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Abstract

To examine the impact of migrants on the average firm productivity, wages and welfare we construct a general equilibrium model with monopolistic competition a la Melitz (2003) considering heterogeneous firms with different productivity levels and imperfect substitutability between migrants and natives. This gives rise to wage differences between natives and migrants. As a consequence firms with a higher share of migrants realize wage cost advantages. The heterogeneous distribution of migrants in our model might foster regional disparities. In the long run equilibrium it depends on the migrant share, which kind of firms survive in the market. Above a certain migrant share only those firms stay in the market which are highly productive or are able to compensate a lower productivity level by wage cost advantages. By modeling this process, we show that a higher migrant share may explain a higher average productivity in a region. Though the relative wages of natives to migrants increase in the migrant share, in contrast the welfare effects for natives are ambiguous: it might be the case that in a region with a higher migrant share the welfare of a native can be lower compared to a worker in a region of the same size with lower migrant share.

Keywords: immigration, firm heterogeneity, skills, tasks, regional labor markets

JEL: R23, J15, J24, J61

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Introduction

There is an ongoing debate about the economic impact of migration for the destination country. While in public debates it is often argued that migration is utilized to keep wages low, researchers mostly found no or even positive effects on the wages of natives (Borjas 1992, 2003, Borjas & Katz 2007, Card 2001, 2007, 2009, Brücker & Jahn 2010, Südekum et al. 2008, D'Amuri et al. 2010). One explanation is that migrants and natives may be imperfect substitutes which means that migrants do not compete with natives on exactly the same jobs (Borjas 2003). A lot of studies confirm the imperfect substitutability (Card & Lemieux 2001, Borjas 2003, D'Amuri et al. 2010, Brücker & Jahn 2012), they estimate a very high elasticity of substitution between migrants and natives, mostly above 10. This indicates that they might be rather good substitutes though imperfect. While these studies are conducted at the aggregate level, Martins et al. (2012) analyze the timing of recruitment and layoff of migrants and natives at the individual firm level. They find that migrants are rather complements than substitutes. We think that this points to a discrepancy between the micro and the macro level. When firms do not have the opportunity to replace native workers by migrants, either due to legal issues or due to the requirements of the job, the substitution process needs to take place between the firms. Another important aspect is that migrants are not uniformly distributed across space. Cities attract migrants because of already existing migration networks and thus the migrant shares in dense regions are usually higher than in rural areas. But even between cities of comparable sizes migrant shares vary a lot. Card (2010) gives an overview about the differences and similarities between studies that use time series data and those that use cross-section data to identify the impact of immigrants. These differences indicate that spatial disparities are important. Though, he concludes that both types of studies show that the labor market is well approximated by imperfect substitutability models with a high elasticity of substitution between migrants and natives.

While the wage effects of migrants on natives are mostly small, Peri (2009) finds a significant influence of immigrants to the productivity of the U.S. states. He conjectures that this increase may be caused by a higher grade of specialization. We basically adopt this idea and assume that firms are differently specialized in the use of foreign and native labor. To account for the difference between inter and intra firm substitutability of migrants and natives we adopt the heterogeneous firm framework by Melitz (2003). We extend the framework in a way that migrants and natives are imperfect substitutes in a CES-production function as in Card & Lemieux (2001). Firms produce individual products and are thus not only heterogeneous regarding to their productivity but also to the possibility to utilize the work of migrants and natives. This means that in some production processes it might be easier to integrate migrants into the workforce. E.g. the clear organizational structure and routine process of meal production and standardization of meal offers and service of McDonalds Restaurants seems to reduce so called babel effects, which increase the transaction costs in a firm due to the lack of cultural knowledge or language skills. The assumption is related to the finding of Peri & Sparber (2008) that migrants tend to choose different types of jobs that intensively require performing manual tasks. In such jobs the disadvantage of the lack of language skills is less important so that migrants have a relative advantage. In our model wage differences between the two groups of workers occur. The advantage of the generality of the model is to leave open the question, to which extent wage differences are due to (statistical) discrimination or job selection, because both types of explanations are consistent with the model framework.

Firms and households are price takers at the labor market. There is no difference on the supply of consumer products between regions and therefore a higher relative supply of the type of work that migrants perform leads to a lower wage relative to natives. The increase of wage differences has the following consequences: firms that insensitively utilize this type of labor increase production and gain more profit, while firms that cannot use the migrants workforce that much decrease production and gain less profit or even be forced to leave the market. We show that the firm dropout is most relevant for the low productive firms so to say in this segment the pie is cut in less pieces the higher the migrant share. The causal relationship in the model then is not due to well known agglomeration economies that firms become generally more productive in cities. Instead low productive firms only can survive, if they are able to integrate migrants into their workforce. This implies a decrease in labor demand which is stronger for natives than for migrants and therefore dampens the relative wage increase of natives. Even though we can conclude that the relative wage of natives in a region increases in the migrant share.

The rest of this paper is organized as follows. The next two sections describe the theoretical model and show simulation results with different productivity levels. The fourth part is the welfare analysis and the fifth part concludes.

A Heterogeneous Firm Model with Wage Cost Advantages – Basic Framework

<u>Firm behavior</u>

The labor force consists of migrants and natives. Firms have to choose the composition of their workforce and the firm size at the same time. The extreme case, in which the size can be chosen freely and the choice about the composition is perfectly bounded can be described by the firm having a Leontieff-type production function

$$q_f = A_f \cdot \max\left(\frac{l_1^f}{\beta_f}, \frac{l_2^f}{1-\beta_f}\right), \tag{1}$$

where q_f is the output, A_f the total factor productivity, $\beta_f \in [0,1]$ is a parameter of the migrant share and l_1^f, l_2^f are the labor demand for job one and two of the firm f. Here the optimal share of job one is given by β_f. A firm with this production function can only respond to changes in wages by a change in the overall output. This can be relaxed by assuming the firms to use the well known CES-production function

$$q_f = A_f \cdot \left(\beta_f^{\frac{1}{\gamma}} \cdot \left(l_1^f\right)^{\frac{\gamma-1}{\gamma}} + \left(1-\beta_f\right)^{\frac{1}{\gamma}} \cdot \left(l_2^f\right)^{\frac{\gamma-1}{\gamma}}\right)^{\frac{\gamma}{\gamma-1}}, \tag{2}$$

where the parameter $\gamma > 0$ is the elasticity of substitution between migrants and natives. For γ equals zero the Leontieff case above holds and both groups of workers are very different, so that no task can be done by the other group at al. For values of γ below one both jobs are usually called complements, for $\gamma = 1$ the firms use Cobb-Douglas technology and for γ approaching to infinity both jobs become perfect substitutes.

Equilibrium

As in the well known Dixit-Stiglitz model of monopolistic competition the representative household maximizes a CES-aggregate over a continuum of product varieties indexed by ω:

$$\mathrm{U} = \left(\int \mathrm{c}(\omega)^{\rho} \mathrm{d}\omega\right)^{1/\rho} \tag{3}$$

with $0 < \rho < 1$ and thus an elasticity of substitution $\sigma = \frac{1}{1-\rho} > 1$. The optimal demand for (product) variety ω is then

$$\mathrm{q}(\omega) = \mathrm{Q} \cdot \mathrm{P}^{\sigma} \cdot \mathrm{p}(\omega)^{-\sigma} \tag{4}$$

with aggregate output $\mathrm{Q} \equiv \mathrm{U}$ and aggregate price index $\mathrm{P} = \left[\int \mathrm{p}(\omega)^{1-\sigma} \mathrm{d}\omega\right]^{\frac{1}{1-\sigma}}$.

Profit maximization implies the individual firm pricing behavior

$$\mathrm{p}(\phi) = \frac{1}{\rho \cdot \phi} \tag{5}$$

where ϕ are the inverse marginal costs needed to produce one unit of the symmetric good

$$\phi(\beta_f, A_f) \coloneqq \frac{A_f}{\left(\beta_f \cdot w_1^{1-\gamma} + \left(1-\beta_f\right) \cdot w_2^{1-\gamma}\right)^{\frac{1}{1-\gamma}}} \tag{6}$$

In this expression w_1 is the wage of migrants (in job 1) and w_2 the wage (in job 2) of natives. As the jobs are not understood as occupations, it may depend on certain firm characteristics like the organizational structure or the firm manager's ability to integrate migrants and thus the share varies across firms. To model this, the factor β_f is drawn stochastically at the moment of firm formation from a known distribution $G(.)$ with density $g(.)$. This involves sunken entry costs e which are for simplicity an amount of natives' labor. Furthermore every year with probability δ the firm may incur a negative productivity shock that forces it to instantly leave the market. Additionally there are per-period fixed costs F, which are also payed in native labor.

As in Melitz (2003) we define a weighted average of the inverse marginal costs for a symmetric good by:

$$\widetilde{\phi}(w) = \left(\int_0^1 \phi(b, w_1, w_2)^{\sigma-1} \mu(a) db\right)^{\frac{1}{\sigma-1}} \tag{7}$$

with the density of firms in the market $\mu(b)$. The price niveau P, the summed output Q, revenue R and firm profit Π can then be stated, with the number of Firms M, as:

$$P = M^{\frac{1}{1-\sigma}} \cdot p(\widetilde{\varphi})\ ;\ Q = M^{\frac{1}{\rho}} \cdot q(\widetilde{\varphi}) \tag{8}$$

$$R = P \cdot Q = M \cdot r(\widetilde{\varphi});\ \Pi = M \cdot \pi(\widetilde{\varphi}) = M \cdot \overline{\pi}. \tag{9}$$

So far the only difference between firms is the share of job 1 on total production. As the wage of migrants necessarily is at least not higher than the wage of natives, a firm has cost advantages relative to a firm with a lower share of job 1. Therefore there may be a minimum share parameter b^*, so that firms with a share parameter of job 1 below this bound are forced to immediately exit the market because they are not able to generate any profit. Such an b^* need not necessarily exist, because it may be the case that even a firm with a share equal to zero may be profitable. But if such an b^* between zero and one exists with $\pi(b^*) = 0$, this leads to the zero-cutoff-condition:

$$\overline{\pi} = w_2 \cdot F \cdot \left(\left(\frac{\widetilde{\phi}(\phi^*)}{\phi^*}\right)^{\sigma-1} - 1\right) \tag{10}$$

where $\phi^* = \phi(b^*, w_1 w_2)$ is the minimum inverse marginal cost relating to b^* and F are fixcosts.

In the steady state the profit of a firm is constant over time, so the expected lifetime profit of a new firm is given by:

$$\mathrm{E}\left(\pi_{\mathrm{f}}^{\mathrm{life}}\right) = -\mathrm{e} \cdot \mathrm{w}_2 + \sum_{\mathrm{i}=0}^{\infty} (1-\delta)^{\mathrm{i}} \cdot \mathrm{E}(\pi_{\mathrm{f}}) = \frac{\mathrm{E}(\pi_{\mathrm{f}})}{\delta} - \mathrm{e} \cdot \mathrm{w}_2 \tag{11}$$

with entry costs e.

The expected per period profit of a firm is given by

$$\mathrm{E}(\pi_{\mathrm{f}}) = 0 \cdot \mathrm{G}(\mathrm{b}^*) + \left(1 - \mathrm{G}(\mathrm{b}^*)\right) \cdot \bar{\pi} \tag{12}$$

and thus the free-entry-condition

$$\bar{\pi} = \frac{\mathrm{e} \cdot \delta \cdot \mathrm{w}_2}{1 - \mathrm{G}(\mathrm{b}\,*)} \tag{13}$$

combined with the zero-cutoff-condition lead to:

$$\frac{\mathrm{e} \cdot \delta}{\mathrm{F}} = \int_{\mathrm{b}^*}^{1} \left(\left(\frac{\mathrm{b}^* + (1-\mathrm{b}^*) \cdot \left(\frac{w_2}{w_1}\right)^{1-\gamma}}{b + (1-b) \cdot \left(\frac{w_2}{w_1}\right)^{1-\gamma}} \right)^{\frac{\sigma-1}{1-\gamma}} - 1 \right) \mathrm{g(b)db} \tag{14}$$

As the right side is decreasing in b^* and increasing in the relative wage $\frac{\mathrm{w}_2}{\mathrm{w}_1}$, the deducted implicit function $\mathrm{b}^*\left(\frac{\mathrm{w}_2}{\mathrm{w}_1}\right)$ is increasing. A higher difference in wages therefore implies more competition in terms of firms that are forced to exit.

To close the model we need to look on the labor market. Looking at the number of firms in the economy M reveals

$$M = \frac{R}{\bar{r}} = \frac{w_1 L_1 + w_2 L_2}{\sigma \cdot w_2 \cdot \left(\frac{e \cdot \delta}{1 - G(b^*)} + F\right)} = \frac{L_1 + \frac{w_2}{w_1} \cdot L_2}{\frac{w_2}{w_1} \cdot \sigma \cdot (\frac{e \cdot \delta}{1 - G(b^*)} + F)} \tag{15}$$

The labor demand for migrants is

$$L_1^D = \frac{1}{1 - G(b^*)} \int_{a^*}^{1} M \cdot l_1(a) g(a) da =$$

$$= \frac{MQP^{\sigma}\rho^{\sigma}w_1^{-\gamma}}{1 - G(b^*)} \cdot \int_{b^*}^{1} b \cdot \left(w_1^{1-\gamma} b + w_2^{1-\gamma}(1-b)\right)^{\frac{\gamma-\sigma}{1-\gamma}} g(b) db \tag{16}$$

and the demand for natives excluding the demand for fixed cost and market entry costs is

$$L_2^D = \frac{MQP^{\sigma}\rho^{\sigma}w_2^{-\gamma}}{1 - G(b^*)} \cdot \int_{b^*}^{1} (1-b) \cdot \left(w_1^{1-\gamma} b + w_2^{1-\gamma}(1-b)\right)^{\frac{\gamma-\sigma}{1-\gamma}} g(b) db \tag{17}$$

so that the relative labor demand is given by:

$$\frac{L_1^D}{L_2^D} = \left(\frac{w_2}{w_1}\right)^{\gamma} \cdot \frac{\int_{b^*}^{1} b \cdot \left(b + \left(\frac{w_2}{w_1}\right)^{1-\gamma} \cdot (1-b)\right)^{\frac{\gamma-\sigma}{1-\gamma}} g(b)db}{\int_{b^*}^{1} (1-b) \cdot \left(b + \left(\frac{w_2}{w_1}\right)^{1-\gamma} \cdot (1-b)\right)^{\frac{\gamma-\sigma}{1-\gamma}} g(b)db} \tag{18}$$

It can be seen that the right side is increasing both in b^* and $\frac{w_2}{w_1}$[3]. The demand for fixed costs and market entry cost is given by

$$L_2^{F+e} = \frac{e \cdot \delta}{1 - G(b^*)} \cdot M + F \cdot M \tag{19}$$

so that the use of the general equilibrium firm number equation leads to:

$$\frac{L_1^D}{L_2^D} = \frac{L_1}{L_2 - M \cdot \left(\frac{e \cdot \delta}{1 - G(b^*)} + F\right)} = \frac{L_1}{L_2 - \frac{1}{\sigma} \cdot \left(\frac{L_1}{\frac{w_2}{w_1}} + L_2\right)} = \frac{\frac{L_1}{L_2}}{\rho - \frac{1}{\sigma \cdot \frac{w_2}{w_1}} \cdot \frac{L_1}{L_2}} \tag{20}$$

The right side is increasing in $\frac{L_1}{L_2}$, because the denominator is positive, and decreasing in $\frac{w_2}{w_1}$. The left side is increasing[4] in b^* and in $\frac{w_2}{w_1}$, so especially using the monotonically increasing implicit function $b^*\left(\frac{w_2}{w_1}\right)$, the left side increases with $\frac{w_2}{w_1}$. Therefore if the implicit function $\frac{w_2}{w_1}\left(\frac{L_1}{L_2}\right)$ is increasing, which is the result one would expect, as for example a relative increase of the supply of migrants leads to a relative decrease of the wage of migrants and vice versa.

Productivity Differences

In the next step the model is expanded by productivity differences. Therefore at the firm foundation a second stochastic parameter is independently drawn, namely the total factor productivity. For simplicity only two different levels are possible: $\mathrm{A_h}$ and $\mathrm{A_l}$ with $\mathrm{A_h} > \mathrm{A_l}$. The probability $\mathrm{Ph} = \Pr\,(\mathrm{A_f} = \mathrm{A_h})$ that a firm f draws the high productivity level is known to the investors. The combination of the zero-cutoff-condition and the free-entry-condition then looks like:

[3] at least if $\gamma \leq 1$ or if $2 \cdot \gamma \geq \sigma$, so $\sigma \leq 2$ is a sufficient condition

[4] see Footnote 3

$$\frac{e \cdot \delta}{F} = (1 - Ph) \cdot \int_{b_1^*}^{1} \left(\left(\frac{b_1^* + (1 - b_1^*) \cdot \left(\frac{w_2}{w_1}\right)^{1-\gamma}}{b + (1 - b) \cdot \left(\frac{w_2}{w_1}\right)^{1-\gamma}} \right)^{\frac{\sigma-1}{1-\gamma}} - 1 \right) g(b)db + Ph$$

$$\cdot \int_{b_2^*}^{1} \left(\left(\frac{b + (1 - b_2^*) \cdot \left(\frac{w_2}{w_1}\right)^{1-\gamma}}{b + (1 - b) \cdot \left(\frac{w_2}{w_1}\right)^{1-\gamma}} \right)^{\frac{\sigma-1}{1-\gamma}} - 1 \right) g(b)db \qquad (21)$$

with the convention that $g(b) = 0$ for every $b < 0$ or $b > 1$, where b_1^*, b_2^* are given by

$$\phi^* = \frac{A_l}{w_1 \cdot b_1^* + w_2 \cdot (1 - b_1^*)} = A_h w_1 \cdot b_2^* + w_2 \cdot (1 - b_2^*), \qquad (22)$$

which relates them to the minimal inverse marginal costs ϕ^* necessary for staying in the market.

Now it is possible to calculate the resulting minimum shares of job 1 of both productivity groups for a given relative wage ratio $\frac{w_2}{w_1}$. Starting with a relative wage of one, which means that there is no wage difference between natives and migrants, only two cases are possible. In the *first case* only the high productive firms are able to stay in the market, in the *second case* all firms will stay in the market. In the following only the second case is shown, as there usually exist low productive firms even if the supply of migrants in a region is low.

In a second step the relative wage and the respective share parameters b_1^*, b_2^* can be inserted in the labor demand equation. The results of this simulation are shown in figure 1. The different colors signify distinct values for the firms elasticity of substitution of migrants and natives γ. The upper right figure shows that the labor demand curve is well behaved. The

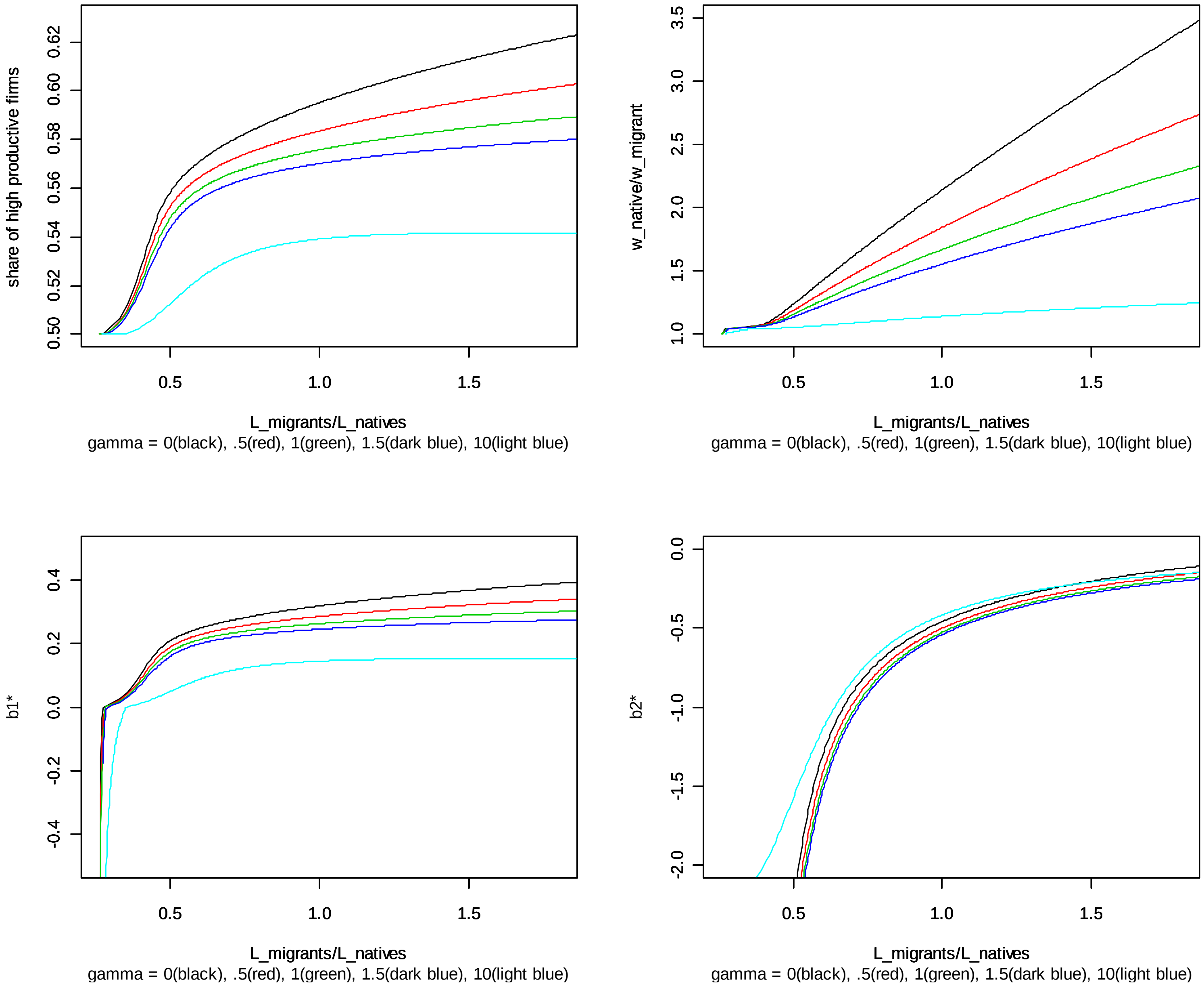

Figure 1: Average Productivity of Firms Remaining in the Market, relative wage and, minimum share parameter for low and high productive firms, second case, Source: Own Simulations

average productivity of firms in the market increases in the relative supply of migrants (figure 1 upper left). The better the firms are able to substitute workers, the less steep the increase is. This productivity increase is driven by the minimum share parameter $b_1{}^*$, which reaches zero in all cases and is increasing in the relative supply (figure 1 lower left). Therefore unproductive firms have to leave the market, if their share parameter is below this value. The minimum share parameter for the high productive firms b_2^* does not reach zero in a relevant range of the relative supply of workers (figure 1 lower right).

Welfare analysis

The welfare of a worker i is given by (using (8) and (5)):

$$U_i = \frac{w_i}{P} = \frac{\sigma - 1}{\sigma} \cdot M^{\frac{1}{\sigma - 1}} \cdot \tilde{\varphi} \cdot w_i \tag{23}$$

Similar to equation (15) the number of firms in the economy M can be calculated in by:

$$M = \frac{L_1 + \frac{w_2}{w_1} \cdot L_2}{\frac{w_2}{w_1} \cdot \sigma \cdot (\frac{e \cdot \delta}{1 - \Gamma(\varphi^*)} + F)} \tag{24}$$

where $1 - \Gamma(\varphi^*)$ measures the propability, that a new founded firm is able to survive in the marked and therefore it holds:

$$\Gamma(\varphi^*) = (1 - Ph) \cdot \int_{a_1^*}^{1} g(a)da + Ph \cdot \int_{a_2^*}^{1} g(a)da \tag{25}$$

which can be calculated from the simulation results.

For the average productivity it holds:

$$\tilde{\varphi} = \left(\frac{1}{1 - \Gamma(\varphi^*)} \cdot ((1 - \mathrm{Ph}) \cdot \int_{a_1^*}^{1} \left(\frac{A_l}{\left(a \cdot w_1^{1-\gamma} + (1 - a) \cdot w_2^{1-\gamma}\right)^{\frac{1}{1-\gamma}}} \right)^{\sigma - 1} g(a)da + \mathrm{Ph} \cdot \int_{a_2^*}^{1} \left(\frac{A_h}{\left(a \cdot w_1^{1-\gamma} + (1 - a) \cdot w_2^{1-\gamma}\right)^{\frac{1}{1-\gamma}}} \right)^{\sigma - 1} g(a)da \right)^{\frac{1}{\sigma - 1}} \tag{26}$$

The number of firms and the welfare effects for both types of workers are calculated for two cases:

1. The migrant share increases, but the size of the labor force is fixed
2. Only the migrant labor force size increases, while the natives labor force size is fixed

In both cases all other parameters like the fix costs are fixed. The first case can be used to compare two regions or cities with the same number of workers but different migrant shares, while the second case investigates the impact of new immigration. The results of the first case are displayed in figure 2, case two in 3.

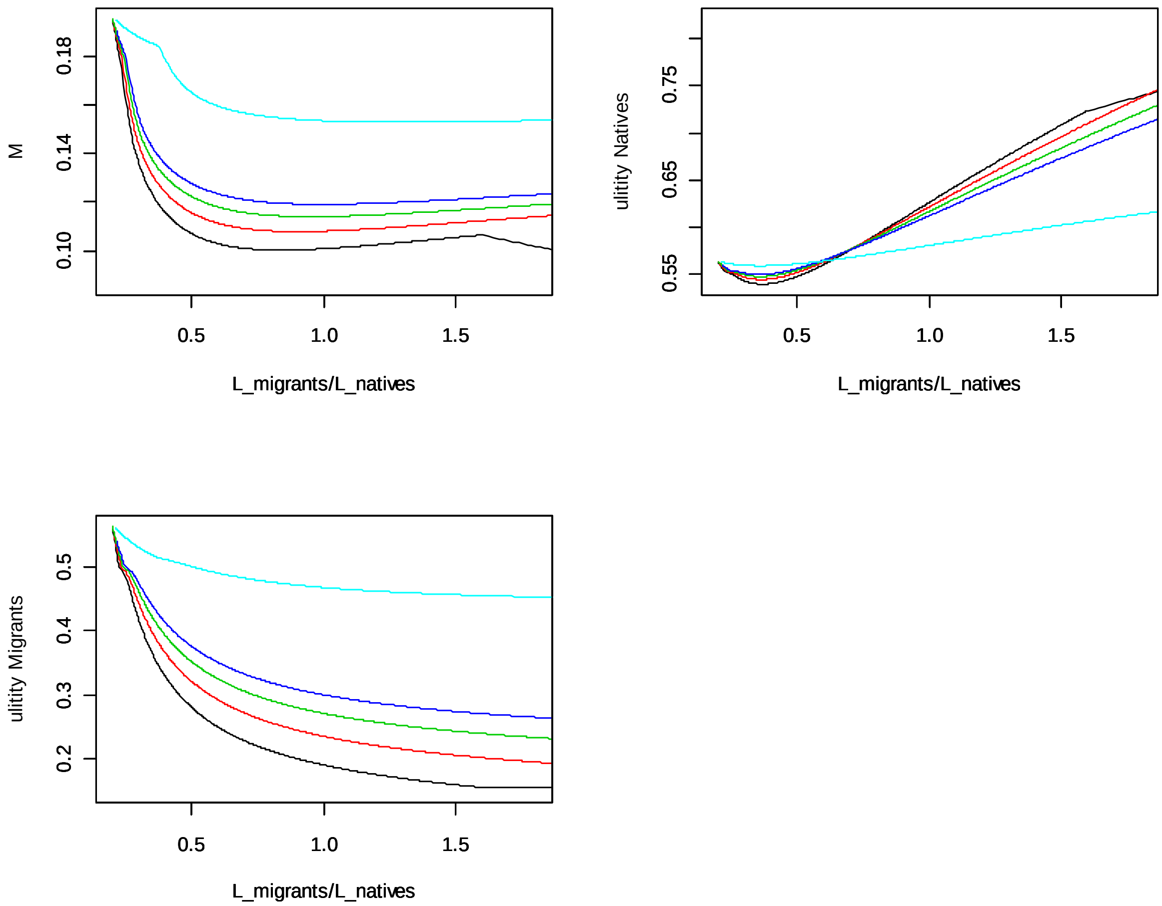

Figure 2: Number of firms and welfare comparison across cities; Source: Own simulations.

In the first case (figure 1) all else equal cities or regions with differing migrant shares are compared. The number of firms in a city or region is broadly decreasing in the migrant share, until it reaches a lower level. This is due to the fact that some low productive firms have to leave the market because their share parameter is too low. The welfare is influenced by three factors: the wage, the average firm productivity and the number of firms. For the natives a higher migrant share has positive effects on wages and firm productivity but negative effects on the number of firms. The results for welfare show that for low migrant shares the negative effects on the number of firms dominate, so that the welfare decreases. For higher shares the wage effect pushes the welfare so that a high migrant share has positive effects on welfare. For migrants the relative wage decreases in the migrant share, so that the welfare of migrants always decreases in the migrant share.

In the second case (figure 2) the effect of a migration shock are studied. Like in the first case a migrant shock starting from a very low level can have negative effects on the number of firms if it is too weak. If the shock is sufficiently strong or the migrant share is sufficiently high before the shock, the scale effects dominate and the number of firms increases. For the natives the wage and productivity effects dominate and their welfare always increases due to a migration shock. For migrants the negative wage effects decrease the welfare unless there is quite perfect substitutability between migrants and natives.

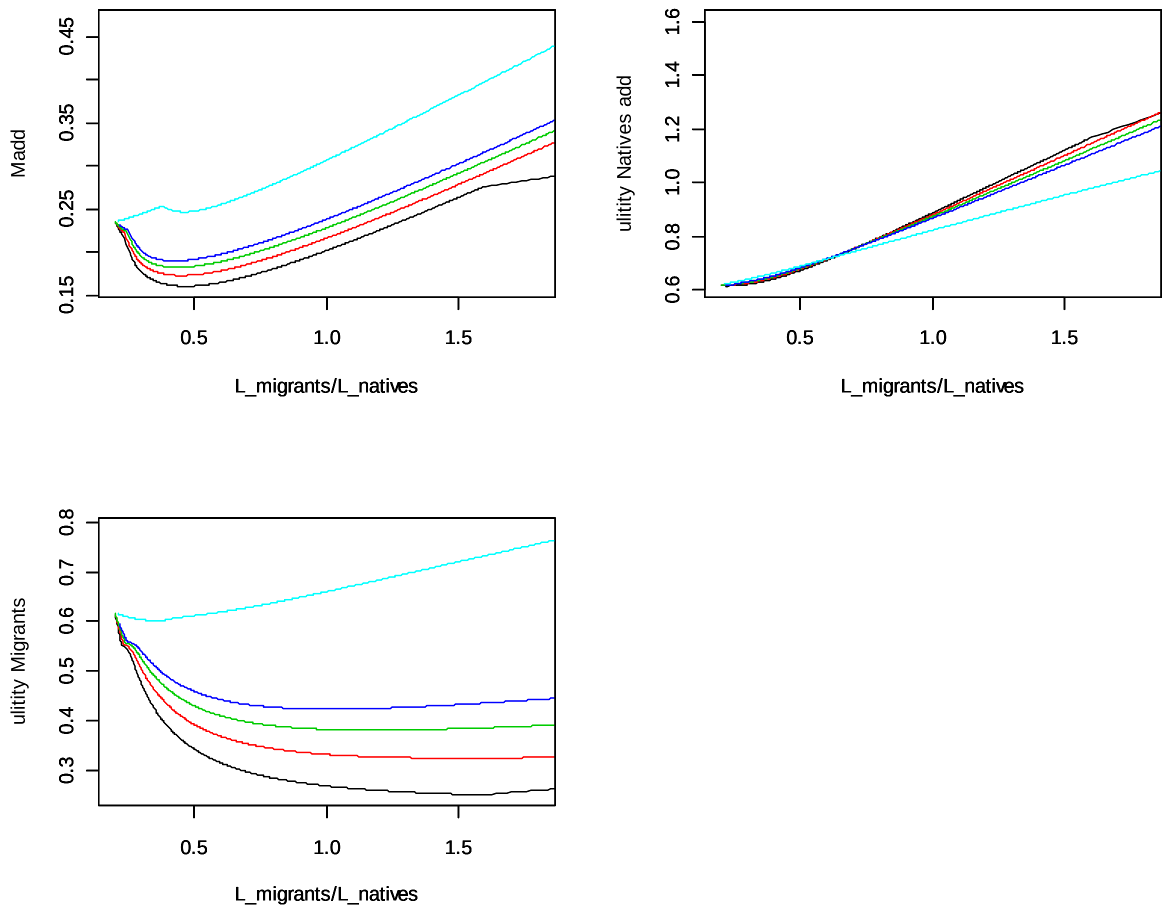

Figure 3: Number of firms and welfare - migration shock; Source: Own simulations

Conclusions

To conclude it is first worth to notice that the implications of the model correspond with empirical evidence for Germany. Firstly the wage difference between migrants and natives should be higher the higher the migrant share. The wages and the wage differences are higher in agglomerated regions, which usually see a larger migrant share.

Secondly, the model implies that a less productive firm is more likely to employ migrants, as wage advantages and productivity are substitutes for each other. Less productive firms that cannot achieve the wage advantages by employing migrants are forced to exit the market.

However, the main conclusion of this model is that a higher average productivity level of firms may be caused by a higher migrant share. This could explain parts of regional disparities, because migrant shares are usually the higher, the more agglomerated a region is and furthermore a higher migrant shares lead to a higher difference in wages, as seen above. The mechanism of the model working here can be described by a firm specialization effect caused by wage advantages, which imposes restrictions on the firm structure. Small firms that are usually less productive are more threatened to exit the market by firms that can realize less wage costs than the more productive firms.

High wage differences between migrants and natives are usually observed in low and medium qualification groups, high qualified migrants often realize similar wages as natives, in some occupations even higher. Therefore the mechanism described in this study offers an explanation especially for the impact of low and medium qualified immigrants, which constitute the biggest part of the overall immigration in most industrialized countries.

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