High tech foreign direct investment and its impact on economic development

Marasco, Antonio

Lahore University of Management Sciences

September 2002

High Tech Foreign Direct Investment and its Impact on Economic Development[1]

Antonio Marasco
Lahore University of Management Sciences (LUMS)[2]

Abstract

Recent empirical studies concerning the impact of foreign direct investment (FDI) on economic development have all been taking into account FDI as a whole. However, the theoretical literature on the topic argues that more attention should be devoted to distinguishing FDI by type, and suggests that FDI with high technological content might play a peculiar role. This paper investigates the existence and the magnitude of this peculiar effect. With reference to developing countries, we find strong evidence that countries with a larger population and a larger stock of human capital, and countries that enjoy lesser uncertainty, are able to attract more FDI with a higher technological content. We also find evidence pointing towards a positive relationship between the share of technology embodied into FDI and the level of economic development in the host country.

JEL classification: C31, F21, O14, O33, O57

Keywords: Cross-section regression; Foreign direct investment; High tech; Manufacturing; Human capital; Development

[2] E-mail address for correspondence: antonio@lums.edu.pk

1 Introduction

Among the many economic items that routinely attract the attention of both policy makers and scholars across the world, one in particular has been studied with special intensity recently, for its alleged role as a propellent of economic development and growth. This item is Foreign Direct Investment (henceforth FDI).[3] Among the many issues that have been raised regarding FDI, two are of interest here: first, and foremost, is FDI a good or a bad thing for the economy of the host country, and then, quite naturally, given that even though with much controversy, many believe FDI to be a good thing, what are the factors that cause FDI.

To date, a large number of empirical studies have been carried out to shed some light on these issues, but, as it is so often the case with empirical research, its boundaries are being set by the limitations in the availability of data that are required to study the particular variable concerned. In the case of FDI, the area that those boundaries define, and that lends itself to being investigated, is of pretty limited size. This is because countries, particularly those in the developing world, have only recently, in some cases very recently or not at all, started keeping records of FDI, as the latter becomes more widely recognized to be a quantity of crucial interest from social, economic and policy making standpoints.

It is probably because of these data limitations that a startling discrepancy has appeared between the empirical and the theoretical literature on FDI and its effects on the economies of the host countries. On one hand, the literature on FDI has been stressing the heterogeneous nature of FDI's structure, with respect to the economic motivation behind FDI flows to the typology of FDI (Barba-Navarretti and Venables, 2004), to the geographical origin and destination of FDI flows and to the type of technology embodied in the various components that make up FDI (Glass and Saggi, 1998). On the other hand, the empirical literature on FDI has failed so far to fully account for the heterogeneity of FDI when studying the impact of FDI on the economy of host nations (more details in the next section).

Recent work on the economic motivation behind FDI flows, distinguishes between market-seeking FDI and efficiency-seeking FDI. The former is said to occur when firms are attracted by a host's market size or by the size of the host's neighbours' markets. The firm's choice to supply foreign markets by local production rather than by exports, results typically in

[3] For a sample of studies that have devoted their attention to FDI, see next section.

the firm duplicating a subset of its activities in the foreign country, a type of investment that is sometimes referred to as horizontal FDI (HFDI).

Efficiency-seeking FDI tries to exploit lower factor costs in the host nation. This is typically achieved by transferring entire phases of the production process to the low cost country. For this reason, this type of FDI is also referred to as vertical FDI (VFDI)[4]. In the present study we shall not make much of the difference between HFDI and VFDI, partly because until recently the overwhelming proportion of FDI was horizontal rather than vertical, (Although the share of VFDI has been increasing since the early 90s[5]), and partly because, in order to be able to break the data down into horizontal and vertical investment, one would have to work with firm level data that are likely to be available for developed countries only, if at all. By contrast, in this study, as will become clear presently, we are going to work with data at the macro level involving both developed and developing economies. We shall concentrate on the geographical destination of receivers of FDI flows, and on the heterogeneous nature regarding the technology embodied into FDI.

With respect to the heterogeneous types of technologies embodied into FDI, a theoretical literature that belongs to the strand of the new, endogenous growth theories, has come up with models that establish a link between the degree of innovative and imitative activities, widely thought to be crucial for the economic performance of host countries, and the quality of technology that is transferred through FDI (Glass and Saggi, 1998). Because of the data limitations discussed earlier, the empirical literature on FDI and economic growth, of which we shall provide a brief account presently, remains, to the best of our knowledge, totally silent on this topic. Indeed this literature invariably prefers to treat FDI in its entirety, as a scalar to be included in the cross sectional, time series or panel regressions that constitute the backbone of all these empirical studies.

The aim of this study is to fill the gap between the theoretical and empirical literatures, by taking seriously the hints that the former has provided on the importance of distinguishing FDI by type according to the level of technology embodied in it. Our objective is twofold: we would like to show that the positive effect of FDI on the development of the receiving nation pertains peculiarly to the type of FDI which has technology embodied in it. In other words, what

---

4 For a summary on several typologies of FDI according to economic motivation, see the recent, comprehensive book on multinational enterprises (MNEs) by Barba-Navarretti and Venables (2004).

5 The source of this information is again Barba-Navarretti and Venables (2004, Chapter 2, page 11).

we would like to show is that the heterogeneity in the technological content of diverse types of FDI matters. In the process, we shall also look at the possible determinants of high tech FDI flows. We would also like to show that such a positive effect, if it exists, will occur if the receiving country is in the developing world. As a motivation, we argue that, because of the lack of significant RnD expenditures and consequent innovative activities in developing countries, transfers of technology through FDI may be a particularly important mode of getting these countries nearer to the technology frontier.

The chapter is organized as follows: Section 2 briefly reviews recent empirical literature on FDI and economic growth; Section 3 lays out the econometric model to be estimated and sketches the econometric challenges being faced in the estimation; Section 4 details data, data sources and how the crucial variable "share of high tech FDI in total FDI" has been computed; Section 5 illustrates the results of the estimation exercise, and finally Section 6 mentions possible extensions and future line of work and draws conclusions.

2 A brief look at the existing empirical literature

Of all the literature which preoccupies itself with the effects of FDI on growth and development in host countries, here we review a recent strand which we feel constitutes an important precedent for this study, since its focus is on the effect of FDI on growth and development at a macroeconomic, country-based level, the same as in the present study. This particular strand is surprisingly thin, despite the fact that the overall literature on FDI and growth is quite abundant, since a large part of it either uses data at firm level or is based on country specific studies (see Barba-Navarretti and Venables, 2004 for an account).

The first study to be surveyed is a cross-section study by Borensztein, De Gregorio and Lee (1998), which is the empirical section of a paper that also features an interesting growth model . These authors estimate the following basic equation[6]:

[6] Borenzstein et al gather data over a 20 years time interval, from 1970 to 1989. They use a number of different data sources. For foreign direct investment, data come from an OECD publication, Geographical Distribution of Financial Flows to Developing Countries, while other national accounts data, such as the growth rate of income, initial income and government consumption are all taken from the so called Penn World Tables, by Summers and Heston. Finally, data on human capital are taken from Barro and Lee (1993), and consist of average years of male secondary schooling.

$$g = c_0 + c_1 FDI + c_2 FDI * H + c_3 H + c_4 Y_0 + c_5 A \qquad (2.1)$$

Where g is the rate of growth of per capita GDP, *FDI* is foreign direct investment and is measured as a ratio to GDP, H is the stock of human capital, Y_0 is initial GDP per capita and is meant to capture the role of the "catch-up" effect, and A is a group of control variables that are frequently included as determinants of growth in cross-country studies (see for an example, Barro and Sala-i-Martin, 1995, chp.12). The main result of this study is that FDI is an important determinant of economic growth only when a country has a minimum threshold stock of human capital. In that case, the contribution to growth by foreign direct investment is found to be bigger than that of domestic capital.

A similar study, by Alfaro et al. (2004), finds that well developed financial markets put the positive contribution of FDI to economic growth beyond doubt. This study focuses on the issues related to the measurement and handling of financial markets development, which is not within the scope of our own study, and otherwise follows the same pattern of analysis as Borenzstein et al. (1998). For this reason, we do not dwell further on it.

De Mello (1999), estimates the impact of foreign direct investment on capital output, output and total factor productivity (TFP) by using both time series and panel data. The second part of this study, the relevant one for our purposes, studies the impact of FDI on output and TFP growth by estimating the following two dynamic panel data equations:

$$x_h(t) = \theta_0 + \theta_1 FDI_h(t) + \theta_2 x_h(t-1) + \varepsilon_h(t) \qquad (2.2)$$

or, if unobservable country-specific growth determinants are to be taken into account, the term $\theta_0$becomes $\theta_{h,0}$, a time-invariant individual country effect term, to yield the following equation:

$$x_h(t) = \theta_{h,0} + \theta_1 FDI_h(t) + \theta_2 x_h(t-1) + \varepsilon_h(t) \qquad (2.3)$$

In both equations, De Mello indexes countries with h, and sets $x = y, k, TFP$, where y is output, k is capital, *TFP* is total factor productivity, and $\varepsilon(t)$ is an error term. Because of the likely correlation between the regressors and the error terms, these equations are not estimated by using ordinary least squares, but by using instrumental variables. The instruments chosen are the lagged dependent variables and lagged values of the host country's per capita income as a share of the U.S. Per capita income. The study uses a sample of 32 countries that are divided into OECD and non-OECD countries. The period considered is 1970-90 and the source employed is the Summers and Heston data set.

The outcome of this analysis is a positive impact of FDI on output growth in all panels, and there is some evidence of substitutability between FDI and domestic investment. In more advanced economies, the more efficient technologies embodied in FDI may lead to a higher rate of technological obsolescence of the capital stock embodying older technologies. For the technological laggards, complementarity seem to prevail. This degree of complementarity suggests that those economies are either less efficient in the use of the new technologies embodied in FDI, or that the latter are not much more modern or productive than the ones existing in the recipient economy. Such findings call for further investigation of both what determines how much of technology is embodied in FDI, and of the effect of the extent of high tech FDI on the economic performance of the host country, particularly when the latter is a developing economy.

Another important paper we want to review is Nair-Reichert and Weinhold (2001). This study has the merit of highlighting the serious problems that the kind of empirical work discussed here may suffer if some crucial aspects are not properly handled. In particular, these authors note that cross-section models, with their inherent lack of dynamic information, due to the complete absence of the time dimension, run a much increased risk of omitted variable bias. In other words ordinary least squares estimates can be biased in ways that are increasingly more difficult to predict, the more variables are included in the regression. Alternative estimation techniques, such as instrumental variable (IV) are often difficult to implement because of a lack of suitable instruments. A further problem is that in a cross-sectional regression it may be difficult to understand which way the causation runs. Taking the case we are studying as an example, even if an equation that regressed FDI on output growth returned a positive coefficient for FDI, this fact alone would not imply yet that FDI causes growth, as it could well be the other way round. This problem is commonly known as endogeneity bias. Both the omitted variable bias and the endogeneity bias can be ameliorated by taking the time dimension into account, that is, by making use of panel data. With panel data, the analyst may include lagged dependent variables which may help to control for both biases. Still, Nair-Reicher and Weinhold argue, even panel data models may not solve all the issues raised by cross-section analysis, particularly if the traditional panel data fixed effect estimator is used. The application of this methodology rests on imposing homogeneity assumptions on the coefficients of the lagged dependent variables when in fact the dynamics are heterogeneous across the panel. Their suggestion is to use an alternative method of estimation, which they call Mixed Fixed and Random Model for causality testing in panel data. Here we do not review the technicalities of this method, as they are beyond the scope of this review. We prefer to concentrate on describing the data used and the results obtained. The data comprise a panel of 24 developing countries for the interval 1971 to 1995. The source is World Development Indicators by the World Bank, except from the data on human capital, which is taken from Nehru et al. (1995) and is average years of schooling. As for their results, Nair-Reichart and Weinhold (2001) adopt the following strategy: in order to put the advantages of their methodology in sharp focus, they present results from a non-dynamic panel study, from a dynamic panel estimated with the traditional fixed effect estimator, and from a dynamic panel estimated with their own mixed fixed and random estimator. The latter shows that while it is possible to speak on the whole of a positive causal relationship between FDI and growth, it is also true that this effect is quite different across countries. The paper concludes by stressing the need for future research to concentrate on country specific determinants of this relationship between investment (both foreign and domestic) and growth. Although with the caveats that have just been discussed, the three studies reviewed so far share as their common feature that they find a positive relationship in some shape or form between FDI and economic growth. By contrast there is another recent work, Carkovic and Levine (2002), whose main finding is that (to quote from them, on page 3) "there is not a robust, causal link running from FDI to economic growth".

Carkovic and Levine (2002) move the same kind of criticism as Nair-Reichart and Weinhold (2001) to previous studies of the effect of FDI on the economy of the host country that had the cross-sectional dimension only. They too claim that those earlier studies cannot properly address problems such as simultaneity bias or country specific effects. In order to overcome these problems, and extract consistent and efficient estimates of the impact of FDI on economic growth, they embrace the Generalized Method of Moments (GMM) panel estimator designed by Arellano and Bond (1995) and Blundell and Bond (1997). Carkovic and Levine (2002) use data based on 72 countries (both developed and developing) over the period 1960-1995. Unlike

Nair-Reichart and Weinhold (2001) though, they cannot find evidence of a link between FDI and economic growth. Our suspicion is that, at least in part, this lack of evidence is due to the fact that Carkovic and Levine (2002) use a pooled sample comprising both developed and developing countries. We believe that FDI's impact on the economy of the host country depends on the level of economic development of that country. In particular, we argue that developing countries move closer to the technological frontier because they can benefit from the technology transfer that takes place owing to the occurrence of FDI. By contrast, developed countries achieve technological progress by performing Research and Development activities. For this reason, the impact of FDI as a carrier of technology in developed economies may be not so significant. Because Carkovic and Levine (2002) use a pooled sample with both types of countries, the positive impact of FDI on growth that stems from enjoying the arrival of new technologies may go undetected.

Other recent work, by de la Potterie and Lichtenberg (2001), independently finds no evidence of a positive impact of inward FDI on productivity levels of the host country. This study uses a sample limited to 13 developed economies (over a time interval of 20 years, between 1971 and 1990). It would seem to confirm that FDI's effect on developed countries' economies is at best of difficult detection.

The fact is that despite the criticisms directed towards cross sectional studies by some of these papers, their contradictory findings show that a deeper level of analysis, to account for (among other things) technological and geographical heterogeneity is called for. Such depth cannot be accomplished while at the same time pursuing methodological perfection, without keeping the dataset from shrinking beyond an acceptable threshold. For this reason we stick with a cross sectional study, whose design is explained in the next section.

3 The econometric framework

As already discussed in Section 2.1, we want to contribute to the literature just reviewed, by bringing to the fore, as a novel element, the importance of FDI with high technological content in the economic process. In order to do so, we construct the variable "share of high tech FDI in total FDI", which we call *HTFDIshare* for brevity.

We run regressions which are centered on *HTFDIshare*, and we then contrast these regressions with similar ones where the only change will be that FDI totals replace *HTFDIshare* . The latter regressions will look much like those in the papers reviewed in section 2.2. As a result of this exercise, we hope to gather enough evidence to be able to unveil a positive relationship between the share of FDI which embodies high technology, as defined below, and the impact the latter has on economic performance. As this is a cross-sectional study with no time dimension, such a positive relationship may not yet be proof of a causal link that runs from the technological content of FDI to development. However the existence of a positive relationship and its specificity to the sample of developing countries (as shown in Section 2.5.3 below) is certainly a first step towards proving that causality.

The equations to be estimated and the econometric issues that they raise will be discussed in this section, while we will delay a detailed description of *HTFDIshare* and the other variables that appear in the regressions, to the next Section 4 concerning the data, because the choices that we have made as for which variables to include and how to construct them were partly dictated by data availability (or lack thereof) and will be better understood along with the description of the data itself.

As a point of departure, in order to derive the first regression, we want to test the claim made by Glass and Saggi (1998) that among the factors responsible for spurring FDI with high technological content in a given country, are resource endowments in that country and the magnitude of the cost disadvantage suffered by multinational firms in that country relative to domestic firms.

Following Romer (1990) we consider two types of resources. One is labor services, measured by counts of people, in this case the population of the country concerned. The second is the stock of human capital, as measured by average years of schooling in that country. As for the cost disadvantage facing multinational firms, we assume that it can be represented by macroeconomic uncertainty in the country of interest; we take the inflation rate to be a proxy for this variable and we measure it by the GDP deflator. The argument for measuring the cost disadvantage facing multinational firms with inflation is that expectations on inflation are less costly to form for local firms than they are for foreign firms. Thus the ensuing regression looks as follows:

$$HTFDIshare_i = \alpha_0 + \alpha_1 \ln pop_i + \alpha_2 H_i + \alpha_3 \ln Infl_i + \varepsilon_1 \qquad (3.1)$$

Where $HTFDIshare$ is "share of high tech FDI stock in total FDI stock for the secondary sector", to be accurately defined in section 4, $\ln pop$ is the log of population, H is average years of schooling and $\ln Infl$ is the log of the GDP deflator. The αs are coefficients to be estimated and ε_1 is a random error term. The subscript $i = 1, ..., 29$ indexes the number of countries included in the sample, while time-wise, all the observation refer to 1990, unless otherwise indicated.

The second equation we want to estimate serves the purpose of measuring the impact of FDI on economic performance, the same way as the literature reviewed in section 2 above. Because we deal with a cross section in a specific year (1990), and because all our data concerning FDI refer to stock and not flow, we do not employ the growth rate of output (g) as the dependent variable. The growth rate of output for 1990 does not have a meaningful relationship with FDI stock in 1990, while, if we were to take an average growth rate over a period of time, the choice of the time interval would be arbitrary and likely to be detached from the time interval involving FDI stock data, since it is difficult to gauge precisely the time interval over which the stock of FDI was formed. We instead employ the log of GDP per capita (in constant 1995 U.S. $) as the dependent variable. This variable is intended to proxy for a country's level of development. Hence the second equation of the model looks as follows:

$$\ln GDPprc_i = \beta_0 + \beta_1 HTFDIshare_i + \beta_2 \ln pop_i + \beta_3 \ln Infl_i + \varepsilon_2 \qquad (3.2)$$

Where the βs are the coefficients to be estimated and ε_2 is a (different) random error term. Notice that besides the high tech FDI share, we control for size, measured by population and macroeconomic uncertainty, measured by inflation.

As for the estimation technique to be used, if OLS were to be employed, the estimate of the coefficient β_1 attached to *HTFDIshare* would not be unbiased, because we assumed *HTFDIshare* to depend on the regressors of the first equation, population, average years of schooling and inflation, two of which are also thought to have an effect on GDP per capita. As a result, one of the crucial assumptions for unbiased OLS estimation, that the regressor *HTFDIshare* and the error term ε_2 be uncorrelated, would no longer hold. In order to overcome this potential flaw, we employ 2SLS estimation instead, and use *H* (average years of schooling) as the instrument in the IV estimation process. Therefore, regression (3.1) as reported above constitutes the first step in the 2SLS estimation procedure, while equation (3.2) is the second step. Notwithstanding the endogeneity problem mentioned, we also perform OLS estimation on the same equations, so to have a yardstick for comparing results and checking for their robustness.

It is a well known fact that when implementing instrumental variable estimation, the choice of instruments determines whether the estimates so obtained are efficient and consistent. A valid instrument is highly correlated with the variable to be instrumented, but shows no correlation with the other endogenous variable(s) in the system. A weak instrument, one that is only weakly correlated to the endogenous variable to be instrumented, decreases the efficiency of the estimate, by yielding much higher standard errors than it would be the case with valid instruments. In section 2.5 we will argue that H_i is a valid instrument, since results therein point to the lack of a significant relationship with gdp per capita, and to a strong relationship to the instrumented variable *HTFDIshare* .

At this point, we have to recall the twofold nature of our aim, which is firstly to gather evidence for the economy-fostering role played by the quality of technology embodied in FDI rather than the absolute level of FDI per se, and secondly, to show that this role is peculiar to developing countries. To achieve the first end, the second step in our strategy is to go through the same estimation procedure as just explained, but to replace the variable *HTFDIshare* with FDI stock total throughout the two equations (3.1) and (3.2).

Such a strategy should shed light on any difference that might exist between *HTFDIshare* and FDI stock total, when everything else in the regressions is held constant. We thus estimate the following two equations:

$$\ln FDItot_i = \gamma_0 + \gamma_1 \ln pop_i + \gamma_2 H_i + \gamma_3 \ln Infl_i + u_1 \quad (3.3)$$

$$\ln GDPprc_i = \delta_0 + \delta_1 \ln pop_i + \delta_2 \ln Infl_i + \delta_3 \ln FDItot_i + u_2 \quad (3.4)$$

Where all the variables are as in equations (3.1) and (3.2), except that now $\ln FDItot$, standing for FDI stock total in secondary sector (in logs), has replaced the variable *HTFDIshare* . The subscript i still indexes countries, while the reference year, unless otherwise indicated, is still 1990. To show the peculiarity of our results to developing countries, the same regressions are repeated for a different set of OECD "developed" countries.

The next section, Section 4, provides an ample and detailed description of the variables included in the regressions and of the data and data sources employed. Regression results will be illustrated in Section 5.

4 Description of variables and data

Starting with (3.1), the dependent variable in that equation is "share of high tech FDI in total FDI", in short *HTFDIshare* . The variable *HTFDIshare* can be thought of as the ratio "high tech FDI / total FDI". In order to compute the numerator of this ratio, we needed to find FDI data classified by sector in a way that would enable us to decide which sector is high tech and which one is not. The only source of FDI data that came close to satisfying such a requirement was the series World Investment Directory published by UNCTC (an arm of the United Nations). Therefore we have relied heavily on this source for getting FDI data. A drawback of this strategy is that, for the most crucial variable of this study, matters such as sample size, which countries to include in the sample, which year to take as reference year, have all been determined by the availability of suitable data in this single data source.

The World Investment Directory (henceforth W.I.D.) classifies FDI data according to the U.N. International Standard Classification (ISIC) Revision 3. This is a very detailed and accurate classification of economic activities, which makes the task of selecting the high tech sectors, to be included in the numerator of *HTFDIshare*, far easier. To illustrate, under the item "Manufacturing" (item D in ISIC Rev. 3) the reader can find the whole array of manufacturing sectors, apparently put in ascending order of technological content, starting with item 15, “manufacture of food products and beverages”, all the way down to end with such items as item 32, ”manufacture of radio television and communication apparatus”, item 33, “manufacture of medical, precision and optical instruments, watches and clocks”, item 34, “manufacture of motor vehicles, trailers and semi-trailers”, item 35, “manufacture of other transport equipment”, and item 36, “other manufacturing”.

In choosing the criterion for picking high tech investments, we were unable to find any guideline in previous studies. Therefore we adopted the following simple approach. Since the sectors in ISIC Rev. 3 are classified in ascending order of technological content, the only issue remained where to put the boundary between what is high tech and what is not. We decided to classify as high tech, investments located under item 29, “manufacture of machinery and equipment”, to item 36, “other manufacturing”, inclusive. We have also added the subcategory “pharmaceuticals, medical chemicals etc.” (item 2423 in ISIC Rev. 3) which fell on the wrong side of the boundary, because we felt it was a sector requiring a sufficiently sophisticated know-how, to warrant a move to the high tech group.

Thus far we have discussed the ISIC Rev. 3 and the W.I.D. Classifications interchangeably. In fact the latter identifies the sectors of economic activity with a terminology that draws very heavily from ISIC Rev. 3, but nevertheless differs slightly from it. For our purposes it is sufficient to note that item D, “Manufacturing” of ISIC Rev. 3 is referred to as “Secondary sector” by W.I.D. All the sectors that precede this item are collected by W.I.D. under the term “Primary sector”, while the sectors that follow item D, are grouped by W.I.D. under the term “Tertiary sector”. This study sticks with the classifications and regroupings made by the W.I.D. Furthermore, since data for the primary and tertiary sector were not always available, we decided to base the computations on the figures from the secondary sector only. Hence, while the numerator of *HTFDIshare* , “high tech FDI”, is computed with the criterion discussed above, the denominator, “total FDI”, consists of the sum of FDI totals for the secondary sector.

Other important features concerning the variable *HTFDIshare* are as follows: the sample includes some 30 developing countries from three main regions: Latin America, East Asia and Eastern Europe. In the sample there are no countries from Africa or the Middle East, as we were not able to find any satisfactory data for those regions. Given the cross sectional nature of this study, we decided to work with FDI stock rather than flow, as the former gives a more accurate picture of past history for every given country. The data are mostly from 1990, the last year for which FDI stock for Latin America were available, so that the sample can include as many countries as possible. Where 1990 data were not available, we considered the year immediately preceding or following 1990. FDI stock data are often given as "approved FDI stock" and/or "actual FDI stock". The two sets of figures differ considerably. Because approved FDI data were more widely available than the actual data, we have chosen to use approved figures as much as possible, and resort to actual figures only when the former was not available.

The only countries for which we could find data for FDI stock both on an approved and actual basis, from the same source, were as follows:

- Indonesia (secondary sector total 1994, in million U.S $): 65 (approved), 19 (actual)
- Malaysia (secondary sector total 1990, in million ringgit): 35 (approved), 15 (actual)

The discrepancy between approved and actual figures does exist, as aknowledged also in the U.N. World Investment Directory (Vol. VII, Asia and the Pacific, page 53):

> "Many countries have a variety of sources for FDI data, including those collected by the central bank for balance-of-payment purposes and those collected by the board of investment or a similar institution for monitoring and investment promotion purposes…A typical occurrence is that data provided by those institutions are on approved FDI investments rather than on the investments actually implemented…In such cases, data on approved investments provide crucial information, but their limitations must be aknowledged. Normally, approved investments are larger than those actually implemented."

While we are ready to acknowledge the problems involved in using both approved and actual FDI data, we do know that this is the only way to keep the sample size from shrinking in a way that would make this study unfeasible.

For a few countries (China, Mexico, Indonesia, Turkey), we could only find FDI totals for the secondary sector without the desired breakdown. In order to obtain a share, for these cases we employed as numerator data on "high tech manufacturing exports", from the World Bank[7]. Under the assumption that these are developing countries wherein not much high tech production originates from domestic capital, the difference between high tech manufacturing FDI and high tech manufacturing exports ought, in theory, not to be large[8].

[7] Since the high tech exports figure is a flow, the variable $HTFDIshare$ is computed by using FDI flow data (from the World Bank) as denominator.

[8] We made a check by comparing $HTFDIshare$ by using both high tech manufacturing exports and W.I.D. High

As for the other variables included in 3.1 and 3.2, data on population, inflation, and GDP per capita (the latter in 1995 constant U.S. $) all come from the source World Development Indicators Online (various issues, but especially 2001) published by the World Bank. Finally the variable *H*, "average years of schooling", comes from the dataset on education to be found in Barro and Lee (1997).

As for the sample of OECD economies, the sample consists of 19 countries (those that were current OECD members in 1990 for which the data were complete). While the variables are constructed in the same way as for the sample of developing countries, the source that has been employed for the FDI data was the OECD own FDI dataset. Sources of data for the remaining variables were the same as for the set of developing countries. More details on variables, data and data sources, along with descriptive statistics, is provided in the appendix to this study.

5 Regression results

For the reasons discussed in Section 3, we perform 2SLS estimation on equations (3.1) and (3.2), where (3.1) is the first stage of the estimation procedure, which goes on to feed (3.2) for the second stage. The tables below report the regression results:

tech FDI data. Although the results are not fully satisfactory (the difference exists indeed), we still do it this way, both because without those countries the sample would be too small, and because this difference can be ascribed more to the fact that FDI flow figures used here are actual flows, while the FDI stock figures used to compute *HTFDIshare* using the W.D.I. Source are often approved figures, than to high tech exports not being a good proxy for high tech FDI in developing countries. Put simply, the discrepancy is due more to denominator than to numerator differences.

Table 1 - First stage results of 2SLS regression of *HTFDIshare* on selected independent variables. OLS regression yields same results - 29 observations

Independent Variable	Dependent Variable: *HTFDIshare*
	OLS and 2SLS (first stage)
H	0.06 (0.012) ***
ln*pop*	0.045 (0.018)**
ln*Infl*	-0.04 (0.018)**
No. observations	29
Adj. R-square	0.5
F test of joint significance	7.73***

Table 2 - Second stage results of 2SLS and OLS regressions of log GDP per capita on selected independent variables - 29 observations

Independent Var.	Dependent Variable: ln*GDPprc*			
	2SLS (1)	2SLS (2)	2SLS (3)	OLS
HTFDIshare	3.57 (1.17)***	-6.48 (4.14)	-1.23 (2.9)	2.19 (1.09)*
H	-	0.59 (0.25)**	0.28 (0.2)	0.08 (0.09)
ln*pop*	-0.45 (0.10)***	-	-0.23 (0.17)	-0.39 (0.11)***
ln*Infl*	0.19 (0.12)	-0.21 (0.25)	-	0.14 (0.11)
No. Observations	29	29	29	29
Adj. R-square	0.45	-	0.27	0.46
F test of joint significance	7.73***	2.26	5.84***	6.96***

*Note: Tables show coefficient values with standard errors in parentheses. In Table 2, (1): second stage of 2SLS regression where instrument is average years of schooling (H), (2): second stage of 2SLS regression where instrument is log of population (*ln*pop), (3): second stage of 2SLS regression where instrument is log of GDP deflator (*ln*Infl). *= significant at 10%; **= significant at 5%; ***= significant at 1%.*

The output for (3.1) (first stage regression), from Table 1, is entirely as expected. All the coefficients attached to the three regressors are statistically significant at the 5% level, and all carry the signs predicted by the theory. So the resources population and human capital have a positive impact on the share of high tech FDI, while ln*Infl*, which is a measure of macroeconomic instability, has a negative impact on *HTFDIshare* .

In Table 2, the first three columns show results for the second stage of the 2SLS estimation procedure. The order condition for identification of the system (3.1, 3.2), dictates that the number of excluded exogenous variables (instruments) be equal to the number of included endogenous variables to be instrumented. In order to satisfy this condition, the variable that is chosen as instrument in each column, is excluded from the regression shown in that column.With the results from Table 2 in hand, we are now in a position to explain and justify the choice of H as our preferred instrument and to comment the evidence gathered following this choice.

We said earlier that valid instruments are strongly correlated with the endogenous variable to be instrumented (here, $HTFDIshare$), but they are exogenous with respect to the other endogenous variables of the system (here, $\ln GDPprc$). It is a property of valid instruments that the stronger the correlation between the instrument and the instrumented endogenous variable, the smaller the standard error of that endogenous variable in the second stage regression. Therefore, in order to assess our instruments against this criterion, we look in Table 2 at the standard errors attached to $HTFDIshare$ in each of the first three colums. We see that the smallest standard error (1.17) which affects the coefficient attached to $HTFDIshare$ is the one obtained when H is chosen as instrument (under 2SLS (1)). This fact points to a stronger relationship of H with $HTFDIshare$ than that enjoyed by the other two candidates as instruments[9].

To assess the exogeneity of the instruments with respect to $\ln GDPprc$, we use the OLS regression of Table 2, column 4. That regression says that H and $\ln Infl$ have no relationship with $\ln GDPprc$, while $\ln pop$ appears to have a strong relationship with $\ln GDPprc$. The result concerning H and $\ln GDPprc$ may seem to be against commonly accepted economic theory, but it actually makes sense for the sample of developing countries gathered here. This sample includes countries from three main geographic regions: Eastern Europe, the Far East and Latin America. As such, this sample exhibits the following two traits: first, the countries from the former Soviet Bloc are characterized by far higher rates of literacy than those of other countries at a similar stage of development. Second, the countries of Latin America feature a distribution of human capital stock that is as heterogeneous as their income distribution, but which does not always follow the same pattern as the income distribution. For instance, while in terms of income the ranking of Argentina, Brazil and Chile is as just listed, Chile is far poorer than its two bigger neighbours. In terms of years of schooling the ranking becomes Argentina (7.77), Chile (7.14) and Brazil (3.76), with Chile very close to Argentina and Brazil very much behind.

---

[9] For a quick check, we run a simple regression of $HTFDIshare$ separately on each of the candidate instruments. This regression returned coefficient values that were highly significant in the case of H, but failed to pass all significance thresholds both in the case of $\ln pop$ and of $\ln Infl$.

In order to have complete peace of mind on the matter of choosing the right instrument, as a further check, we compare each 2SLS regression with the OLS regression and see that the latter confirms the sign and the significance of the 2 SLS regression of column (1), the one where H is chosen[10].

If we move on to assess the evidence presented in Table 2, column 1, the crucial result appears to be that the impact of $HTFDIshare$ on the level of per capita income is positive and significant. We also notice that population has a negative and significant impact on $\ln GDPprc$, possibly because population itself appears in the denominator of GDP per capita, so that when total GDP is held constant, a rise in population causes a fall in GDP per capita. Finally, the coefficient attached to $\ln Infl$ is positive but not significant, and cannot lead to conclusions in either direction.

5.1 Sensitivity Analysis

Our next step is to check that these results do not change dramatically if we modify some of the choices that were made in the design of this model. Our sensitivity analysis will consist of rerunning the regressions (3.1) and (3.2) after making the following three changes.

Firstly, substitute the adopted concept of high tech FDI with a more restrictive one. This will consider as high tech only FDI falling into categories from "radio TV and communication equipment" to "other manufacturing" (see Appendix). Call this new share $HTFDIshare2$. Such a change will serve the purpose of checking whether our definition of high tech FDI is robust to a different choice of categories to be included into it.

Secondly, exclude from the sample the four countries for which high tech FDI had been calculated differently, by using high tech exports in the numerator. Call this one $HTFDIshare3$. In this way, we check that those four countries are not responsible for altering the results of the study.

---

[10]Incidentally, it can also be seen that when $\ln pop$ is the instrument, the value of the F statistic for joint significance is very low.

Table 3 - Sensitivity analysis- first stage regressions

Independent Variable	Dependent variable			
	HTFDIshare 29 obs	*HTFDIshare*2 26 obs	*HTFDIshare*3 25 obs	*HTFDIshare*4 26 obs
ln*pop*	0.045 (0.018)**	0.047 (0.01)***	0.07 (0.02)***	0.25 (0.6)
ln*Infl*	-0.04 (-0.018)**	0.00 (0.01)	-0.05 (0.02)***	-1.10 (0.62)*
H	0.06 (0.012)***	0.02 (0.00)***	0.05 (0.01)***	1.04 (0.47)**
Number of obs	29	26	25	26
F (Prob > F)	10.32 ***	8.11***	12.17 ***	2.66 *
Adj R-squared	0.5	0.46	0.58	0.16

Table 4 - Sensitivity analysis - Instrumental variables (2SLS) regressions

Independent Variable	Dependent variable			
	ln*GDPprc* (1)	ln*GDPprc* (2)	ln*GDPprc* (3)	ln*GDPprc* (4)
HTFDIshare	3.57 (1.17)***	9.51 (4.60)*	4.15 (1.31)***	0.24 (0.10)**
ln*pop*	-0.45 (0.1)***	-0.72 (0.25)***	-0.56 (0.14)***	-0.38 (0.14)**
ln*Infl*	0.19 (0.12)	-0.065 (0.16)	0.218 (0.13)*	0.26 (0.19)
Number of obs	29	26	25	26
F (Prob > F)	7.73***	2.82*	6.06 **	4.30 **
Adj R-squared	0.45	-	0.44	0

*Notes: Tables show coefficient values with standard errors in parentheses. The four regressions are one for each different HTFDIshare : (1) = from the basic model, (2) = HTFDIshare2 , (3) = HTFDIshare3 , (4) = HTFDIshare4 , as explained in the text. No. of observations same as in first stage regression (see table 3). *=significant at 10%; **=significant at 5%; ***=significant at 1% level.*

Finally, when computing the high tech FDI share, use the value of high tech exports in place of high tech FDI for the whole sample, instead of just the four countries for which detailed FDI data were not available. We let this share be *HTFDIshare*4. This procedure provides a check on the robustness of using alternative criteria when detailed FDI data are not available.

A glance at the first stage regressions confirms signs and significance of coefficients in most cases. The exceptions are the coefficients of ln*pop* in (4) and of ln*Infl* in (2). It is especially important that the results regarding positivity and significance of coefficient go through for the human capital regressor represented by average years of schooling.

The second stage instrumental variable regression confirms positivity and significance of the coefficient attached to the share of high tech FDI, measured in four different ways. The sole instance in which significance is not as strong concerns the relationship between a restricted version of $HTFDIshare$ and $\ln GDPprc$ (column denoted $\ln GDPprc$ (2)). Even there, the amount by which the 5% threshold is missed (p-value = 0.051) does not seem to indicate a lack of robustness of our results to alternative definitions of the variable $HTFDIshare$.

This result, along with the one relative to human capital, confirms robustness of the double positive relationship from human capital to high tech FDI and from the latter to the level of GDP per capita that had been found in the basic model. Although such a positive relationship is not yet proof of a causal link that runs from the technological content of FDI to development, because of the lack of a dynamic dimension ineherent in such cross-sectional studies, its existence and specificity to the sample of developing countries (also see Section 3 below) may be considered as a significant contribution towards proving that causality.

5.2 Results when using FDI total instead of high tech FDI share

The next step is to run regressions (3.3) and (3.4) and compare the output from that set of regressions with the results obtained for regressions (3.1) and (3.2). In Table 5 below, we report the regression output for (3.3) and (3.4) together with the regression output for regressions (3.1) and (3.2), in order to facilitate comparison.

This result is completely different from the previous one. In the first stage regression, among the three regressors, population is the only one that retains its positive and significant impact, while the coefficients attached to human capital and inflation are no longer significant at any level. Even more importantly, in the second stage regression none of the regressors has any significant impact on the level of GDP per capita, least of all the total FDI stock of the secondary sector.

Table 5 - First stage regressions - 29 observations

Independent Variable	Dependent Variable	
	HTFDIshare (3.1)	$\ln FDItot$ (3.3)
$\ln pop$	0.045 (0.018)**	0.69 (0.29)**
$\ln Infl$	-0.04 (0.018)**	-0.15 (0.29)
H	0.06 (0.012)***	0.08 (0.20)
Number of obs F (Prob > F) Adj R-squared	29 10.32 *** 0.5	29 2.03 0.1

Table 6 - Instrumental variables (2SLS) regressions - 29 observations

Independent Variable	Dependent Variable	
	$\ln GDPprc$ (1)	$\ln GDPprc$ (2)
HTFDIshare (Lnfdiss)	3.57 (1.17)***	2.52 (5.49)
$\ln pop$	-0.45 (0.10)***	-2.05 (3.72)
$\ln Infl$	0.19 (0.12)*	0.43 (1.11)
Number of obs F (Prob>F) Adj R-squared	29 7.73 *** 0.45	29 0.18 -

Notes: in regressions (3.1) and (3.2) (central column) instrumented is HTFDIshare , Instruments are: $\ln pop$ *,* $\ln Infl$*,* H *; in regressions (3.3) and (3.4) (last column) instrumented is* $\ln FDItot$ *, instruments are* $\ln pop$, $\ln Infl$ *,* H *. Information regarding coefficient values, standard errors and significance levels is provided the same way as in the sensitivity analysis Tables 3 and 4.*

The message is at the same time startling and clear: the double positive relationship that feeds from resources endowments (particularly human capital) and macroeconomic stability into foreign direct investment and from the latter into the level of per capita income is by no means a foregone conclusion. On the contrary, it surfaces only when we put the share of high technology FDI in the middle of this chain, while it disappears if the FDI total is considered instead.

The conclusion just drawn, while startling, should not surprise those that have followed developments in the theory of economic growth over the last decade. The latter has long identified technological change as the root cause of long run economic growth. In developing countries, the sole engine of technological change are the technology transfers from the developed regions, given the almost total lack of any significant local RnD activity. Most likely, the vehicle that permits these technology transfers is foreign direct investment, which in turn is attracted to a developing country if the latter is well endowed with resources and can provide a stable environment. It is important to notice that the findings of this section in some sense can reconcile the contrasting evidence reached by the works reviewed in Section 2, by putting those contradictions down to their failure to account for the technological heterogeneity of FDI.

5.3 Results when using OECD dataset instead of developing countries dataset

As a final check for the relevance of our results, we run the same regressions (3.1) and (3.2) for a data set of OECD countries, leaving the investigation design unchanged, with the same variables and the same 2SLS procedure. Failure to obtain evidence in favor of the double positive relationship from resource endowments to the share of high tech FDI, and from the latter to the level of GDP per capita, would mean that the opposite results which the developing countries regressions produced may have indeed been due to the reasons peculiar to those developing countries that were outlined above. The results from the OECD regressions were as shown in Tables 7 and 8.

Even though the regression equation (3.1) is jointly significant at the 5% level, as shown by the value achieved by the F statistic, of the coefficients associated with the independent variables, only that of log population was statistically significant (at 10%). Its negative sign may be explained by the fact that for OECD countries, the larger the country, the stronger will be any domestic competition, which might scare FDI from flowing into the country concerned.

Table 7 - First stage regressions - 19 observations

Independent Variable	Dependent Variable	
	HTFDIshare (3.1)	*HTFDIshare* (3.1 OECD)
$\ln pop$	0.045 (0.018)**	-0.05 (0.03)*
$\ln Infl$	-0.04 (0.018)**	0.093 (0.06)
H	0.06 (0.012)***	-0.02 (0.02)
Number of obs F (Prob > F) Adj R-squared	29 10.32 *** 0.5	19 4.50** 0.37

Table 8 - Instrumental variables (2SLS) regressions - 19 observations

Independent Variable	Dependent Variable	
	$\ln GDPprc$ (1)	$\ln GDPprc$ (OECD)
HTFDIshare (*HTFDIshare* OECD)	3.57 (1.17)***	-3.10 (3.81)
$\ln pop$	-0.45 (0.10)***	-0.10 (0.2)
$\ln Infl$	0.19 (0.12)*	-0.10 (0.5)
Number of obs F (Prob>F) Adj R-squared	29 7.73 *** 0.45	19 2.37 -

Notes: in regressions (3.1) and (3.2) (central column) instrumented is HTFDIshare , Instruments are: $\ln pop$ *,* $\ln Infl$*, H ; in regressions (3.3) and (3.4) (last column) instrumented is HTFDIshare OECD, instruments are* $\ln pop$ *,* $\ln Infl$ *, H . Information regarding coefficient values, standard errors etc. and significance levels is provided the same way as in the sensitivity analysis Tables 3 and 4.*

In the second stage (regression 3.2), the test for overall statistical significance also failed. Furthermore, all the individual coefficients of the regressors,did not return statistically significant values. This evidence from regression (3.2) is most interesting if contrasted with that from regression (3.2) for the cross-section of developing countries (see Table 8). There, individual coefficients with respect to the share of high tech FDI and $\ln pop$ were highly significant, the former with a positive sign and the latter with a negative sign. The coefficient attached to $\ln Infl$ had a positive sign, but it was significant only at the 10% level. The contrasting findings relative to the effect that a higher share of technology embodied into FDI may have on development, as measured by $\ln GDPprc$, depending on whether the sample employed is of developing or of OECD countries, is a further, clear indication that developing countries are rather peculiar with respect to the way technological change comes about. Failure to account for this geographical heterogeneity, may be one further reason that leads to the contradictory results underscored in Section 2.

6 Conclusions and suggestions for future work

This study attempted to gather evidence in favour of the positive impact of FDI on economic development. We found that the technological intensity of FDI has a positive impact on the development of those countries that we call developing. The two important qualifications here are that FDI is heterogeneous with respect to the technology embodied in it, and that FDI can have a different impact if the receiving nations are at different stages of their development. In particular we argued that the positive role played by FDI depends on its acting as a vehicle for technology transfers. It follows that this role is best fulfilled when the technological intensity of FDI is higher, and when the receiving nation's main mode of achieving technical progress is the technology that it receives from overseas. Developing countries fit this description much more closely than rich countries, for whom the main mode of achieving technical progress are research and development activities.

We also found that a good way to attract high tech FDI is to grow a good stock of human capital and to make sure that the macroeconomic context is as stable as possible. The caveat is that this is a cross sectional study, and as such it may suffer from all the problems noted by Nair-Reicher and Weinhold (2001 and by Carkovic and Levine (2002). However, these problems should be ameliorated, if not eliminated, by the fact that, in our two stages least squares estimation, we instrument the crucial variable *HTFDIshare* with average years of schooling.

Future work may advance knowledge on this topic in several ways. An obvious one would be to remake the analysis carried out here, but with improved data, as they become available. The time dimension could be introduced, by considering FDI flow data for an interval of time, for those countries that have them. If not enough countries have these data, one might restrict the study to one of the three regions considered here, East Asia for instance. The addition of the time dimension may well shed some further light even with the restriction to one region only.

Another possible extension might involve replacing GDP as the dependent variable with others such as domestic investment or employment, in order to explore the effect of high tech FDI on these important quantities.

Yet another possibility, as a follow-up to Section 3 above, is, for the OECD dataset, to base all the regressions discussed thus far on RnD activities, rather than high tech FDI. The expected result here would be that in OECD countries, as FDI is not the sole or even the main carrier of technological change, RnD activities, in close parallel to the role played by high tech FDI in developing countries, have a positive effect on the economic performance of rich countries..

The extensions suggested here should keep researchers keen on this topic for a long time, so that enough research output can be produced to aid policy makers in their quest for a more wealthy future for their countries.

Appendix

The 29 countries included in the developing world sample are: Argentina, Bolivia, Brazil, Chile, Colombia, Dominican Rep., El Salvador, Guatemala, Mexico, Paraguay, Peru, Uruguay, Venezuela, Bangladesh, China, Honk Hong, India, Indonesia (93), Malaysia, Philippines, Rep. of Korea, Singapore, Sri Lanka, Thailand, Turkey, Bulgaria, Czechoslovakia, Hungary, Poland.

Table A1 shows summary statistics for all the variables included in regressions 3.1 to 3.4 when using the developing world sample.

Table A1 - Descriptive Statistics for the variables used in regressions 3.1, 3.2, 3.3 and 3.4, pertaining the sample of 29 developing countries

Variable	Obs	Mean	Std. Dev.	Min	Max
GDPprc (1995 U.S. $)	29	3,626	4,472	277	18,813
$\ln GDPprc$	29	7.67	1.05	5.63	9.84
HTFDIshare	29	0.32	0.2	0	0.75
*HTFDIshare*2	26	0.11	0.1	-0.02	0.32
*HTFDIshare*3	25	0.33	0.2	0	0.75
*HTFDIshare*4	26	2.46	4.99	0	21.15
FDItot (U.S.$ millions)	29	5,837.78	9,936.70	1.30	40,897.30
$\ln FDItot$	29	6.84	2.39	0.26	10.62
pop (units)	29	103,000,000	254,000,000	3,047,000	1,140,000,000
$\ln pop$	29	17.07	1.52	14.93	20.85
H (years)	29	5.88	2.2	2.19	10.35
infl (% annual growth)	29	58.54	104.77	1.8	391.1
$\ln Infl$	29	2.94	1.46	0.59	5.97

The variable $\ln GDPprc$ is the log of GDP per capita measured in 1990, in constant 1995 U.S. $. The data source is the World Development Indicators Online (various issues, but especially 2001) published by the World Bank

The variable *HTFDIshare* has been computed as described in the main text (Section 4), by using the following Classification of Economic Activities found in U.N. World Investment Directory FDI data:

PRIMARY SECTOR
Agriculture
Mining and quarrying
Petroleum

SECONDARY SECTOR
Food, beverages and tobacco
Textiles, leather and clothing
Paper
Chemicals
Basic chemicals

Pharmaceuticals, medic. chem. etc.
Coal and petroleum products
Rubber products
Non-metallic mineral products
Metals
Mechanical equipment
Electrical equipment
Radio, tv and communication equip.
Medical, precision and optical instr.
Motor vehicles
Other transport equipment
Other manufacturing

TERTIARY SECTOR
Electricity, gas and water supply
Construction
Distributive trade
Hotels and restaurants
Transport and storage
Communication
Finance and insurance
Real estate
Other services
Other unspecified

The remaining high tech FDI shares have been calculated as explained in Section 5.1 of the main text. Because of missing or incomplete data, the following countries could not be included in the sample: Mexico, China and Turkey when computing $HTFDIshare2$; Mexico, China, Indonesia and Turkey when computing $HTFDIshare3$; Dominican Republic, Bulgaria and Chechoslovakia when computing $HTFDIshare4$.

The variable $\ln FDItot$ is the logged total FDI stock in the secondary sector for the year 1990. The source for these data are various issues of the World Investment Directory series, published by the UNCTAD. The datum on total FDI stock in the secondary sector for China was not available directly and was therefore computed as follows: Total FDI stock in 1990 * share of secondary sector FDI in total FDI in 1990 for developing countries (Source: UNCTAD, Press Release 2003).

The variable $\ln Infl$ is the logged gdp implicit deflator calculated as an average annual % growth over the 10 years interval 1980-1990. The data source is the same as for the variable $\ln GDPprc$.

The variable H, "average years of schooling", is the average number of years spent in school (including first level, second level and post-secondary) by the population aged 25 years and over, for the year 1990. The data source is the Barro and Lee dataset on education (see Barro and Lee, 1997). The datum on China comes from the Summary Education Profile on China of the World Bank, available at the following web address: http://devdata.worldbank.org/edstats/SummaryEducationProfiles/CountryData/GetShowData.asp?sCtry=CHN,China.

Finally, the variable $\ln pop$ is the logged population total for the year 1990 in each of the 29 countries sampled. The source of the data is the World Development Indicators Online (various issues, but especially 2001) published by the World Bank.

The 19 OECD countries considered were: Australia, Austria (91), Canada, Denmark, Finland (94), France, Germany, Greece (99), Ireland, Italy, Japan, Netherlands (93), Norway, Portugal (95), Spain (00), Sweden (96), Switzerland (93), United Kingdom (94), United States.

In order to avoid overlapping with the sample of developing countries, the criterion followed was to include all those countries that were OECD members in 1990 for which data were available. FDI stock data refer to 1990 unless otherwise indicated in parentheses for the countries concerned. In the case of Greece and Spain, FDI stock data by sectors of industry were not available, so the variable *HTFDIshare* was calculated as the ratio of the sales obtained by the largest affiliates of foreign Trans National Corporations (TNC) in high tech sectors, to the total sales of the largest affiliates of foreign TNC in manufacturing. Table A2 shows descriptive statistics for the sample of 19 OECD countries.

Table A2 - Descriptive Statistics for the variables used in regressions 3.1, 3.2, 3.3 and 3.4, pertaining the sample of 19 OECD countries

Variable	Obs	Mean	Std. Dev.	Min	Max
GDPprc (1995 U.S.$)	19	23,987.45	8,835.65	10,691.83	43,831.34
$\ln GDPprc$	19	10.02	0.39	9.28	10.69
HTFDIshare	19	0.4	0.18	0	0.73
pop (units)	19	41,300,000	59,900,000	3,505,800	249,000,000
$\ln pop$	19	16.77	1.25	15.07	19.33
H (years)	19	8.93	1.9	4.54	12
Infl (% annual growth)	19	6.74	4.79	1.6	19.3
$\ln Infl$	19	1.7	0.67	0.47	2.96

The source for the FDI data was the OECD own FDI dataset, while for the remaining variables the sources were the same as for the set of developing countries.

References

Alfaro, L., Chanda, A., Kalemli-Ozcan, S. and Sayek, S. (2004). 'FDI and economic growth: the role of local financial markets', *Journal of International Economics*, 64 (1), pp. 89-112.

Arellano, M. and Bond, S. (1991). 'Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations', *Review of Economic Studies*, 58(2), pp. 277-297.

Barba-Navarretti, G. and Venables, A. J., with Barry, F. G., Ekholm, K., Falzoni, A. M., Haaland, J. I., Midelfart, K. H., and Turrini, A. (2004). *Multinational Firms in the World Economy*, Princeton University Press.

Barro, R. and Lee, J-W. (1997). 'Schooling Quality in a Cross Section of Countries', Working Paper No. 6198, NBER, www.nber.org.

Barro, R. and Sala-i-Martin, X. (1995). *Economic Growth*, Cambridge, MA: Mc Graw-Hill Press.

Blundell, R. and Bond, S. (1997). 'Initial conditions and moment restrictions in dynamic panel data models', Discussion Paper 97-07, Department of Economics, University College London.

Borensztein E., De Gregorio J. and Lee J.W. (1998). 'How does foreign direct investment affect economic growth?'.*Journal of International Economics,* 45, pp. 115-135.

Carkovic, M. and Levine, R. (2002), 'Does foreign direct investment accelerate economic growth?', mimeo, Department of Finance, University of Minnesota, www.worldbank.org/research/conferences/financial_globalization/fdi.pdf.

De Mello, L.R. Jr. (1999). 'Foreign direct investment-led growth: evidence from time series and panel data', *Oxford Economic Papers*, 51, pp. 133-151.

Glass, A.J. and Saggi, K. (1998). 'International technology transfer and the technology gap' *Journal of Development Economics*, 55, pp. 369-398.

Grossman, G.M. and Helpman, E. (1991). *Innovation and Growth in the Global Economy*, Cambridge, MA: MIT Press.

Nair-Reichert, U. and Weinhold, D. (2001). 'Causality tests for cross-country panels: a new look at FDI and economic growth in developing countries', *Oxford Bulletin of Economics and Statistics*, 63(2), pp. 153-171.

Nehru V, Swanson, E. and Dubey, A. (1995). ‘A new database on human capital stock in developing and industrial countries: sources, methodology and results’, *Journal of Development Economics*, 46, pp. 379-401.

OECD Main Economic Indicators. www.sourceoecd.org.

Pottelsberghe de la Potterie, van, B. and Lichtenberg, F. (2001). 'Does foreign direct investment transfer technology across borders?', *The Review of Economics and Statistics*, 83(3), pp. 490-497.

Romer, P. (1990). 'Endogenous technological change', *Journal of Political Economy*, 98, pp. S71 - S102.

Summary Education Profile on China. World Bank. http://devdata.worldbank.org/edstats/SummaryEducationProfiles/CountryData/GetShowData.asp?sCtry=CHN,China.

World Investment Directory (1992). UNCTC, Vol. II, Central and Eastern Europe.

World Investment Directory (1994). UNCTC, Vol. IV, Latin America and the Caribbean.

World Investment Directory (2000). UNCTC, Vol. VII, Asia and the Pacific.

World Development Indicators Online, World Bank Development Group (2001). http://devdata.worldbank.org/dataonline