 (8.88) ***	0.28 (6.18) ***	0.65 (6.80) ***	0.70 (7.38) ***	0.66 (6.11) ***	0.69 (5.36) ***
$\varepsilon_{HS,wk}$	0.35 (7.07) ***	0.47 (8.17) ***	0.51 (8.27) ***	0.77 (6.88) ***	0.26 (2.78) ***	0.25 (2.26) **	0.15 (1.28)	0.01 (0.33)
$\varepsilon_{LS,oehw}$	0.36 (3.31) ***	0.23 (2.22) **	0.52 (5.43) ***	0.48 (5.30) ***	1.11 (2.67) ***	0.76 (2.29) **	-0.29 (-1.22)	-0.99 (-3.48) ***
$\varepsilon_{HS,oehw}$	-0.27 (-2.36) **	-0.19 (-1.61)	0.39 (3.26) ***	0.44 (4.65) ***	-0.20 (-0.41)	-0.62 (-1.64)	-0.40 (-2.30) **	-0.87 (-4.38) ***
$\varepsilon_{LS,eulw}$	-0.74 (-6.05) ***	-0.58 (-4.82) ***	-0.38 (-3.89) ***	-0.32 (-3.30) ***	-0.84 (-1.99) **	-0.53 (-1.51)	0.04 (0.29)	-0.09 (-0.63)
$\varepsilon_{HS,eulw}$	-0.23 (-2.17) **	-0.30 (-2.62) **	-0.88 (-5.51) ***	-0.94 (-6.96) ***	0.38 (0.68)	0.76 (1.66)	-0.26 (-1.89) *	-0.14 (-0.83)
$\varepsilon_{LS,nic}$	0.58 (6.12) ***	0.68 (5.61) ***	-0.46 (-3.67) ***	-0.19 (-1.94) *	0.45 (1.67) *	0.24 (1.21)	0.76 (2.80) ***	-0.20 (-0.68)
$\varepsilon_{HS,nic}$	0.79 (11.30) ***	0.83 (9.30) ***	-0.03 (-0.20)	0.08 (0.61)	-0.00 (-0.00)	-0.24 (-0.98)	0.38 (1.95) *	-0.13 (-0.51)
$\varepsilon_{LS,rds}$	0.09 (1.09)	-0.01 (-0.09)	0.19 (1.72) *	0.04 (0.39)	-0.04 (-0.18)	-0.20 (-1.08)	0.15 (0.54)	1.23 (3.85) ***
$\varepsilon_{HS,rds}$	-0.02 (-0.21)	0.08 (0.52)	0.38 (2.93) ***	0.38 (3.16) ***	0.16 (0.68)	-0.01 (-0.06)	0.14 (0.63)	0.61 (2.45) **
P-test	GL vs. LGL	LGL vs. GL	GL vs. LGL	LGL vs. GL	GL vs. LGL	LGL vs. GL	GL vs. LGL	GL vs. GL
	1.64 *	1.17	1.30	0.27	-1.83 *	1.15	2.19 *	0.55

Note: Elasticties are computed at the means of the respective variables and are derived from the demand equations, which result from differentiating the cost function. Standard errors have been computed with the ANALYZ procedure in TSP. The system of demand equations has been estimated with an iterative three-stage least squares procedure with lagged RHS variables as instruments. Country dummies have been included in all specifications. J-tests are pairwise non-nested hypothesis tests (Davidson and MacKinnon, 1981) of a traditional GL specification with LGL specifications based on the high-skilled labour demand equation. *- **- *** denotes significance at respectively 10%- 5% and 1%.

There are indications of absolute capital-skill complementarity in two industries and of relative complementarity between capital and high-skilled labour in seven industries whereas low-skilled labour appears to be a substitute for capital in eleven industries with a significant positive elasticity in nine industries.
With respect to the relationship between high-skilled labour and capital, the GL and LGL specifications have a substantial different outcome, in a number of industries even contradictory conclusions (e.g. significant absolute complementarity between capital and high-skilled labour following a LGL specification but significant substitution following a rejected GL specification in ISIC 31).

The geographical splicing of countries whereto production fragments are outsourced seems to matter in a substantial way.
Foreign outsourcing towards high-skill abundant countries increased both the relative and absolute demand for low-skilled workers and decreased the demand for high-skilled workers in most industries in the five EU countries considered.
Outsourcing towards the relatively low-wage EU countries decreased absolute demand for low-skilled as well as demand for high-skilled workers in some industries.
In most industries outsourcing towards the Newly Industrialised Countries increased the absolute demand for high-skilled workers and mostly reduced the relative demand for low-skilled workers but only significantly reduced the absolute demand for low-skilled labour in one out of twelve industries, namely in electrical machinery, which is one of the sectors most mentioned when it comes to foreign outsourcing (UNCTAD 2002).
The results show that foreign outsourcing does not unambiguously harm low-skilled workers and that the impact may depend on the difference in factor intensity in both the outsourcing country and the country whereto production fragments are outsourced, as suggested by some theoretical models (e.g. Deardorff 1998 b and Venables 1999).

Although the estimates of own price elasticity and cross elasticity tend to differ rather substantially, according to which specification is considered, the main conclusions with respect to the impact of international trade on labour demand in the European Union appear to be rather robust, whereas the impact of R&D activities on the demand for labour is very industry-specific and does not show a general bias in favour of high-skilled labour.

Laurent generalized Leontief estimations, using the full panel of EU countries, considering import competition instead of foreign outsourcing, gives similar results, i.e. substantial differences in cross elasticity estimates between a GL and a LGL specification but rather robust results with respect to the impact of international trade on the demand for low-skilled and high-skilled labour.

5.4 First Differences Regressions

In this chapter, the estimations so far have been performed on variables in levels. As already pointed out in chapter 4, panel unit roots tests indicate that none of the variables considered are stationary in the levels and even first differencing does not always result in stationarity. Baltagi and Kao (2000) concluded that there are still a number of unresolved issues with panel unit roots testing (e.g. low power) that should warn for trusting these results blindly. However, especially levels estimations could suffer from substantial spurious correlation due to the regression of non-stationary time series. I have therefore also performed estimations using first differences at the expense of losing valuable information.

The econometric specification for labour demand (see equation 3.49 in section 3.2.6) derived from a translog cost function as used by e.g. Berman, Bound and Griliches (1993) and Feenstra and Hanson (2001) seems a straightforward way to proceed.

They regressed changes in the wage bill share of low-skilled (high-skilled) workers on changes in output and capital intensity, on relative wages of high-skilled (low-skilled) workers and on a number of exogenous variables.

Though a translog cost function results in a specification with the change in the wage bill share as dependent variable, Egger and Egger (2000) and Strauss-Kahn (2003) argued that for EU countries like France and Austria the wage bill shares hardly changed whereas employment shares did. They therefore argued to consider the employment share instead of the wage bill share, assuming wage stickiness.

I have regressed the change in the employment share of low-skilled workers on the change in output (dlog Y), in capital intensity (dlog K/Y), in import competition distinguished by region of origin (doere-dlatin), in exports (dexp) and in R&D expenditures (dlrd) for the panel of EU countries in the period 1985-1995.

Exports are considered to account for the export demand effect, i.e. the relationship between an expansion of export demand and total employment, pointed out by e.g. Egger and Egger (2000) and Abraham and Brock (2003)[39].
The results are reported in table 5.7.

Table 5.7: Determinants of the Employment Share of Low-Skilled Workers (1985-1995)

Dependent variable:	Change in employment share of low-skilled workers		
	FE	**WLS**	**IV**
dlog Y	-1.26 (-0.32)	-0.34 (-0.06)	21.14 (2.58) ***
dlog K/Y	-3.13 (-0.85)	2.83 (0.54)	23.52 (3.28) ***
Doere	0.57 (0.89)	-0.33 (-0.39)	0.36 (0.39)
Deuhw	-0.32 (-0.26)	-1.38 (-1.10)	-0.03 (-0.02)
Deulw	0.46 (0.61)	0.95 (1.08)	0.81 (0.85)
Dasia	-0.38 (-1.35)	-0.90 (-2.37) **	-0.97 (-2.26) **
Dceec	-1.19 (-3.05) ***	-1.41 (-3.41) ***	-1.94 (-4.20) ***
Dlatin	-0.15 (-0.54)	-0.27 (-0.73)	-0.27 (-0.64)
Dexp	0.91 (0.66)	-1.84 (-1.36)	-3.78 (-2.31) **
Dlrd	-2.22 (-1.29)	-2.25 (-1.16)	-0.54 (-0.25)
$\mathbf{R^2_{adjusted}}$	0.06	0.11	0.12

Note: The specification considered is 3.49 (section 3.2.6) but with the share of low-skilled workers in total sector employment as dependent variable. The first column presents the results of a plain fixed effects estimation, the second column presents the results of a fixed effects estimation with observations weighted by each sector's share in total employment and the third column presents the results of a instrumental variables estimation. **- *** denotes significance at 5%- 1% respectively.

The first column presents the results of a fixed effects estimation (FE). In the second column the results are shown for an estimation in which observations have been weighted by each sector's share in total employment (WLS) and in the final column the results of an instrumental variables estimation (IV), accounting for the endogeneity of right-hand side variables (e.g. output) are reported.
Given the use of first differences instead of levels, the R^2 are understandably rather low and the coefficients are less significant than in the levels estimations.
However, a robust finding is the negative impact of import competition of the three NIC groups[40].

39 Including exports in the generalized Leontief estimation, using variables in levels, suggests that exports decreased the relative demand for high-skilled workers.
40 This is also confirmed when the relative wages are not dropped from the equation. See section 3.2.6 for the argument of Berman, Bound and Griliches (1993) to drop wages from the econometric specification.

The impact of imports from the Central and Eastern European Countries (CEEC) is highly significant for the three alternative estimations and the import competition effect of the Asian NIC is significant for the last two alternative estimations

For the un-weighted fixed effects estimation the significance of the Jarque-Bera and the LM heteroskedasticity test suggest misspecification. For the instrumental variables estimation, a test on over-identifying restrictions is rejected, suggesting poor validity of the instruments but I refer to the remarks with respect to this test (e.g. tendency to over-reject in small samples), mentioned above in section 5.2.

The significant positive and suspiciously high coefficient of capital intensity is somewhat surprising though as this suggests strong complementarity between capital and low-skilled labour.

The export demand effect is found to be negative for the last two estimations and significantly so for the instrumental variables estimation.

Using a similar specification, Abraham and Brock (2003) found a positive impact of export demand on labour for a panel of ten EU countries and nine ISIC sectors in the period 1979-1994 but they did not distinguish high-skilled from low-skilled labour. The negative effect could indicate the increase in skill intensity, argued by Feenstra and Hanson (1996), resulting from the outsourcing of low-skill intensive activities to NIC.

For Austria, Egger and Egger (2000) found a significant positive impact of exports on the employment share of high-skilled workers, which is in line with the negative impact on the employment share of low-skilled workers.

The negative sign of R&D expenditures indicates a skill bias in technological activities though the effect is not significant in any estimation.

I have used data from STAN on domestic consumption at the sector level, to assess the possible impact of changes in consumer preferences, e.g. an increased preference for high-skill intensive goods[41]. It is not obvious to compute exogenous changes in consumer preferences. To preclude endogeneity I used lagged changes in each sector's share in total domestic consumption of manufacturing goods. At first sight there appears to be little evidence for a high positive

41This alternative explanation for a decrease in the demand for low-skilled labour in high-skilled labour abundant countries, due to a decreased demand for low-skill intensive goods, has been pointed out to me by Wim Meeusen. As mentioned in section 3.1.1.2, Moutos (2000) reasoned that an increase in real income could increase the demand for high quality goods.

correlation between changes in the consumption shares and skill intensity. For some countries there is even a negative correlation. Including the changes in consumption shares does not provide a significant coefficient in any of the three estimations.

I also regressed the wage bill share of low-skilled workers on the same right-hand side variables, i.e. the original specification that can be derived from a translog cost function. Surprisingly this provides more significant coefficients as shown in table 5.8.

Table 5.8: Determinants of the Wage Bill Share of Low-Skilled Workers (1985-1995)

Dependent variable:	Change in the wage bill share of low-skilled workers		
	FE	**WLS**	**IV**
dlog Y	$-0.32.10^{-2}$ (-0.08)	-0.10 (-0.85)	0.42 (0.60)
dlog K/Y	-0.03 (-0.79)	-0.08 (-0.75)	0.40 (0.73)
doere	0.01 (1.88) *	$-0.38.10^{-2}$ (-0.33)	$0.52.10^{-2}$ (0.35)
deuhw	$-0.65.10^{-2}$ (-0.53)	0.05 (2.25) **	0.04 (1.35)
deulw	$0.46.10^{-3}$ (0.07)	0.03 (2.66) ***	0.01 (1.00)
dasia	$-0.46.10^{-2}$ (-1.65)*	-0.02 (-3.66) ***	-0.03 (-3.00) ***
dceec	-0.01 (-3.04)	-0.04 (-7.43) ***	-0.03 (-4.97) ***
dlatin	$0.13.\ 10^{-2}$ (0.45)	-0.01 (-2.38) ***	-0.01 (-2.15) **
dexp	0.02 (1.33)	-0.11 (-3.95) ***	-0.11 (-1.50)
dlrd	-0.02 (-1.38)	-0.06 (-2.55) **	$-0.83.10^{-2}$ (-0.22)
$\mathbf{R^2_{adjusted}}$	0.04	0.66	0.59

Note: The specification considered is 3.49 (section 3.2.6). The first column presents the results of a plain fixed effects estimation, the second column presents the results of a fixed effects estimation with observations weighted by each sector's share in total employment and the third column presents the results of a instrumental variables estimation. **- *** denotes significance at 5%- 1% respectively.

For the weighted least squares and the instrumental variables estimation the $R^2_{adjusted}$ is rather high for a first differences estimation.

For the plain fixed effects specification there are again indications of misspecification with respect to normality and homoskedasticity. The impact of imports from the NIC is found to be negative and significantly so for all three NIC groups in the last two estimations though the effects are smaller than in the employment share estimations. Exports as well as R&D activities have a negative impact on the wage bill share of low-skilled workers in the last two estimations and these effects are significant in the weighted least squares estimation.

The results of the wage bill share estimation somewhat differentiate the previous results, which seemed to indicate that import competition affected employment rather than wages. The mandated wage regressions considered the impact on wages within a Stolper-Samuelson framework. Within a foreign outsourcing framework import competition need not affect relative product prices in the way predicted by the Stolper-Samuelson theorem.

The negative impact of the trade variables seem to confirm the prediction of Feenstra and Hanson (1996) that outsourcing will increase skill intensity in all sectors, contrary to what is expected in the Heckscher-Ohlin model.

The previous estimates of labour demand elasticity seemed to provide evidence of a negative impact of North-South trade on the employment of low-skilled labour but the estimations in first differences show that wages may have been affected as well. However, the fact that the effects are estimated more accurately in the wage bill share equation but are substantially lower than the effects in the employment share equation could also indicate that a wage bill share specification is more appropriate as it is more closely linked to a translog cost function but that employment is more affected. Actually, if wages are sticky, changes in the employment share also imply changes in the wage bill share.

5.5 Conclusions

In previous empirical work the demand for low-skilled and high-skilled workers with regard to international trade and technological change has been estimated with demand equations that can be derived from flexible cost functions. The two most popular flexible functional forms are the translog (TL) and the generalized Leontief (GL). Barnett (1985) and Barnett, Lee and Wolfe (1985) have shown that these functional forms are actually not very flexible and only appropriate under strict assumptions with respect to the elasticity of substitution between the production factors. They proposed minflex Laurent functional forms, which have better global properties. In this section the impact of international trade on the demand for low-skilled and high-skilled workers in the European Union in the period 1985-1996 has been estimated using a generalized Leontief (GL) cost function as well as a minflex Laurent generalized Leontief (LGL) cost function.

Non-nested hypotheses tests show that in eight out of twelve industries the latter is clearly the preferred specification, whereas only in two industries a traditional GL specification is preferred. The fact that the traditional translog and generalized Leontief have often been rejected in favour of other functional forms and the sensitivity of results to the choice of

function specification should warn against the conclusions that are based on these popular functional forms.
However, although the choice of functional form seems to affect the estimates of own and cross price elasticities of the production factors, conclusions with respect to the impact of international trade on the demand for low-skilled and high-skilled labour are rather robust to the choice of cost function specification.

Overall, in most industries, international trade competition of high-skill abundant OECD countries decreased the relative demand for high-skilled workers whereas import competition of Newly Industrialised Countries appears to have decreased the relative demand for low-skilled workers. Labour demand seems to have been affected in most industries in a similar way, which seems to support a model of foreign outsourcing.

Trusting in the results of the Laurent generalized Leontief specification there is some evidence of complementarity between capital and high-skilled labour.
Estimations using variables in levels could suffer from spurious correlation, i.e. correlation driven by a common underlying trend in the time series even if there is no real long-run relationship between the variables considered.
Panel unit roots tests indicate that none of the variables is stationary in levels and even in first differences stationarity does not seem to be guaranteed. However, there are a number of unresolved problems with panel unit root testing.
First differences estimations provide less significant results, as can be expected, though a robust negative impact of NIC trade competition is found. Overall the results appear to support the view that international trade did have an impact on relative labour demand, which due to sticky wages might have resulted in unemployment rather than in wage changes. The results are however more in line with a model of foreign outsourcing than with a model of international trade in final goods.

6. International Trade and Union Bargaining Power

"*So, those offices which are by right the proper employment of the leisure class are noble; such are government, fighting, hunting, the care of arms and accoutrements, and the like, - in short, those which may be classed as ostensibly predatory employments. On the other hand, those employments which may properly fall to the industrious class are ignoble; such as handicraft or other productive labour, menial services, and the like.*"

-Thorstein Veblen *The Theory of the Leisure Class*.

6.1 Introduction

In this chapter three questions will be analysed:

- Has international trade with the Newly Industrialised countries reduced the bargaining power of labour unions in the European Union?
- What is, given the bargaining regime and union preferences with respect to wages the expected impact on wages and employment of a negative effect of international trade on union power?
- Has international trade affected the bargaining position of low-skilled workers more substantially than the position of high-skilled workers?

In section 3.1.6 collective bargaining was considered as a labour market institution that could hamper wage flexibility and as a result cause unemployment.
OECD (2003 a) argued that changes in those institutional and policy factors, that affect wage setting but not the matching between labour supply and demand, like collective bargaining, were likely to explain the wage moderation that occurred in the 1990s in a number of EU countries. Factors like unemployment benefits and active labour market policies, which affect both the wage setting and the worker-job match were supposed to have played a less substantial role as matching did not seem to have improved.
So wage moderation could be explained by a decrease in the bargaining power of labour unions and globalisation could be the driving force in the weakening of labour unions.

By corroding supernormal profits, increased import competition might have reduced the rents unions can bargain for. If, as argued by Bhagwati (1995), firms have a credible threat to relocate activities to low-wage countries, the bargaining strength of unions could also be affected.

In the previous chapter the demand for labour was derived under the assumption that wages can be sticky. The European model proposed by Krugman (1995 b) is probably more appropriate for the European Union than the Heckscher-Ohlin model with its un-European assumption that labour markets are perfectly competitive. Though explicitly accounting for labour market rigidity, the model does not specify which labour market institutions could cause downward wage rigidity.

In this chapter the impact of import competition of Newly Industrialised Countries on wages and employment is analysed within a union bargaining framework, accounting for the important role labour unions play in wage setting in most EU countries.

Contrary to previous work, the nature of the bargaining regime and union preferences are determined simultaneously as they both condition the impact of bargaining power on wages and employment.

The theoretical framework of bargaining between firms and unions has been outlined in section 3.1.6 and some of the rare empirical studies with respect to the impact of international trade on union bargaining power have been discussed in section 3.2.6.

As mentioned before, in a right-to-manage framework, where unions and employers only bargain for wages, a weakening of union bargaining power will result in falling wages whereas employment could be unaffected. On the other hand, in an efficient bargaining setting (both wages and employment are bargained for) a trade-off between wages and employment reduction could occur if a union values wages more than employment.

If unions bargain for wages and employment, the impact on wages and employment depends on the nature of the bargaining process, the bargaining power of the union and union preferences with respect to wages and employment (McDonald and Solow 1981; Oswald 1985; Holmlund, Løfgren and Engstrøm 1989 and Mezzetti and Dinopoulos 1991).

Data on labour bargaining power are not generally available at sector level. Union membership is not necessarily a good proxy for union bargaining power (Aidt and Tzannatos 2002) and data

on union membership are mostly only available at country level. Lack of data on union bargaining power, a second best solution seems to estimate it. Bughin (1993, 1996) showed how labour bargaining power can be estimated within a production function framework. This approach has the advantage that the validity of different models of union behaviour can be tested statistically and that risk neutrality (i.e. labour unions are pure rent maximizing organisations) does not have to be imposed.
The model is however extended to allow for the simultaneous estimation, in a first step, of union bargaining power and union preferences. In a second step, the first step estimates of union bargaining power are regressed on potential determinants to assess the impact of international trade competition on union bargaining power and to infer the impact on wages and employment from the first-step indications on the bargaining regime and union preferences.

The theoretical framework and the empirical results in this section draw heavily upon Dumont, Rayp and Willemé (2004).

In section 6.2, the theoretical framework is expounded and in section 6.3 the econometric estimation procedure and the estimation results are discussed.

With respect to the literature, in addition to verifying the influence of international trade competition on the bargaining power of labour unions, three extensions are proposed. First, using firm-level data, sector-level bargaining power is estimated for a panel of five EU countries: Belgium, France, Germany, Italy and the United Kingdom. Second, the bargaining regime as well as union preferences is considered to infer how changes in bargaining power due to import competition could affect wages and employment. Finally, the additional variance in the second step estimation, resulting from the fact that the dependent variable in the second step estimation is an estimated rather than a *true* variable is taken into account by correcting second step variances for the additional variance.
I checked the robustness of the estimation results by computing rather than by estimating, union bargaining power, following the procedure proposed by Veugelers (1989). This procedure permits to differentiate between low-skilled and high-skilled workers, which seems appropriate given the empirical evidence that unions tend to recruit low-skilled workers far more than high-skilled workers and the evidence that strong unions are successful in reducing wage inequality.

6.2 Theoretical Framework

In a right-to-manage framework, where a union and a firm only bargain for wages, a trade-off between the wage level and employment follows straightforwardly. The employer unilaterally determines the employment level, which implies a negatively sloped labour demand curve (e.g. Oswald 1985 and Holmlund, Løfgren and Engstrøm 1989).

Mezzetti and Dinopoulos (1991), Bughin (1993, 1996) and Gaston and Trefler (1995) showed what happens when unions bargain for both wages and employment. They assumed Cournot competition between a domestic and a foreign firm. The domestic firm faces a decreasing inverse demand function:

$$p = p(x+y) \tag{6.1}$$

$$x = x(l,i) \qquad \frac{\partial x}{\partial l} > 0 \tag{6.2}$$

where *x* represents domestic output, which depends on labour *l* and other input factors i and *y* represents the exports of the foreign firm to the home market. Profits of the domestic firm are given as:

$$\Pi(x,y) = p(x+y)x - wl - \sum_{i \neq l} p_i i \,,$$

where *w* indicates the (bargained) wage and p_i the (competitively determined) price of other production factors i. The marginal revenue per worker is given by:

$$\frac{\partial R}{\partial l} = \frac{\partial px}{\partial l} = \frac{\partial p(x+y)}{\partial (x+y)}\frac{\partial (x+y)}{\partial x}\frac{\partial x}{\partial l}x + p\frac{\partial x}{\partial l} = p\left(\frac{\partial p(x+y)}{\partial (x+y)}\frac{x+y}{p(x+y)}\frac{x}{x+y} + 1\right)\frac{\partial x}{\partial l} = p\left(1 - \frac{\alpha}{\eta}\right)\frac{\partial x}{\partial l} = p\,(1-m)\,\frac{\partial x}{\partial l} \tag{6.3}$$

with $\eta = -\frac{\frac{\partial (x+y)}{\partial p(x+y)}}{\frac{x+y}{p(x+y)}}$ the price elasticity of demand, $\alpha = \frac{x}{x+y}$ the market share of the domestic firm and *m* the price-marginal cost margin $m = \frac{\alpha}{\eta} = \left(1 - \frac{MC}{p}\right)$.

The domestic firm and the labour union are assumed to bargain for the wage and the employment level, both taking the level of imports *y* as given.
Union preferences are modelled by a Stone-Geary utility function[42]:

$$U(w,l) = \left(w - \overline{w}\right) l^{\gamma} \tag{6.4}$$

where $\overline{w}$ represents the outside wage option and γ reflects the union's relative preference of employment over wages. If $\gamma < 1$ ($\gamma > 1$), the union is wage- (employment-) oriented (Mezzetti and Dinopoulos 1991: p.82). $\gamma = 1$ applies for a risk neutral, i.e. pure rent- maximizing union. In the absence of an agreement, the domestic firm is assumed to produce nothing. Union utility is zero in this case, whereas the profits of the domestic firm equal the cost of the capital engaged. The generalized Nash product of the bargaining process is:

$$G(w,l) = \left(px - wl - \sum_{i \neq l,k} p_i i\right)^{(1-a)} \left(\left(w - \overline{w}\right) l^{\gamma}\right)^{a} \tag{6.5}$$

where a ($0 \leq a \leq 1$) denotes the bargaining power of the union.
Gaston (1998) considered a bargaining model in which firms have the ability to outsource their activities abroad. As in Mezzetti and Dinopoulos (1991) this is reflected in an outside option for the firm, which increases its bargaining power. The focus of Gaston is on the ability of firms to outsource rather than on the impact of internationalisation on product market rents

Import competition can also reduce the (monopoly) rents firms and unions can bargain for. However, in this chapter the focus is on the impact of international trade on the bargaining power of unions. In the traditional representation of the bargaining game (Rubinstein 1982 and Binmore, Rubinstein and Wolinsky (1986) the bargaining power of both players is determined by the respective rates used to discount their payoffs if bargaining takes time and time is money. The more impatient a player is the lower the player's bargaining strength and thus the lower the player's share in the rent.

42 A Stone-Geary utility function models union preferences immediately at the level of the union, contrary to the utility function (3.18) in section 3.1.6, which is obtained by aggregating the utility of individual union members as modelled by (3.17).

However, Binmore, Rubinstein and Wolinsky consider an alternative interpretation of the bargaining strength. If there is an exogenous risk of breakdown bargaining power is determined by the probability of such a breakdown: "*the higher is pary i's estimate of the probability of breakdown, the lower is his bargaining power* (Binmore, Rubinstein and Wolinsky 1986: p. 187)".

McDonald and Suen (1992) link the perceived probability of breakdown to the state of the economy and therefore postulate an inverse relationship between union power and unemployment.

Lindén (1995) and Teulings and Hartog (1998) defined the bargaining parameter *a* as a measure of labour market tightness. The tighter the labour market is the higher the bargaining power of the union will be. Import competition may affect the tightness of the labour market, e.g. by reducing domestic employment opportunities.

Another interpretation could be that if due to increased import competition or the increased ease to outsource activities abroad the credibility of the threat of the firm increases the risk perceived by unions that firms will break down bargaining, reducing the bargaining strength of unions. As such the bargaining power parameter can be considered as a measure of the credibility of the respective outside options. Globalisation is likely to increase the credibility of a firm to break down bargaining and reduce the credibility of unions that alternative wage (e.g. lowest in the sector) can actually be obtained in sectors that witness strong competitive pressure from emerging economies.

Under the assumption that G is strictly concave, a unique solution is given by the first-order conditions for maximization:

$$
\begin{aligned}
\frac{\partial G}{\partial w}=0 \;&\Leftrightarrow (1-a)\left(px-wl-\textstyle\sum_{i\neq l,k} p_i i\right)^{-a}(-l)\left(\left(w-\overline{w}\right)l^{\gamma}\right)^{a}+a\left(px-wl-\textstyle\sum_{i\neq l,k} p_i i\right)^{(1-a)}\left(\left(w-\overline{w}\right)l^{\gamma}\right)^{a-1}(l^{\gamma})=0 \\
&\Leftrightarrow a\left(\frac{px-wl-\sum_{i\neq l,k} p_i i}{w-\overline{w}}\right)\frac{1}{l}=1-a \\
&\Leftrightarrow (1-a)\left(w-\overline{w}\right)=a\left(\frac{VA}{l}-w\right)
\end{aligned}
\qquad (6.6)
$$

$$\frac{\partial G}{\partial l}=0 \Leftrightarrow (1-a)\left(px-wl-\sum_{i\neq l,k} p_i i\right)^{-a}\left(\frac{\partial px}{\partial l}-w\right)\left(\left(w-\overline{w}\right)l^{\gamma}\right)^{a}$$
$$+a\left(px-wl-\sum_{i\neq l,k} p_i i\right)^{(1-a)}\left(\left(w-\overline{w}\right)l^{\gamma}\right)^{a-1}\gamma\left(w-\overline{w}\right)l^{\gamma-1}=0$$
$$\Leftrightarrow (1-a)(p(1-m)\frac{\partial x}{\partial l}-w)+\frac{a}{l}(VA-wl)\gamma=0$$
$$\Leftrightarrow \frac{a\gamma}{l}+\frac{(1-a)}{(VA-wl)}\left(p(1-m)\frac{\partial x}{\partial l}-w\right)=0 \qquad (6.7)$$

VA denotes value added: $VA=px-\sum_{i\neq l,k} w_i i$

Substituting (6.6) in (6.7) and rearranging provides an expression for the contract curve (CC):

$$(\gamma-1)w-\gamma\overline{w}+p(1-m)\frac{\partial x}{\partial l}=0 \qquad (6.8)$$

The slope of the contract curve depends on the value of γ (see figure 3.13 in section 3.1.6). If $\gamma < 1$ ($\gamma > 1$) the contract curve is negatively (positively) sloped. $\gamma = 1$ implies that the contract curve is vertical at the (competitive labour market) full employment level. Hence, the value of γ determines whether in an efficient bargaining regime the wage and employment level are negatively or positively correlated.

In addition to the contract curve, the Nash bargaining curve is derived from (6.7) in order to solve for the wage and the employment level in G. Multiplying both terms by *l* and grouping all the terms in *w* gives:

$$w=\frac{a\gamma}{(1-a+a\gamma)}\frac{VA}{l}+\frac{(1-a)}{(1-a+a\gamma)}p(1-m)\frac{\partial x}{\partial l} \qquad (6.9)$$

Solving (6.8) and (6.9), the optimal wage and employment level, for a given level of imports y and labour bargaining power a, can be obtained. In Appendix 1 it is shown that:

$$\frac{\partial l}{\partial y}<0 \qquad \frac{\partial w}{\partial y}<0 \text{ or } \frac{\partial w}{\partial y}>0 \qquad \frac{\partial l}{\partial a}<0\ (\gamma<1) \qquad \frac{\partial l}{\partial a}>0\ (\gamma>1) \qquad \frac{\partial w}{\partial a}>0 \qquad (6.10)$$

Supposing that labour union power is a negative function of foreign output on the domestic market:

$$a = a(y) \qquad \frac{da}{dy} < 0 \tag{6.11}$$

the wage and employment effect of an increase of foreign output on the domestic market can be obtained, applying the implicit function theorem:

$$\frac{dl}{dy} = \left.\frac{\partial l}{\partial y}\right|_{a=ct} + \frac{\partial l}{\partial a}\frac{da}{dy} \tag{6.12}$$

$$\frac{dw}{dy} = \left.\frac{\partial w}{\partial y}\right|_{a=ct} + \frac{\partial w}{\partial a}\frac{da}{dy} \tag{6.13}$$

From (6.10)-(6.13) the following proposition can be derived:

Proposition 1

In an efficient bargaining regime, if union bargaining power depends negatively on imports, the fall in domestic employment due to an increase in imports is mitigated (exacerbated) if the union is wage- (employment-) oriented. A fall in wages due to an increase in imports is more likely, independently from the wage- or employment-orientation of the trade union.

The evidence on bargaining regimes is far from conclusive though working conditions in addition to wages seem part of the bargaining framework (e.g. Ulph and Ulph 1990; Layard, Nickell and Jackman 1991 and Booth 1995). Dehez, de la Croix and Toulemonde (1999) argued that over-manning or under-utilisation of labour occurs frequently but is largely ignored in the bargaining literature. According to them ignoring the possibility of under-utilisation of labour, as e.g. in Mezzetti and Dinopoulos (1991) and Bughin (1993), could result in misleading conclusions.

Based on Layard, Nickell and Jackman (1991), Haskel and Martin (1992) proposed a labour hoarding model with unions and employers bargaining for wages and work effort.

If unions are concerned about wages as well as work effort, utility can be modelled with the following function:

$$U(w,l_O) = \left(w - \overline{w}\right)\left(\frac{l_O}{l_P} - \frac{\overline{l_O}}{l_P}\right)^{\gamma} \tag{6.4'}$$

l_O represents unproductive overhead labour and l_P productive labour. The ratio $\frac{l_O}{l_P}$ indicates the degree of over-manning (or crew size), which reflects the work effort (Haskel and Martin 1992). Whereas wages and overhead labour are bargained for, the employer unilaterally determines the level of productive labour, i.e. by equating the wage level to the marginal product:

$$\frac{\partial R}{\partial l_P} = p\,(1-m)\frac{\partial x}{\partial l_P} \tag{6.3'}$$

As other assumptions remain unchanged the generalized Nash bargaining function becomes:

$$G(w,l_O) = \left(px - w\left(l_O + l_P\right) - \Sigma_{i\neq l,k}\, p_i i\right)^{(1-a)}\left(\left(w - \overline{w}\right)\left(\frac{l_O}{l_P} - \frac{\overline{l_O}}{l_P}\right)^{\gamma}\right)^{a} \tag{6.5'}$$

The maximization of G subject to (6.3') implies:

$\frac{\partial G}{\partial w} = 0$ i.e. (6.6) with $l = l_O + l_P$.

$$\frac{\partial G}{\partial l_O} = 0 \Leftrightarrow (1-a)\left(px - w(l_0 + l_p) - \sum_{i\neq l,k} p_i i\right)^{-a}(-w)\left(\left(w - \overline{w}\right)\left(\frac{l_O}{l_P} - \frac{\overline{l_O}}{l_P}\right)^{\gamma}\right)^{a}$$

$$+ a\left(px - w(l_0 + l_p) - \sum_{i\neq l,k} p_i i\right)^{(1-a)}\left(\left(w - \overline{w}\right)\left(\frac{l_O}{l_P} - \frac{\overline{l_O}}{l_P}\right)^{\gamma}\right)^{a-1}\gamma\left(w - \overline{w}\right)\left(\frac{l_O}{l_P} - \frac{\overline{l_O}}{l_P}\right)^{\gamma-1}\frac{1}{l_p} = 0$$

$$\Leftrightarrow a\gamma\left(\frac{l_O}{l_P} - \frac{\overline{l_O}}{l_P}\right)^{-1}\frac{1}{l_P} = \frac{(1-a)}{(VA - wl)}w \tag{6.14}$$

Using (6.6) and the definition of l, (6.14) can be rearranged:

$$\gamma\left(w-\overline{w}\right)=w\left(\frac{l_O}{l_P}-\frac{\overline{l_O}}{l_P}\right)\left(1+\frac{l_O}{l_P}\right)^{-1} \tag{6.15}$$

Equation (6.15) provides a first relationship between w and l_O that can be used to solve (6.5'). Multiplying both sides of (6.3') by $\frac{l_P}{px}$ and noting that by definition $\frac{\partial R}{\partial l_P}=w$, (6.3') can be rearranged:

$$(1-m)\varepsilon_{x,l_P}=\frac{wl_P}{px}=(1-m)\varepsilon_{x,l_P}\left(1+\frac{l_0}{l_p}\right) \tag{6.16}$$

where ε_{x,l_P} represents output elasticity of (productive) labour.

Combining (6.14) and (6.16) and rearranging, provides an expression for overhead labour (Haskel and Martin 1992: p.617):

$$\frac{l_O}{l_P}=\frac{a\gamma}{(1-a+a\gamma)}\left(\frac{s_{VA}}{(1-m)\varepsilon_{x,l_P}}-1\right)+\frac{(1-a)}{(1-a+a\gamma)}\frac{\overline{l_O}}{l_P} \tag{6.17}$$

with s_{VA} indicating the share of value added in total sales.

Using (6.15) and (6.17) the optimal levels of w and l_O, for given values of imports and bargaining power, can be determined. Considering the comparative statics (see appendix 2), the sign of most partial derivatives is indeterminate when $\gamma > 1$. Hence, in the labour hoarding framework, when the union is effort-oriented, a priori expectations regarding the effect of import competition (or bargaining power) cannot be formulated unambiguously.

For $\gamma < 1$ it can be shown (see appendix 2):

$$\frac{\partial l_O}{\partial y}<0 \qquad \frac{\partial w}{\partial y}<0 \text{ or } \frac{\partial w}{\partial y}>0 \qquad \frac{\partial l_O}{\partial a}>0 \qquad \frac{\partial w}{\partial a}>0$$

Under the assumption that bargaining power is reduced by import competition, a second proposition can be formulated:

Proposition 2.

In a labour hoarding regime, if the union is wage-oriented and its bargaining power depends negatively on imports, the fall in overhead labour due to an increase in imports is intensified, and a fall in wages due to an increase in imports is more likely.

Since only crew size is bargained for, the effect on productive employment has to be included in order to determine the total employment effect of bargaining. From (6.3') and $\frac{\partial R}{\partial l_P} = w$ it follows that $\frac{\partial l_P}{\partial w} < 0$. Hence, in a labour hoarding model, a reduction of the bargaining power of a wage-oriented union has an undetermined effect on employment: crew size falls but productive labour may increase because of falling wages. However, Layard, Nickell and Jackman (1991) showed that the leverage effect of labour bargaining power on effort would have to be unrealistically high for it to dominate the effect on productive labour. This supports a trade-off between wages and employment in a labour hoarding regime with wage-oriented unions ($\gamma < 1$).

6.3 Two-Step Union Bargaining Estimation Procedure

6.3.1 First Step: Estimation of Union Bargaining Power

Data on union bargaining power at the sector level are hardly available.
A two-step estimation procedure may be a second best approach: in a first step the bargaining power of unions at the sector level can be estimated within a production function framework, using firm level data. In a second step the estimated bargaining power can then be regressed on variables that are assumed to have an impact on union bargaining power.

Bargaining power can be estimated as in Bughin (1993, 1996). Within a labour hoarding framework, the labour share in revenues can be derived from (6.3'), (6.16) and (6.17):

$$s_l = \frac{wl}{px} = k\, s_{VA} + (1-k)\left(1 + \frac{\overline{l_O}}{l_P}\right)(1-m)\, \varepsilon_{x,l_P} \qquad (6.18)$$

with $k = \frac{a\gamma}{(1 - a + a\gamma)}$.

Within an efficient bargaining framework, multiplying the left- and right-hand side of (6.9) by $\frac{l}{px}$ results in an expression for the labour share:

$$s_l = = k\, s_{VA} + (1-k)(1-m)\ \varepsilon_{x,l} \tag{6.18'}$$

The other (intermediate) inputs are assumed to be priced competitively. Profit maximization implies:

$$w_i = (1-m)p\frac{\partial x}{\partial i} \tag{6.19}$$

$$s_i = \frac{w_i i}{px} = (1-m)\varepsilon_{x,i} \tag{6.20}$$

Specifying a functional form for x, k can be estimated from (6.18) and (6.20) for all production factors except one. As in Bughin (1996) the price-cost margin m, as a proxy for firm product market power, is endogenous. However, contrary to Bughin (1996), the estimated parameter k is not simply equated to union power a. As (A1.2) indicates, k is determined by two structural parameters (union preference and bargaining power) and equating k to a implicitly assumes $\gamma = 1$. To identify a and γ, an additional equation can be considered: the first-order condition (6.6) for the maximization of the Nash bargaining function $\partial G / \partial w = 0$, given that (6.18) or (6.18') is derived from $\partial G / \partial l = 0$.

The bargaining regime (efficient bargaining, right-to-manage or labour hoarding), union preferences (wage-oriented, employment-oriented or effort-oriented) as well as the bargaining power itself can be estimated simultaneously using the system of equations (6.6), (6.18) and (6.20) testing whether a number of parameter restrictions can be imposed. Following Bughin (1996), with $\hat{k}_0$ the estimate of k in (6.18) and $\hat{k}_1$ the estimate of $(1-k)\left(1+\frac{\overline{l_O}}{l_P}\right)$, if $k_0 > 0$ then in

an efficient bargaining regime $k_0 - (1 - k_1) = 0$ should hold as it implies $l_O = 0$ (absence of over-manning). The rejection of the null hypothesis can be considered as an indication in favour of a labour hoarding model. Bughin (1996) considered the test $k_0 = 0$ in order to discriminate an efficient bargaining/ labour hoarding model against a right-to-manage model. However, from (A1.2) $k_0 = 0$ could imply $a = 0$ (i.e. a union without any power) as well as $\gamma = 0$. Hence, the hypothesis $\gamma = 0$ is tested to discriminate in favour of the right-to-manage framework.
Union preference is determined from the estimation of $\hat{\gamma}$ and the test $\gamma < 1$ versus $\gamma \geq 1$.

Firm level data are available for estimation at the ISIC two-digit sector level[43] for five countries: Belgium, France, the United Kingdom, Italy and Germany. For the three first countries data are used from Bureau van Dijk (respectively BELFIRST, DIANE and FAME) for the five years 1994-1998. For the same period data for Italy and Germany were taken from the AMADEUS database (Bureau van Dijk).
Other countries were excluded from the analysis because of a too low number of company records available or the lack of data for the relevant variables[44].

Production technology is modelled with a translog function specification with three inputs: labour (L), capital (K) and raw materials and intermediary goods (M):

$$\ln(x) = a_0 + \sum_{i=L,K,M} a_i \ln i + \tfrac{1}{2} \sum_{i=L,K,M} \sum_{j=L,K,M} a_{ij} \ln i \ln j \qquad (6.21)$$

This permits the specification of (6.18) and (6.20). Output, capital stock and raw materials and intermediary goods are proxied by their current values at the firm level, deflated by the sector-level value added price index for the first and the third, and by the gross fixed capital formation price index for capital. The price deflators are computed from the current and constant value time series of value added and investment goods (OECD STAN database). As outside wage option $\overline{w}$, which is required to estimate (6.6), the lowest firm wage level in the sector is considered.

43 ISIC 38 is considered at the three-digit level (381-385).

44 The number of records per sector ranged for Belgium from 137 to 1315, for France from 706 to 2300, for Germany from 127 to 703, for Italy from 742 to 3548 and for the United Kingdom from 55 to 1191.

Adding the usual error term to (6.6)[45], (6.18), (6.20) -for raw materials and intermediary goods- and (6.21)[46], the system of equations is estimated with maximum likelihood, which warrants results that are invariant to which specific share equation is omitted (Greene 2000: p. 642). The explanatory variables were lagged one period. Estimations are performed at sector level using the pooled data set of 1994-1998. The main results are reported in table 6.1.

For all sectors considered (see note to table 6.1) the labour bargaining parameter is significantly different from zero at the 1 per cent level. There were not sufficient data for the *Wood, cork and furniture* (ISIC 33) industry in Germany. Both cross-sector and cross-country variation is substantial, with the first clearly dominating the latter.
Union power estimates are the highest for France and Germany, of intermediate magnitude for Belgium and the lowest for Italy and the United Kingdom[47].

Concerning union preferences, insofar as employment is included in the bargain, unions seem to be strongly wage-oriented: in all but six sectors where γ was found to differ significantly from zero, $\gamma < 1$ is not rejected.
German and French unions are apparently much more wage-oriented than their Belgian, Italian and UK counterparts though with few exceptions unions seem to be rather wage-oriented in all sectors and countries. The pooled estimation does not really permit to conclude that this result supports the view of Gaston (1998) that unions may become more wage-oriented when firms can more credibly threaten to outsource their activities abroad[48].
Regarding the bargaining regime, for most sectors and countries efficient bargaining as well as right-to-manage are rejected, in favour of a labour hoarding framework.

45 Rearranged with w only in the left-hand side term.

46 Given the share restriction the capital equation can be dropped. The translog production function is added to the system of equations to improve the efficiency of the estimates.

47 According to Aidt and Tzannatos (2002: p. 82) France and Germany had a bargaining coverage (i.e. number of workers, unionised or not, that are covered by collective agreements) of 95 and 92 per cent respectively. For Belgium the coverage was 90 per cent and for Italy and the United Kingdom 82 and 47 per cent respectively.

48 For a panel of Belgium, France, Germany and the United Kingdom the correlation between γ and the level of outsourcing in 1996 as well as the change between 1985 and 1996 at the sector level (see chapters 4 and 5) is positive, which seems to contradict that unions in sectors with a high level of outsourcing are more wage-oriented.

Table 6.1: Estimation of Union Power, Union Preferences and the Bargaining Regime (1994-1998)

	BELGIUM			FRANCE			GERMANY			ITALY			UK		
ISIC	a	γ	BR	a	γ	BR	A	γ	BR	a	γ	BR	a	γ	BR
31	0.38***	0.78***	LH	0.63***	0.27***	LH	0.50***	0.07***	LH	0.29***	0.35***	LH	0.49***	0.06**	LH
32	0.50***	0.77***	LH	0.79***	0.24***	LH	0.56***	0.34***	EB	0.25***	0.50***	LH	0.44***	0.30***	LH
33	0.49***	0.67***	LH	0.62***	0.40***	EB				0.27***	0.60***	LH	0.42***	0.26***	LH
34	0.58***	0.74***	LH	0.75***	0.93***	LH	0.63***	0.22***	LH	0.22***	0.64***	LH	0.43***	0.44***	LH
35	0.45**	0.68***	LH	0.65***	0.44***	LH	0.55***	0.32***	LH	0.31***	0.56***	LH	0.48***	0.12**	LH
36	0.34***	1.78***	LH	0.76***	0.17***	LH	0.59***	0.13***	LH	0.28***	0.54***	LH	0.41***	0.77*	RTM-EB
37	0.45***	0.93***	LH	0.77***	0.02	RTM	0.42***	0.07*	RTM-EB	0.31***	0.57***	LH	0.65***	0.22***	LH
381	0.61***	0.41***	LH	0.72***	0.15***	LH	0.61***	0.16**	EB	0.30***	0.55***	LH	0.56***	0.30***	LH
382	0.59***	0.38***	LH	0.83***	0.22***	LH	0.70***	0.06***	EB	0.37***	0.67***	LH	0.52***	0.08**	LH
383	0.59***	0.69**	LH	0.77***	0.32***	LH	0.64***	0.25***	EB	0.37***	0.59***	LH	0.44***	0.16***	LH
384	0.54***	0.68***	LH	0.64***	0.55***	LH	0.77***	0.07***	EB	0.30***	0.52***	LH	0.40***	0.22***	LH
385	0.59***	0.57***	EB	0.77***	0.79***	LH	0.60***	0.08***	EB	0.25***	0.94***	LH	0.26***	0.18	RTM

Note: The a column reports the estimated labour bargaining power, γ reports the estimated union preference and the BR-column the test of the bargaining regime: efficient bargaining (EB) versus labour hoarding (LH) and efficient bargaining/labour hoarding versus right-to-manage (RTM). Estimations refer to all available data for the period 1994-1998. * - ** - *** denotes significance at respectively 10 % - 5 % - 1 %.The sectors are: *Food, drink & tobacco* (ISIC 31), *Textiles, footwear & leather* (ISIC 32), *Wood, cork & furniture* (ISIC 33), *Paper, printing & publishing* (ISIC 34), *Chemicals* (ISIC 35), *Non-metallic mineral products* (ISIC 36), *Basic Metal Industries* (ISIC 37), *Fabricated metal products* (ISIC 381), *Non-electrical machinery* (ISIC 382), *Electrical equipment* (ISIC 383), *Transport equipment* (ISIC 384) and *Precision instruments* (ISIC 385).

For Germany efficient bargaining is not rejected in seven out of the eleven sectors considered.

Following the second proposition, labour market bargaining in most sectors in four out of the five countries considered is consistent with a trade-off between wages and employment due to intensified import competition.

6.3.2 Second Step: The Determinants of Union Power

In this section the bargaining power of unions, estimated at sector level in the first step, is regressed on a number of possible determinants, with a focus on variables reflecting international trade competition. Data on international trade are taken from the OECD International Trade by Commodities Statistics (ITCS) database (see section 4.2) to compute import volumes for each of the five EU countries with respect to two distinct groups of trade partners: the major Newly Industrialised Countries (NIC)[49] from Central and Eastern Europe, (South-) East Asia and Latin America on the one hand and the EU countries and high-skill abundant OECD countries[50] on the other hand.

A number of potential (domestic) determinants of union bargaining power that have been used in previous empirical work are considered as control variables.
Following Veugelers (1989) and Bughin (1991) the Herfindahl index[51] is considered as a measure of industry concentration, i.e. a proxy of imperfect product market competition. Veugelers (1989) argued that market concentration allows management to shift increased costs on to consumers more easily. Therefore they may be inclined to be more easy-going on unions‘ wages demands. However, she added that as concentration reflects the power of firms, the effect on union bargaining power is not entirely unambiguous. Bughin (1991) a priori assumed a negative relationship between the Herfindahl index and union power, given that the more concentrated the industry the more powerful the industry competitors will be. The Herfindahl index has been computed for each industry with the firm level data that were used to estimate union bargaining power at sector level.

49 Czech Republic, Hungary, Poland, Hong Kong, Indonesia, South- Korea, Malaysia, Philippines, Singapore, Thailand, Argentina, Brazil, Chile and Mexico.

50 EU-15 plus Australia, Japan, New Zealand, Norway and the US.

51 The Herfindahl Index measures industry concentration by summing the squared market shares of individual firms.

Bughin (1991), referring to Sneessens (1987), assumed that a low capacity utilization rate implies a low price-cost margin, which will make management more aggressive in negotiation. The relationship between capacity utilization and union power is therefore assumed to be positive. Sector level capacity utilization rates are taken from the OECD Industrial Structure Statistics.

Bughin (1991) used the ratio of R&D expenses to patent revenues to account for the combined effect of wages increasing with the R&D stock and optimal R&D investment, which may be deterred by wage rent seeking. If there are no good instruments available for the R&D variable, the sign is ambiguous due to a possible simultaneity bias. Lack of data on data on patent revenues, R&D intensity is used. The data on R&D stocks are described in section 4.2.

Finally, the skill ratio, measured as the number of high-skilled workers relative to the number of low-skilled workers is also considered as a control variable. There is ample evidence that unions dominantly recruit low-skilled workers and are successful in reducing wage inequality (Freeman 1980; Blau and Kahn 1996; Aidt and Tzannatos 2002 and Card, Lemieux and Riddell 2003). A negative correlation between the skill ratio and union power can be expected.

Union bargaining power, estimated for each individual industry with pooled data over the years 1994-1998 is used to construct a cross-section of five countries and twelve industries. To preclude a simultaneity bias, the right-hand side variables are averaged over the period 1992-1996 rather than over the period 1994-1998. To account for possible heterogeneity among the five EU countries, in addition to country-specific intercepts, country-specific slope effects are included by interacting the control variables with country dummies.

A general-to-specific approach is adopted, starting from a general model with all relevant variables (trade variables[52] and control variables), which is sequentially simplified as much as possible- that is as long as it does not result in misspecification or severe loss of fit- by deleting those variables that are not significant at the 5 per cent level.

The most general model contains 38 variables (five country dummies (CD_i), eleven sector dummies (SD_j), two trade variables ($M_{OECD, ij}$ and $M_{NIC, ij}$) and four control variables (skill ratio

52 To account for heterogeneity among trade partners initially six country groups were considered: high-wage EU countries, low-wage EU countries, high-wage OECD countries, (South-) East Asian NIC, Latin American NIC and NIC from Central and Eastern Europe. However, there were indications of multicollinearity (high R-squared and high joint but low individual significance of the variables) and therefore the first three country groups were joined in an OECD group and the three groups of Newly Industrialised Countries in a NIC group.

SR_{ij}, Herfindahl index HI_{ij}, capacity utilization CU_{ij} and R&D intensity RDI_{ij}) interacted with the five country dummies.

As union bargaining power, estimated in the first step, lies within the [0,1] range, the following logit specification is used:

$$\ln\left(\frac{a_{ij}}{1-a_{ij}}\right) = \alpha_i CD_i + \beta_j SD_j + \alpha_{OECD} M_{OECD,ij} + \alpha_{NIC} M_{NIC,ij} + \left(\alpha_{SR,i} SR_{ij} + \alpha_{HI,i} HI_{ij} + \alpha_{CU,i} CU_{ij} + \alpha_{RDI,i} RDI_{ij}\right) CD_i + \varepsilon_{ij}$$

with a_{ij} union bargaining power in the j-th industry, in the i-th country, and ε_{ij} the usual error term. In table 6.2 the final step of the general-to-specific estimation is reported and the diagnostics of this specification are compared with the diagnostics of the most general model specification.

Table 6.2: Estimation of the Impact of Determinants on Union Bargaining Power for the Panel of Five EU Countries (1994-1998)

Dependent variable:		$\ln\left(\frac{a_{ij}}{1-a_{ij}}\right)$
$\mathbf{M_{OECD}}$		-0.98 (-8.74) **
$\mathbf{M_{NIC}}$		-4.25 (-4.63) **
$\mathbf{SR_{UK}}$		-0.58 (-2.03) *
$\mathbf{HI_{UK}}$		-9.08 (-3.68) **
$\mathbf{CU_{BE}}$		-0.40 (-0.38)
$\mathbf{RDI_{FR}}$		-2.20 (-2.13) *
Diagnostics	**General model**	**Specific model**
R^2 adjusted	0.77	0.87
LM test heteroskedasticity (p-value)	$0.16\ 10^{-4}$ (0.99)	0.69 (0.41)
Jarque-Bera normality test (p-value)	1.02 (0.60)	0.10 (0.97)
RESET functional form test (p-value)	0.98 (0.34)	0.85 (0.36)
F-test zero slopes (p-value)	5.94 (0.00) **	35.9 (0.00) **

Note: The dependent variable (union bargaining power transformed for logit estimation) is taken from the first step estimation, pooled over the years 1994-1998 at industry level. The M variables are the import shares of the respective country groups, averaged over the period 1992-1996. The four control variables are defined in the text. The subscript reflects the interaction with the respective country dummies. The t-values reported in brackets have been corrected to account for the generated regressand problem using the formula derived in the statistical appendix. * - ** denotes significance at respectively 5 % - 1 %.

As the dependent variable in the second step regression is estimated in the first step regression, additional variance has to be accounted for. In the statistical appendix to this chapter a correction procedure that results in a consistent estimation of the variances of the second-step parameters is given. Given the specific nature of the bargaining power estimation procedure (firm-level data in the first step, sector-level data in the second step and the use of a logit specification) the correction differs from the one derived for the two-step mandated wage regressions in chapter 4.

The diagnostics show that the final specific model is well specified and explains a large part of variance in union power. The t-values, reported in brackets, have been corrected to account for the fact that the dependent variable is an estimated rather than a *true* variable, using the formula given in the statistical appendix to this chapter.

Import competition from both OECD countries and the NIC group seems to have had a significant negative impact on the bargaining power of unions, in the five EU countries, in the period considered. The impact of import competition from the group of Newly Industrialised Countries is substantially (and significantly) higher than the impact of OECD countries[53].

Unreported country dummies are highly significant. Actually, dropping the country dummies from the final specific model dramatically reduces the adjusted R-squared to 0.17, suggesting substantial institutional differences between the five EU countries, which can be captured in the constant terms.

Only four out of the twenty original control variables are significant and CU_{BE} (i.e. capacity utilization interacted with a country dummy for Belgium) is no longer significant when correcting the t-values for the generated regressand problem[54]. In interaction with the UK dummy, the skill ratio and the Herfindahl index have a significant negative coefficient. Veugelers (1989) found, for 1978, a significant positive impact of the Herfindahl index on union bargaining power for Belgium, whereas Bughin (1991), also for Belgium, found a negative impact, albeit mostly not significant for the period 1979-1985. For France, R&D intensity has apparently had a significant negative impact on union power in the period considered[55]. The significance of country-specific variables underscores- as do the results of the first step estimation of union power and preferences- the need to account for heterogeneity across EU

53 If China is included in the NIC group the coefficient of imports from the NIC is –2.02.

54 For Belgium, Bughin (1991) found a positive though mostly not significant coefficient for capacity utilization

55 Bughin (1991) found a positive but rarely significant effect of the R&D variable for Belgium in the period 1979-1985.

countries. Institutional differences between EU countries apparently play a dominant role in determining the bargaining power of unions although a common negative impact of import competition is found.

Including variables reflecting exports as Manasse, Stanca and Turrini (2004) did for Italy, results in a negative but highly insignificant coefficient.
The usual alternative explanation for international trade, i.e. skill-biased technological change, was considered by Acemoglu, Aghion and Violante (2001) as a determinant of falling union membership in the United States. They argued that technological change raised the outside option for high-skilled workers, undermining the coalition between low-skilled and high-skilled workers, thereby reducing the bargaining power of unions, which are reported to be successful in reducing wage differences.

To control for the possible impact of technological change, a general-to-specific estimation has been performed with total factor productivity as a proxy for technological change. The data used for TFP are discussed in section 4.2. Total factor productivity is interacted with the country dummies in the general model.

To preclude multi-collinearity between TFP and the R&D variable, the latter is not included in the estimation[56].
The results of the specific model with TFP, reported in table 6.3, confirm the earlier findings. Both imports from OECD and NIC had a significant negative impact on the bargaining power of unions, with the latter again significantly dominating the first.
The skill ratio and Herfindahl index for the United Kingdom are again found to be significant and negative. However, for this estimation, the Herfindahl index is also significant and negative for Belgium and France. The coefficient of total factor productivity is negative, as expected, and significant for Belgium and Germany but only at the 10 per cent level for the latter.

Table 6. 3: Estimation of the Determinants of Union Bargaining Power with TFP as Proxy for Technological Change

56 Including R&D intensity gives similar results.

Dependent variable:	$\ln\left(\frac{a_{ij}}{1-a_{ij}}\right)$
M_{OECD}	-0.93 (-3.05)***
M_{NIC}	-3.92 (-3.96) ***
SR_{UK}	-0.48 (-1.72) *
HI_{FR}	-6.57 (-2.28) **
HI_{BE}	-6.44 (-1.95)*
HI_{UK}	-9.20 (-3.72)***
TFP_{DE}	-1.33 (-1.89)*
TFP_{BE}	-0.77 (-2.24)**
Diagnostics	**Specific model**
R^2 adjusted	0.88
LM test heteroskedasticity (p-value)	0.15 (0.70)
Jarque-Bera normality test (p-value)	1.15 (0.56)
RESET functional form test (p-value)	0.40 (0.53)
F-test zero slopes (p-value)	27.6 (0.00)***

Note: See table 6.2.

When interacting total factor productivity with the trade variables, the coefficient of total factor productivity is no longer significant for Germany and only significant at the 10 per cent level for Belgium, whereas the coefficients of the trade variables remain highly significant. The coefficient of TFP, interacted with imports from OECD countries, is significant for Belgium and the coefficient of TFP interacted with imports from the NIC is significant for Germany (both at the 10 per cent level). The results of the estimation with TFP, interacted with imports, suggest that import competition may have induced technological change, as TFP is only significant in interaction with variables reflecting import competition.

Veugelers (1989) computed the bargaining power of blue-collar and white-collar workers separately, for a cross-section of Belgian manufacturing industries. Her results suggested that both categories of workers should be treated as different groups. Blue-collar workers had a higher bargaining power than white-collar workers.

Veugelers considered an efficient bargaining framework but contrary to the framework presented in this section, she pegged down the parameter reflecting risk preference of the union (γ) at one, implying risk-neutrality. From the wage equation, obtained by differentiating the Nash product with respect to wages, she derived the following expression (Veugelers 1989: p. 176):

$$\frac{L.WP/R}{PCM} = \frac{\tau}{1-\tau} \tag{6.22}$$

with L denoting employment, WP the wage premium, R revenue, τ the bargaining power of the union and PCM the price cost margin (i.e. value added minus labour costs divided by sales).

Rather than estimating bargaining power, she derived the sector-level bargaining strength of unions from the difference between the sector wage level and the competitive wage level (i.e. WP).

Lack of information on marginal labour productivity, she assumed the competitive wage level to be constant across industries and equated it to the lowest wage level in manufacturing industries. She adjusted the wage premium to avoid differences due to characteristics of workers in each industry, like the percentage of female workers, average seniority and the percentage of skilled workers or management executives.

Assuming workers can swiftly shift from one industry to another, which the common threat point for all industries in WP implies, seems more heroic than assuming a common threat point across firms in the same industry, as the estimation within a production function framework using firm level data implies. The procedure of computing bargaining power also implies that unions in the sector with the lowest wage level have no bargaining power at all.

However, the advantage of the approach by Veugelers (1989) is that low-skilled workers can be differentiated from high-skilled workers, which is less feasible at the firm level, a level at which data on employment broken down by skills are not readily available.

Apart from the results of Veugelers, indicating substantial differences in the bargaining power of the two skill groups, as mentioned above, there are clear indications that unions represent low-skilled workers to a larger extent than high-skilled workers. Moreover, in a number of industries, high-skilled workers have their own unions. Differentiating both groups therefore seems appropriate as import competition and other determinants may affect both groups to a different extent.

For the panel of five EU countries, union bargaining power has been computed following the procedure by Veugelers (1989), using the sector data on manual and non-manual workers (see section 4.2). Unfortunately there were no data available on the characteristics Veugelers used (e.g. average seniority) so unadjusted wage premia are used.

Bargaining power has been computed for each sector, for the years 1993-1996, and the average over these years is taken as the dependent variable.
Computing bargaining power for all workers combined results in lower estimates than with the estimation procedure using firm level data. Average bargaining power for the panel of five EU countries, estimated with the latter procedure, is 0.52, whereas following the Veugelers procedure it is 0.47. For Belgium, Veugelers found union bargaining power below 0.50 for most manufacturing industries in 1978, whereas the estimates for union bargaining power, in table 6.1, are well above 0.50 in most industries and countries.
The assumption of risk-neutrality ($\gamma = 1$), implied in the Veugelers procedure, is clearly rejected for most industries, as can also bee seen in table 6.1.
The bargaining power of low-skilled (blue-collar) workers is, as in Veugelers (1989), with an average of 0.29, found to exceed the bargaining power of high-skilled (white-collar) workers, with an average of 0.17.

Table 6.4: Estimation of the Impact of Determinants on the Union Bargaining Power of Low-Skilled and High-Skilled Workers (Panel of Five EU Countries)

		Low-skilled workers		**High-skilled workers**
Dependent variable:		$\ln\left(\frac{a_{ij}}{1-a_{ij}}\right)$		$\ln\left(\frac{a_{ij}}{1-a_{ij}}\right)$
M_{OECD}		-1.84 (-7.52) ***		-1.63 (-6.77) ***
M_{NIC}		-9.64 (-4.80) ***		-8.69 (-4.04) ***
SR_{DE}		-0.47 (-2.97) ***		
SR_{FR}		0.58 (2.62) **		0.91(2.86) ***
HI_{DE}		3.15 (1.77) *		4.37 (3.58) ***
CU_{BE}		0.02 (6.02) ***		
RDI_{BE}				50.1 (2.75) ***
Diagnostics	**General model**	**Specific model**	**General model**	**Specific model**
R^2 adjusted	0.65	0.80	0.76	0.83
LM test heteroskedasticity (p-value)	$0.58\ 10^{-2}$ (0.02) **	4.66 (0.03) **	0.41 (0.52)	$0.59\ 10^{-2}$ (0.94)
Jarque-Bera normality test (p-value)	0.79 (0.68)	0.81 (0.67)	1.08 (0.58)	2.10 (0.35)
RESET functional form test (p-value)	1.33 (0.27)	0.63 (0.43)	0.30 (0.60)	0.335 (0.57)
F-test zero slopes (p-value)	3.66 (0.00) ***	17.8 (0.00) ***	5.36 (0.00) ***	23.0 (0.00) ***

Note: The dependent variable (union bargaining power transformed for logit estimation) is computed at sector level with the formula (6.22) proposed by Veugelers (1989), averaged over the years 1993-1996. As the bargaining power is not estimated but computed the t-values are not corrected, as in table 6.2, but are White heteroskedastic-consistent. * - **-*** denotes significance at respectively 10%- 5 % - 1 %.

Results of a general-to-specific estimation of the determinants of union bargaining power for the group of low-skilled workers and the group of high-skilled workers are reported in table 6.4.

The general as well as the final specification for low-skilled workers seems to suffer from heteroskedasticity, but the reported t-values are, following the procedure by White (1980), consistent for the presence of unknown heteroskedasticity.

Imports competition of OECD countries and the NIC is found to have had a significant negative impact on the bargaining power of both low-skilled and high-skilled workers. Again, the impact of the NIC dominates the impact of OECD countries. The impact of imports, especially of the NIC, is higher for low-skilled workers than for high-skilled workers, though the difference is not statistically significant. R&D intensity has a very high and significant positive impact on the bargaining power of high-skilled workers for Belgium. This could indicate that substantial R&D activities strengthen the bargaining position of highly qualified workers.

Alternative estimations, e.g. with total factor productivity as a control variable, change the remaining significant control variables in the final specification[57] but consistently confirm the significant impact of import penetration, especially with respect to the Newly Industrialised Countries.

57 For Belgium, the impact of TFP on the bargaining power of high-skilled workers is positive and significant, in line with the substantial impact of R&D intensity.

6.4 Conclusions

In this section a two-step procedure has been proposed to estimate the impact of international trade and other potential determinants on union bargaining power, for a panel of five EU countries in the period 1994-1998. The procedure permits to estimate simultaneously the bargaining power and preferences of unions with respect to wages and work effort, as well as to assess the bargaining regime (efficient bargaining, right-to-manage or labour hoarding). In a first step, bargaining power and union preferences are estimated, whereas the bargaining regime is inferred from tests on restrictions. Results suggest that unions are powerful in Germany and France and relatively weak in Italy and the United Kingdom. Overall, unions in the five countries considered show a persistent pattern of wage-oriented behaviour. Given the cross-section nature of the analysis, it is not possibly to say whether this confirms the argument of Gaston (1998) that increased international competition will result in unions becoming more wage-oriented as they will more aggressively bargain for the interests of the median union member, at the expense of the more marginal members.
Employment or working conditions are in general part of the bargaining framework, predominately identified as a labour hoarding framework, with exception of seven out of eleven sectors considered for Germany, for which the results suggest efficient bargaining. The first step estimation indicates that pegging down the risk parameter of unions may bias the results.

A very robust finding of the second step estimation of the determinants of union power is that import penetration, especially from Newly Industrialised Countries, reduced the bargaining power of unions.
Following the proposition derived for a labour hoarding bargaining regime this suggests that, in contrast with the results of the two-step mandated wage regressions, North-South trade actually depressed wages in the panel of the five EU countries considered, whereas employment may actually have increased as a result of falling wages.

Computing bargaining power as in Veugelers (1989), rather than estimating it, provides lower estimates of union power, suggesting a negative bias due to the pegging down of the risk parameter, which as suggested by the first step estimation differs substantially from one (i.e. the value for risk-neutrality).

However, as pointed out by Veugelers (1989) and as supported by studies on union membership it may be important to differentiate between low-skilled and high-skilled workers. The procedure proposed by Veugelers, using sector level data, permits such a distinction, which due to a lack of data on the skill mix at firm level is not feasible within a production function estimation of union power.

The results for the period 1993-1996 confirm the finding of Veugelers (1989) that the bargaining power of low-skilled workers is higher than the bargaining power of high-skilled workers, in line with previous findings that unions tend to recruit low-skilled workers to a larger extent than high-skilled workers.

Estimation of the determinants of (computed) union bargaining power confirms the significant negative impact of imports competition, especially of Newly Industrialised Countries. This impact seems to be higher for low-skilled workers. This would, within a labour hoarding regime, support increased wage inequality, as also found by OECD (2003 a) in the European Union in the 1990s, especially, considering the panel of five EU countries, for Germany and Italy.

Appendix 1: Efficient Bargaining

In order to determine the wage and employment effect of increased imports within an efficient bargaining framework, (6.8) and (6.9) are differentiated with respect to y, resulting in the following system of equations:

$$
\begin{cases}
(\gamma-1)\dfrac{dw}{dy} + \dfrac{\partial}{\partial y}\left(\dfrac{\partial R}{\partial l}\right) + \dfrac{\partial^2 R}{\partial l^2}\dfrac{dl}{dy} = 0 \\
-\dfrac{dw}{dy} + (1-k)\dfrac{\partial}{\partial y}\left(\dfrac{\partial R}{\partial l}\right) + (1-k)\dfrac{\partial^2 R}{\partial l^2}\dfrac{dl}{dy} + k\dfrac{\partial}{\partial y}\left(\dfrac{VA}{l}\right) + k\dfrac{\partial}{\partial l}\left(\dfrac{VA}{l}\right)\dfrac{dl}{dy} = 0
\end{cases}
$$

$\Leftrightarrow$

$$
\begin{cases}
(\gamma-1)\dfrac{dw}{dy} + \dfrac{\partial^2 R}{\partial l^2}\dfrac{dl}{dy} = -\dfrac{\partial}{\partial y}\left(\dfrac{\partial R}{\partial l}\right) \\
-\dfrac{dw}{dy} + \left[(1-k)\dfrac{\partial^2 R}{\partial l^2} + k\dfrac{\partial}{\partial l}\left(\dfrac{VA}{l}\right)\right]\dfrac{dl}{dy} = -(1-k)\dfrac{\partial}{\partial y}\left(\dfrac{\partial R}{\partial l}\right) - k\dfrac{\partial}{\partial y}\left(\dfrac{VA}{l}\right)
\end{cases}
$$

$\Leftrightarrow$

$$
\begin{bmatrix}
(\gamma-1) & \dfrac{\partial^2 R}{\partial l^2} \\
-1 & (1-k)\dfrac{\partial^2 R}{\partial l^2} + k\dfrac{\partial}{\partial l}\left(\dfrac{VA}{l}\right)
\end{bmatrix}
\begin{bmatrix}
\dfrac{dw}{dy} \\
\dfrac{dl}{dy}
\end{bmatrix}
=
\begin{bmatrix}
-\dfrac{\partial}{\partial y}\left(\dfrac{\partial R}{\partial l}\right) \\
-(1-k)\dfrac{\partial}{\partial y}\left(\dfrac{\partial R}{\partial l}\right) - k\dfrac{\partial}{\partial y}\left(\dfrac{VA}{l}\right)
\end{bmatrix}
$$

The determinant of the coefficient matrix of this system is:

$$D = (\gamma-1)\left((1-k)\frac{\partial^2 R}{\partial l^2} + k\frac{\partial}{\partial l}\left(\frac{VA}{l}\right)\right) + \frac{\partial^2 R}{\partial l^2} \tag{A1.1}$$

with $k = \dfrac{a\gamma}{(1-a+a\gamma)}$

Assuming:

$$\frac{\partial^2 R}{\partial l^2} \le \frac{\partial}{\partial l}\left(\frac{VA}{l}\right) < 0 \tag{A1.2}$$

it follows that D < 0.

Applying Cramer's rule [Given a system AX = B, if A is invertible the unique solution of the system is given by $x_i = \frac{\det(A_i)}{\det A}$, with x_i the i-th element of vector X. The matrix A_i is obtained by replacing the i-th column of A by B]:

$$\frac{dl}{dy} = \frac{1}{D}\begin{vmatrix} \gamma - 1 & -\frac{\partial}{\partial y}\left(\partial R \big/ \partial l\right) \\ -1 & -(1-k)\frac{\partial}{\partial y}\left(\partial R \big/ \partial l\right) - k\frac{\partial}{\partial y}\left(\frac{VA}{l}\right) \end{vmatrix}$$

$$\frac{dl}{dy} = -\frac{1}{D}\left(\left((\gamma-1)(1-k)+1\right)\frac{\partial}{\partial y}\left(\partial R \big/ \partial l\right) + (\gamma-1)k\frac{\partial}{\partial y}\left(\frac{VA}{l}\right)\right) < 0 \quad \text{given (A1.2)} \qquad \text{(A1.3)}$$

$$\frac{dw}{dy} = \frac{1}{D}\begin{vmatrix} -\frac{\partial}{\partial y}\left(\partial R \big/ \partial l\right) & \frac{\partial^2 R}{\partial l^2} \\ -(1-k)\frac{\partial}{\partial y}\left(\partial R \big/ \partial l\right) - k\frac{\partial}{\partial y}\left(\frac{VA}{l}\right) & (1-k)\frac{\partial^2 R}{\partial l^2} + k\frac{\partial}{\partial l}\left(\frac{VA}{l}\right) \end{vmatrix}$$

$$\frac{dw}{dy} = \frac{k}{D}\left(-\frac{\partial}{\partial l}\left(\frac{VA}{l}\right)\frac{\partial}{\partial y}\left(\partial R \big/ \partial l\right) + \frac{\partial^2 R}{\partial l^2}\frac{\partial}{\partial y}\left(\frac{VA}{l}\right)\right) \qquad \text{(A1.4)}$$

of which the sign is indeterminate.

The wage and employment effects of union bargaining power is obtained by totally differentiating (6.8) and (6.9):

$$\begin{cases} (\gamma-1)\dfrac{dw}{da} + \dfrac{\partial^2 R}{\partial l^2}\dfrac{dl}{da} = 0 \\ -\dfrac{dw}{da} - \dfrac{\partial k}{\partial a}\left(\dfrac{\partial R}{\partial l}\right) + (1-k)\dfrac{\partial^2 R}{\partial l^2}\dfrac{dl}{da} + \dfrac{\partial k}{\partial a}\left(\dfrac{VA}{l}\right) + k\dfrac{\partial}{\partial l}\left(\dfrac{VA}{l}\right)\dfrac{dl}{da} = 0 \end{cases}$$

$\Leftrightarrow$

$$\begin{cases} (\gamma-1)\dfrac{dw}{da} + \dfrac{\partial^2 R}{\partial l^2}\dfrac{dl}{da} = 0 \\ -\dfrac{dw}{da} + \left[(1-k)\dfrac{\partial^2 R}{\partial l^2} + k\dfrac{\partial}{\partial l}\left(\dfrac{VA}{l}\right)\right]\dfrac{dl}{da} = \dfrac{\partial k}{\partial a}\left(\dfrac{\partial R}{\partial l}\right) - \dfrac{\partial k}{\partial a}\left(\dfrac{VA}{l}\right) \end{cases}$$

$\Leftrightarrow$

$$\begin{bmatrix} (\gamma-1) & \dfrac{\partial^2 R}{\partial l^2} \\ -1 & (1-k)\dfrac{\partial^2 R}{\partial l^2} + k\dfrac{\partial}{\partial l}\left(\dfrac{VA}{l}\right) \end{bmatrix} \begin{bmatrix} \dfrac{dw}{da} \\ \dfrac{dl}{da} \end{bmatrix} = \begin{bmatrix} 0 \\ \dfrac{\partial k}{\partial a}\left(\dfrac{\partial R}{\partial l}\right) - \dfrac{\partial k}{\partial a}\left(\dfrac{VA}{l}\right) \end{bmatrix}$$

Applying Cramer's Rule:

$$\frac{dl}{da} = \frac{1}{D}\begin{vmatrix} \gamma-1 & 0 \\ -1 & \dfrac{\partial k}{\partial a}\left(\dfrac{\partial R}{\partial l}\right) - \dfrac{\partial k}{\partial a}\left(\dfrac{VA}{l}\right) \end{vmatrix}$$

$$\frac{dl}{da} = \frac{1}{D}\left(\partial R/\partial l - \frac{VA}{l}\right)\frac{\partial k}{\partial a}(\gamma-1) \qquad \text{(A1.5)}$$

and

$$\frac{dw}{da} = \frac{1}{D}\begin{vmatrix} 0 & \dfrac{\partial^2 R}{\partial l^2} \\ \dfrac{\partial k}{\partial a}\left(\dfrac{\partial R}{\partial l}\right) - \dfrac{\partial k}{\partial a}\left(\dfrac{VA}{l}\right) & \left[(1-k)\dfrac{\partial^2 R}{\partial l^2} + k\dfrac{\partial}{\partial l}\left(\dfrac{VA}{l}\right)\right] \end{vmatrix}$$

$$\frac{dw}{da} = -\frac{1}{D}\left(\partial R/\partial l - \frac{VA}{l}\right)\frac{\partial k}{\partial a}\frac{\partial^2 R}{\partial l^2}. \qquad \text{(A1.6)}$$

Since $\frac{\partial k}{\partial a} > 0$ and $\frac{VA}{l} > \frac{\partial R}{\partial l}$ (from (6.9), i.e. the fact that the wage in efficient bargaining exceeds the marginal labour revenue) the sign of the last expression is always positive. An increase in union bargaining power results in a higher wage level. However, the output and employment implications of an increase of bargaining power depend on the preference structure of the union: $\gamma < 1$ ($\gamma > 1$) implies $\frac{dl}{da} < 0 \left(\frac{dl}{da} > 0 \right)$. Hence, an increase in the bargaining power of a wage- (employment-) oriented union implies a fall (an increase) in output and employment.

Appendix 2: Labour Hoarding

The impact of increased imports on wages and overhead employment, within a labour hoarding framework, is derived from (6.15) and (6.17). The latter can be simplified using (6.16):

$$\frac{l_O}{l_P} = \frac{a\gamma}{(1-a+a\gamma)}\left(\frac{VA}{wl_P}-1\right) + \frac{(1-a)}{(1-a+a\gamma)}\frac{\overline{l_O}}{l_P}$$

Taking the differential with respect to y:

$$\begin{cases} \frac{1}{l_P}\frac{\partial l_O}{\partial y} - \frac{l_O}{l_p^2}\frac{dl_P}{dy} - \frac{k}{(wl_P)^2}\left(wl_P\frac{\partial VA}{\partial y} - VAl_P\frac{\partial w}{\partial y} - VAw\frac{dl_P}{dy}\right) = 0 \\ \left(w(\gamma-1)-\gamma\overline{w}\right)\frac{\partial l_O}{\partial y} + \left((\gamma-1)\frac{l_O}{l_P} + \gamma + \frac{\overline{l_O}}{l_P}\right)\frac{\partial w}{\partial y} - \frac{l_O}{l_p^2}\left(w(\gamma-1)-\gamma\overline{w}\right)\frac{dl_P}{dy} = 0 \end{cases}$$

$\Leftrightarrow$

$$\begin{cases} \frac{1}{l_P}\frac{\partial l_O}{\partial y} - \frac{l_O}{l_p^2}\left(\left.\frac{\partial l_P}{\partial y}\right|_{w=ct} + \frac{\partial l_P}{\partial w}\frac{\partial w}{\partial y}\right) - \frac{k}{(wl_P)^2}\left(wl_P\frac{\partial VA}{\partial y} - VAl_P\frac{\partial w}{\partial y} - VAw\left(\left.\frac{\partial l_P}{\partial y}\right|_{w=ct} + \frac{\partial l_P}{\partial w}\frac{\partial w}{\partial y}\right)\right) = 0 \\ \left(w(\gamma-1)-\gamma\overline{w}\right)\frac{\partial l_O}{\partial y} + \left((\gamma-1)\frac{l_O}{l_P} + \gamma + \frac{\overline{l_O}}{l_P}\right)\frac{\partial w}{\partial y} - \frac{l_O}{l_p^2}\left(w(\gamma-1)-\gamma\overline{w}\right)\left(\left.\frac{\partial l_P}{\partial y}\right|_{w=ct} + \frac{\partial l_P}{\partial w}\frac{\partial w}{\partial y}\right) = 0 \end{cases}$$

$\Leftrightarrow$

$$\begin{cases} \frac{1}{l_P}\frac{\partial l_O}{\partial y} + \left(\frac{kVA}{w^2 l_P} + \frac{kVA}{wl_P^{\,2}}\frac{\partial l_P}{\partial w} - \frac{l_O}{l_{P^2}}\frac{\partial l_P}{\partial w}\right)\frac{\partial w}{\partial y} = \frac{l_O}{l_{P^2}}\left.\frac{\partial l_P}{\partial y}\right|_{w=ct} + \frac{k}{wl_P}\frac{\partial VA}{\partial y} - \frac{kVA}{wl_P^{\,2}}\left.\frac{\partial l_P}{\partial y}\right|_{w=ct} \\ \left(w(\gamma-1)-\gamma\overline{w}\right)\frac{\partial l_O}{\partial y} + \left((\gamma-1)\frac{l_O}{l_P} + \gamma + \frac{\overline{l_O}}{l_P} - \frac{l_O}{l_P^{\,2}}\left(w(\gamma-1)-\gamma\overline{w}\right)\frac{\partial l_P}{\partial w}\right)\frac{\partial w}{\partial y} = \frac{l_O}{l_P^{\,2}}\left(w(\gamma-1)-\gamma\overline{w}\right)\left.\frac{\partial l_P}{\partial y}\right|_{w=ct} \end{cases}$$

(A 2.1)

Where as before $k = \frac{a\gamma}{(1-a+a\gamma)}$.

As $\frac{dl_P}{dy} = \left.\frac{\partial l_P}{\partial y}\right|_{w=ct} + \frac{\partial l_P}{\partial w}\frac{\partial w}{\partial y}$

The system can be rearranged:

$$\begin{cases} K_1 \dfrac{\partial l_O}{\partial y} + K_2 \dfrac{\partial w}{\partial y} = T_1 \\ K_3 \dfrac{\partial l_O}{\partial y} + K_4 \dfrac{\partial w}{\partial y} = T_2 \end{cases} \quad \text{(A 2.2)}$$

with:

$$K_1 = \frac{1}{l_P} \quad \text{(A 2.3)}$$

$$K_2 = \frac{kVA}{w^2 l_P} + \frac{kVA}{w l_P{}^2}\frac{\partial l_P}{\partial w} - \frac{l_O}{l_{P^2}}\frac{\partial l_P}{\partial w} \quad \text{(A 2.4)}$$

$$K_3 = w(\gamma - 1) - \gamma \overline{w} \quad \text{(A 2.5)}$$

$$K_4 = (\gamma - 1)\frac{l_O}{l_P} + \gamma + \frac{\overline{l_O}}{l_P} - \frac{l_O}{l_P{}^2}\left(w(\gamma-1) - \gamma\overline{w}\right)\frac{\partial l_P}{\partial w} \quad \text{(A 2.6)}$$

$$T_1 = \frac{l_O}{l_{P^2}}\frac{\partial l_P}{\partial y}\bigg|_{w=ct} + \frac{k}{w l_P}\frac{\partial VA}{\partial y} - \frac{kVA}{w l_P{}^2}\frac{\partial l_P}{\partial y}\bigg|_{w=ct} \quad \text{(A 2.7)}$$

$$T_2 = \frac{l_O}{l_P{}^2}\left(w(\gamma-1) - \gamma\overline{w}\right)\frac{\partial l_P}{\partial y}\bigg|_{w=ct} \quad \text{(A 2.8)}$$

Regarding the signs:

- $K_1 > 0$
- Multiply K_2 by w/l_p: $\dfrac{wkVA}{w^2 l_p^2} + \dfrac{kVA}{w l_p{}^2}\dfrac{\partial l_P}{\partial w}\dfrac{w}{l_p} - \dfrac{l_O}{l_{P^2}}\dfrac{\partial l_P}{\partial w}\dfrac{w}{l_p} = \dfrac{kVA}{w l_p^2} + \dfrac{kVA}{w l_p^2}\varepsilon_{l_p,w} - \dfrac{l_O}{l_{P^2}}\varepsilon_{l_p,w}$

Given $\varepsilon_{lp,w} < 0$ the first and the last term are positive and the second is negative. If $\left|\varepsilon_{l_p,w}\right| < 1$ ➔ $K_2 > 0$.

- $K_3 < 0$ if $\gamma < 1$ and of indeterminate sign if $\gamma > 1$.

- $K_4 > 0$ as the sum of the first three terms is positive (from (6.15) and the fact that the wage is a positive mark-up of the outside option), and the last term is of a lower order compared to the two positive terms γ and $\dfrac{\overline{l_O}}{l_P}$ (like the first negative term).
- $T_1 < 0$, since $\dfrac{\partial VA}{\partial y} < 0$, $\dfrac{\partial l_P}{\partial y}\bigg|_{w=ct} < 0$ and assuming $\dfrac{\partial}{\partial y}\left(\dfrac{VA}{l_P}\right)\bigg|_{w=ct} < 0$ i.e. profits per (productive) worker that fall from an increase in import competition (at constant

wages). Assume $\left.\frac{\partial}{\partial y}\left(\frac{VA}{l_P}\right)\right|_{w=ct} < 0$ ➔ $\left.\frac{\partial \mathrm{VA}}{\partial \mathrm{y}}\frac{1}{\mathrm{l_p}}\right|_{\mathrm{w=ct}} - \left.\frac{\partial \mathrm{l_p}}{\partial \mathrm{y}}\frac{\mathrm{VA}}{\mathrm{l_p^2}}\right|_{\mathrm{w=ct}} < 0$. Since $\frac{\partial VA}{\partial y}<0$, $\left.\frac{\partial l_P}{\partial y}\right|_{w=ct} < 0$ ➔ $T_1 < 0$.

- From $\left.\frac{\partial l_P}{\partial y}\right|_{w=ct} < 0$ it follows that $T_2 > 0$ if $\gamma < 1$ and of indeterminate sign if $\gamma > 1$

The matrix notation of (A 2.2) is:

$$\begin{pmatrix} K_1 & K_2 \\ K_3 & K_4 \end{pmatrix}\begin{pmatrix} \frac{\partial l_o}{\partial a} \\ \frac{\partial w}{\partial a} \end{pmatrix} = \begin{pmatrix} T_1 \\ T_2 \end{pmatrix}$$

The determinant of the coefficient matrix:

$$D = K_1K_4 - K_2K_3$$

is positive if $\gamma < 1$ and of indeterminate sign if $\gamma > 1$. Applying Cramer's rule, it follows that:

$$\frac{\partial l_o}{\partial y} = \frac{1}{D}\begin{vmatrix} T_1 & K_2 \\ T_2 & K_4 \end{vmatrix} = \frac{1}{D}\left(T_1K_4 - T_2K_2\right) < 0, \quad \gamma < 1$$
$$\frac{\partial w}{\partial y} = \frac{1}{D}\begin{vmatrix} K_1 & T_1 \\ K_3 & T_2 \end{vmatrix} = \frac{1}{D}\left(K_1T_2 - K_3T_1\right).$$

Since $K_1T_2 > 0$ and $K_3T_1 > 0$ (if $\gamma < 1$), $\frac{\partial w}{\partial y}$ can either be positive and negative. The sign of D, K_3 and T_2 is ambiguous when $\gamma > 1$, hence the sign of $\frac{\partial l_O}{\partial y}$ and $\frac{\partial w}{\partial y}$ cannot be determined in that situation.

Proceeding analogously as regards the differential of the system with respect to a, we obtain:

$$K_1\frac{\partial l_O}{\partial a} + K_2\frac{\partial w}{\partial a} = T_1'$$
$$K_3\frac{\partial l_O}{\partial a} + K_4\frac{\partial w}{\partial a} = 0 \qquad \text{(A 2.9)}$$

where:

$$T_1' = \left(\left(\frac{VA}{wl_P} - 1 \right) - \frac{\overline{l_O}}{l_P} \right) \frac{\partial k}{\partial a} \qquad \text{(A 2.10)}$$

given that $\frac{\partial l_P}{\partial a} = \frac{\partial l_P}{\partial w} \frac{\partial w}{\partial a}$

Given $\frac{\partial \mathrm{k}}{\partial \mathrm{a}} > 0$ it follows from (6.17) that *$T_1' > 0$.*

The sign of the partial derivatives of the two endogenous variables are:

$$\frac{\partial \mathrm{l_o}}{\partial \mathrm{a}} = \frac{1}{\mathrm{D}} \begin{vmatrix} \mathrm{T_1} & \mathrm{K_2} \\ 0 & \mathrm{K_4} \end{vmatrix} = \frac{1}{\mathrm{D}} \left(\mathrm{T_1'K_4} \right) > 0,$$

$$\frac{\partial \mathrm{w}}{\partial \mathrm{a}} = \frac{1}{\mathrm{D}} \begin{vmatrix} \mathrm{K_1} & \mathrm{T_1'} \\ \mathrm{K_{.3}} & 0 \end{vmatrix} = \frac{1}{\mathrm{D}} \left(-\mathrm{T_1'K_3} \right) > 0$$

when $\gamma < 1$ and of ambiguous sign if $\gamma > 1$.

Statistical Appendix

The procedure to correct the standard errors of the coefficients in the second step, of two-step estimations with generated regessands, has already been discussed in the statistical appendix to chapter 4. The derivation in this chapter differs from the standard results, however[58]. The vector of 'observations' in the second step consists of a set of estimated coefficients, each of which is estimated in a separate first step model. Consequently, the associated first step variances need not be homogeneous, a complication that has to be taken into account in the correction of the second step variances.

Moreover, the dimension of the first step estimation (i.e. number of firms in each individual sector respectively) differs from the dimension in the second step (i.e. number of industries).

First step (I.C sets of equations, one for each industry i and country c):

$$W_{j,ic} = X_{j,ic}\ \alpha_{ic} + \delta_{j,ic} \qquad j = 1,...,n_{ic};\ i = 1,...,I;\ c = 1,...,C$$

where n_{ic} is the number of firms in the ith industry of country c.

Second step (one equation, with I.C estimated parameters as the vector of 'observations' of the dependent variable):

$$\alpha^*{}_{ic} = Z_{ic}\beta + \varepsilon_{ic}$$

where given the logit specification:

$$\alpha^*{}_{ic} = \ln\left(\frac{\alpha_{ic}}{1-\alpha_{ic}}\right)$$

The moment conditions to estimate this model are:

$$E\left[g_{ic}\left(X_{ic}, \alpha_{ic}\right)\right] = E\left[X'_{ic}\left(W_{ic} - X_{ic}\alpha_{ic}\right)\right] = 0 \qquad i = 1,...,I;\ c = 1,...,C$$

58 This appendix is borrowed from Dumont, Rayp and Willemé (2004).

$$E\left[h\left(Z,\beta,\hat{\alpha}^*\right)\right]=E\left[Z'\left(\hat{\alpha}^*-Z\beta\right)\right]=0$$

Defining

$$G_\alpha=\begin{bmatrix} E\left[\frac{\partial\, g_{11}\left(X_{11},\alpha_{11}\right)}{\partial\,\alpha_{11}}\right] & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & E\left[\frac{\partial\, g_{IC}\left(X_{IC},\alpha_{IC}\right)}{\partial\,\alpha_{IC}}\right] \end{bmatrix}$$

(assuming independence between sectors and countries implies that G_α is a block-diagonal matrix).

$$H_\alpha=E\left[\frac{\partial\, h\left(Z,\beta,\hat{\alpha}^*\right)}{\partial\,\hat{\alpha}}\right]$$

$$H_\beta=E\left[\frac{\partial\, h\left(Z,\beta,\hat{\alpha}^*\right)}{\partial\,\beta}\right]$$

$$V_{gg}=E\left[g_{ic}\left(X_{ic},\alpha_{ic}\right).g_{ic}\left(X_{ic},\alpha_{ic}\right)\right]$$

$$V_{gh}=E\left[g_{ic}\left(X_{ic},\alpha_{ic}\right).h\left(Z,\beta,\hat{\alpha}^*\right)\right]$$

$$V_{hh}=E\left[h\left(Z,\beta,\hat{\alpha}^*\right).h\left(Z,\beta,\hat{\alpha}^*\right)\right]$$

a consistent estimator of the asymptotic covariance matrix of β is obtained from $F^{-1}\ V\ F^{-1}$' (Hansen 1982):

$$F=\begin{bmatrix} G_\alpha & 0 \\ H_\alpha & H_\beta \end{bmatrix}$$

$$V=\begin{bmatrix} V_{gg} & V_{gh} \\ V_{hg} & V_{hh} \end{bmatrix}$$

The square matrices F and V have been partitioned as in Newey (1984). Applying these results to the present model, assuming independence between residuals from first and second step equations (implying that $V_{gh} = V_{hg} = 0$) yields:

$$F = \begin{bmatrix} -X'_{11}X_{11} & \cdots & 0 & 0 \\ \vdots & \ddots & 0 & \vdots \\ 0 & 0 & -X'_{IC}X_{IC} & 0 \\ & Z'A & & -Z'Z \end{bmatrix}$$

where

$$A = \begin{bmatrix} \dfrac{1}{\alpha_{11}(1-\alpha_{11})} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \dfrac{1}{\alpha_{ic}(1-\alpha_{ic})} \end{bmatrix}$$

$$V = \begin{bmatrix} \sigma^2{}_{\delta_{11}} X'_{11}X_{11} & \cdots & 0 & 0 \\ \vdots & \ddots & 0 & \vdots \\ 0 & 0 & \sigma^2{}_{\delta_{IC}} X'_{IC}X_{IC} & 0 \\ & 0 & & \sigma^2{}_{\varepsilon} Z'Z \end{bmatrix}$$

Inserting the appropriate sub-matrices into F^{-1} V F^{-1}' yields the covariance matrix of the second step regression:

$$\Omega_\beta = (Z'Z)^{-1}\sigma^2{}_\varepsilon + (Z'Z)^{-1} Z' A \left(G_\alpha{}^{-1} V_{gg} \, G_\alpha{}^{-1}\right) AZ (Z'Z)^{-1}$$

The first term in this expression is simply the estimated covariance of the second step (i.e. the conditional covariance) while the second term is the additional variance introduced as a result of the inherent uncertainty of the first step estimator.

7. General Conclusions

"*There's always free cheddar in a mousetrap*"

-**Tom Waits** *God's away on business*.

7.1 Deterioration of the Labour Market Position of Low-Skilled Workers

Most studies on the labour market impact of trade with Newly Industrialised Countries (NIC) focused on the United States where in the 1980s the position of low-skilled workers started to deteriorate dramatically, both in terms of rising wage inequality and decreased relative employment.

For the European Union the evidence is mixed. Whereas in some EU countries (e.g. United Kingdom) wage inequality increased substantially and in some EU countries (e.g. Germany) relative employment of low-skilled workers dropped considerably, a joint decrease in relative wages and employment does not seem to have occurred in the European Union. Stylised facts for the European Union clearly reveal the heterogeneity within the European Union. Both asymmetric shocks and asymmetric effects of common shocks (e.g. due to institutional differences) should be accounted for.

The fact that imports from NIC, especially from the Asian Tigers and Pussycats, swelled up at about the same time did not go unnoticed and international trade was soon rounded up as a usual suspect for the deteriorated labour market position of low-skilled workers.

The public prosecutor could invoke the Stolper-Samuelson theorem, i.e. one of the four core theorems of the textbook Heckscher-Ohlin model, predicting that if a high-skill abundant country opens up to trade with a relatively more low-skill abundant country, the wages of its low-skilled workers (being relatively scarce) are likely to fall as a result of a fall in the relative price of low-skill intensive goods.

The Stolper-Samuelson theorem makes it clear that even though countries may mutually derive net gains from international trade, trade liberalisation is not neutral in terms of income distribution.

Free trade advocates took up the defence of international trade, pointing out the rather strict assumptions underlying the Heckscher-Ohlin framework. Relative factor endowment in

developed countries and NIC can diverge to the extent that both fully specialize in different goods. If so, there would be no competition and free trade would create a tide that lifts all boats, i.e. benefit everyone everywhere. Early empirical work did not seem to provide much evidence that Stolper-Samuelson effects played a substantial role in labour market developments in high-skill abundant countries and skill-biased technological change was increasingly considered as a more likely culprit.
This was pretty much the consensus view in the mid-1990s.

However, in the second half of the 1990s a number of prominent economists started to question this consensus and argued that international trade might have been exonerated too soon.
Some fundamental limitations in previous empirical work, providing circumstantial rather than decisive evidence, were exposed. New empirical methodologies with a closer link to the Stolper-Samuelson theorem were proposed (e.g. the mandated wage regression procedure) and some non-Heckscher-Ohlin mechanisms were considered that allowed for an impact of international trade on wages and employment, irrespective of the changes in relative product prices or the fall in skill intensity predicted by the Heckscher-Ohlin model.

Moreover, the previous apparent dichotomy between international trade and technological change was abandoned for a more realistic analysis accounting for the interlinkage.

Although in some recent estimations indications were found of more considerable labour market effects of North-South trade, with very few exceptions these studies did not provide evidence that international trade has been a dominant explanation for changes in the wages and employment of low-skilled workers. Other factors like exogenous technological change but also, if not predominately, institutional characteristics clearly come into play.

Differences in labour market institutions are often brought forward to explain the diverging labour market performance of a *moneyless* jobs United States and a *jobless* money Europe. Though some degree of trade-off between equity and efficiency seems likely to exist, the evidence is not overwhelming. On the one hand, some economists claim that in most EU countries labour markets are more flexible than generally believed and on the other hand a number of scholars even argue that some labour market rigidities could be beneficial.
However, if labour markets in the European Union are indeed less flexible than in the United States, international trade could affect employment rather than wages and theoretical models

and empirical estimations accounting for imperfect labour markets are probably more appropriate than perfect competition models like the Heckscher-Ohlin framework.
As most of the empirical work considered the United States and for Europe studies mostly only cover a single country, conclusions cannot simply be carried over to the whole European Union, given the substantial (intra-EU) differences in trade flows, specialisation patterns, country size and labour market institutions.

7.2 Data Issues

In this thesis, after reporting, in chapter 2, some stylised facts with respect to wages, employment and international trade and reviewing the theoretical and empirical literature in chapter 3, I reported the results of own estimations carried out for a panel of EU countries, covering the 1980s and 1990s.

Cuyvers, Dumont, Rayp, Stevens and Van den Bulcke (2001 a) constructed a panel of EU countries to estimate the impact of trade with Newly Industrialised Countries on wages and employment in the European Union. The work was instructed by the European Commission to provide information on the possible labour market impact of the further anlargement of the European Union, in preparation to the accession of new member states.

The distinction between high-skilled and low-skilled workers was considered as an important issue, which posed an additional data problem as information broken down by skill level is not readily available.
The division operatives/ non-operatives or manuals/ non-manuals was used to proxy low-skilled/ high-skilled workers as the intrinsically more accurate Labour Force Survey data by occupation only provided information on employment from 1993 onwards and no data on wages. Moreover the reliability of the data can be questioned.
If anything, the availability and quality of data with respect to different skill or educational categories for EU countries appears to be deteriorating, which is problematic for future empirical research and research-based policies.

Gathering comparable data on as many EU countries as possible and for a sufficiently large time period turned out to be a real ordeal. Different data sources had to be used, missing values had to be intra- or extrapolated when necessary and structural breaks, due to different data

sources for different years, had to be smoothed. Even then, some EU countries could not be considered, given a lack of sufficient data.
Eventually, a panel of the following ten countries was constructed for the period 1985-1998: Belgium, Denmark, Finland, France, Germany, Italy, Portugal, Spain, Sweden and the United Kingdom.
For each country, the data cover twelve ISIC manufacturing industries. The two-digit level, except for *Manufacture of Fabricated Metal Products, Machinery and Equipment* (ISIC 38) which is considered at the three-digit level, is rather high and undoubtedly conceals substantial intra-industry heterogeneity but the data did not allow for a more detailed level of aggregation for most EU countries.

At the end of the review of the literature, I argued for the use of some specific methodologies for the empirical assessment of the labour market impact of trade with the NIC.
The main premise for own empirical work was a distinct preference for multiple panel data regressions as they allow to test, within a well-defined theoretical framework, a number of hypotheses.
Panel data estimations provide a convenient way to estimate effects for a group of countries, accounting and testing for the degree of cross-country heterogeneity.
Heterogeneity could be captured by country-specific intercepts, reflecting e.g. institutional differences, allowing for common slope effects across countries. If heterogeneity were more substantial, the hypothesis of common slopes would be rejected.
In addition to possible intra-EU heterogeneity, trade partners are classified into distinct groups of countries, assumed to be relatively homogenous in terms of relative factor endowment, technological level and geographical location. With respect to the Newly Industrialised Countries, (South-) East Asian countries, transition countries from Central and Eastern Europe and Latin American emerging economies are distinguished as separate NIC groups.

7.3 Results of the Two-Step Mandated Wage Regressions

In chapter 4, I discussed the results of two-step mandated wage regressions. The mandated wage regression procedure, proposed by Leamer (1996 a) and further elaborated by Feenstra and

Hanson (1999) and Haskel and Slaughter (2001), is as closely linked to the *correlation version* of the Stolper-Samuelson theorem (i.e. the version that applies to a model with many factors and many goods) as possible. In addition, the procedure permits to disentangle the impact of international trade from the impact of factor-augmenting technological change, which is the main alternative explanation put forward to explain rising wage inequality. Trade-induced technological change, i.e. the indirect impact of international trade pointed out by Wood (1994), can also be accounted for.

Contrary to previous mandated wage estimations, import-weighted foreign R&D stocks have been computed to consider trade-related international R&D spillovers.

Grossman and Helpman (1991) argued that international trade is an important spillover mechanism. In their theoretical model the outcome of technology and trade policies depends on whether spillovers are global or local in scope.

Coe and Helpman (1995) found indications of significant import-related R&D spillovers between OECD countries and Coe, Helpman and Hoffmaister (1995) found evidence of significant North-South R&D spillovers.

North-South spillovers may permit developing countries to close the technology gap, whereas North-North spillovers support technological activities in the developed countries.

In the first step of the mandated wage estimation, changes in domestic product prices and total factor productivity (proxy for technological change) are regressed on a number of external determinants.

I also considered foreign outsourcing, i.e. the fragmentation of the production process and the contracting out of labour-intensive fragments to low-wage countries. Many perceive foreign outsourcing as an increasingly important phenomenon of nowadays globalisation.

In the second step of the mandated wage estimation, the respective contributions of the external determinants, estimated in the first step, are regressed on the shares of the production factors (low-skilled and high-skilled labour). The estimated coefficients of the factor shares can then be considered as the changes in the rewards of the respective factor, *mandated* by the changes in the given external determinant, in order for the long-run perfect competition zero profits condition to hold.

As the dependent variables in the second step are *generated* rather than *true* variables, the standard errors of the second step estimates have to be corrected for additional variance.

Dumont, Rayp, Thas and Willemé (2003) have shown that the correction procedure proposed by Feenstra and Hanson (1997), as applied by Feenstra and Hanson (1999) and Haskel and

Slaughter (2001, 2002), suffers from a negative bias, to the extent that the procedure does not guarantee positive variances. They proposed an *unbiased* correction procedure that guarantees positive variances. This procedure has been applied.

None of the alternative mandated wage regressions for the panel of EU countries provides strong evidence in favour of Stolper-Samuelson effects.

In line with previous estimations, international R&D spillovers are found to be significant.

There are some indications that import competition of the Asian Tigers induced skill-biased technological change but this finding is not very robust.

7.4 Sticky Wages and Labour Demand Elasticity

The assumption of perfectly competitive labour markets is essential for the Stolper-Samuelson theorem to hold. Within the Heckscher-Ohlin model, full employment of all production factors is assumed. Factor rewards are flexible and therefore absorb the impact of international trade. If wages are however to some extent sticky, as they probably are in most countries, changes in relative factor demand could imply unemployment of some production factors.

Blanchflower, Oswald and Sanfey (1992) showed that even for the United States the assumption that wages are fully flexible is not supported by the data.

Given the general perception that labour markets are relatively rigid in most EU countries, e.g. due to minimum wages, collective bargaining and unemployment benefits, Krugman (1995 b) proposed a *European* model that accounts for downward wage rigidity. International trade will affect employment, i.e. induce unemployment of the relatively scarce factor.

In chapter 5, relaxing the Heckscher-Ohlin assumption of perfect labour market competition, extended flexible cost functions are used to derive the demand for production factors and to assess the impact of external determinants on factor demand.

Flexible cost functions impose as little restrictions (e.g. returns to scale, substitution between factors) as possible. The translog (TL) and the generalized Leontief (GL) functions, second-order Taylor expansions of respectively a Cobb-Douglas and a Leontief specification, are the two most popular flexible cost functions.

Morrison and Siegel (1997) proposed an extension of a generalized Leontief cost function, incorporating external determinants that could affect the demand for production factors.

The demand for production factors and the elasticity of factor demand with respect to the external determinants can rather straightforwardly be derived from a GL cost function.

Considering variables reflecting import competition permits to estimate the impact of international trade on the demand for low-skilled and high-skilled workers.
Estimation of factor demand elasticity for a panel of ten EU countries, within an extended GL cost function framework, provides results that are generally in line with prior expectations. Import competition of OECD countries with similar or higher relative skill endowment seems to have decreased the relative demand for high-skilled workers in most of the twelve manufacturing industries considered. Imports from the group of Southern EU countries (Greece, Portugal and Spain) apparently decreased overall demand for labour in the period 1985-1996, i.e. the period of their integration into the European Union.
These results suggest that the relative catch-up of Portugal and Spain could partially have been due to a demand shift in favour of these countries.
Import competition from the NIC increased the relative demand for high-skilled workers in most sectors and significantly decreased absolute demand for low-skilled workers in some sectors (e.g. *textiles, footwear and leather*).
These results seem in line with the predictions of a sticky wage model. However, overall the demand for production factors does not appear to have fallen more spectacularly in some sectors than in others. The fact that changes appear to occur as much within as between industries but that these changes can be explained by international trade rather than by technological factors provides some evidence for foreign outsourcing models, which predict substantial within-industry changes though the high level of industry aggregation undoubtedly conceals intra-industry heterogeneity.

Aggregating the estimated changes in factor demand over twelve manufacturing industries provides an estimate of a 3.6 percent fall in the relative demand for low-skilled workers in the European Union in the period 1985-1996, as a result of trade with Newly Industrialised Countries.

Barnett (1985) and Barnett, Lee and Wolfe (1985) showed that the translog and the generalized Leontief cost function are, contrary to the general belief, not very flexible and rather often violate regularity conditions. The translog cost function has good regional properties if the elasticity of substitution is close to one and the generalized Leontief cost function if the elasticity of substitution is close to zero. As shown by Caves and Christensen (1980) the performance of both functional forms deteriorates rapidly as elasticity moves away from respectively one and zero.

Barnett, Lee and Wolfe (1985) have proposed Laurent minflex translog and generalized Leontief functional forms, which use second-order Laurent expansions rather than second-order Taylor expansions of respectively a Cobb-Douglas and a Leontief function. Monte Carlo simulations show the superior quality, especially when using time series, of these Laurent specifications.

I have considered an extended Laurent minflex generalized Leontief (LGL) cost function to estimate the elasticity of factor demand with respect to international trade variables and compared the results with the estimates of a traditional GL specification. So-called J-tests, proposed by Davidson and MacKinnon (1981), permit to compare both specifications in terms of goodness of fit.

These tests show that in eight out of twelve industries a LGL is preferred to a traditional GL specification.

Moreover, the estimated elasticities differ considerably between both functional forms, especially with respect to the degree of substitution between the production factors.

There are some indications of capital-skill complementarity and of substitution between low-skilled and high-skilled workers.

The results with respect to the impact of international trade on labour demand seem less sensitive to the functional form and LGL estimations confirm the main conclusions of the GL estimations.

As estimations using the levels of variables could suffer from spurious correlation, i.e. correlation driven by a common underlying trend in the time series rather than by a *true* underlying relationship, I also performed estimations using translog specification in first differences, as Berman, Bound and Griliches (1993) and Feenstra and Hanson (2001).

These estimations provide less significant results, as can be expected, but confirm the negative impact of NIC trade on the demand for low-skilled workers, especially concerning trade with the CEEC and Asian Tigers and Pussycats.

There are some indications that wages are affected as well as employment but the employment effects are more substantial, albeit estimated less accurately.

7.5 International Trade and Union Bargaining Power

Finally, in chapter 6, a bargaining framework is proposed to infer the impact of international trade on wages and employment, accounting for a labour market institution that is often considered to play an important role in EU countries, i.e. collective bargaining.
If unions have some bargaining power due to a monopoly position in representing workers, they can bargain for wages, employment or working conditions. Wages resulting from the bargaining process may exceed the marginal product level and lead firms to employ fewer workers than they would at the efficient wage level. Strong unions are often blamed for the high average unemployment rates in the European Union, due to excessive wages demands. As unions, which recruit low-skilled workers more than high-skilled workers, are found to be successful in confining the skill premium they are especially blamed for the high unemployment rates of low-skilled workers.

Lawrence and Lawrence (1985) were among the first to consider the impact of international trade on union bargaining power. If union power is reduced due to increased import competition this will have an impact on wages and employment.

Lack of data on union bargaining power, a theoretical framework has been proposed that permits to estimate union power and at the same time to test for the bargaining regime (efficient bargaining, right-to-manage or labour hoarding) and the extent of wage-orientation of unions.
The bargaining regime and union preferences are crucial for inferring the effects of changes in union power on wages and employment, as shown in chapter 6.
In addition to an efficient bargaining framework, in which unions and firms are assumed to bargain for wages and employment, a labour hoarding framework is considered. In the latter regime, unions are assumed to bargain for wages and work effort. A number of empirical studies indicate that working conditions are part of the bargaining between employers and employees.

Available firm level data allowed estimation for five EU countries (Belgium, France, Germany, Italy and the United Kingdom) and twelve ISIC manufacturing industries in the period 1994-1998.
The results show that efficient bargaining (EB) and right-to-manage bargaining (RTM) regimes are rejected in favour of a labour hoarding (LH) regime, except for Germany for which in some industries an efficient bargaining regime is favoured over the others. This seems in line with previous overall poor empirical evidence for EB and RTM.

Contrary to most previous studies, union preferences are not pegged down at a given level but are estimated. Results clearly indicate that unions are wage-oriented.

In a second step, the union bargaining power, estimated in the first step for each individual country-sector combination, averaged over the period 1994-1998, is regressed on potential determinants like international trade, industry concentration, capacity utilization and R&D activities.

Import competition of OECD countries and Newly Industrialised Countries had a significant negative impact on union power, with the impact of the NIC group being considerably higher than the impact of the OECD group.

In a labour hoarding regime with wage-oriented unions, i.e. the case supported by the first step estimation, wages will probably fall if union bargaining power drops as a result of increased import competition. Crew size will fall (and thus effort increase) as well, but productive labour could increase, with the latter effect probably dominating the fall in unproductive labour. This seems to imply a trade-off between wages and employment for most countries and industries.

At first thought this finding clashes with the results of the mandated wage regressions, which suggested no significant impact on wages in the European Union.

However, the mandated wage regressions focused on the period 1985-1996, as for the last years of the 1990s necessary data were rather unreliable or not available.

The mandated wage regressions fit within a Heckscher-Ohlin framework, with its assumption of perfectly competitive labour markets, whereas the bargaining framework used in chapter 6 clearly sets off with imperfect labour markets, characterized by labour unions that have some power to bargain for wages, employment and/ or working conditions.

Moreover the estimation of the determinants of union bargaining power cover the period 1994-1998.

As mentioned in chapter 2, OECD (2003 a) found indications of a structural improvement in employment performance in most EU countries, in the late 1990s, in contrast with the sluggish growth in the 1970s and the 1980s, when total labour costs outpaced productivity growth. In the 1990s, labour costs lagged productivity growth. The OECD viewed wage moderation as the main explanation for the improved employment record and also mentioned that wage inequality increased substantially in some EU countries in the 1990s, especially in the United Kingdom. They considered falling union power as a likely explanation for wage moderation and increased wage inequality.

There are also some indications of worsening working conditions (OECD 2003 a: pp. 40-48). These stylised facts seem to fit well with the results for five EU countries in the period 1994-1998, which suggest a fall in wages, an increase in work effort and an increase in productive labour.

As unions are known to represent low-skilled workers more than high-skilled workers, it seems appropriate to distinguish both skill categories.
However, firm level data do not allow for such a distinction.
I have therefore followed the procedure proposed by Veugelers (1989), who computed union bargaining power at industry level, as the difference between the sector wage level and the competitive wage level, proxied by the lowest wage level across industries.
Using wage data for manual and non-manual workers, the bargaining power of both groups was estimated for the period 1993-1996. The bargaining power of low-skilled (manual) workers is, as in Veugelers (1989), found to exceed the bargaining power of high-skilled workers.
In line with the previous estimations, import competition has a significant negative impact on the bargaining power of low-skilled as well as high-skilled workers, with the impact of NIC again being more considerable than the impact of OECD countries. The impact of NIC competition is also higher for low-skilled workers than for high-skilled workers.

7.6 General Results

Overall the results of own empirical work on a panel of EU countries for the 1980s and 1990s, presented in this thesis, confirm the conclusions of previous recent empirical studies on the impact of North-South trade on the position of low-skilled workers in developed countries. Trade with Newly Industrialised Countries had a significant impact. Accounting for the interdependence of trade and technological change provides estimates of an additional (often significant) indirect impact that has been ignored in most of the early studies, resulting in an underestimation of the effects of international trade.
With respect to the European Union, employment seems to have been affected more than wages. This finding is in line with stylised facts, showing that except for the United Kingdom, wage inequality did not rise as dramatically in most EU countries as it did in the United States.

The Stolper-Samuelson theorem, with its assumption of perfect labour market competition, is probably too restrictive a framework to assess the labour market impact of international trade, given the importance of labour unions, minimum wages and unemployment benefits in most EU countries

Labour market institutions and the intra-EU heterogeneity with respect to these institutions should be acknowledged.

However, heterogeneity across EU countries is often captured by the country-specific intercepts in the panel estimations, whereas the hypothesis of common slopes is mostly not rejected, suggesting a relatively similar impact of international trade in the European Union.

In the 1990s there were indications of wage effects, with wage moderation resulting in an improved employment performance in the European Union (OECD 2003 a).

This seems to be confirmed by the results of chapter 6, indicating that international trade reduced the bargaining power of unions in the last half of the 1990s, which given the assessment of the bargaining regime and wage-orientation of unions suggests a fall in wages and an increase in productive labour.

If trade with the Newly Industrialised Countries appears to have had a significant impact, it seems only fair to grant that, even accounting for its indirect impact through technological change, it has not been the dominant explanation for labour market developments in the European Union.

Autonomous technological change, i.e. independent of international trade, undoubtedly played a significant role too. Technology policy and domestic R&D activities are in New Growth theories perceived as important determinants of economic performance and the chances are that most technological activities are not neutral in terms of factor intensity.

Summarizing the results I would like to quote Deardorff (1998 a: p. 24):" "*It seems likely that both trade and technology have contributed to the increased skill differential, both in substantial amounts, with technology probably contributing a bit more than trade. I am sceptical of other causes having contributed to it at all, but my range of uncertainty around each of these statements is very large*".

The range of my uncertainty follows from the fact that despite substantial contributions in terms of new theoretical modelling and empirical methodologies, the question what the exact role of trade with NIC has been in the deteriorated position of low-skilled workers cannot yet be answered conclusively. Especially the interaction between international trade and technological change, both with respect to induced technological change in developed countries and the possible technological catch-up through North-South spillovers in emerging economies has to be scrutinized further. New Growth scholars reason that the gains from international trade are probably more ambiguous than in traditional trade theories and that the rationale of trade and technology policies depends on the scope of knowledge spillovers.

However, in my view there is far more need for qualitative and internationally comparable data for a further assessment of this issue than there is for more theoretical modelling, though both are obviously not substitutes.

Finding that with respect to data for EU countries, especially data broken down by skill or educational category, quality and comparability seems to be deteriorating, does not make hopes running high.

The fact that international trade with NIC so far did not have a dominant impact on labour markets in developed countries does not imply that it may not in the future, if countries with large supplies of workers- eager to learn and eager to earn- like China, India and some of the new EU member states further integrate in the world markets and would succeed in closing the technology gap.

The relatively small share of manufacturing industries in most industrialised economies is often evoked to downplay the impact of international trade on developed economies as the services sector is mostly viewed as a non-tradables sector, a view that seems at odds with the reported outsourcing of many services (administrative work, call centres, software development) to low-wage countries and the perceived relevance of a General Agreement of Trade in Services (GATS).

A further reduction of trade barriers in services is negotiated in the recent WTO Development Round and could spread the range for trade competition.

The rising of some Newly Industrialised Countries could severely pressure the social benefit system of countries with an ageing population, in addition to the fact that footloose capital increasingly slips from the tax base in most nation states, though the economic growth of the Newly Industrialised Countries obviously offers trade opportunities for the industrialised countries as well.

7.7 Does the Cause matter for the Cure, does the Cure affect the Cause?

Deardorff (1998 c, 1999) wondered whether knowing that the main cause of rising income inequality has been international trade or skill-biased technological change really matters for the appropriate policy response to increasing income inequality. He gathers it doesn't matter.
As most (trade) economists he did not consider restricting international trade as a reasonable policy instrument to reduce income inequality, irrespective of the impact trade has (had) on income distribution. He argued that taxing imports of low-skill intensive goods has the same effect on production as taxing high-skilled workers and subsidising low-skilled workers or taxing high-skill intensive production and subsidising low-skill intensive production, but in addition distorts demand.
Production taxes are less optimal than taxes on production factors as they, in addition to affecting relative wages and factor supply, reduce the output of the most valuable goods.
Deardorff showed that the optimal policy to cure rising income inequality probably does not depend on the cause of the rise, be it international trade or skill-biased technological change.

Chusseau (2002) pointed out that a policy to increase the average educational level of workers, forges the objectives of full employment, modest wage inequality and rapid technological progress but takes at least 10 to 20 years to pay off. Imposing minimum wages has a more direct impact. Minimum wages could rather quickly increase R&D activities and thereby long-term economic growth, although there may be a temporary increase in the unemployment rate of workers with a low level of education.
However, in the model she proposed, subsidising researchers to confine the cost of R&D activities and redistributing part of the gains to low-skilled workers is superior to a minimum wage policy (Chusseau 2002: p. 266).

Cline (1997) viewed tax credits and loans for higher education as a way to increase the relative supply of high-skilled workers. This relative supply apparently increased in the United States since the 1960s. However, whereas in the 1960s and 1970s this increase resulted in a declining skill premium as the outward shift in demand was smaller than the increase in supply, in the 1980s and the 1990s the increase in the relative demand exceeded the increase in the relative supply, explaining the dramatic rising income inequality in the United States.
Cline also pleaded to consider a policy shift in US immigration policy, focusing on the attraction of high-skilled immigrants. Coppel, Dumont and Visco (2001) raised the difficulty to fine-tune the skill level of migration flows.

Looking at the relative mismatch between labour supply and vacancies in most EU countries, there is an apparent need for education and training.
Some might wonder whether the unrestrained free choice of education is tenable, knowing that many EU countries witness a substantial shortage of engineers and scientists whereas psychology, criminology and political sciences classes are deluged.
Obviously there are limits to an education and training policy. It seems improbable (not to mention undesirable) to turn every 18-year old into a rocket engineer or to convert every 50-year old laid-off shift worker into a tax lawyer.

Deardorff (1999) argued that policies that attempt to reduce the skill premium could affect the relative labour supply if the incentive of people to acquire skills depends on the skill premium. Acquiring skills implies giving up own time (and money). If someone decides not to pursue higher education he or she could start working and earn a pay right away.
If the ability to acquire skills is unevenly distributed among the population, the return to education may be lower for some than for others.
Taxing high-skilled workers and subsidising low-skilled workers could reduce the incentive to acquire skills and as result the relative endowment with high-skilled workers would drop.
Deardorff therefore reasoned that such a policy implies a lower national income than when imposing a non-distorting tax though he subjoined that the latter policy is close to impossible in the real world, in which case taxing and subsidising production factors, production taxes and trade restrictions are, in decreasing order of efficiency, the appropriate policy instruments to reduce income inequality.

Martins and Pereira (2004) found evidence for 16 developed countries in the mid-1990s that the returns to schooling are higher for high-skilled persons than for low-skilled workers. Within the group of high-skilled workers wage inequality is substantial. The authors believe that this could reflect over-education, i.e. high-skilled persons taking a job that does not require many skills, and warn that a policy aiming to reduce wage inequality by simply investing in increasing higher schooling levels will not necessarily be successful as even if all workers would be high-skilled wage inequality could be considerable.

Cline (1997) believed that cuts in social charges for low-skilled workers, especially when financed by environmental levies, could improve job creation in the European Union but warned to think twice before dismantling a social system and wage policies that in his view have been instrumental in a growth of total wage receipts in the European Union that exceeded the growth in the United States, despite the fact that labour supply increased more in the United States than in Europe.

All said and done, I hope this thesis has been a meaningful contribution to the empirical assessment of trade with Newly Industrialised Countries on wages and employment of low-skilled and high-skilled workers in the European Union.

I think it would be unfair to consider international trade as the villain portrayed by some public prosecutors. By and large, empirical evidence shows that if international trade has had a significant role in labour market developments it has not been the dominant determinant. Globalisation is a *mot du jour* that is all too often used by many national policy-makers to shake off own responsibilities.

Though economic integration obviously complicates the formulation of sound policies, in my view, domestic institutions and domestic policies are still the dominant determinants of the economic performance of countries.

If the increase in real wages should preferably not exceed productivity growth and wage moderation is important vis-à-vis a country's main trade partners, I believe the obsession with wages and labour costs is for the greater part beside the mark in the debate on the impact of North-South economic integration. The Factor Price Equalization theorem is by far the unworldliest theorem of the Heckscher-Ohlin framework. Differences in wages across countries can be sustained due to differences in technological (productivity) level. In endogenous growth theories, contrary to the neoclassical growth theory, hysteresis effects are accounted for, which can explain why, with few leap-frogging exceptions, developed countries do not seem to succeed in closing the technology gap.

Investment in innovative activities and knowledge creation at large should ensure that in an integrated world economy, job creation in developed countries counterbalances the jobs that are lost due to the comparative advantage of developing countries in labour-intensive activties. Artificially sustaining a comparative advantage by reducing real wages is not necessarily welfare-improving and could moreover reduce the incentive to innovate.

Judging by the relocation and outsourcing of relatively skill-intensive activities to low-wage countries, maintaining a competitive advantage in skill-intensive activities is not only necessary to ensure well-paid jobs for low-skilled workers but increasingly also to ensure well-paid jobs for all workers, irrespective of their skill level

Maintaining a comparative advantage in high-skill intensive products requires substantial and incessant investment in R&D activities and technological innovation.

As argued by Jaffe (1996) and Dumont and Tsakanikas (2001) policy support for R&D activities should be determined by the size of the spillover gap (difference between private and social benefits) of R&D and not so much by the magnitude of spillovers, as projects with large spillovers as such may very well be projects with large private benefits and thus have a high probability that they will be carried out irrespective of public support.

An assessment of the social benefits of R&D activities and innovation implies that technology and innovation policy should link up with a broader policy view, incorporating issues related to the labour market (e.g. low employment rates of the low-skilled), international trade (dynamic comparative advantage) and the environment.

If I do not view international trade as a villain, I do not consider it as the benefactor portrayed by some free trade advocates either.

When accounting for the endogeneity of technological change or the high unemployment rates in many industrialised countries, the mutual gains from international trade are more ambiguous than suggested by traditional trade theories.

Moreover, trade liberalisation is not neutral. Even **if** the net effect is positive for most countries, the lives and works of many could be affected drastically. Shifts in comparative advantage and specialisation patterns do not occur instantaneously and imply re-orientation and the closing down of factories.

Policy-makers would do well to hear out those that are actually affected by international trade and consider the most effective and efficient policy instruments to distribute the gains from international trade, if they want to promote international trade as a mechanism to reduce poverty in developing countries as well as to guard against a dual economy in developed countries.

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