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Mario Larch and Wolfgang Lechthaler

Abstract:

In the presence of increasing specialization of workers it becomes more and more difficult for firms to find the most suitable ones. In such an environment a multinational enterprise (MNE) has an advantage because it can exchange workers between plants in different countries. Recruiting from the home and foreign plant leads to a larger labor market pool for an MNE, reducing the mismatch of its workforce. This paper analyzes the consequences of this advantage for production, employment, prices and wages.

We find that the additional ability to recruit workers from the home and foreign labor market leads to lower mismatch, higher average productivity of workers, lower prices, higher output, and higher employment of a plant of an MNE as compared to a national firm, while the wage-effects depend on firm productivity. These facts are well in line with recent empirical findings.

Keywords: Labor Market Pooling; Multinational firms; Intra-wage distribution; Heterogeneous firms

JEL classification: F23, F12, J41

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1 Introduction

The impact of globalization on labor market outcomes continues to be an important concern of scholars and policy makers alike (e.g., see the volumes of Abowd and Freeman, 1991; and Feenstra, 2000). One important driver of globalization in the last two decades has been the increased importance of multinational enterprises (MNEs) (see Markusen, 2002; Barba Navaretti, Venables, Barry, Ekholm, Falzoni, Haaland, Midelfart and Turrini, 2004).

The effects of MNEs were mainly discussed in connection with their advantages to economize on economies of scale and transport costs, disentangle the stages of production and knowledge spill-overs. However, there is an additional advantage which is revealed in the stylized facts but not accounted for in the literature: The possibility of MNEs to recruit workers in different countries and exchange them between production plants.

Labor migration of highly skilled workers induced by MNEs was found to be an important channel by, for example, Miller and Cheng (1976), Salt (1992), and Tzeng (1995). According to the Yearbook of Immigration Statistics,[1] in 2007 more than 9% of all work-related immigrations were due to movements within the plants of an MNE. This figure becomes even more impressive when looking at the migration of workers with the highest skills exclusively. For priority workers the share is higher than 24% even if the migration of the relatives of high skilled workers is included in the number of work-related immigrations. Including only high skilled workers without their families further increases the share to approximately 59%. These figures have been very stable over the last few years and clearly demonstrate that migration by MNEs is an important issue.[2] However, the international exchange of skilled workers by MNEs has not been investigated theoretically so far.

This paper tries to close this gap. Introducing two countries with separated labor

[1] See http://www.dhs.gov/ximgtn/statistics/publications/yearbook.shtm.

[2] Furthermore, highly-skilled employees of MNEs have a special status in the immigration law, making it easier for them to migrate, which effectively reduces the costs of migration for the employees of an MNE.

markets leads to the possibility for an MNE to exchange workers between its plants in different countries. It can recruit the best-fitting workers from various countries and move them to the production site where they are most productive. Hence an MNE can draw on a bigger pool of workers than a typical national firm. For a national firm without foreign representation it would be much more costly to find suitable workers abroad.[3]

To model the idea of labor market pooling of MNEs we use the approach of Amiti and Pissarides (2005) and adept it to a market with both, national and multinational firms.[4] All firms and workers are lined up along a "skills-circle" and the output of a firm depends on the distance of its own location on the circle to the location of its workers. The farther the distance, the higher is the mismatch and the lower is production. Firms compete for the workers by posting a wage per efficiency unit and workers choose the firm offering them the highest effective wage. We assume that there are two countries. An MNE has branches in both countries and can move workers from one branch to the other and thus reduce its mismatch.

We analyze the consequences of this advantage for production, prices, employment and the wage structure.[5] We find that MNEs using the same production technology as a national firm have a lower mismatch concerning needs and skills for their workforce, have more productive workers, demand lower prices, produce more, and employ more people. Concerning the wage, we show that MNEs pay lower wages per efficiency unit and lower average wages, but that the wage distribution within the firm is narrower. However, the results concerning wages depend crucially on the assumption that both, national and multinational firms, use the same production technology and that wages vary linearly with productivity. If multinationals are assumed to be more productive or heterogeneity of workers varies non-linearly with

[3] For simplification, we assume that it is prohibitively costly for national firms to hire foreign workers.

[4] Early contributions of monopsonistic labor market models with skill differentiation are Thisse and Zenou (2000) and Sato (2001).

[5] To get clear-cut results, we abstract from other differences between national firms and MNEs, as for example scale economies, internalization advantages, the economization on transport costs, or productivity advantages. For an overview see Markusen, (2002), Barba Navaretti, Venables, Barry, Ekholm, Falzoni, Haaland, Midelfart, and Turrini (2004), and Helpman (2006).

distance, MNEs may end up paying higher average wages.

Additionally, the proposed model allows for labor migration through internal movements induced by MNEs. The exchange of high skilled workers induced by MNEs was found to be an important channel of international migration of the highly skilled workers (see Cheng (1976), Salt (1992), and Tzeng (1995)).[6] Note that so far the heterogeneous firm models allowing for MNEs have assumed immobile, homogeneous workers, where firms end up paying the same wages.

After reviewing the relevant literature in Section 2, we begin by formulating a benchmark model in Section 3, where - for an MNE - there are no costs associated with the acquisition of foreign workers. The main results are presented in Section 4. We proceed by assuming recruitment costs, depending on the distance of the plants, and movement costs, depending on the number of workers hired abroad in Section 5. Both extended versions of the model include national firms and MNEs of the benchmark model as special cases. Conclusions are drawn in Section 6.

2 Literature

The theoretical literature on trade and MNEs mainly emphasizes the effects on trade and production, whereas less emphasis was put on the labor market outcomes (see for an overview of the most important topics Markusen, 2002; Barba Navaretti, Venables, Barry, Ekholm, Falzoni, Haaland, Midelfart and Turrini, 2004).

However, there are a few recent papers that explicitly deal with these issues. Markusen and Venables (1997) show that MNEs may lead to an increase in the ratio of skilled to unskilled wages specifically in high income countries. While their emphasis is on aggregate labor market outcomes in a country, we focus on the differences between MNEs and national firms concerning the employed labor.

[6]According to OECD (2005) bilateral aggregate migration flow data, discussed in Docquier and Marfouk (2004), 50 percent of migrants of OECD countries are skilled or highly skilled. Additionally, skilled migration flows are growing at twice the rate of unskilled migration flows. And as an example, over 80 percent of skilled migrants from the European Union to the United States are executives and managers.

Zhao (1998) studies the impact of foreign direct investment (FDI) on wages and employment in the presence of trade unions.[7] In his framework, FDI always reduces the negotiated wage and reduces union employment and the competitive wage if the union cares more about employment than wages or is equally concerned about employment and wages. These effects are weaker, if labor management bargaining is firm-specific and unionization is industry-wide. Zhao (1998) therefore analyzes imperfect labor markets in the presence of FDI, but sticks to the assumptions of homogenous labor and identical firms.

Eckel and Egger (2009) stick to the assumption of homogenous workers, but introduce firms that differ with respect to their productivity à la Melitz (2003). Additionally, they allow for trade and investment costs in order to investigate how the traditional proximity-concentration trade-off interacts with the bargaining power of unions in determining the incentives for multinational activity. In contrast to previous work, that relied on the "efficient bargaining" framework where both employment and wages are subject to negotiations, Eckel and Egger (2009) use the "right-to-manage" assumption, where firms and unions negotiate the wage rate and firms can unilaterally set employment. Their main findings are that wage bargaining between firms and unions makes multinational activity more attractive and that workers as a group benefit from globalization, even though there may be real income losses of workers employed in a multinational firm. However, all these papers do not allow for the exchange of workers between plants, which is at the heart of our analysis.

Malchow-Møller, Markusen, and Schjerning (2006) develop a heterogeneous-firm model à la Melitz (2003) in which ex-ante identical workers learn from their employers in proportion to the firm's productivity. They allow foreign-owned firms which have, on average, higher productivity in equilibrium due to entry costs, and therefore

[7] Earlier papers that deal with multinational firm's ability to shift production in the case of disagreement with local unions are Mezzetti and Dinopoulos (1991) and Zhao (1995). Whereas Zhao (1995) extends the framework of Mezzetti and Dinopoulos (1991) to a setting with two symmetric countries, Zhao (1998) focus on the impact of FDI on the determination of wages and employment and endogenizes the competitive wage in the non-unionized sector instead of treating it as a given constant.

have higher wage growth and, with some exceptions, pay higher average wages. In their model ex-ante identical workers learn from their employers in proportion to the firm's productivity, and foreign-owned firms have, on average, higher productivity in equilibrium due to entry costs. This leads MNEs to be the more productive firms in equilibrium paying higher wages. In contrast to our focus, there is no role for mismatch and mobility of workers between countries. Thus, the mechanism studied in our paper, namely the advantage of labor market pooling of MNEs, is ruled out by assumption in Malchow-Møller, Markusen, and Schjerning (2006).

The empirical results concerning the effect of foreign ownership on labor market outcomes are quite conclusive, establishing the fact that MNEs pay on average higher wages in their foreign subsidiaries than domestically-owned firms. This result was obtained with firm-level data,[8] as well as with matched employer-employee data.[9] For a survey see Lipsey (2002). However, empirical results are less clear cut concerning the reasons of this wage premium. Dobbelaere (2004) for example concludes: "*In our view, the higher technology level of foreign firms and the presence of international rent sharing are two plausible explanations for the significant multinational wage premium in Bulgaria.*" Similarly, Aitken, Harrison, and Lipsey (1996) find foreign ownership and productivity differences as equally plausible sources for the explanation of the wage gap. Globerman, Ries, and Vertinsky (1994) find that foreign affiliates have significantly higher value added per worker and pay higher wages than do Canadian establishments, but these differences vanish once they control for factors such as size and capital intensity. Hence, while the wage premium of foreign owned firms is supported very well in the data, controlling for productivity explains large parts of this premium.

Furthermore, it is well established in the empirical literature that there is a selection of only the most productive firms into foreign activities.[10] Taking these facts

[8]See Aitken, Harrison, and Lipsey, 1996; Dobbelaere, 2004; Doms and Jensen, 1998; Feliciano and Lipsey, 2006; Girma, Greenaway, and Wakelin, 2001; Globerman, Ries, and Vertinsky, 1994; Howenstine and Zeile, 1994; Lipsey and Sjöholm, 2004; Muendler and Becker, 2006.

[9]See Becker and Muendler, 2008; Heyman, Sjöholm, and Tingvall, 2007; Martins, 2004.

[10]See Dunne, Roberts and Samuelson, 1989; Davis and Haltiwanger, 1992; Bernard and Jensen, 1995, 1999, 2004; Roberts and Tybout, 1997; Clerides, Lach and Tybout, 1998; and Bartelsman and Doms, 2000.

together, the empirical findings suggest that MNEs pay higher wages because they are more productive.

We want to study how the advantage to exchange workers between plants in different countries effects equilibrium outcomes of MNEs as compared to national firms, disregarding all other differences between national firms and MNEs. We introduce MNEs that have plants in both countries, but produce with the same technology as firms that operate only in a single market. Specifically, we do not assume that MNEs can take advantage of economies of scale resulting from fixed costs or are more productive for exogenous reasons leading to lower variable costs. Rather both plants have to incur the same amount of fixed costs as local national firms. However, MNEs can recruit workers in the labor markets of both countries via their plant in the other country, whereas national firms are restricted to their home labor market. In this sense, MNEs "pool the labor markets".

3 A Model of Labor Market Pooling by Multinational Firms

The main goal of our model is to analyze how a major advantage of an MNE effects production, wages and the wage distribution at the firm level. The advantage we are talking about is the fact that an MNE having a plant in more than one country can exchange workers between the plants (labor market pooling by MNEs). In contrast, national firms having a plant in one single country, can only hire workers from that country. Additionally, acquisition of workers from abroad is assumed to be prohibitively costly for a national firm. For an MNE, which has plants in more than one country, the situation is different. If the branch in country A wants to recruit workers from country B, it can draw on the expertise of the plant in country B.

In order to create an incentive for a firm to employ workers from abroad, we allow for heterogeneity among workers. With heterogeneous workers, moving workers between plants opens the possibility to transfer workers from various countries to the production site where they are most productive. As a result, the mismatch between workers and the firm they are employed at is reduced. To model the heterogeneity of workers we use the approach of Amiti and Pissarides (2005).

In our model workers are not distinguished by different "levels" of skills, but rather specialize in different tasks. Hence, the heterogeneity stems from the fact that they are "specialized" in certain tasks which are determined by their position on a skills circle. The firms are also located on this skill circle, and their position indicates the kind of skills they need for production. The quality of a match is then given by the distance between the worker and the firm. The higher this distance, the bigger the discrepancy between the skill-needs of the firm and the skills the workers can offer. This then results in a lower productivity of the worker.

The starting point of our analysis is the model by Amiti and Pissarides (2005). The circumference of the circle is $2H$. We assume that workers are uniformly distributed along the circle, while firms are free to choose their position. Since, for a given labor force, the circumference of the circle tells us how far away from each other the workers are located, H can also be interpreted as a measure of heterogeneity. A higher H implies larger heterogeneity among workers. If $H = 0$ all workers are homogeneous.

In our model there are two countries, home and abroad. Both countries have a large number of national firms, which serve only their home market. They are monopolistic competitors with free entry to the market, so that their profits are driven down to zero. In both countries, workers are distributed along a circle, as described above. Furthermore, we assume that both countries are identical, which also applies to the skills circle, meaning that a worker in country A at a certain position has exactly the same skills as a worker from country B who sits at the same position of the skills circle in his country.

So far the assumptions are identical to Amiti and Pissardies (2005). Now we deviate from their model by allowing two national firms to merge to one MNE, having one branch in each country. The advantage of this merger is that the MNE can now use the branch in country A to screen the labor market in country A not only for workers for the plant in country A, but also to recruit the most suitable workers for country B (and vice versa). Due to the heterogeneity on the labor market this allows an MNE to achieve better match-quality than the national firms which cannot recruit workers from abroad.[11] The focus of our analysis is the comparison of an MNE with a national firm and not the decision to form such a merger. Therefore, we assume that only one merger takes place.[12] Similar to Neary (2009) for national firms in different industries, we assume that an MNE is small enough so that it does not affect the behavior of national firms. It produces in both countries and sells the output where it is produced.

For the benchmark model we assume that an MNE can move workers freely from one country to the other, without any costs or restrictions, and that it has full knowledge about the labor market in every country. Both these assumptions are extreme and not very realistic but they serve well to work out the effects of labor movements of highly skilled workers between plants of an MNE. Later on we will extend the model by introducing costs for moving workers from one country to the other and costs for recruiting workers.

3.1 National Firms

3.1.1 Profit Maximization

Every national firm i faces the downward sloping demand curve:

$$x_i = p_i^{-\sigma}, \tag{1}$$

[11]As in Amiti and Pissarides (2005) it is assumed that workers do not move on their own from one country to the other. Only when they are actively recruited by a firm from abroad will they move.

[12]See Neary (2009) for a very nice discussion of the motives to form a merger, both, from an industrial organization and an international trade perspective. Additionally, Neary (2009) develops a framework of oligopoly in general equilibrium where trade liberalization can trigger international merger waves. In this framework merges lead to a distribution of income towards profits at the expense of wages.

where σ is the price-elasticity of demand.[13] The inverted production function is described by:

$$L_i^E(w_i) = \alpha + \beta x_i(w_i). \tag{2}$$

The parameters α and β denote fixed and marginal costs measured in labor units, respectively. L_i^E is effective labor input[14] which depends positively on w_i, the wage posted by firm i. The profit function of a firm is given by:

$$\pi_i = p_i x_i(w_i) - w_i L_i^E(w_i). \tag{3}$$

The firm maximizes profits under the constraints (1) and (2). The first order condition (FOC) is found by substituting out price and quantity in the profit function (by using the production function (2) and demand (1)) and taking the derivative with respect to the wage:[15]

$$\frac{\partial \pi_i}{\partial w_i} = \frac{\sigma - 1}{\sigma \beta} \left(\frac{L_i^E - \alpha}{\beta} \right)^{-1/\sigma} \frac{\partial L_i^E}{\partial w_i} - L_i^E - w_i \frac{\partial L_i^E}{\partial w_i} = 0. \tag{4}$$

The derivative $\partial L_i^E / \partial w_i$ will be determined in the section describing the labor market.

3.1.2 Skill Differentiation and Supply of Labor

The time structure is as follows. First, from a given situation without an MNE, two national firms merge and form an MNE. Then the MNE chooses its strategy, i.e. it occupies a certain part H_m of the skills-circle, anticipating the strategies of national firms. Finally, the national firms choose their strategy, assuming that the number of

[13] This demand equation could be derived from a utility function such as $U = \sum_i (\sigma/(\sigma-1))\, x_i^{(\sigma-1)/\sigma} + Y$, where Y is a good from another industry. For an application to trade and MNEs, see Ludema (2002).

[14] Described in more detail further below.

[15] This equation is a variant of the common price-markup equation, which can also be found in Amiti and Pissardies (2005). We use this formulation because it is more general and allows direct comparison with the first order condition for the MNE derived later on.

national firms is big enough so that the probability of being a neighbor to an MNE is close to zero.[16] These assumptions allow us to model the national firms in exactly the same way as Amiti and Pissarides (2005), i.e., Cournot-Nash competition leads to symmetric locations of the national firms along that part of the circle which is not occupied by an MNE.[17]

Given this symmetric structure it is clear that the distance between any two *national* firms is $(2H - 2H_m)/N$, where N is the number of national firms and H_m is the part of the circle which is occupied by one plant of an MNE. The worst case of mismatch of workers is half this distance, which we shall define as m.

Now we are in a position to analyze the wage-posting of national firms. The actual wage of a worker is the product of two things: The wage per efficiency unit w_i posted by the firm, which is equal for all workers employed by that firm, and the productivity of the worker. The productivity of a worker for a specific firm is $1 - d$, where d is the distance between the firm and the worker on the skills circle. Thus, the wage that the worker receives, is given by $w_i(1 - d)$.

A worker always prefers to work for the employer offering the highest wage. Hence, a worker located at some distance d from firm i will choose to work for this firm whenever:

$$w_i(1 - d) \geq w_n(1 - (2m - d)), \tag{5}$$

i.e. when the wage he is earning in firm i is larger than the wage offered by the neighboring firm, w_n. The neighboring firm is $2m$ away from firm i and so the distance of the worker to this firm is $(2m - d)$, which implies a productivity of $(1 - (2m - d))$. Firm i gets all the workers for which the above equation is fulfilled

[16]This is in line with Amiti and Pissarides (2005) who also assume a very large number of firms.

[17]If we did not use these assumptions, the national firm neighboring an MNE would behave differently than the other national firms, which implies that the neighbor to this neighbor would behave different as well, and so on. This would result in a huge degree of heterogeneity among national firms without buying any further insights. Cosnita (2005) considers these interaction effects in a setting where two out of three or four firms merge to a two-plant firm in a homogenous good Cournot competition environment. It is shown that a lot of different location patterns are subgame perfect Nash equilibria.

and thus we can determine the maximum distance of a worker by rearranging it to:[18]

$$d_i = \frac{w_i - w_n(1-2m)}{w_i + w_n}, \tag{6}$$

which is valid in both directions. Since workers are assumed to be uniformly distributed along the circle this brings the firm a total of $L_s d_i / H$ workers with average mismatch $d_i/2$ and average productivity $1 - d_i/2$. The total number of effective units of labor supplied to the firm is therefore:

$$L_i^E = \frac{d_i}{H}\left(1 - \frac{d_i}{2}\right) L_s = \frac{L_s}{2H} \frac{(w_i - w_n + 2mw_n)(w_i + 3w_n - 2mw_n)}{(w_i + w_n)^2}. \tag{7}$$

Symmetry among national firms implies $w_i = w_n$. From the equation above we can derive the effect of wage changes on effective labor supply:[19]

$$\frac{\partial L_i^E}{\partial w_n} = \frac{L_s(1 - 2m + m^2)}{2Hw_n}. \tag{8}$$

3.2 Multinational Firms

As motivated above, in the presence of a heterogenous workforce an MNE has an incentive to exchange workers between the plants. Therefore, part of the workers recruited in country A will actually be employed in B and vice versa. In this section we assume that an MNE underlies no restrictions whatsoever concerning the movement of workers. Therefore, there are no restrictions concerning the location of the two national firms which merge, with the only restriction that their shares on the skills circle shall not overlap, which would be suboptimal. Then the plant in country A will recruit workers up to a distance d_m from the home country and up to a distance d_m^* from abroad.[20] Likewise for the other plant and thus the movement of workers can be illustrated as in Figure 1. In fact, from the point of view of the

[18] The reader should be careful to not confuse the variables m and d_i. While m denotes half the distance between two national firms and is predetermined by the market, d_i is the maximum distance of a specific worker to the firm, which can be influenced by the posted wage.

[19] For a derivation see Appendix A.

[20] Due to symmetry and lack of movement costs, the two distances will be equal to each other in the benchmark model, i.e. $d_m = d_m^*$.

workers it is as if an MNE had even *two* plants instead of one single in each country, because it is recruiting from two spots on the skills circle. However, workers in one interval are only recruited for migration and production in the other country.

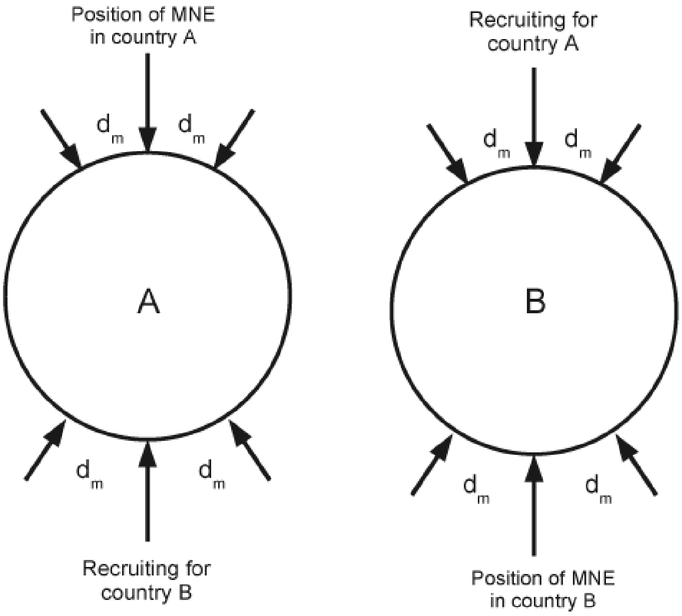

Figure 1: Recruiting of the Multinational Firm on the Skills Circle

In the figure we show the very extreme case of both plants of an MNE being situated at the exact opposite of each other on the skills circle. This is only to illustrate that the recruiting underlies no restrictions in the benchmark. In the extended model with recruitment and movement costs, this will no longer be the case and the plants are located next to each other.

3.2.1 Profit Maximization

In this section we illustrate the situation of one plant of an MNE. The decisions of the other plant are analogous. An MNE faces the same demand function as the national firms given in Equation (1). However, as every plant of an MNE employs workers from both countries, the production function changes to:

$$x_m = \frac{L_m^E + L_m^{E^*} - \alpha}{\beta}, \tag{9}$$

where L_m^E denotes the labor input originating from the same country as the plant is located in, while $L_m^{E^*}$ are the workers coming from the foreign country. In a similar manner the profit function modifies to:

$$\pi_m = p_m x_m - w_m L_m^E - w_m^* L_m^{E^*}. \tag{10}$$

In an MNE, two wages have to be chosen, one for the workers of the home country and one for the workers of the foreign country, it also has two FOC's:

$$\begin{aligned} \frac{\partial \pi_m}{\partial w_m} &= \frac{\sigma-1}{\sigma\beta}\left(\frac{L_m^E + L_m^{E^*} - \alpha}{\beta}\right)^{-1/\sigma} \frac{\partial L_m^E}{\partial w_m} - L_m^E - w_m \frac{\partial L_m^E}{\partial w_m} = 0, \\ \frac{\partial \pi_m^*}{\partial w_m^*} &= \frac{\sigma-1}{\sigma\beta}\left(\frac{L_m^E + L_m^{E^*} - \alpha}{\beta}\right)^{-1/\sigma} \frac{\partial L_m^{E^*}}{\partial w_m^*} - L_m^{E^*} - w_m^* \frac{\partial L_m^{E^*}}{\partial w_m^*} = 0. \end{aligned} \tag{11}$$

3.2.2 Supply of Labor

The problem of an MNE considering wage-posting is very similar to the decision of a national firm described in Section 3.1.2. The main difference is that the distance between an MNE and its neighboring firms is no longer given by $2m$ but by $m + m_m$ where m_m is the worst mismatch for an MNE.[21] Then a worker with distance d' to an MNE will decide to work for an MNE whenever:

$$w_m(1-d') \geq w_n(1-(m+m_m-d')), \tag{12}$$

which implies that the distance of the worker farthest away but still choosing an MNE is:[22]

$$d_m = \frac{w_m - w_n(1-m-m_m)}{w_m + w_n}. \tag{13}$$

[21]Or to put it differently, the maximal distance of a national firm to one of its employees is m, while the maximal distance of an MNE to one of its employees is m_m. Thus, the distance between an MNE and its neighboring national firm is $m + m_m$.

[22]Of course in equilibrium the worst mismatch is equal to the farthest distance, or $m_m = d_m$.

The effective labor supply of an MNE is given by:

$$L_m^E = \frac{d_m}{H}\left(1 - \frac{d_m}{2}\right) L_s = \frac{L_s}{2H} \frac{(w_m - w_n + (m + m_m)w_n)(w_m + 3w_n - (m + m_m)w_n)}{(w_m + w_n)^2}. \tag{14}$$

From this equation we can derive the derivative of labor supply with respect to the wage:

$$\frac{\partial L_m^E}{\partial w_m} = \frac{L_s}{H} \frac{w_n^2(4 - 4(m + m_m) + (m + m_m)^2)}{(w_m + w_n)^3}. \tag{15}$$

This equation corresponds to Equation (8) for national firms, which is less complex due to $w_i = w_n$ implied by symmetry, while it is not generally true that $w_m = w_n$.

3.3 The Equilibrium

So far we have described the decisions of the single firms. Now we investigate the equilibrium on the labor market, the number of national firms and the resulting mismatch.

To determine the equilibrium, we begin by setting labor supply equal to labor demand which both depend on mismatch. Labor supply has already been derived above, given by Equation (7). Labor demand can be found by using the zero-profit condition. First we set profits equal to zero for national firms and deduce the price a national firm will charge. From this we can derive quantities produced. Labor demand is then given by the amount of labor needed to produce this quantity:[23]

$$L_i^D = \frac{\alpha\sigma}{\sigma - (\sigma - 1)(1 - m)^2}. \tag{16}$$

Effective labor demand is upwards sloping in m, while labor supply is downwards sloping. Together the two determine equilibrium mismatch.

Given equilibrium mismatch, we can derive the optimal wage of a national firm and

[23]Detailed derivations can be found in Amiti and Pissarides (2005).

effective labor supply from Equations (4), (7) and (8). Finally, production and price follow from Equations (1) and (2). Combining Equations (4) and (8) as described in Appendix B, the equilibrium for the national firms is fully determined by the five equations:

$$
\begin{aligned}
x_i &= p_i^{-\sigma}. &(17)\\
L_i^E &= \frac{\alpha\sigma}{\sigma-(\sigma-1)(1-m)^2}. &(18)\\
L_i^E &= \alpha+\beta x_i. &(19)\\
L_i^E &= \frac{m}{H}\left(1-\frac{m}{2}\right)L_s. &(20)\\
\frac{L_s(1-2m+m^2)}{2Hw_n} &= \frac{L_i^E}{\frac{\sigma-1}{\sigma\beta}\left(\frac{L_i^E-\alpha}{\beta}\right)^{-1/\sigma}-w_n}. &(21)
\end{aligned}
$$

The five equations are product demand, labor demand, the production technology, labor supply and finally the first order condition for profit maximization of national firms. Note that the five equations above do not determine the number of national firms in the market. The number of national firms is found by using the definition of mismatch:

$$N=\frac{H-H_m}{m}, \tag{22}$$

where H_m is the labor recruited in one country by an MNE for both, domestic and foreign production.

In a similar manner as for the national firms, it is now possible to derive the wages w_m and w_m^* and the corresponding labor supply from the corresponding FOCs. Using the production function and the demand equation, an MNE's production quantity and the charged price can be determined.

We have eight endogenous variables for a single plant of an MNE (x_m, p_m, L_m^E, $L_m^{E^*}$,

d_m, d_m^*, w_m and w_m^*) and the eight equations determining the equilibrium are:

$$\begin{aligned}
x_m &= p_m^{-\sigma}. && (23)\\
L_m^E + L_m^{E^*} &= \alpha + \beta x_m. && (24)\\
L_m^E &= \frac{d_m}{H}\left(1 - \frac{d_m}{2}\right) L_s. && (25)\\
L_m^{E^*} &= \frac{d_m^*}{H^*}\left(1 - \frac{d_m^*}{2}\right) L_s^*. && (26)\\
d_m &= \frac{w_m - w_n(1 - m - m_m)}{w_m + w_n}. && (27)\\
d_m^* &= \frac{w_m^* - w_n^*(1 - m^* - m_m^*)}{w_m^* + w_n^*}. && (28)\\
\frac{L_s}{H}\frac{w_n^2(4 - 4(m + m_m) + (m + m_m)^2)}{(w_m + w_n)^3} &= \frac{L_m^E}{\frac{\sigma-1}{\sigma\beta}\left(\frac{L_m^E + L_m^{E^*} - \alpha}{\beta}\right)^{-1/\sigma} - w_m}. && (29)\\
\frac{L_s^*}{H^*}\frac{{w_n^*}^2(4 - 4(m^* + m_m^*) + (m^* + m_m^*)^2)}{(w_m^* + w_n^*)^3} &= \frac{L_m^{E^*}}{\frac{\sigma-1}{\sigma\beta}\left(\frac{L_m^E + L_m^{E^*} - \alpha}{\beta}\right)^{-1/\sigma} - w_m^*}. && (30)
\end{aligned}$$

4 Main Results

4.1 Homogeneous Firms

This section compares output, prices, employment and wages of national firms and an MNE if they use the same production technology. The results are stated in propositions if we derive them analytically and in the form of results if we rely on numerical simulations. Table 1 summarizes results for the most important variables in our benchmark case.[24]

Proposition 1 ***Production:*** *Every plant of an MNE produces more than a national firm.*

[24] In line with Amiti and Pissardies (2005) we use the following parameter values: $H = 1$, $\alpha = 1/4$, $\beta = 3/4$, $L_s = L_s^* = 100$. The only deviation from Amiti and Pissarides is $\sigma = 6$, which is more in line with the empirical literature (see for an overview of different approaches to estimate σ Anderson and van Wincoop (2004), pages 715-716.). Further below we show what happens when we vary the values of σ.

	National Firms	MNE	Ratio
Output	1.4327404	1.5992759	1.1162356
Price	0.8084418	0.7937604	0.9818399
Employment	2.6668914	2.9094954	1.0909688
Wage per Efficiency Unit	0.8744725	0.8691337	0.9938949
Average Wage	0.8686422	0.8659728	0.9969269
St. Dev. of Wages	0.0033661	0.0018250	0.5421542
Mismatch	0.0133345	0.0072737	0.5454844

Table 1: Base Case.

Proof: See Appendix C.

The intuition is as follows. Given the advantage of being able to move workers from one country to the other, an MNE can produce the same amount of output in every plant as a national firm with fewer workers from *one* country. This improves the quality of the workforce (measured by mismatch) and thereby reduces marginal costs. It becomes efficient for an MNE to produce more than a national firm in every plant.

Proposition 2 ***Price:*** *An MNE charges a lower price for the produced good than a national firm.*

The demand structure assumed in equation (1) implies a constant price-elasticity. Hence, if a firm wants to sell more, prices have to go down in order to find their demand. Given Proposition 1, we know that an MNE produces more. Hence, it immediately follows that an MNE charges a lower price.

Result 1 ***Employment:*** *Every plant of an MNE employs more workers than a national firm.*

Even though every employed worker is more efficient due to a better match, the output increase in every plant of an MNE is large enough to raise labor employment above the level of a national firm. In the numerical example (see Table 1), output is nearly 12% higher in a plant of an MNE than in a national firm, whereas the number of employed workers in an MNE plant exceeds labor employment of a national firm by about 9%. This is due to the increased efficiency of the employed workers. Hence output raises more than labor employment increases.

In order to get some feeling for the relationship of mismatch and employment levels, note that for symmetric countries employment levels are given by $2m_m L_s/H$ for a plant of an MNE and by mL_s/H for a national firm. Hence, differences in employment levels only depend upon the relative magnitudes of m_m and m.

One plant of an MNE and a national firm would employ the same number of people, if $m_m = m/2$. If mismatch of an MNE in every country is lower/higher than half the magnitude of the mismatch in a national firm, then the employment level of an MNE will be lower/higher than for a national firm. Given our numerical examples using plausible parameter values, a mismatch lower than half seems huge. Hence, it is most likely that every plant of an MNE will employ more workers than a national firm.

Proposition 3 ***Wage per Efficiency Unit:*** *An MNE offers a lower wage per efficiency unit than a national firm.*

Proof: See Appendix D.

If an MNE offers the same wage as the national firms, it will attract twice as many workers: From country A it gets the same number of workers as a national firm, but at the same time it gets the same number of workers from country B and moves them to country A. Thus, if it is efficient for an MNE to use more than twice as many workers as a national firm, it will offer a higher wage per efficiency unit than the national firms. Otherwise, its wage will be lower.

In Proposition 1 we stated that every plant of an MNE produces more than a national firm. However, the output does not double. Hence, in order to recruit only the needed amount of workers, an MNE will offer a lower wage per efficiency unit than a national firm in every country.

Note that this result is not in contrast to empirical findings that MNEs pay higher *average* wages. In the empirical literature MNEs are found to be more productive than national firms. Controlling for firm productivity, the wage premium considerably shrinks and sometimes vanishes. [25] In Section 4.2 we allow for productivity differences between the MNE and the national firms and show that in such a case the MNE pays higher wages per efficiency unit.

Proposition 4 ***Average Wage:*** *The average wage and mismatch is lower for an MNE than for a national firm.*

Proof: See Appendix E.

Average wages are given by:

$$\bar{w}_m = w_m\left(1 - \frac{m_m}{2}\right), \quad \bar{w}_n = w_n\left(1 - \frac{m}{2}\right).$$

As an MNE offers a lower wage per efficiency unit, w_m, also mismatch, m_m, is lower in equilibrium. However, there are two effects on the average wage working in opposite directions. Of course, a wage decrease directly decreases the average wage. But at the same time a lower wage per efficiency units leads to a smaller share on the skills circle. This implies that average productivity of workers increases. A higher average productivity raises the average wage.

With the assumed linear relationship of productivity and distance, this second effect can never dominate the direct effect of a decrease of the wage per efficiency unit. Thus, for the average wage of an MNE the same is true as for the wage per efficiency unit: The average wage of an MNE is lower.

As already argued above, allowing for productivity differences between national firms and the MNE can overturn the result that the MNE pays lower wages per efficiency unit. The same is true for average wages (see Section 4.2). Furthermore, it should be noted that the perfect correlation between wages per efficiency unit and the average wage hinges on the assumption that mismatch increases linearly with distance. Assuming, for example, that productivity varies quadratically with distance instead of linearly, i.e., assuming that the wage a worker receives is given

[25] Furthermore, under certain assumptions average wages may be higher even though wages per efficiency units are lower, as shown in Appendix E.

by $w_i(1-d^2)$ instead of $w_i(1-d)$, would lead to the possibility that the average wage of the MNE is higher even tough the wage per efficiency unit it posts is lower, just because the importance of lower mismatch is increased (see Appendix E for a derivation).

Proposition 5 ***Standard Deviation of Wages:*** *The intra-firm wage dispersion is lower for a plant of an MNE than for a national firm.*

Given our assumptions that productivity is based on mismatch and that workers are uniformly distributed along the skills circle, wages in our model are also uniformly distributed. The standard deviation of a uniformly distributed variable is defined as:

$$dev = \frac{b-a}{\sqrt{12}} \tag{31}$$

where a and b are the minimum and the maximum of the distribution, respectively. The boundaries of the wage distribution are w_m (resp. w_n) and $w_m(1-d_m)$ (resp. $w_n(1-m)$) and thus the standard deviation of wages in a national firm and an MNE are given by:

$$dev[w_n] = \frac{w_n m}{\sqrt{12}}, \qquad dev[w_m] = \frac{w_m m_m}{\sqrt{12}}. \tag{32}$$

As already stated above, an MNE offers a lower wage and has a lower mismatch than a national firm, both factors tending to decrease wage dispersion. Hence, the advantage of an MNE to realize a more homogeneous workforce through migration leads to less dispersion of wages.

Result 2 ***Increasing Labor Heterogeneity:*** *An increase in labor heterogeneity aggravates the differences between an MNE and a national firm for all variables except the intra-firm wage distribution and mismatch.*

Table 2 summarizes the effects of an increase in labor heterogeneity, showing the ratios of the values for an MNE and a national firm. Increasing labor heterogeneity means that with the same wage per efficiency unit, less suitable workers are

	H=0.5	H=1.0	H=1.5	H=30
Output	1.0622862	1.1162356	1.1640010	2.1431375
Price	0.9899800	0.9818399	0.9750071	0.8806939
Employment	1.0494173	1.0909688	1.1267517	1.6000109
Wage per Efficiency Unit	0.9966447	0.9938949	0.9915686	0.9565545
Average Wage	0.9983164	0.9969269	0.9957436	0.9760621
St. Dev. of Wages	0.5229481	0.5421542	0.5586258	0.7652488
Mismatch	0.5247087	0.5454844	0.5633759	0.8000054

Note: Numbers give ratios of MNE to NE values.

Table 2: Base Case: Variation of Skill Differentiation H.

attracted. As a consequence, output, wages and employment of both, MNE and national firms, go down, while the price goes up.

However, the advantage of an MNE to draw from two labor market pools becomes more important. When heterogeneity among workers increases, it is an even greater advantage to recruit from a larger pool. The possibility to attract workers not only from the home labor market, but also from the foreign labor market, directly implies a higher match quality (relative to national firms). A higher match quality leads to an increase in the optimal firm size (in terms of output level and employment) of an MNE relative to a national firm. However, the increase in firm size itself can only be achieved by accepting relatively more mismatch and relatively higher intra-firm wage dispersion. In equilibrium, the differences between MNE and national firm become more pronounced concerning output, wages, and employment, whereas the differences of the intra-firm wage distribution and mismatch shrink.

Result 3 ***Increasing Demand Elasticity:*** *An increase in the elasticity of demand aggravates the differences between an MNE and a national firm for all variables except the intra-firm wage distribution.*

	σ=3	σ=4	σ=5	σ=6	σ=7	σ=8	σ=9	σ=10
Output	1.0329322	1.0566603	1.0848619	1.1162356	1.1495914	1.1839215	1.2184220	1.2524838
Price	0.9892576	0.9863162	0.9838414	0.9818399	0.9802818	0.9791171	0.9782884	0.9777387
Employment	1.0198002	1.0393064	1.0634503	1.0909688	1.1206979	1.1516452	1.1830125	1.2141886
Wage per Efficiency Unit	0.9964018	0.9954102	0.9945735	0.9938949	0.9933651	0.9929679	0.9926844	0.9924953
Average Wage	0.9981943	0.9976941	0.9972710	0.9969269	0.9966575	0.9964549	0.9963095	0.9962119
St. Dev. of Wages	0.5080654	0.5172681	0.5288398	0.5421542	0.5566311	0.5717734	0.5871790	0.6025382
Mismatch	0.5099001	0.5196532	0.5317252	0.5454844	0.5603489	0.5758226	0.5915062	0.6070943

Note: Numbers give ratios of MNE to NE values.

Table 3: Base Case: Variation of demand elasticity σ.

As illustrated in Table 3 the elasticity of substitution (i.e. competition) has very similar effects as labor heterogeneity. Increased competition (a higher elasticity of substitution) implies that the advantage of the MNE becomes more important. While competition leads to lower prices and higher employment and output for national firms and the MNE, the MNE increases employment and production more. This expansion comes at the cost of more mismatch and a wider intra-firm wage distribution.

4.2 Heterogeneous Firms

We have assumed so far that both national firms and MNEs produce with the same technology. However, recently firm heterogeneity was reconsidered in international trade as one important channel in order to explain endogenous selection of different organizational forms. For an overview see Helpman (2006) and Bernard, Jensen, Redding, and Schott (2007).

In the already huge and still growing literature on firm heterogeneity, Helpman, Melitz, and Yeaple (2004) as well as Grossman, Helpman and Szeidl (2006) focus on the firms' choice between exports and (various forms of) FDI. Firms are heterogeneous with respect to their productivity as in Melitz (2003), and the decision to export or to become multinational therefore also depends on the productivity of the firms. Specifically, the most productive firms engage in FDI, whereas slightly less productive firms decide to serve the foreign market via exports. The least productive but still active firms sell their products only locally.

Without productivity differences between firms, we find that an MNE pays lower wages. Introducing firm productivity differences by assuming that the marginal costs for the national firms β_n are higher than the marginal costs β_m for an MNE, this result can be overturned.[26]

Result 4 ***Productivity Differences:*** *Productivity advantages of an MNE aggravate the differences between an MNE and a national firm for output, employment and prices. The differences between wages become smaller until an MNE even pays*

[26]Note that, in contrast to the literature cited above, we do not introduce fixed costs and a distribution of productivity but just assume that MNEs are more productive, since this is sufficient to illustrate the main effects.

	β_n/β_m=1	β_n/β_m=0.92	β_n/β_m=0.83	β_n/β_m=0.75	β_n/β_m=0.67
Output	1.1162356	1.7873157	2.9258471	4.8764854	8.2254523
Price	0.9818399	0.9077504	0.8361639	0.7679192	0.7038391
Employment	1.0909688	1.5154202	2.1679774	3.1682275	4.6794608
Wage per Efficiency Unit	0.9938949	0.9967362	1.0011364	1.0079569	1.0184399
Average Wage	0.9969269	0.9983572	1.0005720	1.0040052	1.0092818
St. Dev. of Wages	0.5421542	0.7552371	1.0852205	1.5967184	2.3828748
Mismatch	0.5454844	0.7577101	1.0839887	1.5841138	2.3397304

Note: Numbers give ratios of MNE to NE values.

Table 4: Base Case: Productivity Differences between national firms and MNEs.

higher wages.

Table 4 summarizes the results for various levels of productivity differences between national and multinational firms. Specifically, we maintain the assumption that $\beta_n = 3/4$ and vary β_m. The first column reproduces the case of identical productivities. As the productivity of an MNE relative to the national firm increases, implying a fall in marginal costs, relative output increases and prices fall. The firm is now able to produce more output with a given amount of labor. In order to sell it on the market, prices have to fall.

The employment level of every plant of an MNE compared to a national firm rises, which is the net-effect of three forces: (i) the level effect due to the increased output, leading to a higher employment level, (ii) the increasing mismatch, leading to lower efficiency of workers, and therefore an increasing amount of workers, (iii) the higher productivity level, leading to a lower employment level. The first two effects outweigh the last one, leading to a positive net-effect on employment.

Wages per efficiency unit also increase with increasing productivity of the firm. The reason is that in order to produce a higher quantity, more workers have to be hired. This can only be achieved by paying higher wages, which attracts more workers to an MNE. Observe that eventually the productivity advantage of an MNE becomes large enough so that he pays higher wages. The behavior of average wages is similar, but less strong, as an increasing workforce leads to a lower average efficiency of workers. The intra-firm wage distribution also rises with increased firm productivity, which is again a direct result of the increasing heterogeneity of workers employed.

To sum up, adding firm productivity differences in our model leads to predictions that cope very well with empirical findings concerning, wages, output and employment.

5 Extensions

So far we have assumed that an MNE can move workers without any restrictions from one country to another. However, as stressed by Franko (1973) for example, transferring their employees abroad can induce large costs. Besides a premium of 10 to 20 percent of base salary, there are numerous allowances for housing, costs of living, school, and moving (see for example Reynolds, 1972; Tzeng, 1995). At the same time, recruiting from a foreign country is likely to be more expensive than hiring at home, even if an MNE can benefit from the knowledge of the plant in that country. Therefore we will extend the benchmark model by introducing two different kinds of costs. Both extended models will include an MNE and the national firms of the previous sections as special cases. Specifically, if the costs introduced in this section are zero, then we are back to the case of an MNE in the benchmark model, while for national firms the costs are infinite. Thus, in our model MNEs and national firms are equivalent except with regard to the costs they face with respect to hiring workers from the other country.

5.1 Recruitment Costs

In this section we discuss recruitment costs. In our model a plant of an MNE is not only recruiting workers for itself but also for the plant in the other country. However, since the plants are not located at exactly the same position, it is likely that screening those workers is costly (see for example Helpman, Itskhoki, and Redding, 2008). Moreover, the farther the distance of the plants on the skills circle (i.e. the more heterogeneous their skill-needs), the more expensive the screening process will be. In the benchmark model it was of no importance where the two plants of an MNE were located (as long as their shares of the circle did not overlap). Now we assume that an MNE has to pay an extra-cost which depends positively on the distance between the two plants, because it is more difficult to recruit workers that are far away on the circle.

5.1.1 The Model

With regard to recruitment costs we have to distinguish two different cases. If recruitment costs are positive but small this will imply that the first order conditions of the benchmark model are still valid, but now the merger will take place between firms which are located on neighboring parts of their respective country's skills-circle to minimize the costs (see the left sketch of Figure 2). The distance between the two plants will be $2d_m$.

More interesting is the case where the recruitment costs are so high that it is optimal for an MNE to lower the distance between the two plants even below $2d_m$. Then the plant will still recruit workers up to a distance d_m from that side where it is facing a national firm. But on the other side of the circle, where its neighbor in the labor market is its own affiliate, the distance will be smaller. Let us call this distance d_i with $d_i < d_m$. This case is illustrated in the right sketch of Figure 2. The distance between the two plants now reduces to $2d_i$ and we no longer need to care about the wage to attract workers, because if it is large enough to attract workers with distance d_m it is certainly large enough for workers with distance d_i.

Effective labor supply changes to:

$$L_m^E = \frac{d_m}{2H}\left(1 - \frac{d_m}{2}\right) L_s + \frac{d_i}{2H}\left(1 - \frac{d_i}{2}\right) L_s, \tag{33}$$

which is very similar to Equation (14) of the benchmark but differs with respect to two points. The obvious one is the inclusion of d_i. The second one is the division by two of both expressions, which is due to the fact that d_m and d_i are only relevant on one side of the plant. Note that, due to symmetry, the average productivity of workers, $1 - d_m/2$, on the side where the national firm is the neighbor does not differ from the one in the benchmark.

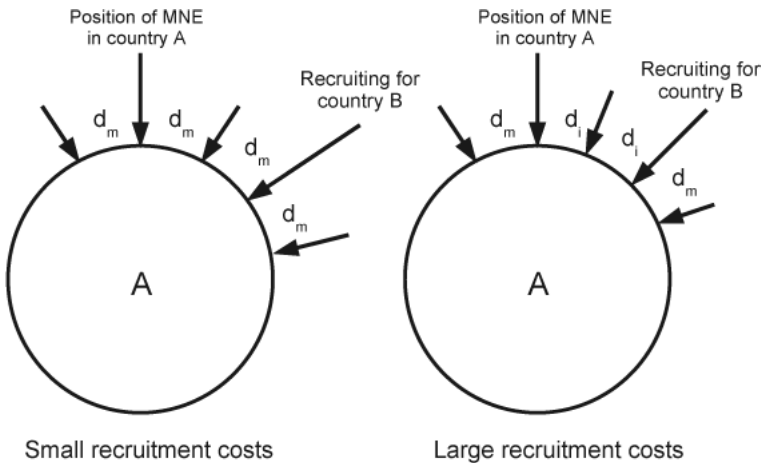

Figure 2: The Model with Large and Small Recruitment Costs

Assuming that the costs of recruitment of one plant are $c(d_i)$ with $c'(d_i) > 0$, the profit function of an MNE modifies to:

$$\pi_m = p_m x_m - w_m L_m^E - w_m^* L_m^{E*} - c(d_i). \tag{34}$$

Since an MNE has an additional control over which it has to decide we need a second first order condition governing the choice of d_i.[27] It is found by taking the derivative of the profit function with respect to d_i and setting it equal to zero:

$$\begin{aligned} \frac{\partial \pi_m}{\partial d_i} &= \frac{\sigma - 1}{\sigma \beta} \left(\frac{L_m^E + L_m^{E^*} - \alpha}{\beta} \right)^{-1/\sigma} \left(\frac{\partial L_m^E}{\partial d_i} + \frac{\partial L_m^{E^*}}{\partial d_i} \right) - w_m \left(\frac{\partial L_m^E}{\partial d_i} + \frac{\partial L_m^{E^*}}{\partial d_i} \right) \\ &\quad - c'(d_i) = 0. \end{aligned} \tag{35}$$

The first term is the marginal revenue of an increase in d_i, while the second and third term are the marginal costs consisting of the additional wage payments and the additional recruitment costs. Note that the FOC is including the influence of d_i on both, the labor supply from the home country and from the foreign country, because it is using workers from both countries.

[27]The FOC for d_m is the same as in the benchmark with the only difference that it has to be divided by two.

Finally, the impact of d_i on effective labor supply is found in the definition of labor supply (Equation (33)):

$$\frac{\partial L_m^E}{\partial d_i} = \frac{L_s}{2H}(1 - d_i). \tag{36}$$

For an overview of all the equations of this extended version see Appendix F.

5.1.2 Results

For the simulations we have normalized the recruitment costs to the largest value for which it is still true that $d_i = d_m$. The second column in Table 5 labelled "Costs=1" gives the results for this case. We then increase the recruitment costs compared to this situation. The fourth column, for example, shows what happens, when the recruitment costs are doubled. The table shows that the basic picture is still the same: An MNE produces more, employs more workers but offers a lower wage.

Result 5 ***Recruitment Costs:*** *Recruitment costs do not qualitatively change the results but mitigate the difference between an MNE and a national firm.*

Looking at employment, the effects of increases in recruitment costs might seem rather small. While in the benchmark an MNE employs approximately 2.7% more workers than a national firm, it still employs 1.2% more workers when costs are doubled. Looking at wages the effects become even smaller, they are below half a percentage point. However, a huge structural change hides behind these figures, which is illustrated by the seventh row, showing the relation between d_i and d_m. While, by definition, both are the same in the benchmark case, an increase of costs by 50% is sufficient to lower the ratio to just one half. This change is caused by a simultaneous increase in d_m and decrease in d_i. The plants of an MNE move closer together, which implies that between the two plants fewer workers can be recruited. Therefore, an MNE tries to take bigger advantage of its possibility to move workers by increasing d_m.

Comparing the different columns in Table 5, we see that an MNE becomes more

	Costs=1	Costs=1.5	Costs=2	Costs=3	Costs=5	Costs=10	Costs=100
Output	1.0368515	1.0245649	1.0184219	1.0122798	1.0073671	1.0036832	1.0003683
Price	0.9939867	0.9959635	0.9969622	0.9979679	0.9987774	0.9993875	0.9999386
Employment	1.0265424	1.0169416	1.0124205	1.0080885	1.0047604	1.0023453	1.0002314
Wage per Efficiency Unit	0.9934650	0.9956146	0.9967001	0.9977929	0.9986723	0.9993348	0.9999334
Average Wage	0.9967106	0.9985388	0.9991854	0.9996474	0.9998811	0.9999756	1.0000007
St. Dev. of Wages	0.5099170	0.5812370	0.6626155	0.7633567	0.8536028	0.9254139	0.9924321
d_i/d_m	1.0000000	0.5086421	0.3409143	0.2053773	0.1143876	0.0542688	0.0051877

Note: Numbers give ratios of MNE to NE values.

Table 5: Recruitment Costs.

and more like a national firm, the higher the recruitment costs are. The distance d_i between the two plants converges towards zero, while all other values converge towards the values of a national firm. This reflects the fact that in our model the only difference between an MNE and a national firm is the possibility to move workers between the plants in different countries.

5.2 Movement Costs

Next we want to relax the assumption that it is costless to migrate workers from one country to the other. Therefore, we introduce movement costs, which depend positively on the number of workers moved by an MNE.

5.2.1 The Model

For a fixed number of workers on the labor market, the number of workers that migrate depends exclusively on the distance d_m^*. Hence, we can write the profit function as:

$$\pi_m = p_m x_m - w_m L_m^E - w_m^* L_m^{E*} - c(d_m^*), \tag{37}$$

where $c(d_m^*)$ are the movement costs, with $c'(d_m^*) > 0$.

Effective labor supply is the same as in the benchmark model. The same is true for the FOC for choosing d_m. However, while in the benchmark the FOC for d_m^* was the same as the one for d_m, now we have to take account of the movement costs and

	Costs=0	Costs=0.01	Costs=0.05	Costs=0.1	Costs=1
Output	1.1162356	1.0296119	1.0074942	1.0038769	1.0004002
Price	0.9818399	0.9951482	0.9987564	0.9993553	0.9999333
Employment	1.0909688	1.7589476	1.9383392	1.9680456	1.9966959
w_m/w_n	0.9938949	0.9983738	0.9995835	0.9997841	0.9999777
w_m^*/w_n^*	0.9938949	0.9885507	0.9871456	0.9869142	0.9866912
Average Wage	0.9969269	0.9984898	0.9995633	0.9997693	0.9999757
St. Dev. Of Wages	0.5421542	0.8160748	0.9510610	0.9745035	0.9973508
d_m^*/d_m	1.0000000	0.1626143	0.0376340	0.0191991	0.0019558

Note: Numbers give ratios of MNE to NE values.

Table 6: Movement Costs.

thus the FOC changes to:

$$\frac{\partial \pi}{\partial d_m^*} = \frac{\sigma - 1}{\sigma \beta} \left(\frac{L_m^E + L_m^{E^*} - \alpha}{\beta} \right)^{-1/\sigma} \frac{\partial L_m^{E^*}}{\partial d_m^*} - w_m^* \frac{\partial L_m^{E^*}}{\partial d_m^*} - L_m^{E^*} \frac{\partial w_m^*}{\partial d_m^*} - c'(d_m^*) = 0. \quad (38)$$

Again the first term is the marginal revenue of increasing the distance, while the remaining terms make up the marginal costs. The second and third terms illustrate the additional wage payments, while the last term reflects the marginal movement costs. The effect of d_m^* on labor supply is found by taking the derivative of Equation (14):

$$\frac{\partial L_m^{E^*}}{\partial d_m^*} = \frac{L_s^*}{H^*}(1 - d_m^*). \quad (39)$$

For a summary of all equations see Appendix G.

5.2.2 Results

For the simulations we have normalized the movement costs to relative shares of the total wage bill of an MNE in the benchmark model. Thus the value 0.1 in the table means that an MNE has to pay 10% of the wage bill as movement costs if it migrates the same number of workers as in the case of zero movement costs. Of course it can (and will) reduce the costs by migrating less workers.

Result 6 ***Movement Costs:*** *Movement costs do not qualitatively change the results but mitigate the difference between an MNE and a national firm.*

Table 6 summarizes the results. Again, the most dramatic effects can be found in the last row showing the ratio of MNE's shares on the skills circle in both countries (d_m^*/d_m). Relatively low costs of 1% of the wage bill is sufficient to reduce the share abroad, d_m^*, (and thereby the number of workers moved) to 16% of the share in the home country, d_m. A further increase to 5% reduces the ratio to 3.8%.[28] Again, we can see that an MNE converges towards a national firm, if the costs of moving a worker become larger and larger, while qualitatively the effects are not changed.

6 Conclusions

Workers are heterogeneous. Hence, finding the right employees is not an easy task. This is well known and investigated in labor economics. However, the role of foreign owned firms is largely disregarded in this respect. This is even more astonishing given the important role MNEs play as employers.

Hence, we investigate how MNEs affect the labor market if they face a heterogeneous labor mass. In this setup, the main advantage of an MNE is that it can recruit suitable workers in the home and foreign market, as it is present with a plant in both countries. We show that this implies that an MNE, compared to national firms, has lower mismatch, more productive workers, lower prices, higher output, and higher employment. Whether an MNE pays higher or lower wages depends crucially on the assumptions about productivity. All this is in line with recent empirical research. Furthermore, labor migration through internal movements can be explained, which was found to be especially relevant for the high skilled intensive sector.

[28]These effects might appear large but it should be taken into account that 5% of the wage bill is also quite a lot. Our model is a static one-period model. If the wage is interpreted as present value of all future wage-payments, then of course the same interpretation applies to the movement costs and thus 5% of the wage bill is a large amount.

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Appendix

A Derivation of Equation (8)

$$\frac{\partial L_{Si}^E}{\partial w_i} = \frac{L_S A}{2H(w_i + w_n)^4},$$

with $A = (2w_i + 3w_n - 2mw_n - w_n + 2mw_n)(w_i + w_n)^2 - 2(w_i + w_n)(w_i^2 + 3w_n w_i - 2mw_n w_i - w_n w_i - 3w_n^2 + 2mw_n^2 + 2mw_n w_i + 6mw_n^2 - 4m^2 w_n^2)$. Evaluating at $w_i = w_n$ leads to:

$$\begin{aligned}
\left.\frac{\partial L_{Si}^E}{\partial w_n}\right|_{w_i = w_n} &= \frac{L_S(4w_n 4w_n^2 - 4w_n(8mw_n^2 - 4m^2 w_n^2))}{2H(2w_n)^4} \\
&= \frac{L_S(4w_n - w_n(8m - 4m^2))}{2H(2w_n)^2} \\
&= \frac{L_S(1 - 2m + m^2)}{2Hw_n}.
\end{aligned}$$

B Derivation of Equation (21)

Reformulate the demand equation as:

$$p_i = x_i^{-1/\sigma}.$$

Reformulate production function as:

$$x_i = \frac{L_i^E - \alpha}{\beta}.$$

Now we can write profits as a function of labor and wage:

$$\begin{aligned}
\pi_i &= x_i^{-1/\sigma} x_i - w_i L_i^E. \\
\pi_i &= \left(\frac{L_i^E - \alpha}{\beta}\right)^{\frac{\sigma-1}{\sigma}} - w_i L_i^E.
\end{aligned}$$

The FOC can then be written as:

$$\frac{\partial \pi_i}{\partial w_n} = \frac{\sigma - 1}{\sigma\beta} \left(\frac{L_i^E - \alpha}{\beta} \right)^{-1/\sigma} \frac{\partial L_i^E}{\partial w_i} - L_i^E - w_i \frac{\partial L_i^E}{\partial w_i} = 0.$$

Using the fact that in the symmetric equilibrium $w_i = w_n$ and $\frac{\partial L_i^E}{\partial w_n} = \frac{L_s(1-2m+m^2)}{2Hw_n}$, we can reformulate as follows:

$$\frac{L_s(1 - 2m + m^2)}{2Hw_n} = \frac{L_i^E}{\frac{\sigma-1}{\sigma\beta} \left(\frac{L_i^E - \alpha}{\beta} \right)^{-1/\sigma} - w_n}.$$

C Proof of Proposition 1

To see whether a plant of an MNE produces more than a national firm we need to look at the FOC given in Equation (11). We rearrange in such a way that we see the marginal return of an increase in the wage on the left-hand side and the marginal costs on the right-hand side:

$$\frac{\sigma - 1}{\sigma\beta} \left(\frac{L_m^E + L_m^{E^*} - \alpha}{\beta} \right)^{-1/\sigma} \frac{\partial L_m^E}{\partial w_m} = L_m^E + w_m \frac{\partial L_m^E}{\partial w_m}. \tag{A1}$$

Putting the last term on the right-hand side to the left and single out $\partial L_m^E / \partial w_m$, we see that in order to obtain a positive solution for L_m^E, the following condition has to hold:

$$\frac{\sigma - 1}{\sigma\beta} \left(\frac{L_m^E + L_m^{E^*} - \alpha}{\beta} \right)^{-1/\sigma} > w_m. \tag{A2}$$

Let us assume for the moment that every plant of an MNE produces the same amount as a national firm. We shall show that in such a case marginal returns exceed marginal costs. Therefore, it cannot be optimal for an MNE to produce the same in every plant as a national firm, but instead it will produce more.

If every plant of an MNE produces the same quantity as a national firm, then the effective labor supply would have to be the same: $L_i^E = L_m^E + L_m^{E^*}$. Using symmetry, we can write $L_m^E = L_m^{E*} = L_i^E/2$. The FOC of an MNE can now be written as:

$$\frac{\sigma-1}{\sigma\beta}\left(\frac{L_i^E-\alpha}{\beta}\right)^{-1/\sigma}\frac{\partial L_m^E}{\partial w_m} = \frac{L_i^E}{2} + w_m\frac{\partial L_m^E}{\partial w_m}.$$

Comparing with the FOC of a national firm given in Equation (4), it is immediately clear that marginal costs (on the right hand side) are lowered directly. The reason is the lower demand for labor in every country. However, we also need to check indirect effects via $\partial L_m^E/\partial w_m$. To do so take the ratio of $\partial L_i^E/\partial w_n$ and $\partial L_m^E/\partial w_m$:

$$\frac{\partial L_i^E/\partial w_n}{\partial L_m^E/\partial w_m} = \frac{(1-2m+m^2)(w_n+w_m)^3}{2w_n^3(4-4(m+m_m)+(m+m_m)^2)} < 1. \tag{A3}$$

If $w_m = w_n$ and $m = m_m$ this expression is equal to one. However, since an MNE needs to recruit less labor from a single country, $w_m < w_n$ and $m_m < m$. Hence the ratio will be smaller than one, as the derivatives with respect to w_m and m_m are positive:

$$\begin{aligned}\frac{\partial\left(\frac{\partial L_i^E/\partial w_n}{\partial L_m^E/\partial w_m}\right)}{\partial w_m} &= \frac{3(1-2m+m^2)(w_n+w_m)^2}{2w_n^3(4-4(m+m_m)+(m+m_m)^2)} \\ &= \frac{3(m-1)^2(w_n+w_m)^2}{2w_n^3(m+m_m-2)^2} > 0.\end{aligned}$$

$$\frac{\partial\left(\frac{\partial L_i^E/\partial w_n}{\partial L_m^E/\partial w_m}\right)}{\partial m_m} = \frac{(m-1)^2(w_n+w_m)^3}{2w_n^3}\left(\frac{2(2-m-m_m)}{(m+m_m-2)^4}\right) > 0,$$

where $2-m-m_m$ is positive, as $m<1$ and $m_m<1$.

Equation (A3) implies that the labor supply of an MNE reacts stronger to changes in the wage or put formally: $\partial L_m^E/\partial w_m > \partial L_i^E/\partial w_n$. Coming back to the FOC in Equation (A1) we see that this implies that the marginal return for an MNE is increased. At the same time marginal costs are increased but given the relation in (A2) this effect weights less than the increase in marginal returns.

Putting all this together, we see that marginal returns exceed marginal costs if every plant of an MNE produces the same amount as a national firm. Therefore, it cannot be optimal. Rather, it pays off for an MNE to produce more than a national firm in every plant.

D Proof of Proposition 3

In Proposition 1 we found that an MNE produces more than a national firm. To see whether an MNE offers a higher wage, assume for the moment that both wages are equal: $w_n = w_m$. Following a similar argumentation as above, we look at the FOC of an MNE. If marginal returns exceed marginal costs then an MNE will offer a higher wage than a national firm and vice versa.

If an MNE pays the same wage per efficiency unit as a national firm, it will get the same share of the skills circle. But an MNE gets workers from both countries and thus production will be considerably higher. Since the price goes down with quantity produced, marginal returns go down as well, which can be seen by inspection of $\left(\frac{L_m^E + L_m^{E^*} - \alpha}{\beta}\right)^{-1/\sigma}$.

Again, the indirect effect via the influence of the wage on labor supply is also at work here. However, the ratio given in Equation (A3) is equal to one if we assume $w_n = w_m$ and $m = m_m$.

Hence, with the same marginal costs, marginal revenues are lower for an MNE, because it recruits twice the amount of workers in every plant given the same wage is offered as in a national firm. Hence, an MNE can raise profits by lowering wages, which proofs that in equilibrium $w_m < w_n$.

E Proof of Proposition 4

The relation between the wage of an MNE and the wage of national firms can be derived from Equation (12):

$$w_m(1 - d') \geq w_n(1 - (m + m_m - d')),$$

In equilibrium the worst mismatch for an MNE is equal to m_m, and for the national firm the worst mismatch is given by m. Hence, we can simplify to:

$$\frac{w_m}{w_n} = \frac{(1-m)}{(1-m_m)}.$$

As we know from Proposition 3 that an MNE charges a lower wage per efficiency unit, i.e. $w_m < w_n$, it immediately follows that $m > m_m$. Hence, in equilibrium mismatch of workers is lower for an MNE than for a national firm.

Average wages are given by:

$$\bar{w}_m = w_m\left(1-\frac{m_m}{2}\right), \quad \bar{w}_n = w_n\left(1-\frac{m}{2}\right).$$

Using the fact that $w_m = w_n\frac{(1-m)}{(1-m_m)}$, we can write the ratio of average wages as:

$$\frac{\bar{w}_m}{\bar{w}_n} = \frac{(2-m_m)(1-m)}{(1-m_m)(2-m)} = \frac{2-2m-m_m+mm_m}{2-2m_m-m+mm_m} < 1,$$

since $m > m_m$. Hence, the average wage of an MNE is lower than that for a national firm.

Now assume that productivity varies not linearly with distance but rather quadratically. Hence, we may write:

$$w_m(1-d'^2) = w_n(1-(m+m_m-d')^2).$$

This leads to:

$$\frac{w_m}{w_n} = \frac{(1-m)^2}{(1-m_m)^2}.$$

Average wages are then given by:

$$\begin{aligned}\bar{w}_m &= \frac{w_m}{m_m}\int_0^{m_m}(1-x^2)dx \\ &= \frac{w_m}{m_m}\left(m_m - \frac{m_m^3}{3}\right) \\ &= w_m\left(1-\frac{m_m^2}{3}\right).\end{aligned}$$

The ratio of the average wage of an MNE and a national firm is then given by:

$$\begin{aligned}\frac{\bar{w}_m}{\bar{w}_n} &= \frac{(3-m_m^2)(1-m^2)}{(1-m_m^2)(3-m^3)} \\ &= \frac{3-3m^2-m_m^2+m^2m_m^2}{3-3m_m^2-m^2+m_m^2m^2} \gtrless 1.\end{aligned}$$

Hence, with quadratically varying productivities of workers, MNEs may end up with a lower wage per efficiency unit but a higher average wage than a national firm. For example, for $m_m = 0.6$ and $m = 0.7$, we have $\frac{w_m}{w_n} = 0.796875$ and $\frac{\bar{w}_m}{\bar{w}_n} = 1.07403$.

F Main Equations for the Model with Recruitment Costs

$$x_m = p_m^{-\sigma}. \tag{A4}$$

$$L_m^E + L_m^{E^*} = \alpha + \beta x_m. \tag{A5}$$

$$L_m^E = \frac{d_m}{2H}\left(1 - \frac{d_m}{2}\right) L_s + \frac{d_i}{2H}\left(1 - \frac{d_i}{2}\right) L_s. \tag{A6}$$

$$L_m^{E^*} = \frac{d_m^*}{2H^*}\left(1 - \frac{d_m^*}{2}\right) L_s^* + \frac{d_i}{2H}\left(1 - \frac{d_i}{2}\right) L_s. \tag{A7}$$

$$d_m = \frac{w_m - w_n(1 - m - m_m)}{w_m + w_n}. \tag{A8}$$

$$d_m^* = \frac{w_m^* - w_n^*(1 - m^* - m_m^*)}{w_m^* + w_n^*}. \tag{A9}$$

$$\frac{L_m^E}{\frac{\sigma-1}{\sigma\beta}\left(\frac{L_m^E + L_m^{E^*} - \alpha}{\beta}\right)^{-1/\sigma} - w_m} = \frac{L_s}{2H}\frac{w_n^2(4 - 4(m + m_m) + (m + m_m)^2)}{(w_m + w_n)^3}. \tag{A10}$$

$$\frac{L_m^{E^*}}{\frac{\sigma-1}{\sigma\beta}\left(\frac{L_m^E + L_m^{E^*} - \alpha}{\beta}\right)^{-1/\sigma} - w_m^*} = \frac{L_s^*}{2H^*}\frac{w_n^{*2}(4 - 4(m^* + m_m^*) + (m^* + m_m^*)^2)}{(w_m^* + w_n^*)^3}. \tag{A11}$$

$$\begin{aligned}\frac{\partial \pi_m}{\partial d_i} &= \frac{\sigma - 1}{\sigma\beta}\left(\frac{L_m^E + L_m^{E^*} - \alpha}{\beta}\right)^{-1/\sigma}\left(\frac{\partial L_m^E}{\partial d_i} + \frac{\partial L_m^{E^*}}{\partial d_i}\right) \\ &\quad - w_m\left(\frac{\partial L_m^E}{\partial d_i} + \frac{\partial L_m^{E^*}}{\partial d_i}\right) - c'(d_i) = 0.\end{aligned} \tag{A12}$$

$$\frac{\partial L_m^E}{\partial d_i} = \frac{L_s}{2H}(1 - d_i). \tag{A13}$$

$$\frac{\partial L_m^{E^*}}{\partial d_i} = \frac{L_s^*}{2H^*}(1 - d_i). \tag{A14}$$

G Main Equations for the Model with Movement Costs

$$x_m = p_m^{-\sigma}. \tag{A15}$$

$$L_m^E + L_m^{E^*} = \alpha + \beta x_m. \tag{A16}$$

$$L_m^E = \frac{d_m}{H}\left(1 - \frac{d_m}{2}\right) L_s. \tag{A17}$$

$$L_m^{E^*} = \frac{d_m^*}{H^*}\left(1 - \frac{d_m^*}{2}\right) L_s^*. \tag{A18}$$

$$d_m = \frac{w_m - w_n(1 - m - m_m)}{w_m + w_n}. \tag{A19}$$

$$d_m^* = \frac{w_m^* - w_n^*(1 - m^* - m_m^*)}{w_m^* + w_n^*}. \tag{A20}$$

$$\frac{L_s}{H}\frac{w_n^2(4 - 4(m + m_m) + (m + m_m)^2)}{(w_m + w_n)^3} = \frac{L_m^E}{\frac{\sigma-1}{\sigma\beta}\left(\frac{L_m^E + L_m^{E^*} - \alpha}{\beta}\right)^{-1/\sigma} - w_m}. \tag{A21}$$

$$\frac{\sigma - 1}{\sigma\beta}\left(\frac{L_m^E + L_m^{E^*} - \alpha}{\beta}\right)^{-1/\sigma}\frac{\partial L_m^{E^*}}{\partial d_m^*} - w_m^*\frac{\partial L_m^{E^*}}{\partial d_m^*} - L_m^{E^*}\frac{\partial w_m^*}{\partial d_m^*} = c'(d_m^*). \tag{A22}$$

$$\frac{\partial L_m^{E^*}}{\partial d_m^*} = \frac{L_s^*}{H^*}(1 - d_m^*). \tag{A23}$$