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The Impact of Medium-Skilled Immigration: A General Equilibrium Approach*

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Abstract

This paper analyses the impact of the skill composition of migration flows on the host country's labour market in a specific-factors-two-sector model with heterogeneous labour (low-, medium-, and high-skilled). We assume price-setting behaviour in both manufacturing and services sectors. The low- and medium-skilled labour markets are characterized by frictions due to wage bargaining. Moreover, we assume bumping down of unemployed medium-skilled workers into low-skilled service jobs whereas endogenous benefits create an interdependency between the two bargaining processes. Particular attention is paid to medium-skilled migration which enables us to augment the literature by replicating important stylized facts regarding medium skills, such as i) the interaction between immigration, low-skilled unemployment and medium-skilled over-qualification, ii) the polarization effect where both low- and high-skilled wages increase relative to the medium-skilled. The model is calibrated using German data. The key findings are: (i) a perfectly balanced migration has a neutral impact on the receiving economy due to international capital flows; (ii) immigration of medium-skilled labour together with some high-skilled labour lowers the low-skilled unemployment rate and has a positive effect on output per capita; (iii) migration of only medium-skilled labour has a neutral GDP per capita effect.

Keywords Medium-Skilled Migration · Wage and Price Setting · Specific Factors Model · Unemployment · Over-qualification · Wage Polarization

JEL F22 · J51 · J52 · J61 · J64

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1. Introduction

The admission of ten Central and Eastern European countries (CEECs) into the European Union has made the incumbent member states worried about the adverse economic consequences due to potential mass migration from those countries.[1] This has lead to transitional restrictions – with UK, Sweden, and Ireland as exceptions – on the free movement of workers vis--vis new member states. With the end of the transitional periods as of May 2011 the debate concerning the East-West mass migration has revived in countries like Germany and Austria, the closest countries to those new members, that had fully prolonged the transitional periods up to seven years. The main rationale for this restrictive action and the general concerns is explained by the perception regarding the adverse consequences for the natives, particularly, for the least skilled workers (cf. for a survey Dustmann et al. (2008)).[2] The empirical evidence on the labour market impact of migration is rather mixed and clusters usually around zero.[3] However, widely recognized phenomena in the literature on the economic impact of immigration are that high-skilled immigrants have a positive influence on GDP growth and employment, while low-skilled migrants have a negative influence.[4]

Economic theory provides clear grounds for both phenomena, although the appropriateness of the empirical approach has been questioned and criticized (see Borjas (2003)). The displacement effect of native workers due to immigration can be explained by two main forces: i) the substitution effect, and ii) the "crowding-out" effect. While the former denotes the shifts in the relative factor demand determined by the underlying production technology, the second effect emphasizes the shifts in the labour supply that might displace the least skilled from the labour market. This paper incorporates both effects. The empirical evidence indicates, in fact, that immigrants face a higher risk of *over-qualification*, i.e. they perform jobs for which skill requirement is less than their qualifi-

[1]On 1 May 2004, eight CEECs, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, and Slovenia plus two Mediterranean countries Malta and Cyprus joined the EU with Bulgaria and Romania followed on 1 January 2007.

[2]See also Boeri and Brcker (2005) who emphasize the concerns regarding welfare-effects.

[3]The empirical studies looking at the post-accession effects for the UK labour market could not find any significant impact on native wages and unemployment (cf. Gilpin et al. (2006), Lemos and Portes (2008), Blanchflower et al. (2007)). See also Kahanec and Zimmermann (2010) for a survey of the literature.

[4]See, for instance, Hunt and Gauthier-Loiselle (2008) for the impact of high-skilled migration on innovation; for a more general discussion on immigration and economic growth, see Hanson (2012), and on immigration and the welfare sates, see Griswold (2012).

cation − see OECD (2007) for a cross-country evidence and Drinkwater et al. (2009) for UK.

Surprisingly enough, very little attention is paid to the impact of medium-skilled migrants as a separate category, although nowadays they constitute the major component of immigrants and employees.[5] This paper seeks to correct this omission by analysing the impact of immigration in a two-sector model, with three types of skills. We assume wage-and-price-setting behaviour in both manufacturing and services sectors. This enables us to augment the literature by replicating important stylized facts regarding medium skills, such as i) the interaction between immigration, low-skilled unemployment and medium-skilled over-qualification, ii) the so called polarization effect where both low- and high-skilled wages have increased relative to the medium-skilled wages.[6]

A seminal way of analyzing the impact of immigration on output, wages and (un)employment has been introduced by Borjas (2003) and Ottaviano and Peri (2008, 2011) for the U.S. economy. They use a production function in which output is produced utilizing capital and labour, while labour is defined by a multi-level-nested (skill-experience-nationality) CES composite − a common approach in the labour markets studies (cf. Card and Lemieux (2001)). From this function demand for labour is derived, and the market clearing wage results from equality with exogenous labour supply. Since in the European context labour markets usually do not clear, in particular not when immigration is involved, several recent papers analyse the wage and (un)employment effects of migration for imperfect labour markets. Three recent papers in this field are Brcker and Jahn (2011), D'Amuri et al. (2010), and Felbermayr et al. (2010), which all apply to the case of Germany. All three studies use the multi-level nested CES production function to derive demand for labour. However, instead of competitive wages, they introduce a wage setting curve where wages for a certain skill are negatively related to unemployment in that skill group. Using data for Germany, they estimate the elasticity of substitution between the different education-experience groups as well as between natives and foreigners. Moreover, they estimate the unemployment elasticity of wages. Given these estimation results they then simulate the impact of immigration on wages and (un)employment of each sub

[5] Since we match our model with German data using the EU KLEMS data set, the different skill groups are defined as follows. High-skilled: University graduates, Medium-skilled: Intermediate qualifications, and low-skilled: No formal qualifications, see Timmer et al. (2007).

[6] Storesletten (2000) is an exception doing generational accounting for medium-skilled migration.

group.[7]

All these studies, however, focus mainly on two types of migration scenarios in the simulation of their models: low-skilled or high-skilled migration flows. The overall result from these studies is that incumbent immigrants are mostly hurt by new immigrants, while natives are positively (or at least neutrally) affected in the long-run. We hope, therefore, to provide new insights by adding interesting labour market features such as wage determination through multiple sectoral bargaining processes interconnected by bumping down and endogenous benefits.

We, therefore, pursue a different route, which essentially opens the black box of a multi-level-nested CES to describe the substitution possibilities. In our approach, we specify a specific-factors two-sector model, with three types of labour. Motivated by our stylized facts which will be presented below, the manufacturing sector employs medium and high-skilled labour, while the service sector employs low and high-skilled labour in both cases next to capital. This model resembles to some extent that of Felbermayr and Kohler (2006, 2007) who examine the immigration effect for heterogeneous and perfectly competitive labour markets (low, medium, and high skill levels) and allow for inter-industry trade in a similar specific-factors model. However, in our model we allow for both wage bargaining and price setting in both sectors, which allows for unemployment of low skilled workers and bumping down of medium skilled workers to low skilled jobs. The advantage of this approach in our view is that the substitution between types of workers is less mechanical when compared to the multi-level CES, and less rigid over time. We allow for economic mechanisms to play a role due to shifts in the sectoral composition of the economy and substitution between labour and capital within sectors, next to bumping down of medium skilled workers to low skilled jobs. Moreover, this approach allows us to focus on the impact of medium skilled immigration, which is the dominant type of immigration nowadays (see Table 1), but largely ignored in the literature. The focus on medium skilled migration is important not only from an economic point of view, but also from a policy perspective. High-skilled immigration is not controversial due to its commonly accepted and well documented beneficial impact on the receiving country. Politically less accepted are policies in favour of unskilled immigration, simply because

[7] As shown recently by Ottaviano and Peri (2011), the elasticity of substitutions between different skill-age groups is significantly affected by the nesting structure of the labour composite. See also Borjas et al. (2008, 2011) for further discussion on this issue.

of its perceived adverse welfare and economic effects. Therefore, as we show below, the neutral impact of medium-skilled labour migration induces an interesting policy implication for the future labour shortage problems indicating the permanent outflow from the labour market, e.g. due to ageing.

The set up of the paper is as follows. The next section presents the stylized facts on migration pattern, labour market composition, and trends in employment and wages in the manufacturing and service sectors for Germany. In section 3. we demonstrate the theoretical framework with two major sectors, three skill groups and a double wage bargaining model determining the wages of medium- and low-skilled labour. In section 4., we provide first a qualitative assessment of the comparative static analysis, derived by means of log-linearisation around the steady-state, followed by an intuitive interpretation of the theoretical results. In section 5., we calibrate the model for Germany using the EU-KLEMS data set to measure the quantitative importance of various migration scenarios. Finally, section 6. presents the concluding remarks.

2. Stylized facts

At the aggregated level, the average impact of immigration on unemployment and wages of native workers has been explored quite extensively and tend to cluster around zero, as discussed above. However, as already emphasized, the literature on migration has somehow ignored the potential impact of medium-skilled work force, although it accounts for a large part of the total labour force as well as of the foreign work force nowadays. Table 1 highlights this feature in the case of Germany by showing the composition of the total labour force across manufacturing and service sectors as well as of the foreign labour force by skill groups for the years 1991 and 2005. Noticeable, the most pronounced increase was in the share of foreign medium-skilled labour.

Another phenomenon that has recently attracted the attention is the job polarization phenomenon in many developed countries. Table 2 presents this for Germany where we show the percentage changes in the total employment shares as well as in the wage rates by education and industry for the period 1991-2005. One sees clearly that high-skilled employment shares increased in both sectors, whereas the low-skilled share in manufacturing declined and the medium-skilled share in services. Moreover, both low-

Table 1: Total and foreign labour force, by education groups

	1991				2005			
	Total			Mig.	Total			Mig.
Skills	Agg.	Manuf.	Serv.		Agg.	Manuf.	Serv.	
High (%)	8	6	9	4	10	7	10	6
Medium (%)	64	63	65	48	62	66	61	61
Low (%)	28	31	25	48	28	27	28	33

Notes: Agg.=Aggregate, Manuf.=Manufacturing, Serv.=Services, Mig.=Migrants. The total shares denote the shares in hours worked, and are calculated from EU KLEMS. The number for foreigners are taken from Brcker and Jahn (2011), but denoting, respectively, the years 1990 and 2004. Medium-skilled consists of the educational groups: vocational and high-school.

and high-skilled wages grew faster relative to medium-skilled wages reflecting the U-shaped trend found in the empirical literature (see, for example, Autor and Dorn (2010) for the U.S. and Goos et al. (2009) for Europe). While the main rationale behind this trend is explained by the advances in information and communication technology (see, for instance, Van Reenen et al. (2010)), this paper gives an alternative explanation. We show that it might also be due to relative increase in the medium-skilled labour force due to migration. This brings us to the next stylized fact.

A study by OECD (2007) documents that the labour market performance of immigrants is denoted by higher risk of *over-qualification*. Recent studies on post-EU-enlargement provide further evidence. For example, Drinkwater et al. (2009) analyse the performance of Polish immigrants in the UK labour market and find that majority of them are employed in low-skilled and low-paid jobs despite having relatively high levels of education.[8]

Moreover, a recent study by Brynin and Longhi (2009) finds for Germany, using households survey data, a relative excess of over-qualification at the medium-skilled level which contributes to almost half of all overqualified persons. This indicates that beside the standard argumentation of denoting the technical change as the main deriving force

[8] See also Kahanec and Zimmermann (2010) for a review of the recent literature.

Table 2: Changes in wage rates and employment shares, by education and industry

	1991 – 2005	
	Wage Rate	Employment Share
Manufacturing Sector (in %)		
High	59	25
Medium	40	4
Low	42	−15
Service Sector (in %)		
High	44	13
Medium	36	−7
Low	41	5

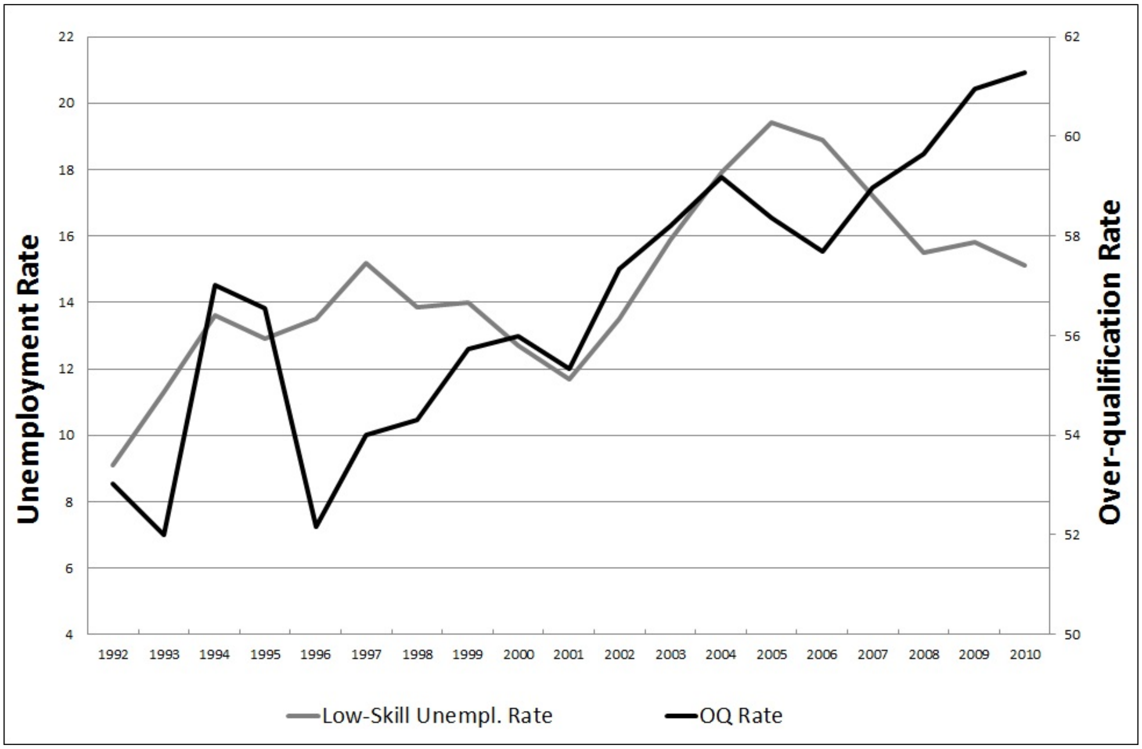
Notes: The numbers denote log-differences. Employment shares designate the shares in hours worked. *Source*: EU KLEMS.

behind the increase in low-skilled unemployment rate, the increase in the low-skilled unemployment rate might be the consequence of an increase in supply of better educated workers leading to the so called “crowding-out” of low-skilled workers. Using German data, Figure 1 shows the relation between low-skilled unemployment rate and the over-qualification rate of low-skilled type of jobs. Except for 2000-2004 (the ICT bust period) where a positive relation can be seen, it designates a reverse relation, especially, in the recent years. This observation might be the result of the 2005 labour market reforms in Germany, the so-called *Hartz* reforms.

We summarize these stylized facts as follows

1. Medium-skilled workers constitute a major component of the labour force and of immigrants
2. High-skilled employment rises in both sectors with low-skilled declining in manufacturing sector and medium-skilled in service sector
3. Medium-skilled labour has a higher incidence of over-qualification
4. There is a negative relation between the over-qualification rate in low-skilled jobs and the low-skilled unemployment rate

Figure 1: Trends in low-skilled unemployment and over-qualification rates



Note: The over-qualification (OQ) rate denotes the proportion of medium-skilled workers in low-skilled jobs. *Source*: Eurostat.

5. Both low-skilled and high-skilled wages have increased relative to the medium-skilled wage, which points at wage polarization

3. The theoretical framework

The economy is defined by two major sectors, *manufacturing* (Y_m) and *services* (Y_s), each producing a good by utilizing physical capital and labour. These two goods are in turn used in a CES aggregate to produce a final consumption good (X). We interpret X as the total GDP which is taken as the numeraire, i.e. its price is set to unity. The CES aggregate can be interpreted as the production technology of a final good sector or as the utility function of a representative household. In light of the stylized facts reported in Section 2., we assume that medium-skilled labour is specific to manufacturing sector and low-skilled labour specific to the services sector - although bumping down of medium skilled labour to low skilled service jobs can occur. Capital and high-skilled labour are employed in both sectors. We assume that firms in manufacturing and services sectors have a monopoly power which is ensured by a fixed entry cost. The high skilled wage is determined on a competitive labour market, but medium and low skilled wages are determined by wage bargaining. We elaborate these points below in the context of a general equilibrium framework.

3.1. Final consumption good

The final consumption good (or the GDP) is produced by the following CES function

$$X = \left(\gamma Y_m^{\frac{\theta-1}{\theta}} + (1-\gamma) Y_s^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}} \tag{1}$$

where $\theta > 1$ denotes the elasticity of substitution between the two sectors and $0 < \gamma < 1$ is the distribution parameter.

From (1), we obtain the isoelastic demand functions for manufacturing and service goods

$$Y_m^d = \gamma^\theta X \left(\frac{P_m}{P}\right)^{-\theta} \tag{2a}$$

$$Y_s^d = (1-\gamma)^\theta X \left(\frac{P_s}{P}\right)^{-\theta} \tag{2b}$$

respectively, where $P = \left((1-\gamma)^\theta P_s^{1-\theta} + \gamma^\theta P_m^{1-\theta}\right)^{\frac{1}{1-\theta}}$ denotes the macroeconomic price index which is taken as numeraire in the remaining part of the analysis. As a consequence all variables are defined in real terms and we assume no inflation.

3.2. Manufacturing and services goods

After incurring a fixed cost, firms in both sectors produce a good with a standard Cobb-Douglas production technology with constant returns to scale. Note that positive profits are ensured simply by the assumption of relatively high fixed costs such that free-entry is ruled out, see Cahuc and Zylberberg (2004, Ch. 7) for a general discussion. Based on our discussion above, in the manufacturing sector high- (H_m) and medium-skilled (M)

labour are employed, whereas in the service sector high- (H_s) and low-skilled (L) labour are utilized.

The production functions for manufacturing and services are given by

$$Y_m = AK_m^{\nu} H_m^{\alpha} M^{1-\alpha-\nu} \tag{3a}$$

$$Y_s = BK_s^{\eta} H_s^{\beta} L^{1-\beta-\eta} \tag{3b}$$

respectively, where $0 < \{\alpha, \beta, \nu, \eta\} < 1$. The total factor productivity in manufacturing and services is denoted by exogenous variables A and B, respectively, with $A > B$ reflecting the higher productivity of manufacturing relative to services.

3.3. Factor demand

Firms determine factor demand by minimizing their costs given the factor prices. The rental cost of capital, r^*, is determined on the international capital market since capital is assumed to be perfectly mobile. Furthermore, high skilled workers are assumed to be mobile between the service and manufacturing sectors. As a consequence the high-skilled wage is equalized between the two sectors: $w_H^m = w_H^s = w_H$. The wage bargaining in the medium skilled and the low skilled labour markets determine w_M and w_L, respectively. Factor demand, then, is determined by minimizing the manufacturing production costs

$$C_m = w_H H_m + w_M M + r^* K_m \tag{4}$$

subject to production technology (3a). Similarly, factor demand in the service sector is determined by minimizing the service production costs

$$C_s = w_H H_s + w_L L + r^* K_s \tag{5}$$

subject to the production technology (3b). Solving the optimization problems, the factor demand functions in the manufacturing sector are given by

$$H_m^d = \alpha \frac{Y_m}{A} \left(\frac{w_H}{W^m} \right)^{-1} \tag{6a}$$

$$M^d = (1 - \alpha - \nu) \frac{Y_m}{A} \left(\frac{w_M}{W^m} \right)^{-1} \tag{6b}$$

$$K_m^d = \nu \frac{Y_m}{A} \left(\frac{r^*}{W^m} \right)^{-1} \tag{6c}$$

and in the services sector by

$$H_s^d = \beta \frac{Y_s}{B} \left(\frac{w_H}{W^s} \right)^{-1} \tag{7a}$$

$$L^d = (1 - \beta - \eta) \frac{Y_s}{B} \left(\frac{w_L}{W^s} \right)^{-1} \tag{7b}$$

$$K_s^d = \eta \frac{Y_s}{B} \left(\frac{r^*}{W^s} \right)^{-1} \tag{7c}$$

where $W^m = \left(\frac{r^*}{\nu}\right)^{\nu} \left(\frac{w_H}{\alpha}\right)^{\alpha} \left(\frac{w_M}{1-\alpha-\nu}\right)^{1-\alpha-\nu}$ and $W^s = \left(\frac{r^*}{\eta}\right)^{\eta} \left(\frac{w_H}{\beta}\right)^{\beta} \left(\frac{w_L}{1-\beta-\eta}\right)^{1-\beta-\eta}$ denote the geometric weighted average factor price composite in the manufacturing and services sectors, respectively.

Substituting (6a)-(6c) into the cost function, (4), and similarly (7a)-(7c) into (5), we obtain the minimized cost functions

$$C_m^*(w_H, w_M, r^*) = \frac{W^m}{A} Y_m \tag{8a}$$

$$C_s^*(w_H, w_L, r^*) = \frac{W^s}{B} Y_s \tag{8b}$$

for manufacturing and service good producers, respectively.

3.4. Price setting for intermediate goods

As shown in the previous section, firms in the two major sectors face a downward-sloping domestic demand function for their products. Therefore, a representative manufacturing good producer sets the price of her good by maximizing her profit

$$\Pi_m = P_m Y_m - C_m^*(W^m, Y_m) \tag{9}$$

subject to (2a). Similarly, a representative service good producer maximizes her profit

$$\Pi_s = P_s Y_s - C_s^*(W^s, Y_s) \tag{10}$$

subject to (2b). Solving the maximization problems, yield the standard pricing behaviour, respectively, in the manufacturing and service sectors

$$P_m = \frac{\theta}{\theta - 1} \frac{W^m}{A} \tag{11a}$$

$$P_s = \frac{\theta}{\theta - 1} \frac{W^s}{B}. \tag{11b}$$

3.5. Wage setting and the labour market features

As discussed above, high skilled workers are mobile between the two intermediate sectors, and we assume labour market clearing for them. However, in line with the European labour market institutions, wage bargaining occurs in both low- and medium-skilled labour markets - see, for example,Brcker and Jahn (2011) where wage-setting curves differ across sectors. In our framework two different labour unions negotiate the wages for medium- and low-skilled workers in the manufacturing and services sectors, respectively. But, as we elaborate below, wages are not independent. On the one hand medium skilled workers can be bumped down into the service jobs, earning low-skilled wages, which influences the reference wage of medium skilled workers. On the other hand, medium skilled wages will have an impact on the level of the benefits, which will influence the reference wage of low skilled workers.

Following Booth (1995) and Layard et al. (2005), wages are determined by the *right-to-manage* bargaining solution so that the negotiating parties only bargain over the wages, whereas the optimal employment decisions is made by the firms. In doing so, we also follow the conventional way by assuming that in each sector there exists a continuum of identical firms and unions and therefore neglect firm-union-specific indices (cf. Koskela and Stenbacka, 2009, 2010). Firm's net gain is simply the flow of profits, i.e. net of the fixed costs. This is given for the manufacturing and services firms, respectively, by the equations (9) and (10). The net gain for the labour union is simply the net result of the bargained wage and the outside option. Thus, the objective function of the manufacturing and service labour unions is given, respectively, by

$$U_m = (w_M - \bar{w}_M)M \tag{12}$$

$$U_s = (w_L - \bar{w}_L)L \tag{13}$$

where $\bar{w}_j, \forall j = L, M$ denotes the outside option which is taken as given by each labour union. Thus, the medium-skilled wage is the result of the following maximization problem

$$\max_{w_M} \Omega_M = \left((w_M - \bar{w}_M)M^d\right)^{\delta_m} \Pi_m^{1-\delta_m} \text{ s.t.}(2a), (6b), (9), (11a)$$

Similarly, the low-skilled wage is set by solving the following maximization problem

$$\max_{w_L} \Omega_L = \left((w_L - \bar{w}_L)L^d\right)^{\delta_s} \Pi_s^{1-\delta_s} \text{ s.t.}(2b), (7b), (10), (11b)$$

where δ_i $(i = s, m)$ denotes the bargaining strength of the labour union. The solution of the wage negotiation yields, after some manipulation, the standard result

$$w_j = (1 + \lambda_i)\bar{w}_j \ \forall j = M, L \tag{14}$$

where the mark-up on the medium- and low-skilled outside options is given, respectively, by

$$\lambda_m = \frac{\delta_m}{(1 - \alpha - \nu)(\theta - 1)} \tag{15a}$$

$$\lambda_s = \frac{\delta_s}{(1 - \beta - \eta)(\theta - 1)}. \tag{15b}$$

3.5.1. Manufacturing wage curve

As shown by the stylized facts, medium skilled workers have a relatively high incidence of over qualification. Several empirical studies suggest that a significant and increasing proportion of low-skilled jobs are nowadays carried out by better educated, over-qualified workers - see Borghans and de Grip (2000) and Hartog (2000) for an overview of these studies.

Following these stylized facts, we assume that the medium-skilled workers face the risk of holding a low-skilled job in the services sector when they cannot find employment in the manufacturing sector. As a consequence, they will lead the low-skilled workers into unemployment. This suggests that the rise in low-skilled unemployment would not only be the result of a relative demand shift, but also the consequence of a relative supply shift which leads to "crowding-out" of low-skilled workers as has also been observed by Pierrard and Snessens (2003).

The medium-skilled over-qualification rate is defined by

$$o_M \quad = \quad 1 - \frac{M}{N_M} \tag{16}$$

with N_M as the total medium-skilled labour force.

Since frictions in the medium-skilled labour market is described by the over-qualification risk, then in the general equilibrium context as well as by the symmetry assumption, the reference wage of a medium-skilled worker ($\bar{w}_M$) can be interpreted as:

$$\bar{w}_M = (1 - o_M) w_M + o_M w_L. \tag{17}$$

Substituting this expression into (14) and rearranging, we obtain the manufacturing wage curve (WC_m)

$$w_M = \Phi(\lambda_m, o_M) w_L, \tag{18}$$

where $\Phi(\lambda_m, o_M) = \frac{(1+\lambda_m)o_M}{1-(1+\lambda_m)(1-o_M)}$. That is, as long as the manufacturing union has some bargaining power, $\delta_m > 0$, it will set a markup denoted by $\Phi(\cdot)$ over the low-skilled wage rate. If, however, $\delta_m \to 0$, then $\lambda_m \to 0$ and $w_M \to w_L$ denoting the perfect competition case. One can easily show that $\partial \Phi / \partial o_M < 0$ implying the wage curve is increasing in employment of medium skilled workers.

3.5.2. Service wage curve

The low-skilled unemployment rate is defined by:[9]

$$u_L = 1 - \frac{L - o_M N_M}{N_L} \tag{19}$$

with N_L denoting the total low-skilled labour force.

Contrary to manufacturing, low-skilled workers face the risk of being unemployed and thus receiving an unemployment benefit, b. Recalling the symmetry assumption, the outside option (or the average income) of the low-skilled workers is defined as:

$$\bar{w}_L = (1 - u_L) w_L + u_L b \tag{20}$$

Furthermore, we assume that the level of benefits is tied closely to the average wage which is in line with the evidence. Weiss and Garloff (2009), for example, show that the level of benefits is tied closely to per-capita income in most European countries while in the Anglo-Saxon countries there was no adjustment over the last two decades. Consequently, we define b as a percentage (ξ) of average low- and medium-skilled wages weighted by κ:[10]

$$b = \xi(\kappa w_M + (1 - \kappa) w_L). \tag{21}$$

Using this definition for b in (20) and substituting then the resulting equation in (14), after rearranging, we obtain the following aggregated service wage curve (WC_s)

$$w_L = \Psi(\lambda_s, u_L) w_M \tag{22}$$

where $\Psi(\lambda_s, u_L) = \frac{(1+\lambda_s)\xi\kappa u_L}{(1+\lambda_s)(1-\xi(1-\kappa))u_L - \lambda_s}$. Similarly to the manufacturing wage curve, one can verify that $\partial\Psi/\partial u_L < 0$. Hence the wage curve is increasing in the employment of

[9]Note, the service trade union does not take into account the crowding-out effect when negotiating over the wage rate and therefore, the *perceived* unemployment rate is simply given by $u_L^p = 1 - \frac{L}{N_L}$. We use this property in the analysis of the interaction between the service and manufacturing wages.

[10]Note that for $\kappa = 0$ we obtain the standard definition of unemployment benefits as the constant "replacement rate", $b/w_L = \xi$. In this case, however, the linkage between w_L and w_M disappears and the service wage curve will be defined as $w_L = (1 + \lambda_s)((1 - u_L)w_L + u_L b)$. Consequently, the equilibrium unemployment rate, u_L, will be constant and depends only on the parameters of the model implying that it does not react any longer to a migration shock.

low-skilled workers. Note that if the service labour union looses the bargaining power, then the perfect competition outcome with no unemployment results, i.e. if $\delta_s \to 0$, then $\lambda_s \to 0$ and $w_L \to b$.

3.6. Interaction between low- and medium-skill wages

Due to the risk of over-qualification and the endogenous unemployment benefits, there is an interdependency between the low- and medium-skill wages. We show that the condition for the unique equilibrium is assured by the fact that both wage curves are monotonically increasing in the wage rates, starting from positive intercepts. However, the latter requires lower boundaries on both unemployment and over-qualification rates. Moreover, both curves should intersect such that the following relation is ensured, $w_M > w_L > 0$.

We now elaborate on the shape and properties of both wage curves derived in the previous section.

3.6.1. Properties of manufacturing wage curve

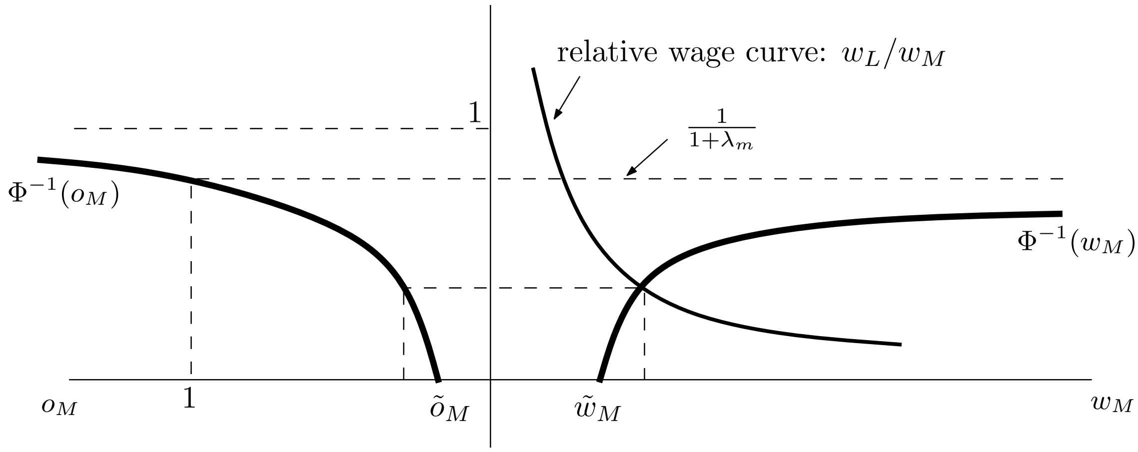
The partial features of the manufacturing wage curve (i.e. taking w_L as given), can be demonstrated as follows. For a better realization, rewrite (18) as

$$\frac{w_L}{w_M} = \Phi(\lambda_m, o_M)^{-1} \equiv 1 - \frac{\bar{\lambda}_m}{o_M(w_M)} \tag{23}$$

where $\bar{\lambda}_m = \frac{\lambda_m}{1+\lambda_m}$ and $o_M(w_M)$ is given by (16). Now, the LHS and RHS can both be seen as a function of w_M for given values of w_L. This is because manufacturing unions take the outside option (w_L) as given when they negotiate. Then, it can be easily verified that the LHS of (23) is a decreasing function of w_M but the RHS is increasing for certain values of both o_M and w_M, as will be discussed below. These relationships are illustrated in Figure 2.

Consider first the right panel of Figure 2. Then, recalling (18), we can draw two curves: one shows the negative relation between the relative wage rate due to changes in w_M (LHS of (23)) holding the low-skilled wage fixed; the second curve illustrates the positive relation between the inverse-wage-mark-up function (Φ^{-1}) and the medium-skilled wage rate (w_M). This relation follows from the positive relationship between the over-qualification rate and the medium-skilled wage rate as higher wages induces a

Figure 2: Properties of manufacturing wage curve



decline in the labour demand and increase, thus, the risk of over-qualification. Recalling the medium-skilled labour demand (6b) and the over-qualification rate (16), then, one can verify the limit cases

$$\lim_{w_M \to \infty} M^d = 0 \quad \Rightarrow \quad \lim_{w_M \to \infty} o_M = 1 \quad \Rightarrow \quad \lim_{w_M \to \infty} \Phi^{-1} = \frac{1}{1+\lambda_m}.$$

The intersection between the two curves in the right plane will determine the equilibrium over-qualification rate and medium-skilled wage level for changes in the low-skilled wage rate. We conclude

Lemma 1. *Positive wages are ensured iff* $o_M \in (\tilde{o}_M, 1)$.

Proof. The proof is rather straight forward. Due to the non-negativity assumption of the wage rates, it follows from (23):

$$\begin{aligned}
\Phi^{-1} &> 0 \\
\frac{\bar{\lambda}_m}{o_M} &< 1 \\
o_M &> \tilde{o}_M \equiv \frac{\lambda_m}{1+\lambda_m} \\
w_M &> \tilde{w}_M \equiv \left[\frac{(1-\alpha-\nu)(r/\nu)^{\nu}(w_H/\alpha)^{\alpha}}{N_M} \frac{(1+\lambda_m)Y_m}{A} \right]^{\frac{1}{\alpha+\nu}}
\end{aligned}$$

where we used the over-qualification definition (16) and labour demand function (6b) for the last inequality. This defines the lower boundary of the over-qualification rate. □

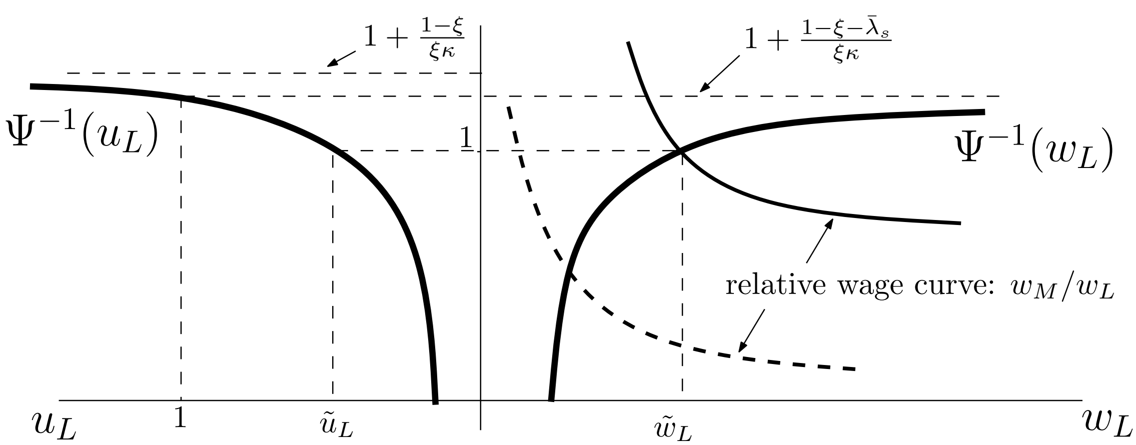
3.6.2. Properties of service wage curve

Similarly, the partial behaviour of the service wage-curve can be assessed as follows. First, rewrite (22) as

$$\frac{w_M}{w_L} = \Psi(\lambda_s, u_L)^{-1} \equiv 1 + \frac{1-\xi}{\xi\kappa} - \frac{\bar{\lambda}_s}{\xi\kappa u_L} \tag{24}$$

where $\bar{\lambda}_s = \frac{\lambda_s}{1+\lambda_s}$. With the same intention described above, we define both the LHS and RHS of (24) as functions of w_L for given values of w_M. The argumentation is analogue to one on the manufacturing wage curve. Thus, we can define two curves with opposite relations to changes in w_M as shown in the right plane of Figure (3), whereas the left plane shows the relation between (Ψ^{-1}) and the unemployment rate (u_L).

Figure 3: Properties of service wage curve



However, the condition that must be satisfied in this case is summarized by the following lemma.

Lemma 2. *The relation $w_M > w_L$ is ensured iff $u_L \in (\tilde{u}_L, 1)$.*

Proof. From (24), it follows:

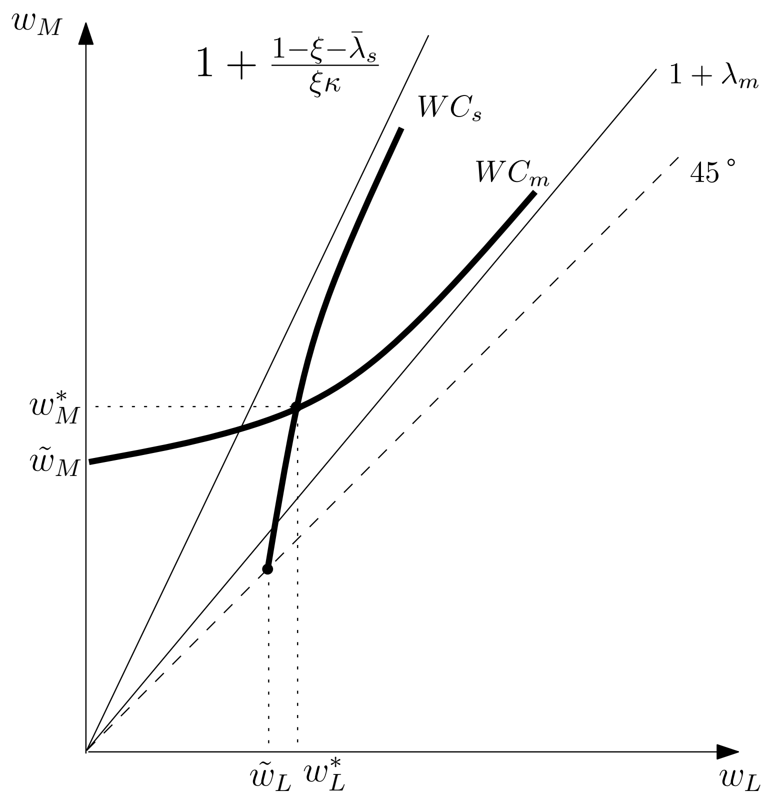
$$\begin{aligned}
\Psi^{-1} &> 1 \\
\frac{\bar{\lambda}_s}{u_L} &< 1-\xi \\
u_L &> \tilde{u}_L \equiv \frac{\bar{\lambda}_s}{1-\xi} \\
w_L &> \tilde{w}_L \equiv \left[\frac{(1-\beta-\eta)(r/\eta)^{\eta}(w_H/\beta)^{\beta}}{((1-q)N_L)}\frac{Y_s}{B}\right]^{\frac{1}{\beta+\eta}}
\end{aligned}$$

where $q \equiv (1-\frac{\bar{\lambda}_s}{1-\xi})$. For the last inequality we used the definition of perceived unemployment rate (explained in footnote 9), and the low-skilled labour demand (7b). This implies that for values of unemployment rate $u_L \in (0, \tilde{u}_L]$ the relation between low- and medium-skilled wage rates is violated, i.e. $w_M \leq w_L$. Therefore, to ensure $w_M > w_L$, the unemployment rate must be strictly larger than the lower boundary $\tilde{u}_L$. □

Now, from these conditions, the unique intersection of the two wage-setting curves can be shown graphically in the (w_M, w_L)-plane. By Lemma 1 and 2, $w_M > w_L > 0$. This indicates that in the (w_M, w_L)-space the wage relation should always be above the 45 degree line. Starting with WC_m, one sees from the RHS plane of Figure 2 that for large values of the low-skilled wage rate, the medium-skilled equilibrium wage rises along the Φ^{-1} curve due to upward shifts of the relative wage curve. Hence, higher w_L increases equilibrium w_M and with it the over-qualification rate which converges to $1+\lambda_m$, the reciprocal of the limit shown in Figure 2.

Analogously, the derivation of WC_s can be explained by recalling the RHS of Figure 3. Now, changes in w_M are associated with moving along the Ψ^{-1} curve. However, as explained above, the necessary condition requires that $\Psi^{-1} > 1$ for $w_L > \tilde{w}_L$. This indicates that in (w_M, w_L)-space the WC_s must start above the 45 degree line. As described above, higher w_M leads to higher w_L along the Ψ^{-1} curve converging to the limit $1+\frac{1-\xi-\bar{\lambda}_s}{\xi\kappa}$. However, it should be noted that in the (w_M, w_L)-plane, the inverse service wage curve is drawn. To ensure a unique equilibrium, $1+\frac{1-\xi-\bar{\lambda}_s}{\xi\kappa} > 1+\lambda_m$ must hold which leads to the following lemma.

Figure 4: Unique equilibrium



Lemma 3. *A unique intersection between the two wage curves is ensured for all*

$$\xi < \tilde{\xi} \equiv \frac{1}{1+\lambda_s}\frac{1}{1+\kappa\lambda_m}.$$

In Table 3, we summarize these conditions and assume that they hold.[11]

An illustration of the interdependence process is that an increase in productivity of manufacturing, relative to that of services, increases the wage rate in the services sector without any justification by the corresponding productivity increases in the latter. This phenomenon is also widely recognized as the main cause of the so-called *Baumol's disease*, which refers to the increasing share of services relative to manufacturing in an advanced economy - see, for instance, Hartwig (2011). It also corresponds to the observation that the low wage differentiation in the Continental Europe is attributed to the centralization and coordination of wage formation (Siebert, 1997).

[11]In the calibration of the model we show that these conditions do hold for plausible parameter values - see Appendix.

Table 3: Equilibrium Conditions

Parameter/Variable	Range	Condition
o_M	$\in (\tilde{o}_M, 1)$	Lemma 1
w_M	$> \tilde{w}_M$	
u_L	$\in (\tilde{u}_L, 1)$	Lemma 2
w_L	$> \tilde{w}_L$	
ξ	$< \tilde{\xi}$	Lemma 3

4. The General Equilibrium Solution

In this section we present the general equilibrium comparative static analysis. The approach we choose is the following: First, we derive the changes from the initial equilibrium. We then give the intuitive interpretation of the results followed by a summary of the general equilibrium repercussions on the over-qualification and unemployment rates as well as on the relative wages.

4.1. A theoretical assessment without capital input

Following the standard approach pursued by Jones (1965), the comparative static analysis can be assessed by means of log-linearization to denote changes from the initial equilibrium, i.e. $\hat{x} = \ln\left(\frac{x+dx}{x}\right) \simeq dx/x$.

By the *Le ChatelierSamuelson* principle, ignoring capital will only affect the results quantitatively, but not in qualitative terms, see Felbermayr and Kohler (2007). For that reason, and for convenience, we simplify the analysis by setting $\nu = \eta = 0$, and thus reducing the model to a two-factor production function with labour as the only input factor.

To begin with, take the total differentiation of the log-difference of the labour demand functions (6a) and (6b), (7a) and (7b), to obtain

$$\hat{w}_H - \hat{w}_M = \hat{M} - \hat{H}_m \tag{25.1}$$

$$\hat{w}_H - \hat{w}_L = \hat{L} - \hat{H}_s \tag{25.2}$$

Linearising the equilibrium conditions for the low- and medium-skilled labour markets, $L = (1-u_L)N_L + o_M N_M$ and $M = (1-o_M)N_M$, as well as the market clearing condition for the high-skilled labour, yield

$$\hat{L} = l(\hat{N}_L - \bar{u}_L\hat{u}_L) + (1-l)(\hat{N}_M + \hat{o}_M) \tag{25.3}$$

$$\hat{M} = (\hat{N}_M - \bar{o}_M\hat{o}_M) \tag{25.4}$$

$$\hat{N}_H = h\hat{H}_m + (1-h)\hat{H}_s \tag{25.5}$$

where $\bar{u}_L = \frac{u_L}{1-u_L}$, $\bar{o}_M = \frac{o_M}{1-o_M}$, and $h = \frac{H_m}{N_H}$. Note that changes in the low-skilled employment are weighted by $l = \frac{(1-u_L)N_L}{L}$. Similarly, log-linearisation of the wage curves (18) and (22), yield

$$\hat{w}_M - \hat{w}_L = \varepsilon_m\hat{o}_M \tag{25.6}$$

$$\hat{w}_L - \hat{w}_M = \varepsilon_s\hat{u}_L \tag{25.7}$$

where $\varepsilon_m = -\frac{\bar{\lambda}_m}{o_M}\Phi(\cdot)$ and $\varepsilon_s = -\frac{\bar{\lambda}_s}{\xi\kappa u_L}\Psi(\cdot)$ denote the wage curve elasticities. From the price-setting definitions (11a) and (11b) we obtain

$$\hat{P}_m = (\alpha\hat{w}_H + (1-\alpha)\hat{w}_M) \tag{25.8}$$

$$\hat{P}_s = (\beta\hat{w}_H + (1-\beta)\hat{w}_L) \tag{25.9}$$

Log-linearisation of the intermediate goods demand equations, (2a) and (2b), yields

$$\hat{Y}_m = \hat{X} - \theta\hat{P}_m \tag{25.10}$$

$$\hat{Y}_s = \hat{X} - \theta\hat{P}_s \tag{25.11}$$

Changes in the total output can, then, be determined by log-linearising (1) which yields

$$\hat{X} = \varphi_x\hat{Y}_m + (1-\varphi_x)\hat{Y}_s \tag{25.12}$$

with $\varphi_x = \gamma\left(\frac{Y_m}{X}\right)^{\sigma_x} = \frac{P_m Y_m}{X}$ denoting the share of Y_m in X. Finally, log-linearising the production functions (3a) and (3b), respectively, yields

$$\hat{Y}_m = \alpha \hat{H}_m + (1-\alpha)\hat{M} \tag{25.13}$$

$$\hat{Y}_s = \beta \hat{H}_s + (1-\beta)\hat{L} \tag{25.14}$$

This system of fourteen equations, (25.1)-(25.14), allows for the assessment of the general equilibrium effects on the fourteen endogenous variables $\hat{X}, \hat{Y}_m, \hat{Y}_s, \hat{P}_m, \hat{P}_s, \hat{H}_m, \hat{H}_s, \hat{M}, \hat{L}, \hat{o}_M$, $\hat{u}_L, \hat{w}_H, \hat{w}_M, \hat{w}_L$.

4.2. Comparative static analysis

In this section we examine the impact of an exogenous increase in the labour supply, which we attribute to immigration in each of the labour markets of our model. Particularly, we are interested in the repercussions on the low- and medium-skilled labour markets and on output. Intuitively, the wage-setting mechanism reveals that any exogenous increase in the labour endowments worsening (or improving) the labour market condition for one of the unionised labour, *ceteris paribus*, has also consequences for the other unionised labour. This is due to the fact that an increase in o_M (or u_L) will force the unions for wag restraint. Therefore, the wage indexation between both medium- and low-skilled unionised workers, resulting from the double bargaining mechanism as well as the endogenous unemployment benefits, implies that the outside option of the other unionised labour market will be affected too. Note that the bumping down effect has an additional direct impact on the low-skilled wages as u_L increases, see Eq. (19).

Accounting for the general equilibrium repercussions, however, we find that the wage restraint behaviour induces a higher labour demand for that type of labour. This is accompanied by changes in the allocation of high-skilled labour across the sectors as well as in the demand for goods due to goods price effects. As we show below, the crucial factor that determines the qualitative impact of migration reveals to be the factor cost share of the high-skilled labour. In what follows, we omit the formal proofs and provide instead the economic intuition of the results.[12].

The first interesting outcome of the analysis regarding changes in the wages as well

[12] A full formal derivation of the general equilibrium comparative static analysis is beyond the scope of this paper, and is therefore given in an extra appendix which can be provided upon request.

as in unemployment and over-qualification rates is the following

Proposition 4. *A proportional increase in supply of all three skill groups is consistent with no change in the wages as well as in over-qualification and unemployment rates.*

The proportional increase of the labour force implies a scale effect as more resources are available in the economy to utilize. Note, however, that the marginal productivity of labour, the high-skilled labour reallocation, the output expansion of both sectors all depend on the size of $(\alpha-\beta)$, as we show below when discussing migration of each type of labour separately. Intuitively, for similar cost shares of the high-skilled labour across the two sectors, i.e. $(\alpha-\beta)\rightarrow 0$, both sectors expand symmetrically due to proportional changes in the production costs, or alternatively in the marginal productivity, and thus inducing constant relative goods prices. Therefore, X, Y_m, Y_s, L and M all increase approximately proportionally. As shown in the last column of Table 4, the impact of migration of any skill group on X is always positive. Thus, setting $\hat{X}=0$ does not affect the results qualitatively, and allows for a better exposition of the driving forces behind the immigration effects.

Next, we discuss the qualitative effects of an exogenous shock of each of the skill groups separately on low- and medium-skilled labour markets. An alternative way to demonstrate the effects on the unemployment and over-qualification rates is to reduce the system of equations derived in the previous section and to solve it for $\hat{o}_M$ and $\hat{u}_L$. In doing so, we obtain the following expressions[13]

$$\begin{aligned} \hat{o}_M &= \frac{(\theta-1)\theta}{\zeta}(\beta-\alpha)\hat{w}_H-\frac{(\beta+\theta(1-\beta))-(\alpha+\theta(1-\alpha))(1-l)}{\zeta}\hat{N}_M \\ &\quad +\frac{(\alpha+\theta(1-\alpha))l}{\zeta}\hat{N}_L \qquad (26) \\ \hat{u}_L &= -\varkappa\hat{o}_M \qquad (27) \end{aligned}$$

where ζ is a negative constant and $\varkappa=\frac{\varepsilon_m}{\varepsilon_s}>0$. These two equations can be utilized to illustrate the role of the high-skilled cost shares (α,β), and to analyse the effects of different migration flows.

[13] The derivation can be worked out as follows: equalize (25.13) and (25.10) as well as (25.14) and (25.11) to eliminate $\hat{Y}_m$ and $\hat{Y}_s$. Then, solve (25.1) and (25.2) for $\hat{H}_m$ and $\hat{H}_s$, respectively, and substitute them in the previously obtained equations. We then obtain two equations which can be solved for $\hat{w}_M$ and $\hat{w}_L$. Utilizing them in Eq. (25.6) and making use of (25.3) and (25.4), then after rearranging we obtain Eq. (26).

Table 4: Comparative Static Results

		$\hat{w}_H$	$\hat{w}_M$	$\hat{w}_L$	$\hat{o}_M$	$\hat{u}_L$	$\hat{X}$
	$\beta > \alpha$				$+$	$-$	
$\hat{N}_H$	$\beta = \alpha$	$-$	$+$	$+$	0	0	$+$
	$\beta < \alpha$				$-$	$+$	
	$\beta > \alpha$				$+/-$	$-/+$	
$\hat{N}_M$	$\beta = \alpha$	$+$	$-$	$-$	$+$	$-$	$+$
	$\beta < \alpha$				$+$	$-$	
$\hat{N}_L$		$+$	$-$	$-$	$-$	$+$	$+$

Assume first the scenario where only high-skilled immigration is allowed, i.e. $\hat{N}_H > 0 = \hat{N}_M = \hat{N}_L$. Unambiguously, the Walrasian nature of the high-skilled labour market induces a decline in $\hat{w}_H$. The labour market implication for the other two skill groups reduces, therefore, to the coefficient of w_H in (26). However, the crucial assumption that characterizes this coefficient is the following. As pointed out by Hamermesh (1993), in a two factor model the inverse of the elasticity of substitution is called the *elasticity of complementarity* indicating the percentage change in factor prices due to a 1 percent change in relative inputs. It denotes how factor prices that a representative firm must pay respond to an exogenous change in factor supply. Using a Cobb-Douglas function implies that both elasticities of substitution and of complementarity equal unity. On the other hand, the goods demand functions show to what extent demand for the two goods will adjust for changes in the goods prices which is determined by the parameter θ. Thus, in our setting, the labour substitution effect within each of the two major sectors is always dominated by the goods demand effect, i.e. $\theta > 1$. This relation is shown in the numerator of the $\hat{w}_H$ coefficient in Eq. (26).[14] The results are summarized in the next proposition.

Proposition 5. *If the economy is characterized by a Cobb-Douglas technology and* $1 - 1/\theta > 0$*, then high-skilled migration has*

i) *a neutral impact on both low- and medium-skilled labour markets for all* $\alpha \approx \beta$

[14] See Felbermayr and Kohler (2007) for the case of CES production functions.

ii) *a positive (negative) effect on the low (medium)-skilled labour market for all $\alpha < \beta$, and vice versa.*

The intuition is the following. It is clear that the right-hand-side of (26) reduces to the coefficient of w_H. As mentioned above, due to the complementarity effect both $\hat{w}_L$ and $\hat{w}_M$ increase. However, the relative increase depends on the size of the high-skilled cost share in each sector. The complementarity effect, for example, will be stronger in the manufacturing sector, for all $\alpha > \beta$, as the marginal productivity of medium-skilled workers rises relatively stronger than of low-skilled workers - or alternatively, we could argue that manufacturing firms experience a stronger decline in the production costs relative to the firms in the service sector. As goods prices are endogenous, the relative manufacturing goods price declines inducing a favourable shift in the demand for manufacturing goods, and thus, to a reallocation of high-skilled labour towards that sector. However, in the service sector the demand for low-skilled labour increases accompanied by a decline in u_L and an increase in o_M. This can be verified from the coefficient of w_H in (26). The opposite result for $\alpha < \beta$ follows by analogy. These effects are illustrated in the first five columns of Table 4 related to the impact of high-skilled migration ($\hat{N}_H$).

The assessment of only medium-skilled migration, i.e. $\hat{N}_M > 0 = \hat{N}_H = \hat{N}_L$, leads to the following results

Proposition 6. *Immigration of only medium-skilled workers has a negative effect on both medium- and low-skilled wages, a positive effect on the over-qualification rate, but a negative impact on the low-skilled unemployment.*

In this case, the right-hand-side of (26) reduces to the two first expressions on the RHS. It is straightforward that the high-skilled wage rate increases due to the complementarity effect. Therefore, following the discussion above, we have to elaborate on the signs of the two coefficients. Assuming $(\alpha - \beta) \to 0$ the analysis reduces to the coefficient of $\hat{N}_M$ which will be then simply $-(\alpha + \theta(1-\alpha))l/\zeta$ with $\zeta < 0$. Thus, the medium-skilled labour market friction unambiguously increases which in turn indicates from (27) that $\hat{u}_L < 0$.[15] The intuition behind the increase in the over-qualification is that due to labour market frictions not all new arriving medium-skilled workers can be absorbed by the labour market. This can be verified from (25.4) where the medium-skilled

[15] In the unlikely extreme where $(\alpha - \beta) \to -\infty$, we find $\hat{o}_M < 0 < \hat{u}_L$ inducing $(\hat{w}_M - \hat{w}_L) > 0$.

labour demand grows less proportional to $\hat{N}_M$. Since, the bumping down effect induces in turn an increase in low-skilled unemployment, *ceteris paribus*, the unions in the service sector are forced for wage restraint inducing a decline in the low-skilled wage. However, lower wages induce an increase in the demand for low-skilled employment. On the other hand, the relative increase in the high-skilled wage rate due to the complementarity effect, induces firms to substitute for high-skilled labour in both sectors. The low-skilled labour demand effect is stronger so that the bumping down effect is dominated which is also verified by our numerical assessment. Thus, the decline in the low-skilled wage rate is mitigated by this effect.

This leads us to the second interesting observation where the relative wage effects are consistent with wage polarization. This can be simply verified from (25.6) where for $(\alpha - \beta) \to 0$, $\hat{o}_M > 0$ inducing $\hat{w}_M - \hat{w}_L < 0$. Similarly, it holds by utilizing (27). Obviously, it follows $\hat{w}_H - \hat{w}_M > 0$ from (25.1).

Proposition 7. *Medium-skilled immigration induces wage polarization.*

The discussion on the results of low-skilled immigration is based on similar argumentation. A summary of the results is presented in Table 4. As mentioned above, the Table also shows that total output will increase in all scenarios. The reason is obvious. A more interesting question is, however, whether output per capita will increase. To answer that question we will turn to the simulation results of the model, presented in next section.

5. Numerical assessment

To simulate the model, we use the EUKLEMS database to calibrate the parameter values which is presented in the Appendix. We use the calibrated parameters and benchmark values of the variables to simulate the impact of migration on output and the labour market.

5.1. Migration scenarios

Similarly to Felbermayr and Kohler (2007), we simulate migration scenarios for different skill compositions of migration flows. Table 5 gives an overview of our simulation scenarios.

Table 5: Simulation scenarios

Scenario	Description
(I)	Perfectly balanced immigration
(II)	Inflow at tails
(III)	Inflow of medium- and high-skilled
(IV)	High-skilled inflow only
(V)	Medium-skilled inflow only
(VI)	Low-skilled inflow only

In scenario (I), we assume a proportional increase in all skill levels which resembles approximately the Dutch immigration scenario, see Muysken and Ziesemer (2011). In scenario (II) we assume immigration to be composed of 75% low-skilled and 25% high-skilled labour. As pointed out by Felbermayr and Kohler (2007), this denotes the most realistic case for the past in the OECD countries, as it features bimodality in migration flows with a bias towards low-skilled migration. We also simulate the model for the current migration pattern within the EU (scenario (III)) where the majority of migrants from new member states (Poland and Baltic states) are predominantly young with medium- or high skill levels (Blanchflower et al., 2007). In doing so, we use as a benchmark the relative share of high-skilled foreign labour force in the U.S. which can be seen as a target value and subtract from that the value for Germany.[16] We, then, compute the percentage inflows such that the overall size of inflows equals 10% of the total labour force.[17] The resulting inflow consists for 44.3% of high skilled workers and the remaining part, 55.7%, is medium skilled. We also assess the quantitative impact of each skill groups separately in the scenarios (IV)-(VI). Furthermore, to ensure comparability between the different cases and due to the fact that just under 10% of the German workforce are foreign born, all scenarios are specified such that the overall size of the inflow is approximately 10%

[16]As used in the migration literature, see Ziesemer (2011), we take the Worldbank data on migration stocks which provide information by educational attainment of immigrants and total labour force. However, the Worldbank data set provides only information for 1975 to 2000 which we use as a proxy.

[17]The computation is as follows: the share of high-skilled immigrants in the U.S. labour force is about 10.91% and in the German labour force about 6.48% in 2000 which makes a difference of 4.43%. Therefore, in scenario (III) the high-skilled labour force has to rise by $44.30\% = 4.43\% \times (N/N_H)$ which gives us a total increase in medium-skilled labour force by $8.80\% = (10\% - 4.43\%) \times (N/N_M)$.

of the initial labour force. Finally, we assume a full adjustment of capital stock. Hence, the results indicate long-run effects.

5.2. Simulation results

The effect of various migration inflows is shown in Table 6. Interestingly, a perfectly balanced migration flow has a neutral impact on the receiving economy. This is mainly due to the linear homogeneity nature of the production functions and full capital adjustments which verifies the results of the theoretical part (Section 4.2.). Migration flow at the tails of the skill distribution (scenario II) has mild positive wage effects for low- and medium-skilled labour, while high-skilled labour is hurt slightly. The labour market conditions of medium-skilled workers improve significantly while low-skilled unemployment risk is increased slightly. Deterioration in the relative commodity prices induces favourable demand shift for service goods and thus triggers relatively more high-skilled towards that sector. We see that the one-skill-type migration policy (scenarios (IV)-(VI)) reflect perfectly the predictions of the model discussed in the theoretical part. Therefore, changes in commodity prices (P_m, P_s) due to changes in factor prices (w_H, w_M, w_L) have significant effects on the reallocation of the mobile labour and on the labour market outcomes of the sector-specific labour. Looking at the welfare effects by means of GDP per head, we obtain the widely observed results where high-skilled migration (scenario IV) is unambiguously beneficial for the receiving country reflected in an increase of GDP per capita by 9% whereas low-skilled migration (scenario VI) might indeed be harmful, a decline of GDP per capita by 2%. However, with respect to medium-skilled migration (scenario V), the result implies a neutral impact as denoted by the overall increase of GDP per capita by almost 10%. Moreover, the impact on the relative medium-skilled wage rate shows the polarization effect confirming our hypothesis that the rise in medium-skilled migration might partly explain this phenomenon.

Finally, the most plausible scenario of a migration flow at the higher skill distribution (scenario III), which is dominated by medium skilled workers, has a positive welfare effect as per capita income rises by 3.75%. This induces us to conclude that overall medium skilled immigration has a positive effect on the economy.

Table 6: Simulation of labour market effects of migration

% changes in	Variables	(I)	(II)	(III)	(IV)	(V)	(VI)
Labour supply	$\hat{N}_H$	10.00	11.13	44.3	100.00	0.00	0.00
	$\hat{N}_M$	10.00	0.00	8.80	0.00	15.88	0.00
	$\hat{N}_L$	10.00	33.39	0.00	0.00	0.00	37.04
Relative wages	$\hat{w}_H - \hat{w}_M$	0.00	−2.84	−37.24	−98.86	11.81	9.05
	$\hat{w}_L - \hat{w}_M$	0.00	−0.743	0.48	0.72	0.28	−0.91
Over-qual. rate	$\hat{o}_M$	0.00	−5.38	3.43	5.24	2.00	−6.61
Unempl. rate	$\hat{u}_L$	0.00	0.60	−0.39	−0.59	−0.22	0.74
Employment							
Medium	$\hat{M}$	10.00	7.12	4.25	−6.95	13.23	8.76
Low	$\hat{L}$	10.00	9.44	7.57	3.27	11.04	10.07
Reallocation	$\hat{H}_m$	10.00	9.97	41.50	91.91	1.41	−0.29
	$\hat{H}_s$	10.00	11.54	45.29	102.86	−0.50	0.10
Capital	$\hat{K}_m$	10.00	8.06	11.08	11.47	10.83	7.52
accumulation	$\hat{K}_s$	10.00	9.63	14.88	22.42	8.93	7.91
Prices	$\hat{P}_m$	0.00	0.37	0.89	2.57	−0.44	0.09
	$\hat{P}_s$	0.00	−0.15	−0.37	−1.08	0.19	−0.04
Output	$\hat{Y}_m$	10.00	7.69	10.19	8.90	11.28	7.43
	$\hat{Y}_s$	10.00	9.78	15.25	23.50	8.74	7.95
	$\hat{X}$	10.00	9.17	13.75	19.19	9.49	7.80

Notes: Scenario (I) has, actually, an asymmetric impact. That is, expansion of service sector is slightly stronger than of manufacturing, e.g. $\hat{Y}_s = 10.000103$ and $\hat{Y}_m = 10.000088$. This is due to the fact that the high-skilled shares are not identical.

6. Concluding remarks

In this paper we present a theoretical model motivated by our stylized facts with two major (manufacturing and services) sectors and heterogeneous labour markets defined by three skill groups to analyse the impact of various skill compositions of immigration. Particular attention is paid to the impact of immigration of medium skilled workers. Although this has been neglected in the literature, our stylized facts show the importance of this specific skill group. The analytical solution of the model shows that it is able to reproduce the stylized facts. We elaborate the labour market as well as the welfare impacts of different migration scenarios. The following outcomes are at the core of our analysis. First, a perfectly balanced immigration flow has a neutral effect on the receiving economy such that GDP per capita remains constant. Regarding the effect of different skill compositions of immigrants two types of immigration scenarios (skilled and unskilled) have been extensively studied. In line with the common conclusion we also find that high-skilled immigration is beneficial for the receiving economy, whereas low-skilled immigration is harmful. Our main results, which focus on medium skilled immigration, are complementary to these findings. First, a stronger wage indexation between medium-skilled and low-skilled might indeed explain the recent negative relation between the over-qualification rate and the unemployment rate. Second, our framework indicates that the recent wage polarization effect might be partly explained by the relative increase in the supply of medium-skilled labour.

Using data for Germany, we analyse the quantitative impact of different immigration scenarios. The results reveal, indeed, that immigration of medium-skilled labour can generate favourable economic outcomes. It boosts, in particular, the labour market conditions for low-skilled labour. An increase in the medium-skilled endowments raises total output to the increase of the labour force, indicating a neutral impact. Moreover, simulating the recent migration pattern (medium- and high-skilled) in the course of EU enlargement reveals an improvement by 3.75% in per capita income. Second, while the impact of immigration on unemployment and on over-qualification has been separately analysed, this paper elaborates the immigration effect on both types of labour market frictions simultaneously.

Our numerical results also reveal that sector-specific migration induces a reallocation of high-skilled labour towards that sector and thus a relatively stronger expansion of that sector. Contrary to standard specific-factors models with Walrasian labour markets where increase in the endowments of the sector-specific factor leads to a contraction of the other sector due to the reallocation of the mobile factor, we observe that in any migration scenarios both sectors always expand. The reasoning for this result is that now immigration of any sector-specific labour has also an adverse effect on the wages of the other sector-specific labour, an outcome which is essentially due to the wage setting mechanism resulting from our bargaining model. This induces firms to utilize the previously idle labour in response to the reallocation of the high-skilled labour into the other sector.

Furthermore, the endogenous goods prices resulting from the price-setting behaviour are the important economic mechanism in explaining the substitutability between different type of labour. Our findings reveal that labour migration has a productivity effect for the firms by lowering the production costs. This in turn explains the changes in the skill intensity across the sectors which in the case of the Cobb-Douglas technology is essentially determined by the relative high-skilled cost shares across the sectors. Moreover, the neutral impact of medium-skilled migration gives an important insight for policy design regarding migration policies to satisfy the future labour replacement demand, for instance, due to ageing.

Appendix: Benchmark statistics and calibration

In order to provide a numerical solution of the model, we match the theoretical model with the data for a certain period. In doing so, we define values for the production side such as the input shares as well as for variables and parameters of our designed labour market like unemployment and over-qualification rates. Our exogenous parameters are $(\alpha,\beta,\nu,\eta,\sigma_x,\theta,\kappa,\xi,\delta_m,\delta_s,\lambda_m,\lambda_s)$. The endogenous variables are $(H_m,H_s,M,L,u_L,o_M,$ $w_H,w_M,w_L,l,h,Y_m,Y_s,P_m,P_s)$ with the following exogenous variables (N_H,N_M,N_L). We compute the values mostly from the EUKLEMS database.[18] We also use when necessary different sources to obtain the values for the specific labour market parameters and variables. Table 7 provides an overview of the calibrated and benchmark equilibrium values. Note, in order to have the best-fit of the model with the data, we define the cost shares of

[18] For an extensive description of the data and the calibration approach, we refer the reader to the working paper version which will be provided upon request.

the specific input factors simply as the sum of low- and med-skilled workers cost shares in each sector. Table 8 summarizes further the labour market benchmark values.

Table 7: Calibrated and benchmark equilibrium values for the industries

Description	Parameter/Variable	Value
Manuf. value-add (in 1000 Euros)[(a)]	P_mY_m	583,191
Service value-add (in 1000 Euros)[(a)]	P_sY_s	1,393,790
High-skilled labour force (in 1000 persons)[(a)]	N_H	3870
Med-skilled labour force (in 1000 persons)[(a)]	N_M	24043
Low-skilled labour force (in 1000 persons)[(a)]	N_L	10092
Total labour force	$N = N_H + N_M + N_L$	38005
Unemployment rate[(b)]	u_L	0.156
Manuf. capital cost share[(a)]	ν	0.27
Manuf. high-skilled cost share[(a)]	α	0.11
Manuf. med-skilled cost share[(a)]	$1-\alpha-\nu$	0.62
Serv. capital cost share[(a)]	η	0.38
Serv. high-skilled cost share[(a)]	β	0.13
Serv. low-skilled cost share[(a)]	$1-\beta-\eta$	0.49
Elasticity of Substitution[(c)]	$\theta = \frac{1}{1-\sigma_x}$	4
	σ_x	0.75

(a) Computed from EUKLEMS data base.
(b) From OECD (2007, Table II.A1.1), denoting 2003-2004 average.
(c) From Abraham et al. (2009).

Table 8: Labour market benchmark values

Description	Parameter/Variable	Value
Over-qualification rate$^{(d)}$	o_M	0.57
Manuf. high-skilled empl. (in 1000)$^{(e)}$	H_m	1012
Serv. high-skilled empl. (in 1000)	$H_s = N_H - H_m$	2859
	$h = \frac{H_m}{N_H}$	0.26
Med-skilled empl. (in 1000)	$M = (1 - o_M)N_M$	10339
Low-skilled empl. (in 1000)	$L = (1 - u_L)N_L + o_M N_M$	22223
	$l = (1 - u_L)N_L/L$	0.38
High-skilled wage rate$^{(f)}$	$w_H = \alpha P_m Y_m/H_m$	63.38
Med-skilled wage rate$^{(f)}$	$w_M = (1 - \alpha - \nu)P_m Y_m/M$	34.97
Low-skilled wage rate$^{(f)}$	$w_L = (1 - \beta - \eta)P_s Y_s/L$	30.73
Manuf. trade union bargaining power$^{(g)}$	δ_m	0.137
	λ_m	0.0743
Serv. trade union bargaining power$^{(h)}$	δ_s	0.087
	λ_s	0.0658
Proportionate factor$^{(i)}$	ξ	0.565
Weighting factor$^{(j)}$	κ	0.50
Manuf. wage curve	$\Phi(\cdot) = \frac{w_M}{w_L}$	1.14
Service wage curve	$\Psi(\cdot) = \frac{w_L}{w_M}$	0.88
Elasticity manuf. wage curve	$\varepsilon_{o_M} = -\frac{\partial \log \Phi(\cdot)}{\partial \log o_M} = -\frac{\lambda_m}{1+\lambda_m}\frac{1}{o_M}\Phi(\cdot)$	-0.14
Elasticity serv. wage curve	$\varepsilon_{u_L} = -\frac{\partial \log \Psi(\cdot)}{\partial \log u_L} = -\frac{\lambda_s}{1+\lambda_s}\frac{1}{\xi \kappa u_L}\Psi(\cdot)$	-1.23

(d) Calibrated to ensure $w_H > w_M > w_L > b$.
(e) Calibration is based on the condition $\alpha \frac{P_m Y_m}{H_m} = w_H = \beta \frac{P_s Y_s}{N_H - H_m}$.
(f) Calibration is based on the EUKLEMS data.
(g) Calibrated from the manufacturing wage-setting curve (18) and (15a).
(h) Calibrated from the manufacturing wage-setting curve (22) and (15b).
(i) Assumed.
(j) Assumed.

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