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Differential labor mobility, agglomeration, and skill-biased migration policies

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Abstract

The paper analyzes the impact of skill-biased migration policies under the economics of agglomeration. It therefore develops an agglomeration model with two types of mobile worker who are heterogeneous and differ both within and between skill groups with respect to their migration propensity. On the one hand, the model reveals that the effectiveness of migration policies depends on the level on trade costs. On the other hand, it shows that increasing (reducing) political barriers to migration for one factor of production, reduces (increases) the migration incentive of the other. Consequently, pro-skilled and contra-unskilled migration policies attenuate each other or can even be counterproductive.

JEL classification: F12; F15; F22; R12

Keywords: agglomeration; labor mobility; economic geography; skill-biased migration policies

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1 Introduction

Industrialized countries are moving towards immigration policies that favor inflows of highly skilled labor. This trend becomes manifest in a variety of policy measures. In the Netherlands and Ireland fast-track visa for specialists facilitate immigration. Canada, Australia, New Zealand and the UK have adopted (or are about to adopt) a point-based immigration scheme where potential migrants earn points on the basis of their qualifications and language skills, their work experience and other personal factors (e.g., age, education of spouse, existing family ties in the destination country). The score achieved in the skill assessment helps to identify and to facilitate entry for highly skilled workers. Other countries, as in the case of Canada, further support the inflow of skilled labor by promoting access to the labor market for their spouses. The current migration policies of the United States are based on immigration quotas with respect to different skill levels. They promote the inflow of skilled labor by non-immigrant visa (H1B visa, which permit a limited duration of stay) or the United States Permanent Resident Card (green card, which does not restrict the duration of stay). But opinions are voiced to adopt a point-based immigration scheme, as well (compare Bartlett (2007)).

Most models which stress and analyze the impact of migration are neoclassical. Like an osmotic process, these models predict migration flows from regions where labor is abundant to regions where it is scarce. Hereby, factor flows change the relative scarcity of factors of production, competing away differences in wages so that regions will converge. But this not necessarily have to be the case. With the development of new trade models and the seminal core-periphery model by the Nobel laureate Krugman (1991) issues of the geographical distribution of economic activity have (re-)entered the focus of economic interest. Since then, a wave of research has yielded both substantial theoretical and empirical insights into the causes, the evolution and the consequences of geographical concentration (see Combes *et. al.* (2008) and Fujita *et. al.* (1999) for an overview). But although many of these model depart from labor mobility, unfortunately only recently "migration theory now recognizes the benefits of agglomeration" as put by the current World Development Report (2009). One of the pioneers to realize the relevance of agglomeration forces in the migration process were Commander *et. al.* (2004). The authors offered a first re-interpretion of standard new economic geography models and worked out significant contributions with respect to migration theory (or more concisely brain drain) as there were trade cost dependent migration pressure, uneven development as a natural phase of world development, and skilled labor emigration being detrimental for those left behind. However, as this paper will show, agglomeration models have more to offer with respect to migration theory, especially if there is more than one mobile type of workers involved. Not only have there been first theoretical advances but also empirical evidence which suggest to consider agglomeration economies as a driving force of migration (see Fujita *et. al.* (1999) and Combes *et. al.* (2008) for critical overviews). Especially the results by Crozet (2004) and Pons *et. al.* (2007) are worth mentioning. The authors find that indexes which measure the access to sources of supply are a significant determinant of people's migration decision. Or stated intuitively, people value agglomeration benefits.

So far, agglomeration models based on labor mobility have been exploited to explain the patterns of spatial agglomeration and their evolution with respect to the level of economic integration. These frameworks establish a relation between trade costs and the degree of spatial agglomeration. They predict dispersion of economic activity at high levels of trade costs. Economic integration then leads to agglomeration and, depending on the specification of the particular model, to redispersion once trade costs are sufficiently low. These models have been fruitful to explain the emergence and the evolution of regional agglomeration pattern, but due to their basic structure they are not suitable to analyze the impact of skill-biased migration policies. Although they typically depart from two factors of production, only one input is assumed to be mobile between regions, whereas the other factor of production is bound to its region of origin.

This paper develops an agglomeration model with two mobile types of labor, which differ with respect to their abilities and migration impediments. Taking agglomeration forces explicitly into account, it addresses the effects of skill-biased migration policies in a setting where market size plays a role. On the one hand, the model reveals that the effectiveness of migration policies depends on the level on trade costs. On the other hand, the paper shows that skill-biased migration policies which discriminate between migrants of different skill groups attenuate each other and can even be counterproductive with respect to the initial policy intention.

The contributions of the approach presented here are two-fold:
Firstly, the paper develops an agglomeration model with two types of mobile and heterogeneous workers. Here, heterogeneity becomes manifest in two respects. On the one hand, labor differs with respect to its ability. There are self-employed workers (who are referred to as skilled labor) and (unskilled) employees, who are employed by firms. On the other hand, workers have individual sources of (dis-) utility - be it from heterogeneous preferences over locations, costs or benefits from being remote from one's own socio-cultural surrounding and/or political barriers to migration.

Secondly, the model is used to analyze the impact of skill-biased migration policies under increasing returns to scale. In standard agglomeration models this has not been feasible as they depart from only one mobile type of labor. The paper shows that measures which promote the inflow of skilled labor *ceteris paribus* increase the immigration incentive for unskilled labor. If immigration policies, in turn, artificially increase migration impediments for unskilled labor, skilled workers, too, haver fewer incentives to immigrate. This is counterproductive to policy measures which aim at increasing immigration flows of the skilled workforce. These effects seem familiar from neoclassical migration models, but there are substantial differences. While in neoclassical models immigration affects marginal productivities and wages, here individual productivities are held constant. Rather, the fundamental intuition behind changes real wages is the home market effect. Larger markets attract a larger share of businesses and working places for skilled labor. Markets with a great number of businesses and firms attract both skilled and unskilled labor. Consequently, migration policies which impede labor to enter the country keep markets artificially small and decrease the immigration incentive for both skilled and unskilled labor. Apart from that, neoclassical approach predict deconcentration, whereas here labor may migrate where it is already abundant. Hereby, regional asymmetries arise endogenously from ex ante identical regions.

This paper is not the first attempt to analyze the impact of migration impediments in form of taste heterogeneity and regional preferences under agglomeration economics, but it exhibits significant differences to former approaches. Ludema and Wooton (1999) and Tabuchi and Thisse (2002) have developed agglomeration models with two types of labor as factors of production. Different from here, one of them is immobile between regions, whereas the other can freely migrate but is heterogeneous with respect to appreciations of regions. In Murata (2003) there is only one factor of production, which is mobile between regions. To derive non-trivial result it departs from heterogeneous preferences over locations, which impede migration movements.

This paper is organized as follows: section 2 describes the basic assumptions of the model and derives the short-run equilibrium for any given distribution of skilled and unskilled labor. Section 3 is dedicated to the long-run equilibrium of the model and determines the agglomeration pattern of both skilled and unskilled labor. In section 4, the impact of skill-biased migration policies is analyzed. Section 5 concludes.

2 The model

2.1 The basic set-up

There are two countries in the economy named home (H) and foreign (F)[1]. Both countries are identical with respect to production technologies and the (initial) endowment of factors of production. There are two types of households, skilled and unskilled. The world population of unskilled labor is given by L which is the sum of unskilled labor living in home (L_H) and foreign (L_F). The world-wide mass of skilled people is formalized by K and is composed of skilled people of both regions, K_H and K_F (the subindex indicates the region of residence). Each type inelastically supplies one unit of factor input and receives unskilled wages (W) or skilled wages (R) as income, respectively. This income is entirely spent for the consumption of goods from which people derive utility. There are two types of goods. The homogeneous good (A) is produced under perfect competition with a linear constant returns to scale technology using unskilled labor as the only input. The homogeneous good can be traded without trade costs and serves as

[1] The basic set-up departs from Pflüger (2004) and Russek (2008).

the numéraire. Furthermore, there is a set of heterogeneous goods (X) which shall be called manufacturing goods. Each variety is produced under monopolistic competition and increasing returns to scale using both skilled and unskilled labor. Unskilled labor is the only variable factor of production. The marginal input requirement is constant and is given by c. Furthermore, each firm needs one unit of skilled labor as fixed input (*e.g.*, headquarter services or R&D). Varieties of heterogeneous goods incur trade costs when traded between the regions, within a region trade is costless.

Both skilled and unskilled labor are assumed to be mobile across regions, but incur costs when migrating from one region to the other. These costs differ between individuals. Within one region both types of workers are perfectly mobile between sectors. $\lambda = K_H/K$ and $(1-\lambda) = K_F/K$ express the share of skilled workers living in home (foreign) in relation to the world population of skilled workers. The share of unskilled workers residing in home (foreign) with respect to the world population of skilled labor is denoted by $\rho = L_H/K$ and $(\overline{\rho} - \rho) = L_F/K$. The parameter $\overline{\rho} = L/K$ is the world population of unskilled workers relative to the world population of skilled labor.

2.2 Preferences and demand

Preferences for goods are homogeneous and are given by a logarithmic quasi-linear utility function. The homogeneous good enters the utility function in the form of the linear extension, whereas the aggregate of heterogeneous goods enters logarithmically and is modeled as a CES bundle:

$$\begin{aligned} U &= \alpha \ln C_X + C_A \qquad \text{where } C_X \equiv \left[\int_{i=0}^{N_H} x_i^{\frac{\sigma-1}{\sigma}} \mathrm{d}n + \int_{j=N_H}^{N_F} x_j^{\frac{\sigma-1}{\sigma}} \mathrm{d}n \right]^{\frac{\sigma}{\sigma-1}} \\ \alpha &> 0, \qquad \sigma > 1 \end{aligned} \tag{1}$$

C_X (C_A) is the quantity consumed of the heterogeneous aggregate (homogeneous good), σ measures the elasticity of substitution between any pair of heterogeneous goods and is assumed to be greater one. The positive parameter α measures the weight of heterogeneous goods in the utility function. x_i (x_j) represents the per capita consumption of a domestic (imported) heterogeneous good. N_H and N_F stand for the number of domestic and foreign firms producing each one variety of the manufacturing good. Households maximize their utility given the budget constraint defined as follows:

$$PC_X + C_A = Y \qquad \text{where} \;\; P \equiv \left[\int_{i=0}^{N_H} p_i^{1-\sigma} \mathrm{d}n + \int_{j=N_H}^{N_F} (\tau p_j)^{1-\sigma} \mathrm{d}n \right]^{\frac{1}{1-\sigma}}, \tau > 1 \quad (2)$$

P is the optimal CES price index where the price of the domestic (imported) variety is given by p_i (p_j). As the homogeneous good is the numéraire, its price is normalized to one. The parameter τ is greater one and captures the (iceberg) trade costs. The income per household is given by Y which is W for unskilled and R for skilled labor. Utility maximization with respect to quantities consumed yields the following demands and the indirect utility function V:

$$\begin{aligned} C_X &= \alpha/P, \qquad C_A = Y - \alpha \\ x_i &= \alpha \; p_i^{-\sigma} \; P^{(\sigma-1)}, \qquad x_j = \alpha \; (\tau p_j)^{-\sigma} \; P^{(\sigma-1)} \\ V &= Y - \alpha \ln P + \alpha(\ln \alpha - 1) \end{aligned} \quad (3)$$

To guarantee that both types of goods are consumed, α is assumed to be less than Y.

2.3 Production and short-run equilibrium

The homogeneous good is produced under constant returns to scale and perfect competition. The production technology of the numéraire is assumed to be linear using a unit input requirement of unskilled labor. Consequently, the wage of unskilled workers equals one.

Each variety of the heterogeneous good is produced under increasing returns to scale with a linear production technology using unskilled labor as variable input. To produce one unit of the good, c units of unskilled labor is needed. Furthermore, one unit of skilled labor is required as fixed input to produce at all. Firms serve both the domestic and the foreign market. Exporting goods incurs trade costs which are formalized by iceberg trade costs. Hence, if τx units are sent away, x units arrive at the foreign market. Firms aim to maximize their profit function Π which for firm i is given by

$$\Pi_i = (p_i^H - c)(L_H + K_H)\ x_i^H\ +\ (p_i^F - c)(L_F + K_F)\ \tau x_i^F - R_i \tag{4}$$

The first (second) term on the LHS is the demand of the domestic (foreign) market. Maximizing profits with respect to the prices p_i^H and p_i^F leads to the following equilibrium prices:

$$p_i^H\ = p_i^F = p = \frac{\sigma}{\sigma - 1}c \tag{5}$$

Equilibrium prices are characterized by a constant mark-up over marginal costs (mill pricing). Due to free market entry and exit of firms, profits are zero in equilibrium. Setting the equilibrium price equal to average production costs reveals the equilibrium relation between firm size and skilled wages:

$$R_i = \frac{X_i c}{\sigma - 1} \tag{6}$$

where X_i is the aggregate production of variety i. In equilibrium aggregate production has to be equal aggregate demand by all skilled and unskilled workers. As prices are given by Eq. (5), the market clearing condition is uniquely determined by:

$$X_i = \frac{\alpha(\sigma - 1)(L_H + K_H)}{\sigma c[K_H + \phi K_F]} + \frac{\alpha(\sigma - 1)(L_F + K_F)\phi}{\sigma c[\phi K_H + K_F]} \tag{7}$$

where the RHS of Eq. (7) is the aggregate demand from domestic and foreign consumers. ϕ measures the freeness of trade and is commonly given by $\phi = \tau^{1-\sigma}$. If trade costs tend to infinity, ϕ tends to zero. If trade is costless, ϕ is one. As X_i is identical for all firms i, the subindex of X and R can be omitted. Substituting Eq. (7) into Eq. (6) and dividing both the denominator and the enumerator by K yields the equilibrium wage for skilled workers in region H for any given domestic share of skilled and unskilled labor (for region

F the analogous holds true):

$$R_H = \frac{\alpha}{\sigma}\left[\frac{\lambda+\rho}{\lambda+(1-\lambda)\phi} + \frac{\phi[(1-\lambda)+\overline{\rho}-\rho]}{\phi\lambda+1-\lambda}\right] \tag{8}$$
$$R_F = \frac{\alpha}{\sigma}\left[\frac{\phi(\lambda+\rho)}{\lambda+(1-\lambda)\phi} + \frac{1-\lambda+\overline{\rho}-\rho}{\phi\lambda+1-\lambda}\right]$$

Once the goods market equilibrium is determined, the labor market equilibrium can be characterized. The demand for unskilled labor per manufacturing firm in region H related to the equilibrium aggregate production X per variety is given by $N_H cX$. Putting Eq. (6) into this expression yields the following expression for the labor demand of the domestic manufactoring sector:

$$L^D = N_H R_H(\sigma - 1) \tag{9}$$

Unskilled workers who are not employed in the manufacturing sector find employment in the homogeneous good sector. The demand for unskilled labor given by Eq. (9) is assumed to be less than the regional supply of unskilled labor L_H so that in either region both types of goods are produced. Due to unskilled labor mobility the regional supply of unskilled labor is not exogenously given, but rather arises endogenously. In section 3 it is shown that the regional supply of unskilled labor is a function of trade costs and the geographical distribution of skilled workers. Taking into account the mobility of unskilled labor, the assumption of regional non-specialization is fulfilled for any given level of trade costs and for any geographical distribution of skilled labor whenever $\alpha < \sigma/2(\sigma-1)$ and $\overline{\rho} > \alpha(\sigma-1)/(\sigma/2-\alpha(\sigma-1))$. Furthermore, unskilled labor must not too mobile[2]. Substituting equilibrium prices from Eq. (5) into the CES- price index yields:

$$P_H = p^*[\lambda+(1-\lambda)\phi]^{\frac{1}{1-\sigma}} \qquad P_F = p^*[\lambda\phi+(1-\lambda)]^{\frac{1}{1-\sigma}} \tag{10}$$

[2]Due to the analytical expression of the labor supply curve the points of intersection between the labor supply and demand curve cannot be determined analytically. But as both the labor demand and the labor supply are increasing in λ, it is possible to focus on $\lambda = \{0, 0.5, 1\}$. At these points the labor supply is always greater than the labor demand, if the above parameter restriction hold. Assuming that matching costs of unskilled labor are not too small ensures that labor supply of unskilled workers is greater than labor demand for any $\lambda \in [0,1]$.

3 Long-run equilibrium

In the long run, skilled and unskilled labor are mobile across regions, but incur mobility costs. Following Tabuchi and Thisse (2002), these costs may arise from preferences over locations, from being remote from one's socio-cultural surrounding, political obstacles and other factors of influence. Consequently, they should be understood as permanent matching costs. The strength of these impediments to migration depends largely on (partially unobserved) personal characteristics, so that these costs differ between individuals. Heterogeneity is modeled by stochastic utility functions which are given by $\overline{V}_{rsk} = V_{rs} + \epsilon_{rsk}$. The term $\overline{V}_{rsk}$ is the perceived utility of person k with ability s (skilled labor is subindex by λ, unskilled by ρ) in region r, the expression V_{rs} is given by Eq. (3) and stands for the indirect utility in region $r \in [H, F]$ for skill-level s. ϵ_{rsk} is a stochastic component which accounts for unobserved sources of (dis-)utility of person k and ability s in region r. Within skill groups, ϵ_{rsk} is assumed to be independently Gumbel[3] distributed for all k with a a variance of $\pi^2\eta^2/6$ and mode m_{sr}, which may vary between regions. The parameter η is a positive scale parameter. π is the circular constant.

A worker of ability s migrates to the region where his perceived indirect utility $\overline{V}_{rsk}$ is greatest. This assumes that the migration decision is lead by two major components. On the one hand individual characteristics, on the other a comparison of real wages. Here, real wages do not only contain information about wage and price levels (compare Eq.(3)) but also include a measure of access to sources of supply (see Eq. (10)). The latter is shown to be a significant determinant of people's migration decision (compare Pons *et. al.* (2007) and Crozet (2004) for more details). As ϵ_{rsk} are independently distributed within skill groups and only vary with respect to modes, the share of workers of type s in region H with respect to the corresponding worldwide stock of these workers is determined by the probability that $\overline{V}_{sH}$ exceeds $\overline{V}_{sF}$. The share of s-workers in F is determined analogically. As the difference in two Gumbel distributed variables follows a logistic distribution (compare Anderson *et. al.* (1992)), the condition for a spatial equilibrium of each type of

[3]The type of distribution is irrelevant. But assuming a Gumbel distribution leads to a closed form solution of the matching cost function.

labor in region H is given by

$$\Delta V_s - \left(\eta \ln\left[\frac{\psi}{1-\psi}\right] - (m_{sH} - m_{sF})\right) = 0 \tag{11}$$

where ψ denotes either the share of skilled labor λ or the share of unskilled labor $\rho/\overline{\rho}$ in H. ΔV_s is the difference in indirect utilities relevant for workers of skill-type s. Using Eq. (3), ΔV_s is given by

$$\Delta V_s \equiv V_{sH} - V_{sF} = -\alpha(\ln P_H - \ln P_F) + (Y_{sH} - Y_{sF}) \tag{12}$$

The second and third term on the RHS of Eq. (11) capture the matching costs $C(\psi)$. Term three is the difference in modes and is a measure of relative regional attractiveness. The more attractive is region H in comparison to region F, the smaller are matching costs. The term in logs captures the impact of individual heterogeneity, whose strength is determined by η: the greater η, the greater are matching costs. Following the empirical literature (e.g., Carrington and Detragiache (1998), Docquier and Marfouk (2006), Borjas *et. al.* (1992), Hunt (2000)), these costs are assumed to differ between skilled and unskilled labor, so that skilled labor faces lower costs than unskilled labor. On the one hand skilled labor should have greater ease to adapt to new socio-cultural environments. On the other hand, (score-based) immigration policies favor skilled labor rather than unskilled labor immigration. In what follows η takes on the value ν (μ) for skilled (unskilled) labor with $\nu < \mu$.

Using Eq. (10) and (8) in (12) and taking into account that in both regions unskilled wages equal one, the conditions for spatial equilibria are given by

$$\begin{array}{rcllll} S(\lambda) & \equiv & \frac{\alpha}{\sigma-1}\ln\frac{\lambda+\phi(1-\lambda)}{\lambda\phi+1-\lambda} & +\Delta R & -\left(\nu\ln\left[\frac{\lambda}{1-\lambda}\right] - \Delta m_\lambda\right) & = 0 \\ G(\rho/\overline{\rho}) & \equiv & \frac{\alpha}{\sigma-1}\ln\frac{\lambda+\phi(1-\lambda)}{\lambda\phi+1-\lambda} & & -\left(\mu\ln\left[\frac{\rho/\overline{\rho}}{1-\rho/\overline{\rho}}\right] - \Delta m_\rho\right) & = 0 \end{array} \tag{13}$$

where $\Delta R = \frac{\alpha(1-\phi)}{\sigma}\left(\frac{\rho+\lambda}{\lambda+(1-\lambda)\phi} - \frac{\overline{\rho}-\rho+1-\lambda}{\phi\lambda+1-\lambda}\right)$. Equations $S(\lambda)$ and $G(\rho/\overline{\rho})$ are the migration incentives of skilled and unskilled labor net of mobility costs. The two equations in λ and $\rho/\overline{\rho}$ determine **simultaneously** and **unambiguously** the spatial equilibria. To analyze the stability of the equilibria defined by Eq. (13), it is assumed that skilled labor takes the initiative to deviate from a spatial equilibrium, whereas unskilled labor is assumed to follow. The approach is motived by the fact that skilled workers face less matching costs and, therefore, have greater ease to choose their region of residence[4]. For any distribution of skilled labor, the equilibrium share of unskilled labor is given by solving $G(\rho/\overline{\rho})$ in Eq. (13) with respect to $\rho/\overline{\rho}$:

$$\frac{\rho(\Delta V_U)}{\overline{\rho}} = \{1 + \exp[(-\Delta V_U - \Delta m_\rho)/\mu]\}^{-1} \tag{14}$$

Here, $\Delta V_U = \Delta V_U(\lambda, \phi)$ represents the migration incentive of unskilled labor as defined by Eq. (12). Using Eq. (14) in $S(\lambda)$ yields the equilibrium condition of skilled labor taking into account the reaction of unskilled workers $S(\lambda) = S(\lambda,\ \rho(\lambda, \phi),\ \phi)$.

3.1 Model forces and their interplay

Assume for now that there are no differences in regional attractiveness except individual heterogeneity, so that $m_{sH} = m_{sF}$. Consequently, the symmetric allocation of skilled and unskilled labor is always an equilibrium ($S(\lambda = 0.5) = 0$). The stability of this equilibrium is revealed by the sign of the first derivative of $S(\lambda)$ with respect to λ evaluated at symmetry, which is given by:

$$\left.\frac{\mathrm{d}S(\lambda)}{\mathrm{d}\lambda}\right|_{\lambda=1/2} = \left[\frac{\partial(-\alpha\Delta\ln P)}{\partial\lambda} + \frac{\partial\Delta R}{\partial\lambda} + \frac{\partial\Delta R}{\partial\rho}\frac{\mathrm{d}\rho}{\mathrm{d}\lambda} - \frac{\partial C(\lambda)}{\partial\lambda}\right]_{\lambda=1/2} \tag{15}$$

where $\Delta\ln P \equiv \ln P_H - \ln P_F$ and $\Delta R \equiv R_H - R_F$. The analytical expressions of the linkages can be found in appendix A. The first expression is the supply linkage. When λ rises the price index in H falls, because more varieties are produced domestically and do not have to be imported. In F the opposite holds true, which leads to a greater migration incentive for skilled labor toward H. The second term of Eq. (15) can be decomposed into two different forces (compare Pflüger and Südekum (2008)). Firstly, holding the individual demand per good constant, an increase in λ leads to a bigger domestic market

[4] Alternatively, unskilled labor could take the initiative to deviate from a spatial equilibrium, whereas skilled labor follows according its equation of motion. But the results and insights can be shown to be identical.

and higher profits. This increases the attractiveness of region H (demand linkage by skilled labor). Secondly, holding the market size constant, the lower price index in H relatively increases the price of a variety in region H. Consequently, people demand less units per variety, which lowers the profit of domestic firms making the region less attractive (competition effect). The third term of the LHS of Eq. (15) is the demand linkage by unskilled labor which originates in unskilled labor mobility. An increase in λ raises the migration incentive of unskilled workers as the price index drops in H and rises in F. The gap in regional price levels then increases the share of unskilled labor residing in H and increases the domestic market. This in turn raises domestic profits and the wages of the skilled workforce. Summarizing, there are three forces which foster agglomeration, whereas the competition serves as dispersion force. The fourth term of Eq. (15) reflects the fact that skilled workers face matching costs. Migration is profitable if the increase in real wages outweighs the marginal costs associated with it.

Eq. (13) and (15) show that the migration incentive (terms one to three) can be additively separated from migration costs (term four). The migration incentive of skilled labor is a function of the degree of unskilled labor mobility (μ) and its relative population size ($\overline{\rho}$). The mobility parameter μ influences the relative strength of the demand linkage by unskilled labor and the competition effect. If $\mu > \alpha/(\sigma - 1)$, the (dispersive) competition effect is stronger than the (agglomerative) demand linkage by unskilled workers at any level of trade costs. The relative population size $\overline{\rho}$ determines by how much the competition effect exceeds the demand linkage. If $\overline{\rho}$ is great ($\overline{\rho} > \overline{\rho}_t$, see appendix B), the net dispersion force is strong leading to a migration incentive at symmetry (bold lines) as shown by Fig. 1a. The figure plots the level of trade freeness against the marginal migration incentive at $\lambda = 0.5$. The migration incentive is negative for high levels of trade costs, but becomes positive once trade costs have fallen below a critical threshold. The smaller the relative population size of unskilled workers, the less important are the competition effect and the demand linkage by unskilled workers. Consequently, the (agglomerative) supply and demand linkage by skilled labor gain strength. The latter forces are the stronger, the higher are trade costs (see appendix A). Fig. 1b shows the corresponding migration incentive for $\overline{\rho}_t/2\sigma < \overline{\rho} < \overline{\rho}_t$. The migration incentive of skilled labor is positive for any level of trade costs and exhibits a maximum in $\phi \in [0,1]$. For $\overline{\rho} < \overline{\rho}_t/2\sigma$ the migration incentive is positive for all levels of trade costs but downward-sloping in $\phi \in [0,1]$ as depicted in Fig 1c. Next, assume that $\mu < \alpha/(\sigma-1)$. The demand linkages by skilled and unskilled labor then overcompensate the competition effect. Agglomeration forces prevail so that the migration incentive for skilled labor is positive but steadily decreasing in $\phi \in [0,1]$. See also Fig. 1c.

[Figures 1a to 1c about here]

Next the impact of matching costs for skilled labor is considered. At symmetry the marginal costs are given by 4ν, which is constant (see appendix A). The dashed horizontal lines in Figs. 1a to 1c reflect different values of these costs. The intersections between migration incentive and the marginal migration cost curves are the break point (*i.e.*, the level of trade costs at which a symmetric allocation becomes unstable) and the redispersion point (*i.e.*, the level of trade costs at agglomeration becomes unstable). If marginal costs are greater than the migration incentive, the population is dispersed. Otherwise, we observe (partial) agglomeration. Analytically, the two critical thresholds are determined by setting Eq. (15) evaluated at symmetry equal to zero and solving it for ϕ:

$$\phi_b = \frac{\mu(\sigma-1)[\alpha(1+\overline{\rho})-\nu\sigma]-\alpha^2\overline{\rho}-\sqrt{Z}}{\mu\left[\nu(\sigma-1)\sigma-\alpha(2+\overline{\rho}-(3+\overline{\rho})\sigma)\right]-\alpha^2\overline{\rho}} \tag{16}$$

$$\phi_r = \frac{\mu(\sigma-1)[\alpha(1+\overline{\rho})-\nu\sigma]-\alpha^2\overline{\rho}+\sqrt{Z}}{\mu\left[\nu(\sigma-1)\sigma-\alpha(2+\overline{\rho}-(3+\overline{\rho})\sigma)\right]-\alpha^2\overline{\rho}} \tag{17}$$

$$\text{with} \quad Z = \alpha\mu\left[\alpha\left(\mu(2\sigma-1)^2+4\nu\overline{\rho}(\sigma-1)\sigma\right)-4\mu\nu(1+\overline{\rho})(\sigma-1)^2\sigma\right]$$

where ϕ_b (ϕ_r) is the break (redispersion) point. Whether and which of these two thresholds is real and lies in the inteval $\phi \in [0,1]$, depends on the degree of matching costs of both types of labor, μ and ν, as well as the relative population size $\overline{\rho}$. Table 1 summarizes the results.

Parameter values are displayed in appendix B. Whenever ν is greater than the upper bound ν_{max}, the migration incentive is always less than the marginal migration costs for

Table 1: Overview of parameter restrictions

μ	case	$\overline{\rho}$	ν_{min}	ν_{max}
$\mu > \alpha/(\sigma-1)$	(a)	$\overline{\rho} > \overline{\rho}_t$	0	$\overline{\nu}$
	(b)	$\overline{\rho}_t/2\sigma < \overline{\rho} < \overline{\rho}_t$	$\underline{\nu}$	$\overline{\nu}$
	(c)	$\overline{\rho} < \overline{\rho}_t/2\sigma$	0	$\underline{\nu}$
$\mu < \alpha/(\sigma-1)$	(d)	$\overline{\rho} > 0$	0	$\underline{\nu}$

all levels of trade costs so that dispersion is the only stable equilibrium[5]. Therefore, neither the break nor the redispersion point exist. If in cases (**a**) and (**b**) it holds true that $\nu_{min} < \nu < \nu_{max}$, both the break and redispersion point lie in the interval $\phi \in [0,1]$. Consequently, we observe dispersion - agglomeration - redispersion in the process of economic integration. If in case (**b**) the level of skilled migration costs is smaller than the lower threshold ν_{min}, only ϕ_r is in $\phi \in [0,1]$. Consequently, even at high levels of trade costs, the economy is (partially) agglomerated in either region. Economic integration then leads to further agglomeration before redispersion is observed . In cases (**c**) and (**d**) the greatest migration incentive is observed at high levels of trade costs. As long as migration costs of skilled labor are lower than ν_{max} reported in Table 1, only ϕ_r is in $\phi \in [0,1]$ so that we also observe agglomeration for high levels of trade costs. Falling trade cost lead to redispersion.

The comparative statics of the break and redispersion point are straightforward: $\partial\phi_b/\partial\alpha < 0$ and $\partial\phi_r/\partial\alpha > 0$ which is due to stronger agglomerative forces as heterogeneous goods get more weight in the utility function, $\partial\phi_b/\partial\mu > 0$ and $\partial\phi_r/\partial\mu < 0$ meaning weaker agglomerative forces as the unskilled demand linkage becomes less important. With respect to changes in the elasticity of substitution, we find that $\partial\phi_b/\partial\sigma > 0$ and $\partial\phi_r/\partial\sigma < 0$ since agglomeration forces become weaker as firms have less market power and lower mark-ups over marginal costs. And finally, we have $\partial\phi_b/\partial\overline{\rho} > 0$ and $\partial\phi_r/\partial\overline{\rho} < 0$, if migration costs of unskilled labor μ are greater than $\alpha/(\sigma-1)$. The competition effect then outweighs the demand linkage of unskilled labor, so that a greater number of unskilled labor strengthens the dispersive competition effect. Otherwise, we find that $\partial\phi_b/\partial\overline{\rho} < 0$ and $\partial\phi_r/\partial\overline{\rho} > 0$.

[5] The value $4\nu_{max}$ corresponds with the greatest value of migration incentive in the interval $\phi \in [0,1]$.

3.2 The patterns of regional development

3.2.1 Skilled labor agglomeration

The focus of this section is to highlight the interaction between the migration incentive of skilled labor and its matching costs graphically[6]. This graphical-intuitive approach was first used by Ludema and Wooton (1999) and has proven to be a usefool tool in analyzing more complex agglomeration models. Recall that in Eq. (13) the matching costs of skilled labor (MC_λ in short) can be separated additively from the migration incentive (MI_λ in short). Consequently, the two curves can be depicted separately in a single diagram. As in Ludema and Wooton (1999) a spatial equilibrium is obtained at points of intersection between MI_λ and MC_λ. The stability of such an equilibrium is revealed by the slopes of the respective curves. Whenever the slope of MC_λ is greater (smaller) than the slope of MI_λ at a point of intersection, the spatial equilibrium is (un-)stable.

Fig. 2a and 3a show the migration incentive curve as well as the cost curve for different values of trade costs and structural parameters. MC_λ is independent of trade costs and is upward sloping in the whole interval $\lambda \in [0, 1]$. The greater ν, the steeper is the curve. When λ tends to 1 (0), MC_λ tends to (negative) infinity. For $m_{sH} = m_{sF}$ and $\lambda = 0.5$, MC_λ takes the value zero. When the relative attractiveness of region H (F) increases, *i.e.* $m_{sH} > (<) m_{sF}$, MC_λ shifts downward (upward).

The shape of MI_λ depends on the degree of unskilled labor mobility μ as well as the relative stock of unskilled labor $\overline{\rho}$. For parameters of case (**a**) in Table 1 and $\mu > \mu_{crit} > \alpha/(\sigma - 1)$ (see appendix B), MI_λ is concave around $\lambda = 0.5$ and is as shown by Fig. 2a. At high levels of trade costs MI_λ is downward-sloping, but economic integration increases the migration incentive. Once the break point is reached, falling trade costs lead to a smooth and reversible transition from dispersion to partial agglomeration. Further reductions of trade costs reduce the migration incentive and lead to redispersion of skilled labor. Once trade costs have fallen below the redispersion point, dispersion is the only stable equilibrium. The resulting pattern of regional development is bubble-shapedas shown in

[6] Analytically, the type of agglomeration pattern is determined by the sign of the third derivative of the migration incentive $S(\lambda)$ with respect to λ evaluated at the critical levels of trade costs ϕ_b and ϕ_r. Appendix B shows these measures.

Fig. 2b. Case (**b**) yields qualitatively similar results, if $\underline{\nu} < \nu < \overline{\nu}$. Observe that complete agglomeration never is an equilibrium, because MC_λ tends to (negative) infinity when λ tends to 1 (0).

[Figures 2a and 2b about here]

If unskilled labor faces small mobility costs so that $\alpha/(\sigma-1) < \mu < \mu_{crit}$ and the relative population size of unskilled labor exceeds a certain threshold $\overline{\rho} > \overline{\rho}_{crit} > \overline{\rho}_t$ (see appendix B), MI_λ is convex around symmetry and is as shown by Fig. 3a. The evolution of MI_λ with respect to falling trade costs is similar to the above: At high (low) levels of trade costs, economic integration makes MI_λ rotate counterclockwise (clockwise). The interplay of MI_λ and MC_λ leads to a set of regional distribution patterns as described in Ludema and Wooton (1999) and Basevi (1999). The probably most prominent shape of economic distribution is the spearhead as shown in Fig. 3b. But while Ludema and Wooton (1999) have to rely on simulations and intuitive guesses to determine to resulting shape of economic distribution, this paper provides analytical measures which unambiguously reveal the type of agglomeration pattern (see appendix B).

[Figures 3a and 3b about here]

Fig. 4 shows the resulting distribution of skilled labor of case (**b**), if matching costs of skilled labor are relatively small so that $\nu < \nu_{min}$. Partial agglomeration prevails even at very high levels of trade costs. Falling trade costs first foster the concentration of economic activity, before redispersion is observed. A similar pattern arises in cases (**c**) and (**d**). But here the highest degree of economic concentration is observed at (prohibitively) high levels of trade costs. Economic integration then reduces the incentive to agglomerate and leads to dispersion. Fig. 5 shows the corresponding distribution of economic activity.

[Figures 4 and 5 about here]

3.2.2 The distribution of unskilled labor

Once the equilibrium share of skilled labor is determined, one can derive the equilibrium distribution of unskilled labor at any level of trade costs by using $\rho^*/\overline{\rho} = \rho^*/\overline{\rho}(\lambda^*(\phi), \phi)$

described by Eq. (14)[7]. Observe that $\rho/\overline{\rho}$ follows a logistic probability function with the migration incentive for unskilled labor ΔV_U being the argument. As the migration incentive of unskilled labor is monotonically increasing in the degree of skilled labor agglomeration, there is a positive one-to-one relationship between skilled and unskilled labor distribution agglomeration. It follows that both types of labor agglomerate in the same region.

[Figures 6a and 6b about here]

Figs. 6a and 6b show the evolution of unskilled labor concentration (black lines) and the skilled labor agglomeration (gray lines) with respect to falling trade costs. As long as skilled labor is dispersed, unskilled labor is equally split between regions, as well. Once trade costs have fallen below the breakpoint ϕ_b, skilled and, therefore, unskilled labor agglomeration becomes stable. If skilled labor agglomeration is smooth and reversible (catastrophic) as described in Fig. 2b (2c), unskilled labor agglomeration is smooth (catastrophic), as well. Falling trade costs have two opposing effects on the migration incentive of unskilled workers:

$$\frac{\mathrm{d}\Delta V_U}{\mathrm{d}\phi} = \frac{\partial \Delta V_U}{\partial \lambda^*}\frac{\mathrm{d}\lambda^*}{\mathrm{d}\phi} + \frac{\partial \Delta V_U}{\partial \phi} \tag{18}$$

The first term of the RHS of Eq. (18) reflects the fact that economic integration changes the pattern of skilled labor agglomeration as shown by Figs. 2b to 5. The second expression shows that falling trade costs reduce the difference in domestic price levels so that the migration incentive of unskilled labor decreases. As long as λ^* is increasing in ϕ, these two forces oppose each other. Due to symmetry in price levels at dispersion, the overall effect of economic integration on the migration incentive of unskilled labor at the break point is positive (because $\partial \Delta V_U/\partial \phi(\lambda = 0.5) = 0$). Consequently, around ϕ_b the share of unskilled labor $\rho^*/\overline{\rho}$ is increasing in ϕ. Once skilled labor agglomeration has peaked in either region, both forces act into the same direction leading to redispersion of

[7]Keep in mind that λ^* and $\rho^*/\overline{\rho}$ are simultaneously determined. The proceeding merely highlights the relation between skilled and unskilled agglomeration.

the unskilled workforce. When trade costs fall below the redispersion point, dispersion of both skilled and unskilled labor is the only stable equilibrium.

The relative distribution of both types of labor depends on the degree of mobility of the unskilled workforce. Recall that λ^* determines the migration incentive of unskilled labor (MI_ρ), which is in upward-sloping function in λ^* and intersects the matching cost function of unskilled (MC_ρ) only once at $\lambda^* = \rho^*/\overline{\rho} = 0.5$. As unskilled workers migrate until MC_ρ equals MI_ρ, the relative distribution of labor is determined unambiguously by the relative position of these two functions. It can be shown that when unskilled labor is relatively immobile, *i.e.* $\mu > \alpha/(\sigma - 1)$, the share of skilled workers exceeds the share of unskilled labor in the agglomeration core. If unskilled labor is relatively homogeneous and mobile, *i.e.* $\mu < \alpha/(\sigma - 1)$ there exists a set of parameters at which the share of unskilled labor is greater than the share of skilled workers.

4 Policy implications

Governments seek to influence the skill pattern of immigrants: migration policies usually prefer skilled labor immigration, while trying to impede the inflow of unskilled workers. Here, governmental migration impediments (incentives) are understood as measures which increase (lower) the costs of living in a particular region: formal bureaucratic duties like periodical renewal procedures for visa, participation constraints for social welfare programs, or residence authorizations and work permissions for spouses and other family members. This aim of this section is to offers a positive analysis of the impact of each of these policy measures under increasing returns to scale.

Consider an economy in a stable spatial equilibrium and assume (w.l.o.g.) that there is partial agglomeration in H ($\lambda^* > 0.5$), which the government in H wants to foster while at the same time impeding the immigration of unskilled labor. Pro-skilled immigration policies reduce the costs of skilled migrants and make migration more profitable. Analytically, this can be represented by greater values of $m_{\lambda,H}$ or lower values of ν. Changes in ν affect individuals differently, especially those who have the highest costs gain most[8]. Varying

[8] Observe that $\mathrm{d}C(\lambda)/\mathrm{d}\nu = \ln \lambda/(1 - \lambda)$, which is an increasing function in λ.

$m_{\lambda,H}$, instead, affects everyone equally. Here, we follow (w.o.l.g.) the latter and represent political migration impediments (incentives) by changes in distributional modes[9]. *Ceteris paribus*, lowering the costs for skilled migrants increases the net immigration incentive $S(\lambda)$ and leads to a higher equilibrium share of skilled labor $(\mathrm{d}\lambda^*/\mathrm{d}m_{\lambda,H} > 0)$. But pro-skilled immigration policies induce a second effect further enhancing skilled labor immigration: As the equilibrium share λ^* increases, the immigration incentive for unskilled labor increases, as well. Analytically, we find $\mathrm{d}G(\lambda^*)/\mathrm{d}m_{\lambda,H} = (\partial G/\partial\lambda^*)(\mathrm{d}\lambda^*/\mathrm{d}m_{\lambda,H}) > 0$. Consequently, the equilibrium share of unskilled labor $\rho^*/\overline{\rho}$ rises, which increases the domestic market, raises profits of domestic firms and implies a positive feedback on skilled immigration. The overall effect of pro-skilled migration policies on the immigration incentive of skilled workers can be summarized as follows

$$\frac{\mathrm{d}S[\lambda^*, \rho/\overline{\rho}(\lambda^*)]}{\mathrm{d}m_{\lambda,H}} = \frac{\partial S(\lambda^*)}{\partial m_{\lambda,H}} + \frac{\partial S(\rho/\overline{\rho})}{\partial\rho/\overline{\rho}}\frac{\partial\rho/\overline{\rho}}{\partial\lambda^*}\frac{\mathrm{d}\lambda^*}{\mathrm{d}m_{\lambda,H}} \tag{19}$$

where the first term on the RHS captures the direct impact of lower costs and the second term embraces the indirect effect through unskilled labor immigration. Both forces work into the same direction. Graphically, pro-skilled migration policies shift MC_λ downwards as shown by Fig. 7. Consequently, the equilibrium share of skilled labor increases. Note that by construction MI_λ already takes into account the positive feedback by unskilled labor immigration.

In analogy to the above, contra-unskilled immigration policies lead to tougher migration impediments and are equivalent to lower values of $m_{\rho,H}$. *Ceteris paribus*, the propensity of unskilled workers to migrate decreases. Analytically, it holds true that $\mathrm{d}G(\rho^*/\overline{\rho})/\mathrm{d}m_{\rho,H} > 0$, so that the equilibrium share of the unskilled workforce $\rho^*/\overline{\rho}$ becomes smaller. This in turn has an impact on the equilibrium level of skilled workers - due to a smaller market and domestic aggregate income, profits of domestic firms decrease making the domestic market less profitable. Analytically, we find that

$$\frac{\mathrm{d}S(\lambda^*)}{\mathrm{d}m_{\rho,H}} = \frac{\partial\Delta R^*}{\partial\rho^*/\overline{\rho}}\frac{\mathrm{d}\rho^*/\overline{\rho}}{\mathrm{d}m_{\rho,H}} > 0 \tag{20}$$

[9] Qualitative results can be shown to be identical irrespectively of which parameter is affected.

Consequently, the equilibrium share of skilled labor decreases ($\mathrm{d}\lambda^*/\mathrm{d}m_{\rho,H} < 0$), which has a negative feedback on the equilibrium distribution of unskilled workers. Summarizing, the overall effect of contra-unskilled migration policies on the immigration incentive of the unskilled workforce is given by

$$\frac{\mathrm{d}G}{\mathrm{d}m_{\rho,H}} = \frac{\partial G}{\partial m_{\rho,H}} + \frac{\partial G}{\partial \rho^*/\overline{\rho}} \frac{\partial \rho^*/\overline{\rho}}{\partial \lambda^*} \frac{\mathrm{d}\lambda^*}{\mathrm{d}m_{\rho,H}} \tag{21}$$

The first term on the RHS of Eq. (21) captures the direct effect by migration impediments. The second term embraces the indirect effect via changes in the equilibrium size of skilled labor. Both forces reduce the migration incentive of unskilled workers. Graphically, contra-unskilled migration policies shift MI_λ downwards: a lower share of unskilled labor reduces the migration incentive of skilled workers independently of their spatial distribution as shown by Fig. 8. Consequently, the equilibrium share of skilled labor decreases.

The impact of skill-biased immigration policies is straightforward. Lower impediments for skilled migrants increase the immigration incentive for both skilled and unskilled workers. But increased obstacles for unskilled workers impede unskilled labor immigration and reduce the immigration incentives of skilled labor. Graphically, the counterproductive impact of these policy measure can be depicted by shifting both MI_λ and MC_λ downwards. The overall impact on the migration incentives of both types of labor and their spatial distribution depends on the actual policy design. But it becomes clear that these two policies attenuate each other and can even lead to counterproductive outcomes. So, if the impact of contra-unskilled policies is sufficiently strong, so that the migration incentive of skilled labor is lowered by more then it is enhanced by pro-skilled policies, a new equilibrium with a smaller domestic share of skilled and unskilled labor may arise. It is also possible that pro-skilled migration policies increase the migration incentive of unskilled labor to such an extent that it overcomes the impediments introduced by contra-unskilled policies. Consequently, skill-biased migration policies may also lead to a new equilibrium with a greater share of both skilled and unskilled labor.

Furthermore, it can be shown that the effectiveness of migration policies depends on the level of trade costs. Using $S(\lambda) = S(\lambda,\ \rho(\lambda,\phi),\ \phi)$ derived from Eq. (13), implicit derivation leads to:

$$\begin{aligned}
\operatorname{sgn}\left[\mathrm{d}\left(\frac{\mathrm{d}\lambda^*}{\mathrm{d}m_{\lambda,H}}\right)\Big/\ \mathrm{d}\phi\right] &= \operatorname{sgn}\left[\left(\frac{\partial(\Delta V - C(\lambda^*))}{\partial\lambda^*}\right)^{-2}\cdot \mathrm{d}\left(\frac{\partial(\Delta V - C(\lambda^*))}{\partial\lambda^*}\right)\Big/\ \mathrm{d}\phi\right] \\
&= \operatorname{sgn}\left[\mathrm{d}\left(\frac{\partial(\Delta V - C(\lambda^*))}{\partial\lambda^*}\right)\Big/\ \mathrm{d}\phi\right] \qquad (22)
\end{aligned}$$

Here, $\mathrm{d}\lambda^*/\mathrm{d}m_{\lambda,H}$ can be interpreted as a measure of effectiveness of pro-skilled migration policies. According to Eq. (22) it depends on the evolution of the marginal migration incentive in equilibrium (i.e., the slope of MI_{λ^*}). As in section 3.1 the marginal migration incentive can be interpreted as a measure of the relative strength of agglomeration and deglomeration forces. At high levels of trade costs, deglomeration forces are dominant so that migration impediments have to be relaxed strongly to induce migration. Economic integration raises the relative strength of agglomeration forces which boost the impact of policy measures promoting the inflow of skilled labor. At low levels of trade costs, spatial issues and agglomeration forces become less and non-monetary factors (heterogeneity) become more important in the choice of location, so that policy measures have less impact on the migration decision. Qualitatively identical results can be shown to hold true for the effectiveness of contra-unskilled migration policies.

5 Conclusion

This paper has developed an agglomeration model with two mobile types of workers. Individuals are heterogeneous both within skill types and between skill groups. Heterogeneity reflects the fact that workers have different preferences over locations, heterogeneous costs from being remote from one's own socio-cultural surrounding or different obstacles to migration. The model has been used to analyze the impact and the effectiveness of skill-biased migration policies in settings where market sizes play a significant role.

Five central market and non-market forces, which give rise to regional agglomeration pattern, have been worked out. Firstly, an inflow of skilled labor shifts production toward the immigration area and increases the gap in regional price levels (supply linkage). Secondly, the inflow of skilled labor increases the domestic market size and domestic aggregate income making domestic firms more profitable (demand linkage by skilled labor). But the creation of new firms also increases competition for costumers, which lowers profits of domestic firms and decreases the immigration incentive of skilled labor (competition effect). Fourthly, the shift in production and the rising gap in regional price level induce the inflow of unskilled workers. The latter raise the domestic aggregate income, increasing profits of domestic firms (demand linkage by unskilled labor). Furthermore, both skilled and unskilled labor face mobility costs which act as (non-market) dispersion force.

The geographical distribution of skilled and unskilled workers depends on two sets of parameters. On the one hand, trade costs. When trade costs are greater than a critical threshold (break point) or less than a lower critical value (redispersion point), only the symmetric distribution of both factor of production is stable. If trade costs are in between these thresholds, regional symmetry becomes instable giving rise to partial agglomeration of skilled and unskilled labor in the same region. On the other hand, it is the level of matching costs of both types of labor which influences the pattern of economic distribution. Here, two different effects have to be distinguished. Firstly, lower matching costs for any type of labor increase its net value of migration, which fosters its regional concentration. Secondly, there is an inverse relationship between matching costs of one type of labor and the migration incentive of the other, which is an important feature of the model: The smaller are migration impediments of unskilled employees, the stronger is the immigration incentive for skilled labor. The intuition originates in the home market effect - lower impediments to unskilled labor migration induce its inflows, increasing the domestic market and aggregate income. Larger markets, in turn, make domestic firms more profitable and lead to higher skilled wages. Consequently, the regional concentration of skilled labor increases for any given level of trade costs and migration impediments for skilled labor. The same holds true with respect to migration impediments for skilled workers: lowering migration impediments for skilled labor, enhances the inflow of skilled labor. The shift in production towards the immigration country increases real wages of unskilled workers for any level of unskilled migration impediments. The resulting inflow of unskilled migrants leads to a positive feedback on the migration incentive of skilled workers, so that we observe the same effects on the degree of spatial agglomeration as described above.

Summarizing we have the following: pro-skilled policies increase the immigration incentive of skilled and unskilled labor, contra-unskilled measures decrease the incentives for both types. Consequently, it is the interdependency and mutual reinforcement of skilled and unskilled labor migration which attenuates the effectiveness of skill-biased migration policies or, depending on the design, even leads to counterproductive policy outcomes. But not only the policy mix is a determinant of the effectiveness of skill-biased migration policies, but also the level of trade costs. Migration policies are most effective at medium levels of trade costs, while at high and low levels of trade costs they loose influence on the migration decision. At high levels of trade costs, migration leads to losses in real wages as deglomeration forces dominate. Migration policies have to overcome them. If markets are well integrated, agglomeration forces are weak so that non-market determine the location decision. At medium levels of trade costs, migration policies are fostered by agglomeration forces, so that their impact is boosted.

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A Model forces and breakpoint

The first derivative evaluated at $\lambda = 0.5$ can be decomposed into the following forces:

- Supply linkage:

$$\frac{\partial(-\alpha \ln \Delta P)}{\partial \lambda}\bigg|_{\lambda=1/2} = \frac{4\alpha(1-\phi)}{(\sigma-1)(1+\phi)} > 0 \tag{23}$$

- Demand linkage of skilled labor:

$$\frac{\partial \Delta R}{\partial \lambda}\bigg|_{\lambda=1/2, x^* fixed} = \frac{4\alpha(1-\phi)}{\sigma(1+\phi)} > 0 \tag{24}$$

- Competition effect:

$$\frac{\partial \Delta R}{\partial \lambda}\bigg|_{\lambda=1/2, market size fixed} = -\frac{4\alpha(\overline{\rho}+1)(1-\phi)^2}{\sigma(1+\phi)^2} < 0 \tag{25}$$

- Demand linkage of unskilled labor:

$$\frac{\partial \Delta R}{\partial \rho}\frac{\partial \rho}{\mathrm{d}\lambda}\bigg|_{\lambda=1/2} = \frac{4\alpha^2\overline{\rho}(1-\phi)^2}{\mu(\sigma-1)\sigma(1+\phi)^2} > 0 \tag{26}$$

- Marginal migration costs of skilled labor:

$$\frac{\partial C}{\partial \lambda}\bigg|_{\lambda=1/2} = 4\nu \tag{27}$$

The sum of competition effect and demand linkage of unskilled labor : Eq. (25)+(26):

$$\mathrm{DL}_U + \mathrm{CE}\,|_{\lambda=1/2} = \frac{4\alpha\left[\overline{\rho}\left[\alpha-\mu(\sigma-1)\right]-\mu(\sigma-1)\right]}{\mu(\sigma-1)\sigma(1+\phi)^2} \tag{28}$$

For $\mu > \alpha/(\sigma-1)$ this expression is less than zero for any given value of $\overline{\rho}$. Furthermore, the first derivate with respect to $\overline{\rho}$ is then negative. A greater number of unskilled labor increases the relative strength of the competition effect.

The sum of the demand linkage of both skilled and unskilled labor as well as the competition effect: Eq. (24)+(25)+(26):

$$\mathrm{DL}_S + \mathrm{DL}_U + \mathrm{CE}\,|_{\lambda=1/2} = \frac{4\alpha(1-\phi)(\alpha\overline{\rho}(1-\phi)-\mu(\sigma-1)(\overline{\rho}(1-\phi)-2\phi))}{\mu(\sigma-1)\sigma(1+\phi)^2} \tag{29}$$

If $\mu < \alpha/(\sigma-1)$, this expression is positive for any given amount of unskilled labor $\overline{\rho}$. Consequently, the agglomeration forces prevail. The first derivative with respect to $\overline{\rho}$

reveals that that the net agglomeration forces become stronger, the greater the unskilled workerforce.

B Critical parameter values

$$\overline{\rho}_t = \mu\sigma / \left(\mu(\sigma-1)-\alpha\right) \tag{30}$$

$$\overline{\nu} = \frac{\alpha\mu(2\sigma-1)^2}{4\left[\mu(\overline{\rho}+1)(\sigma-1)-\alpha\overline{\rho}\right](\sigma-1)\sigma} \tag{31}$$

$$\underline{\nu} = \frac{\alpha\left[\alpha\overline{\rho}+\mu(\overline{\rho}+\sigma-\overline{\rho}\sigma)\right]}{\mu(\sigma-1)\sigma} \tag{32}$$

$$\overline{\rho}_{crit} \equiv \frac{2\mu^3(\sigma-1)^3\sigma}{\alpha\mu^2(\sigma-1)^2(4\sigma-1)-2\mu^3(\sigma-1)^3\sigma-\alpha^3(2\sigma-1)} \tag{33}$$

$$\mu_{crit} \equiv \frac{\alpha(2\sigma-1)}{4(\sigma-1)\sigma}+\frac{1}{4}\sqrt{\frac{\alpha^2(\sigma(20\sigma-12)+1)}{(\sigma-1)^2\sigma^2}} \tag{34}$$

The third derivative of $S(\lambda, \rho(\lambda, \phi), \phi)$ with respect to λ and evaluation at symmetry is given by

$$S_\lambda^{(3)}(\lambda=0.5, \phi_c) = -\frac{32\left(\alpha^2\overline{\rho}\left[\alpha^2-4\mu^2(\sigma-1)^2\right](1-\phi_c)^4-F(1-\phi_c)^3\right)}{\mu^3(\sigma-1)^3\sigma(1+\phi_c)^4}-32\nu \tag{35}$$

where $\phi_c \in \{\phi_b, \phi_r\}$ and $F = \alpha\mu^3(\sigma-1)^2\left[\sigma-3\overline{\rho}(\sigma-1)(1-\phi_c)+(7\sigma-6)\phi_c\right]$.

If $S_\lambda^{(3)}(\lambda = 0.5, \phi_c) < 0(> 0)$, the transition between dispersion and agglomeration at ϕ_c is smooth (catastrophic).

Figure 1a

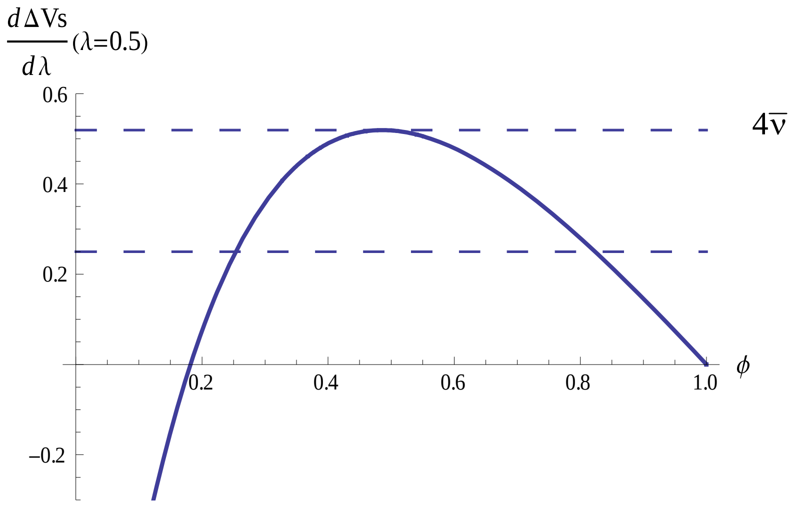


Figure 1b

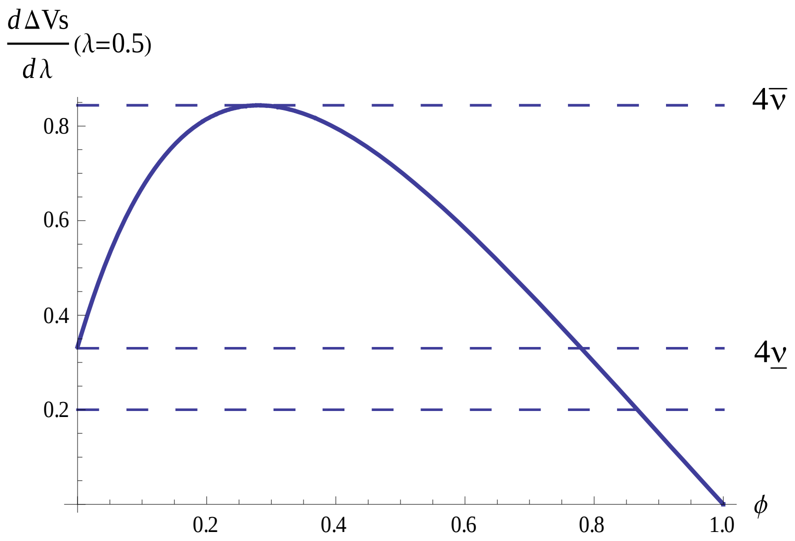


Figure 1c

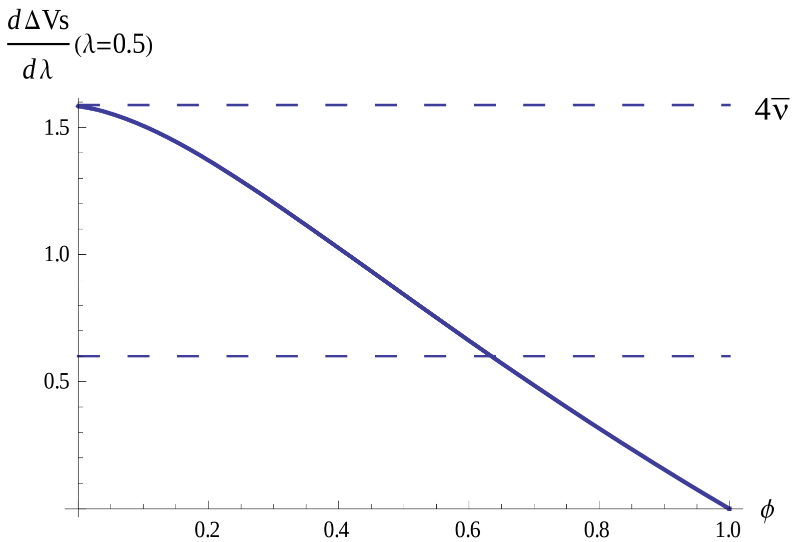
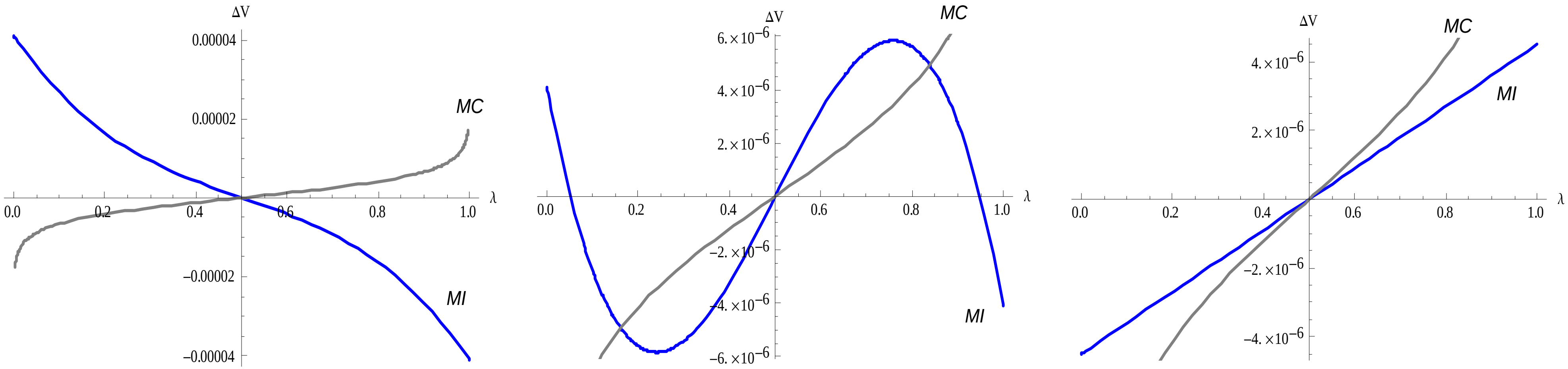


Figure 2a – The interplay of migration incentive and matching costs (numerical evaluation for $\alpha = 0.5, \sigma = 2, \overline{\rho} = 150, \mu = 0.9, \nu = 0.000003$)



$\phi = 0.91507$ $\phi = 0.915115$ $\phi = 0.999994$

Figure 2b – Bubble bifurcation (numerical evaluation for $\alpha = 0.5, \sigma = 2, \overline{\rho} = 150, \mu = 0.9, \nu = 0.000003$)

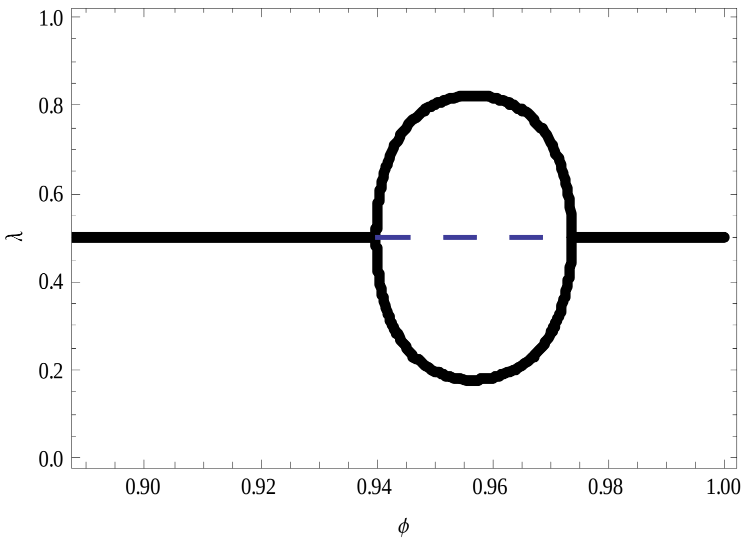
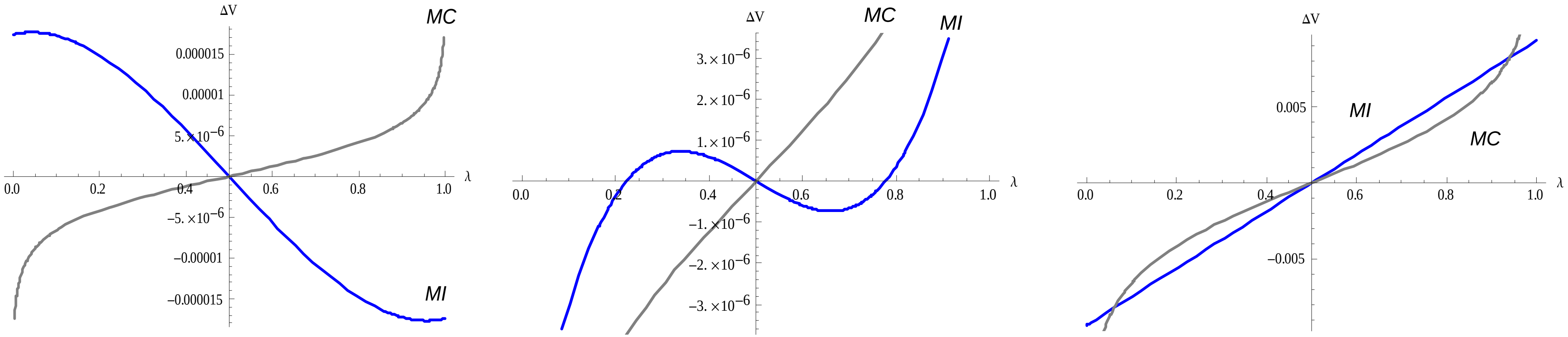


Figure 3a - The interplay of migration incentive and matching costs (numerical evaluation for $\alpha = 0.2, \sigma = 2, \overline{\rho} = 100, \mu = 0.25, \nu = 0.003$)



$\phi = 0.82345$ $\phi = 0.82352$ $\phi = 0.965$

Figure 3b - Spearhead bifurcation (numerical evaluation for $\alpha = 0.2, \sigma = 2, \overline{\rho} = 100, \mu = 0.25, \nu = 0.003$)

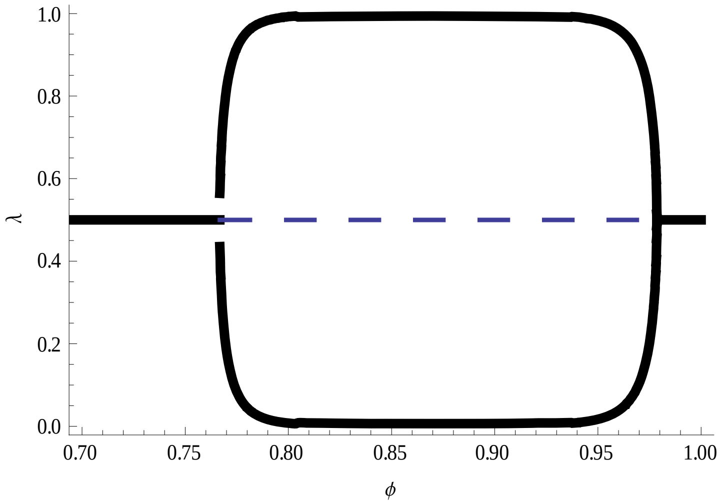


Figure 4 – numerical evaluation for $\alpha = 0.5, \sigma = 2, \overline{\rho} = 8, \mu = 0.6, \nu = 0.14$

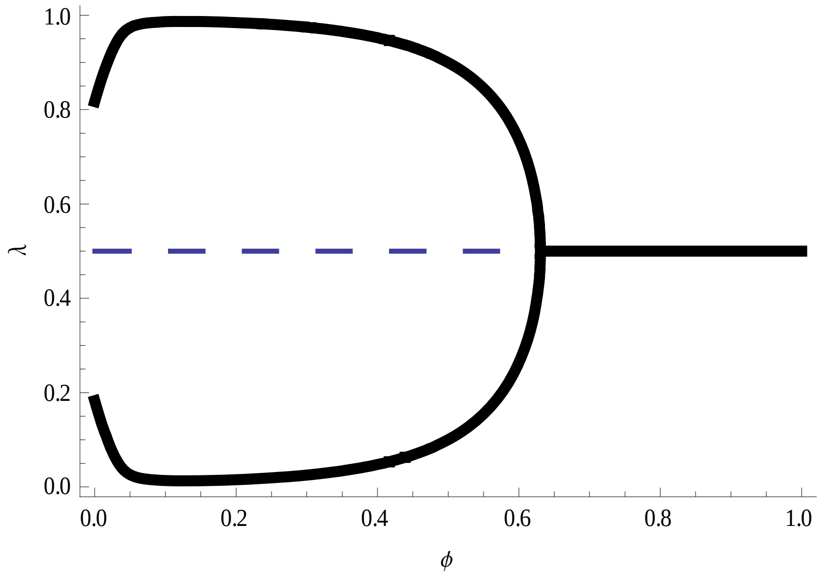


Figure 5 - numerical evaluation for $\alpha = 0.5, \sigma = 2, \overline{\rho} = 3, \mu = 0.6, \nu = 0.1245$

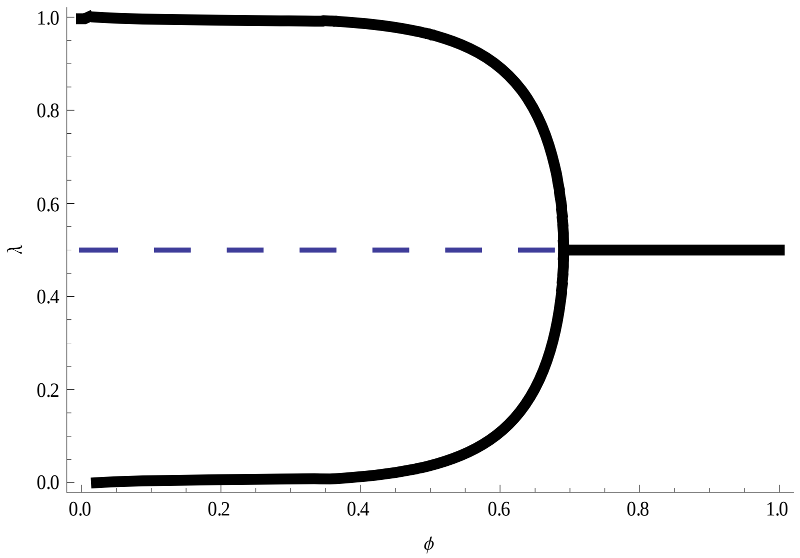


Figure 6a – The distribution of skilled (black lines) **and unskilled labor** (gray lines)

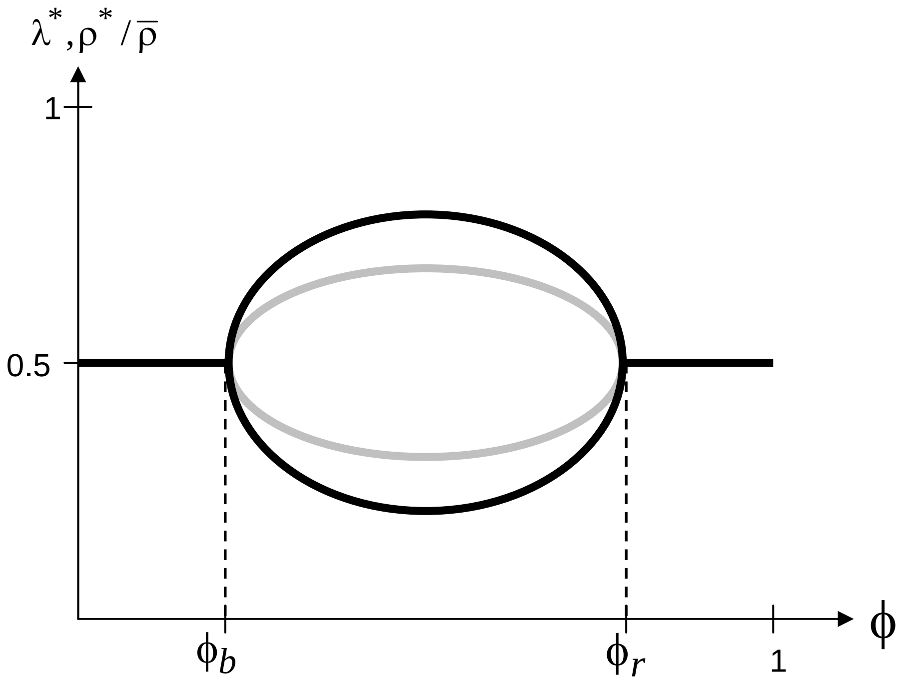


Figure 6b – The distribution of skilled (black lines) **and unskilled labor** (gray lines)

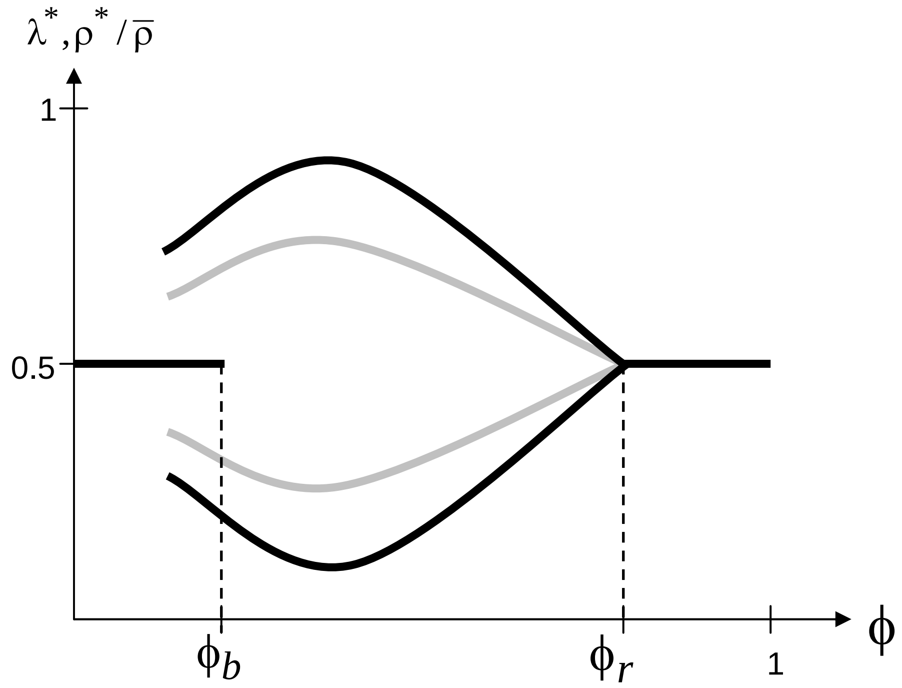


Figure 7 - The impact of pro-skilled migration policies

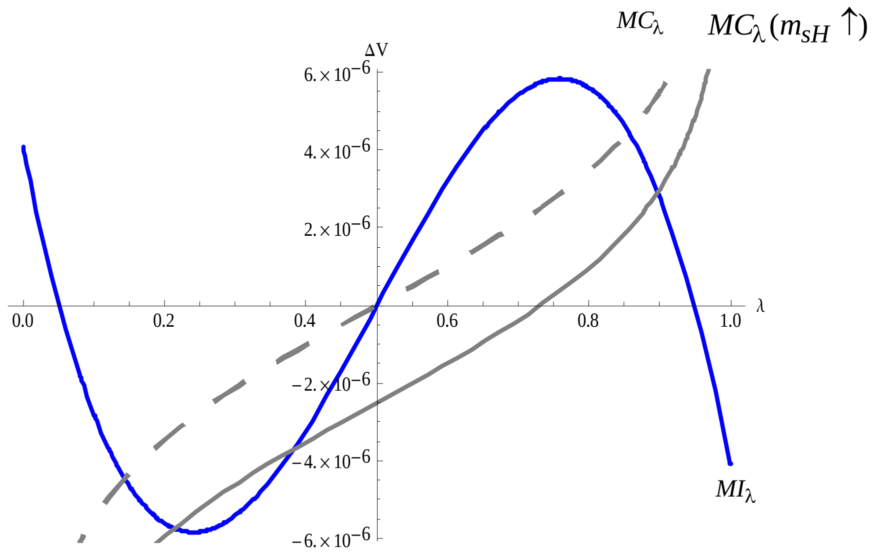


Figure 8 - The impact of contra-unskilled migration policies