The Sluggish Movement of Workers: Rethinking Immigration Absorption, Rybczynski effects and Wage responses[1]

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Short Abstract: Two stylized facts have shaped the literature on how immigration has affected host countries. On the one hand, there has been a long debate on whether immigration affected significantly labor markets or not. The debate is not yet concluded, however we can argue that, if anything, immigration has had a negative impact on the wages of natives more similar to the arrived immigrants. On the other hand, and more recently, there has been convincing evidence on how immigration was absorbed into the labor market in the host country. Rather than observing the expected Rybczynski effects, what different researchers have found is that firms tend to use a higher proportion of the immigrated factor type (for instance unskilled migrants), something that has been seen as a puzzle. By introducing costs of changing from one sector to the other in a two sector - two skill model I will show that most of these empirical findings can be explained rather naturally. The main mechanism is that when immigration arrives natives have incentives to change their jobs. If there are no costs to this change people will do so and immigration will not have any effect. On the contrary, if costs are high, there will be people willing to move to other jobs but they will not be able to pay for the cost of doing so. This has important consequences to how people reallocate after immigration arrives and how wages respond to immigration. The main two results of the model are, first, that immigration is partially absorbed by movements of workers between different industries and partially by changes in the factor intensity. Second, immigration increases the wage dispersion among natives. Summarizing, this research allows to combine the evidence on wages and on immigration absorption to reach new conclusions, that are then tested empirically.

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Long Abstract: Two stylized facts have shaped the literature on how immigration has affected host countries. On the one hand, there has been a long debate on whether immigration affected significantly labor markets or not. The debate is not yet concluded, however we can argue that, if anything, immigration has had a negative impact on the wages of natives more similar to the arrived immigrants and no or little impact on average wages. On the other hand, and more recently, there has been convincing evidence on how immigration was absorbed in the host country. Rather than observing the expected Rybczynski effects (at US state level), what different researchers have found is that firms tend to use a higher proportion of the immigrated factor type (for instance unskilled migrants). The combination of these two facts creates a puzzle for standard theory, since in a closed economy we would see strong effects on wages and changes in the the way firms produce, while in a small open economy we would see no effects on wages but no changes in the factor use. In this paper I propose a two sector - two factor model to reconcile the fact that we observe no changes in wages and changes in the factor intensity use. To do so, I introduce costs for the workers changing from one sector to another in a small open economy set-up. When doing so, these two stylized facts are explained, together with Borja's observation that workers more similar to migrants suffer from immigration. Moreover, this simple model predicts that the most important consequence of immigration is that it increases the wage dispersion amongst natives. The reason is quite simple. When migrants arrive to the host country they raise incentives for the natives workers to change jobs. If there is a cost in doing so, then workers choosing not to move will accept a lower wage, while workers choosing to move will do so only at a higher wage. This is true for each type of worker (unskilled or skilled) irrespective of the type of immigration. Moreover, this could be one of the economic reasons behind the negative attitude toward immigrants. The paper also investigates this consequence of immigration empirically. The way it is done, is by comparing the wage dispersion of natives across US states, as well as the wage premium in sector with more or less immigration. In order to correct for possible endogeneity, I also use an IV approach, using as instrument the immigration networks identified by Altonji and Card. Both the OLS regressions and the IV regressions show that a 10% inflow of migrants increases the hourly wage dispersion of native by around 2$, or a 10% of the US average hourly wage and that sector with higher immigration have higher wage gaps between skilled and unskilled US workers. Finally, the paper shows that Rybczynski effects are a feble result in a different way than Opp, Tombazos and Sonnenschein (2008). By introducing these costs of changing from one sector to the other, one can show that in certain cases we should observe reverse-Rybczynski effects. The idea is again quite simple. Let's assume that the costs of changing for the skilled workers are higher than the unskilled. For instance, imagine that they are sufficiently large as to ensure that no skilled worker will be willing to move. Then, even if there is an inflow of unskilled workers, both the unskilled sector and the skilled sector will expand, contrary to Rybczynski prediction that the skilled sector will contract. In sum, a small modification to standard theory is enough to reconcile some of the observed facts, and predict new testable implications.

JEL Classification: F11, F22, J31, J61

Key Words: Rybczynski effects, Immigration Absorption and Wage Dispersion

0. Introduction

There are various ways to look at the immigration phenomenon and various questions one could try to answer. When faced with a map showing the diverse immigration rates across countries or regions, probably the first reaction is to try to answer why the picture is like that. In other words, why migration moves to certain places rather than to others. This is relevant because in a perfect world with trade, factor prices would be equated across countries and migration would be completely unrelated to economics, at least between similar countries[3]. This question was first analyzed by the seminal paper by Borjas (1987). His idea is that migration is due to economic reasons that can be somehow summarized by the wages people receive in different parts of the world. If the higher expected wage compensates the cost of migration, people simply migrate.

The second natural question that one may ask when thinking about immigration is what are the effects of migrants to the host country. Maybe we can understand that there are income differences across countries and that for some economic reason migration makes sense, but what is the effect of an inflow of migrants. Does this affect the way the host country produces? Or maybe what it produces? Does immigration affect unemployment or wages? Moreover, why do countries restrict migration? Is it comparable as to why they restrict trade? (Freeman, 2006; Hatton, 2006)

This last set of questions has become one of the major debates of the literature on immigration. There are various approaches. One possible approach is to go to that data and try to answer what is happening. Evidence gathered so far only ads more puzzles. On the one hand, we observe that people's attitudes toward migration are far from being neutral, and tend to blame it for some of the economic problems (Bauer, Lofstrom, Zimmermann, 2000). Another important aspect about these attitudes is that they are skill dependent, being high skilled workers more pro-migration and less skilled workers more against it (Mayda 2006). On the other hand, people find little or hardly significant evidence on negative effect of immigration on labor market outcomes (Friedberg and Hunt, 2001; Friedberg, 2001; Gang Tiang and Shan, 1999; Ottaviano and Peri, 2006 among others). A first sensible answer to such a contradiction is that negative attitudes toward immigration have nothing to do with economics (or very little) (Hansmueller and Hiscox, 2007), however one can also try to better understand what is going on in economic terms.

[3]Some more specification would be required here, see Markusen (1983) for a better discussion

In this paper I will introduce some new insights to try to understand the effect of immigration on the host country integrating two stylized facts. Firstly, the literature has observed little impact of immigration on wages. The literature started by looking on cross regional differences in the US and found negative but not significant effects of immigration on wages (Altonji and Card, 1991). This evidence was criticized for the possible endogeneity problems that essentially may have downward biased the impact of immigration. The reason is that migrants would tend to go where the economic conditions are the best, thus a negative impact would hardly be seen by cross regional differences. Another way to look at it was by using "natural experiments". This is to look for cases in which immigration was not attributable to economic factors and see its impact (Card, 1990 or Friedberg, 2001 among others). Again, there was some evidence on a negative effect of immigration on wages and unemployment, but rather insignificant. Finally, Borjas et al. (1997) and Borjas (2003) argued that if the impact of immigration could be seen it should be from a General Equilibrium perspective, that is, by looking at the whole economy. This approach increases this negative impact significantly, though mainly for certain types of workers. The model I will introduce in this paper gives another perspective on why the impact on wages is small but negative for some types of workers.

Secondly, recent literature has tried to see how migration is absorbed. Maybe one of the reasons for this apparent low impact of immigration on host countries is that there are different channels by which an inflow of migrants is absorbed. The first to look at this kind of evidence were Hanson and Slaughter (2002) and Lewis (2004) and others followed them (González and Ortega, 2008, Dustman and Glitz, 2008; Lewis, Doms and Beaudry 2006). They all find that the main vehicle through which immigration[4] is absorbed is by changes in the ways firms produce. This is somehow puzzling since standard Rybczynski theory implies that a labor shock should be absorbed by changes on how much each sectors produce, rather than by changes in the relative use of each of the factors.

In this paper I will show that these two stylized facts can be reconciled by adding costs of changing from one sector to another. This will be the first main contribution of this paper. The second main contribution of the paper will be to empirically test the new insights coming from the model, other than how immigration is absorbed. In particular, one of the most important consequences of adding costs of moving from one sector to another is that immigration should increase wage dispersion, both of native workers and of the total population. The reasoning is quite straightforward: if there are costs to moving from sector to sector, the workers in a sector receiving

[4] or changes in the local labor supply

immigrants will search jobs in another sector only if the wage in this other sector is sufficiently high. To identify the causal relation between the immigration proportion and standard deviation of US workers wage in each of the US States, I will use the instrument of previous literature (since Altonjii and Card, 1991), finding a significant positive relation. Another implication of the model I will later develop, is that the wage differential between high skilled workers and low skilled workers will be higher in those sectors where there is more immigration. The reason is again the costs of moving, combined with the fact that, compared to US natives, immigrants tend to be less skilled (Borjas, 2002).

In the next section I will review the literature on the impact of immigration on the host country. In section 3 I will introduce the model, which is a very simple standard model with effort costs of changing from one sector to the other. This simple modification will have very powerful consequences. In section 4 I will analyze the data through the lenses of this new model. The last section concludes.

1. Literature Review

The immigration literature has developed enormously in the last twenty years or so. There are many aspects that people have looked at and even evidence pointing toward different results. In this paper I will focus my attention on the literature reporting the impact of immigration on the host country. To begin with, it is natural to ask why immigration should have an impact on the host country at all. To start thinking on this issue, it might be useful to think on a closed economy with aggregate production function $Y = F(K, L)$ and standard homothetic preferences. In this case, if capital is elastically supplied, a shock to L will not have any impact. Firms will purchase more capital until the capital labor ratio is again at its optimum. Different results are obtained if capital is inelastically supplied. If there is a fix amount of capital, then an increase in the labor supply will lower the capital labor ratio, affecting the wages of workers.

Probably it is reasonable to assume elastic supply of capital, by assuming that capital can always be bought at international markets and that the economy is too small to affect its price (or equivalently, assume that there is no capital in the economy) or that in the long run capital can be built. In that case, immigration will not have any impact, unless L is actually an aggregation of different labor types. For instance, if $L = CES(L_1, L_2, ..., L_N; \sigma)$ then if there is a shock to one type of labor, then this labor type's wage will decrease, whereas the others will increase, be unaffected or even decrease if it turns out to be perfectly substitutable to the labor type shocked.

A natural way to look at further in this question is by empirically analyze the impact of immigration on wages, which has been the ground for a vast literature. The first studies to see this impact did cross regional comparisons using regional data (Altonjii and Card, 1991 for the US; or Pischke and Velling (1997) for the German case). One can go to the data and see if regions or states with higher immigration densities have lower wages or not (or decreases of the real wages or not), possibly across different education groups. Altonjii and Card (1991) report little impact of immigration on low skilled workers in the US. The main problem of this approach is its endogeneity. Naturally, immigrants will decide where to go by choosing the places where they think there are more opportunities. If that is the case, we would observe that high intensive migration regions are the same that present good economic conditions, and possibly, higher wages[5]. Even if immigration had a negative impact, a simple regression would have a positive or non-significant coefficient if the endogeneity is sufficiently strong. A way to solve this problem is to look at instruments that try to address this endogeneity. The instrument used since Card and Altonjii (1991) is migration networks.

Another way to solve the endogeneity problems is to look for examples in which immigration is not induced by economic reasons. The first paper using a "natural experiment" was in Card (1990) on the Mariel Boatlift to Miami in 1980. This represented an exogenous shock to the Miami labor force of around a 7%. Card used it to look at the impact on wages and unemployment rates in comparison to other American cities, which served as control group. His conclusions are that, even if there were demonstrations against the cubans arriving to Miami in 1980, neither wages nor unemployment rates were affected in different ways than in the control cities and even less, in a more negative way than these. There have been other "natural experiments, such as the arrival to Israel of Jews coming from the Soviet Union between 1990 and 1994. Between these four years the Israeli labor force was shocked by a 12% increase due to the end of immigration restrictions by the Soviet Union. Friedberg (2001) uses such a case to investigate the effect on Israel of such a shock, not accross regions, but accross occupations. Her findings are surprising. When she runs simple OLS regressions she finds a negative and significant negative coefficient. However, when she instruments to correct for any possible endogeneity by the job of the immigrants before arriving to

[5]This problem might be partially fixed by using geographic fixed effects. However, if considering growth in wages a similar problem arises that is even more severe

Israel, this coefficient gets reversed[6]

Probably, the most influential piece of evidence relating wages and immigration is presented by Borjas and other co-authors. They argue that in the spatial correlations approach endogeneity problems cannot be correctly addressed and that the evidence coming from "natural experiments" has the problem that it is just a before and after observation. To try to see the actual effect, then, one should look at the evidence on the whole economy. To do this one should construct different cells that divide the labor force into different groups (enough to have sufficient variation) and see if the cells receiving more immigration are the ones suffering from a higher impact or not (Borjas, Freeman and Katz, 1997; Borjas, 2003). Borjas (2003) reports a negative impact of immigration on wages, but it is a far from robust result[7].

In any case, the variation they look at is across education and experience groups, implicitly assuming that variation across occupations is not so important. However, it could well be the case that migrants simply cannot work in certain sectors, or that it is more costly for them to work in some sectors (for example language intensive ones) than in others. Similarly, it is implicitly assumed that natives cannot move out of their cell when immigration arrives. That is, it is implicitly assumed that every native will remain with the same level of education and experience irrespective of the inflow of migrants in their cell. This is certainly true in the case of experience levels, since no one can at a given point in time increase their experience by x years. Probably it is also the case for the education level, or at least it will be costly for anyone to increase their educational level. If we consider also variation across occupations or industries, the assumption of the immobility across cells is probably too crucial. If that is the case, what one should look at is whether those sectors hit by immigration are also sectors from which natives can easily "escape" or not.

A way to understand the findings by Lewis (2004) and subsequent studies is precisely by incorporating the idea that once working in a firm it is costly to change to a firm from another sector. These costs can be understood both as lack of sector specific experience needed to perform well in a different sector, or as the cost of getting out of the job, finding another one and learning the specific skills for the new job. Even if standard Rybczynski theory would imply that the economies

[6] There are also other papers looking at "natural experiments" such as Hunt (1992) or even Angrist and Kuegler (2003), but neither of them reaches conclusve evidence

[7] This paper has strongly been criticized by Ottaviano and Peri (2006), arguing that because of the fact that migrants and natives are not perfect substitutes, native wages are less affected than showed by Borjas (203). This has been again rebated by Borjas, Grogger and Hanson (2008) by reexamining the data used by Ottaviano and Peri.

tend to specialize in those sectors that are relatively abundant with, the evidence on the US (and other countries) suggests that the way in which unskilled migration is actually absorbed is mainly by increasing the proportion between unskilled to skilled in each industry (from now on "within industry" absorption) rather than across industries (Lewis, 2004).

At this point is important to correctly understand the difference between "within absorption" and "between absorption" of immigration. In a 2 sectors 2 factors open economy framework, one can model unskilled immigration as shock to one of the factors in production. What is expected is then Rybczynski effects. That is, an inflow of a certain type of workers will increase the production of the sector that uses it more intensively more than proportionally and decrease the production in the other sector. In terms of factor use, it is easy to show that the expanding sector will absorb both the increase in the immigrated factor as well as part of the other factor. Importantly, this model assumes that there are no changes in the way the two goods are produced. That is, the fact that unskilled and skilled workers can freely move from one sector to the other implies that the ratio between the two factors remains unchanged and that immigration is fully absorbed between industries. The same evidence is found by González and Ortega (2007) and Dustmann and Glitz (2008).

The way these findings have been addressed theoretically is by considering the possibility that firms endogenously determine the way they want to produce according to the available labor force (Beaudry, Doms and Lewis, 2006). However, it might be the case that it is the labor market that is doing precisely this job, or at least partially. If there are costs of changing from one sector to the other, the natural outcome is to see how firms gain bargaining power and can pay lower wages (and hire more workers) of the type of workers hit by immigration, without changing their technology. This idea will be fully developed in this paper by assuming no technological change (something that will be taken into account in the empirical part). The connection between wages and migration absorption is the novelty of this paper.

2. Immigration in the Small Open Economy model

In this section I will present a 2x2 small open economy model with costs of changing from one sector to the other. This small modification of the standard Heschker-Ohlin model will allow to reconcile most of the findings of the empirical literature. In particular, we will concentrate on three stylized facts. First, the model will show that far from being surprising, the within industry absorption of immigration is one natural way to absorb immigration, once there are certain costs to change jobs. Secondly, this model will allow us to think on the negative impact of immigration on wages, helping as well in understanding why there are studies that find negative and significant evidence of this impact, while others find that the evidence is not significant. Thirdly, the model will predict effects of immigration that were not predicted before, that will be discussed in detail later and in the empirical part.

The model is structured as follows. We should think as modeling a US state, this is way we can consider that capital is perfectly supplied and that prices are exogenous. There will be two periods. In the first period the population of the economy decides in what sector to work (given their skill level), in order to be able to work and consume in the second period. There will be two sectors in this economy, that will use skilled and unskilled labor with different intensities. In the second period, consumers have Cobb-Douglas preferences over the two goods of the economy. I will finally assume that in the second period immigration of a certain type and sector arrives and starts working unexpectedly, something that was not taken into account in the working decision of natives in the first period. This arrival of immigrants will give incentives to the natives to change their job in the second period. In particular, if there is an arrival of low skilled migrants entering sector 2, then the high skilled in sector 1 will have incentives to work in sector 2 and the low-skilled from sector 2 will have incentives to work in sector 1. However, there will be some costs for changing from one sector to the other. This latter aspect will be crucial for the model. Once we introduce these costs we can reconcile the stylized facts mentioned before.

With this set-up the equilibrium would be the standard Heschker-Ohlin model equilibrium. However, the unexpected immigration of the second period will change the allocation of workers across sectors. Moreover, it will do so in ways different from the classical theory. To keep ideas fixed, one has to think on an economy endowed with U unskilled workers and S skilled workers that are able to work in one of the two sectors of the economy. Sector 1 will be the skilled intensive sector, while sector 2 will be the unskilled intensive sector. In a standard H-O world, and inflow of unskilled workers would expand (more than proportionally) the unskilled sector and contract the skilled sector. By adding costs of changing from one sector to the other, we can prove that this classical result does not hold anymore. On the contrary, even if some Rybczynski effects might take place, another important channel through which immigration is absorbed is an increase in the ratio of unskilled to skilled workers in at least one of the two sectors.

2.1 Preferences

Preferences will be Cobb-Douglas over the two goods available in the economy and they will discount the cost of changing sector in case they decide to do so in the second period. So, in general, $U(C_1, C_2) - \mathbf{1}_{\{X=1\}} G(E) = \eta ln C_1 + (1-\eta) ln C_2 - \mathbf{1}_{\{X=1\}} ln(E)$, where E is effort the effort of changing from one sector to the other. So consumer maximize:

$Max C_1^{\eta} C_2^{1-\eta}$, subject to their earnings (Y)

And their demand is:

$C_1 = \frac{Y\eta}{p_1}$ and $C_2 = \frac{Y(1-\eta)}{p_2}$

The indirect utility function will be $V(Y(E), p) - \mathbf{1}_{\{X=1\}} G(E) = \eta ln \frac{Y\eta}{p_1} + (1-\eta) ln \frac{Y(1-\eta)}{p_2} - ln(E) = lnY - ln(E) + \eta ln(\eta) + (1-\eta) ln(1-\eta) - \eta ln p_1 - (1-\eta) ln(p_2) = lnY - ln(E)$.

This last equivalence holds since we are using the ideal price index: $((p_1/\eta)^{\eta})((p_2/1-\eta)^{1-\eta}) = 1$, $p = \frac{p_1/\eta}{p_2/1-\eta}$, $p_1 = p^{1-\eta}$ and $p_2 = p^{-\eta}$. Note that the costs of changing sector take place only in the second period if needed, that is only if $X = 1$, where X is a binary variable that takes the value of 1 if the decision is to change sector, and takes the value 0 otherwise. Without immigration these costs are needless, however with immigration they are crucial.

2.2 Production and equilibrium without immigration

There will be two sectors with a representative firm using two factors: low skilled labor (U) and High skilled labor (S). Firms will maximize profits having the following production functions: $Q_1 = U_1^{\alpha} S_1^{1-\alpha}$ and $Q_2 = U_2^{\beta} S_2^{1-\beta}$. The fact that sector 1 is assumed to be the skill intensive sector implies that $\beta > \alpha$. The two firms will behave competitively, and maximize their profits. The representative firms will hire workers and pay them the marginal cost. In this context, profit maximization is the same than cost minimization, thus, using the cost functions and the *Shepard's lemma* one can obtain the allocation of workers to each of the sectors and the wages they will earn:

$$W_s = p^{1-\eta+\frac{\alpha}{\beta-\alpha}} \theta_1^{\frac{-\beta}{\beta-\alpha}} \theta_2^{\frac{\alpha}{\beta-\alpha}} \tag{1}$$

$$W_u = p^{1-\eta+\frac{\alpha-1}{\beta-\alpha}}\theta_1^{\frac{1-\beta}{\beta-\alpha}}\theta_2^{\frac{\alpha-1}{\beta-\alpha}} \tag{2}$$

$$U_1 = \frac{\alpha\beta}{\beta-\alpha}\tilde{p}\frac{\tilde{\theta}_2}{\tilde{\theta}_1}S - \frac{\alpha(1-\beta)}{\beta-\alpha}U \tag{3}$$

$$S_1 = \frac{(1-\alpha)\beta}{\beta-\alpha}S - \frac{(1-\alpha)(1-\beta)}{\beta-\alpha}\tilde{p}^{-1}\frac{\tilde{\theta}_1}{\tilde{\theta}_2}U \tag{4}$$

$$U_2 = \frac{(1-\alpha)\beta}{\beta-\alpha}U - \frac{\alpha\beta}{\beta-\alpha}\tilde{p}\frac{\tilde{\theta}_2}{\tilde{\theta}_1}S \tag{5}$$

$$S_2 = \frac{(1-\alpha)(1-\beta)}{\beta-\alpha}\tilde{p}^{-1}\frac{\tilde{\theta}_1}{\tilde{\theta}_2}U - \frac{\alpha(1-\beta)}{\beta-\alpha}S \tag{6}$$

Where $\theta_i = (\frac{1-\alpha_i}{\alpha_i})^{\alpha_i} + (\frac{1-\alpha_i}{\alpha_i})^{\alpha_i - 1}$, for $\alpha_i \in \{\alpha, \beta\}$, $\tilde{p} = p^{1/\beta-\alpha}$ and $\tilde{\theta} = \theta^{1/\beta-\alpha}$.

Note that these equations allow to see the classical results of the 2x2 model[8]: *the Stolper-Samuelson theorem* and the *Rybczynski theorem*. In particular, an inflow of I unskilled migrants would imply that the U in these equations becomes $U+I$. These results and equilibrium wages and allocations will be used in subsequent sections as the reference equilibrium, modified by immigration. The following section analyzes how immigration affects this equilibrium.

3. A Small Open Economy Model with costs of changing from sector to sector

3.1 The impact of unskilled immigration

In this section I will fully develop the model for the special case in which immigration "hits" only one sector and one skill group. This assumption can be justified by the recent experience of countries such as US or Spain, in which large inflows of immigrants have entered some very specific sectors such as construction or services. In fact, I am not the first one to put the attention to this fact. The OECD in their annual "International Migration Outlook" consistently reports that migrants enter some specific sectors rather than to any sector in the economy. The measure it is normally used is whether the share of foreign born workers over total workers is the same than the

[8]The only novelty in this set-up is the utility. However, since there is no immigration expected in the second period it is optimal to allocate optimally from the beginning

share of migrants over the total working force. Sectors such as services and construction are clearly the ones where immigration enters the most. Other studies have also reported the importance that tasks have when working. As argued by Peri and Sparber (2008) or Ottaviano and Peri (2007) there might be important consequences for the debate over immigration if natives and foreigners are not able to do the exact same tasks. In particular, there is some evidence on the difficulty some migrants have to adapt to a new language (Berman, Lang and Siniver, 2003). Another fact is that migrants cannot enter certain sectors immediately because of legal constraints, the most obvious one is the public administration. In any case, it seems a reasonable assumption to think that migrants enter one sector only (in a two sector economy).

The second aspect that has been observed in the countries that have received the largest inflows of migrants is that migration has been mainly unskilled. This is the case in the US. There has been a clear tendency toward receiving increasingly less (relative to natives) skilled immigration. As Borjas reports (1994, 1999 or 2003) the evolution of migrants arriving to the US during the decades of the 70s, 80s and 90s has seen how they were progressively less skilled compared to the US population. For example the High School dropouts accounted for nearly a half of the immigrants in the 70s, compared to a nearly 40% of the native, while in the 90s, the numbers changed to almost a 40% of school dropouts in the immigrants, compared to a 15% for the case of the natives.

The same is true for the Spanish case. In this case, Spain had relatively low rates of immigration before the year 2000. In the five years that followed it, Spain has become one of the countries receiving a greatest number of migrants. In particular, the inflow of people to Spain has moved from a total number of 35,616 in 1997 to a total number of 802,971 in 2006, according to the INE. The inflow has increased at a constant rate, thus the proportion of foreign born work force has more than doubled from 2001 to 2006, moving from a 4,8% to a 10.8% (González and Ortega, 2007). Moreover, this immigration has been mainly unskilled, and has concentrated mainly in the Spanish coast and in Madrid (González and Ortega, 2007). Similar findings hold true for Germany, though not as strong as the American and the Spanish case.

These facts justify the following assumption:

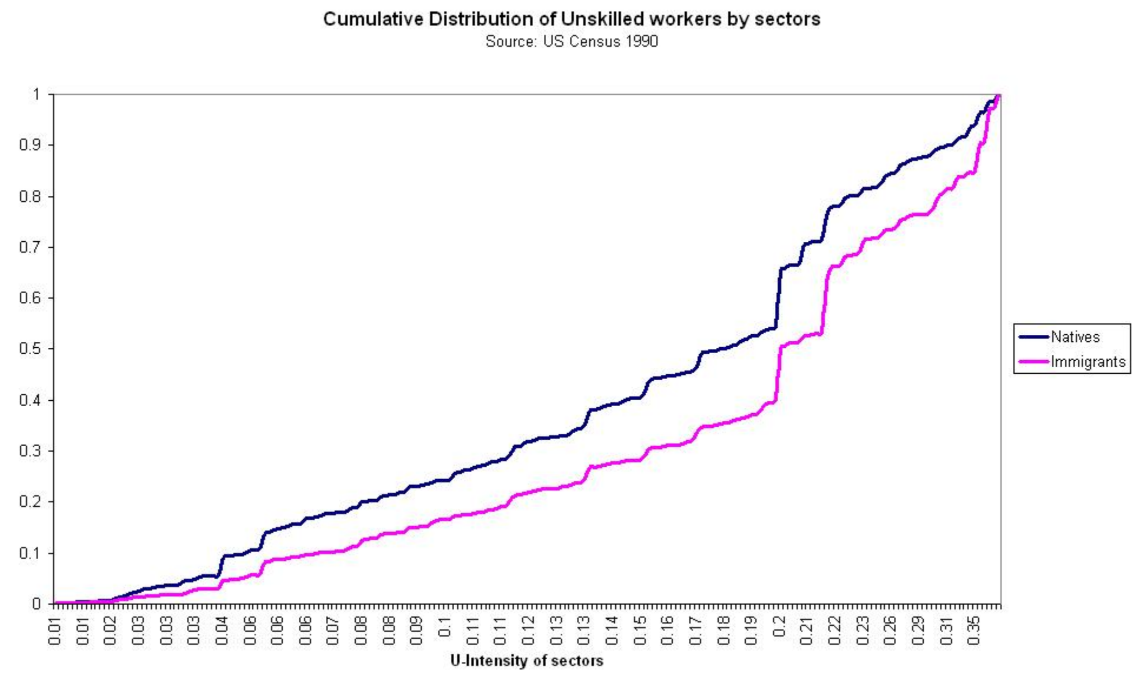
Assumption:

1. There will be I unskilled immigrants entering the unskilled sector unexpectedly[9] in the second period.

2. I will assume that workers can change sector (at a cost) but not their skill as specified earlier.

A graphical justification of *Assumption 1.* is the following graph where I show that the cumulative distribution of immigrants is biased toward the unskilled sectors. The x-axis orders the sectors by unskilled intensity.

Figure 1: Cumulative Distributions of Immigrants workers and US workers in 1990 (by industry U-intensity)



A word on how such a shock affects the incentives of the workers to change their job might

[9]I have a version of the model where I relax the unexpectedness of immigration, without affecting the results if immigration is imperfectly forecast. If immigration is perfectly forecast, then there is no difference between a migrant and a native. Also, it is possible to use different specifications for the costs of changing from one sector to the other. In particular, the results do not change substantially if we assume that the cost functions are increasing in the number of movers

be relevant here. Note that an inflow of I migrants potentially lowers the wage of the unskilled in sector 2, while it increases the wage for the skilled. Since without immigration wages were equalized across sectors, this gives incentives for the unskilled in sector 2 to try to work for sector 1, while it also gives incentives for the skilled in sector 1 to search the higher wage offered to the skilled in sector 2. In absence of any costs of changing from one sector to the other, the prevalent incentive will be the movement of skilled from sector 1 to sector 2, and, as predicted by Rybczynski, this will enlarge sector 2 and reduce sector 1 [10]. If we consider costs of moving from one sector to the other this is no longer true, and results become significantly different and significantly closer to the observable evidence.

To be very specific, I will consider that if a skilled worker wants to work to the other sector it has to make an effort E_S, that is taken into account in her utility function as specified previously. The effort that an unskilled worker has to make will be denoted by E_U and it enters the utility function in the same way. For the moment I do not make any specification on which of these two costs is higher, however, intuition might tell us that we can presume that the high-skilled costs is higher[11].

In such a case we will have that the equilibrium condition is to have equal (if possible) utilities across the different skill groups: $V(W'_{s1}, 1) \geq V(W'_{s2}, E_S)$ and $V(W'_{u2}, 1) \geq V(W'_{u1}, E_U)$, which translate into, $W'_{s1} \geq W'_{s2}/E_S$ and $W'_{u2} \geq W'_{u1}/E_U$. These will be strict inequalities if there are no movements of workers across sectors for each of the skill levels, and equalities otherwise. The problem is exactly the same as the Heschker-Ohlin world but in this case we take $\{U_1, S_1, U_2, S_2\}$ as given and we have to determine whether there will be movements across sectors or not, and how the output will be affected by an inflow I of immigrants.

There will be four possible equilibria:

1. The no-movement equilibrium

2. The skilled movement equilibrium

3. The unskilled movement equilibrium

[10] Note that the incentives go in the opposite directions. That is, if enough skilled workers move to the unskilled sector this can even reverse the incentives of the unskilled workers, meaning, as in the Rybczynski case, that also unskilled workers will move to the unskilled sector

[11] Note that the costs are of changing from one sector to another, not from one job to another within the same sector

4. The skilled-unskilled movement equilibrium

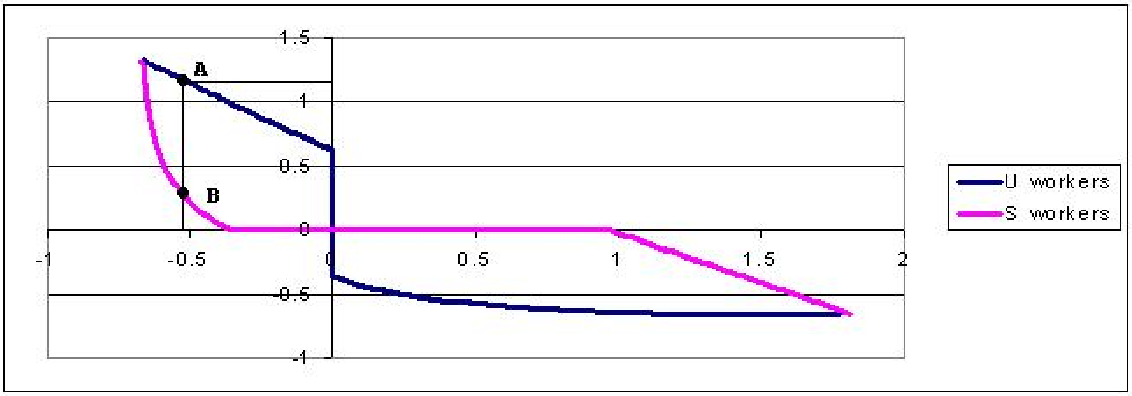
These equilibria can be represented graphically by showing the utilities of skilled and unskilled workers equalized across sectors as a function of the skilled and unskilled movers. In the x-axis there are the unskilled movers and in the y-axis the skilled movers. Note that the range in the x-axis is the total amount of unskilled workers in the economy, while the y-axis range is the total amount of skilled workers. Each point in this plane represents a pair (N, M) that indicates how many workers are moving from the skilled sector to the unskilled sector in the case of the skilled workers (N), and vice versa for the unskilled (M). Each of the two schedules represents pairs in which the U-workers (respectively S-workers) see their utility equalized across sectors. For instance, in point A the unskilled workers utility would be equalized across sectors. Similarly, at point B the utility of skilled workers will be equalized across sectors. However, since points A and B do not coincide, either skilled workers, unskilled workers or both will have incentives to switch to the other sector. The only point at which these incentives would be shut down is at the intersection of both schedules.

Two important aspects of the model can be seen through this graphs. First, the intersection takes place in the first quadrant for whenever there are sufficiently important costs (i.e. all but equilibrium 4a). This is completely different from what Rybczynski would predict, since in this case workers would move to the unskilled sector irrespective of their type. Second, the number of workers moving $(M + N)$ is smaller whenever there are costs (i.e. all but equilibrium 4a). This latter fact is important in order to reconcile the observation that immigration is absorbed mainly "eithin industries" rather than "between" them.

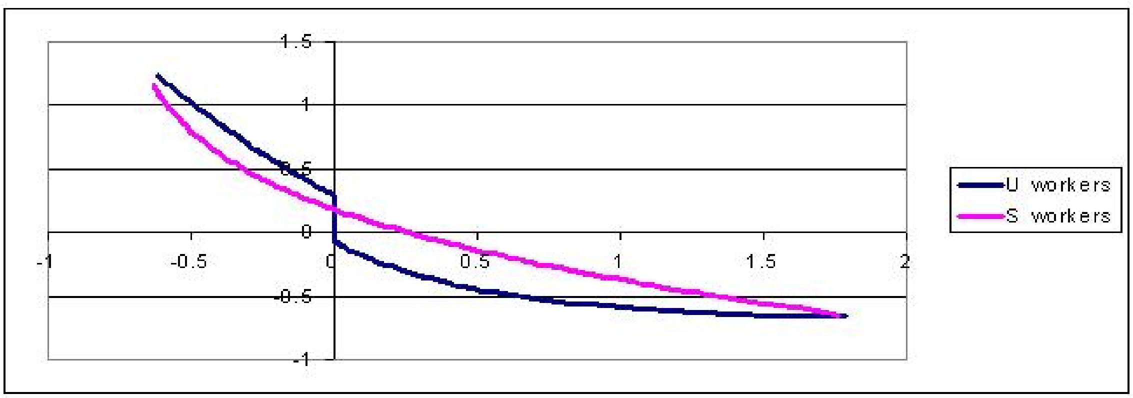
Rybczynski would predict equilibrium 4a (in which the costs are $E_S = 1$ and $E_U = 1$). In this paper I will show equilibrium 3, because I will be presuming that $E_S > E_U$. In future research I will try to track these costs to be able to identify empirically in what equilibrium we are. However, the case in which $E_U > E_S$ is almost symmetric and only changes the extent to which one sector or the other expands.

Figure 2: The different equilibria

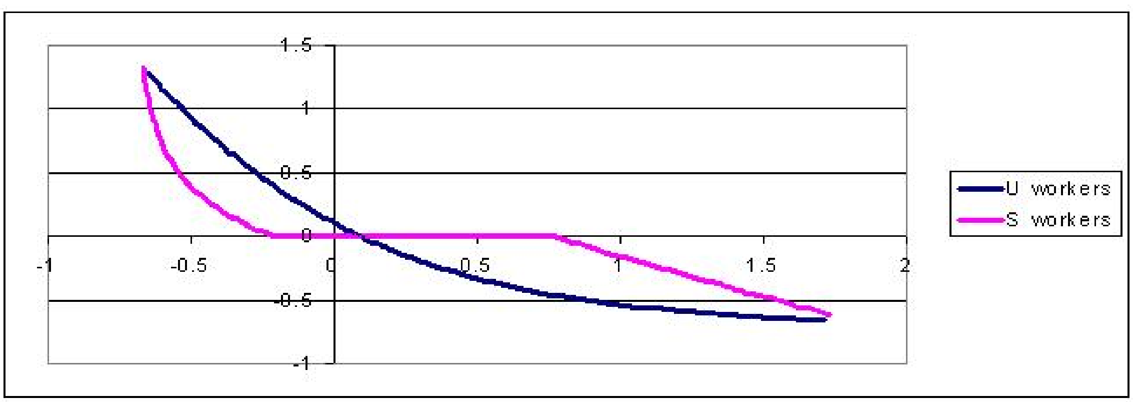
Equilibrium 1:



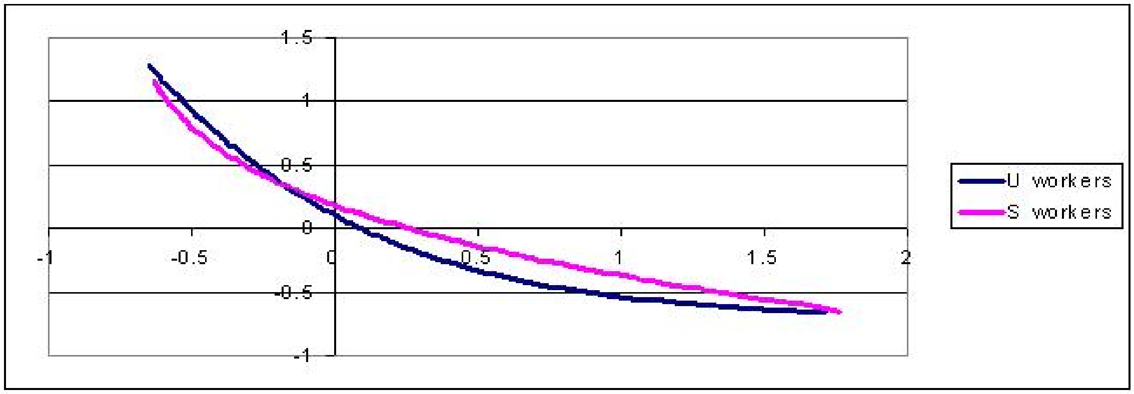
Equilibrium 2:



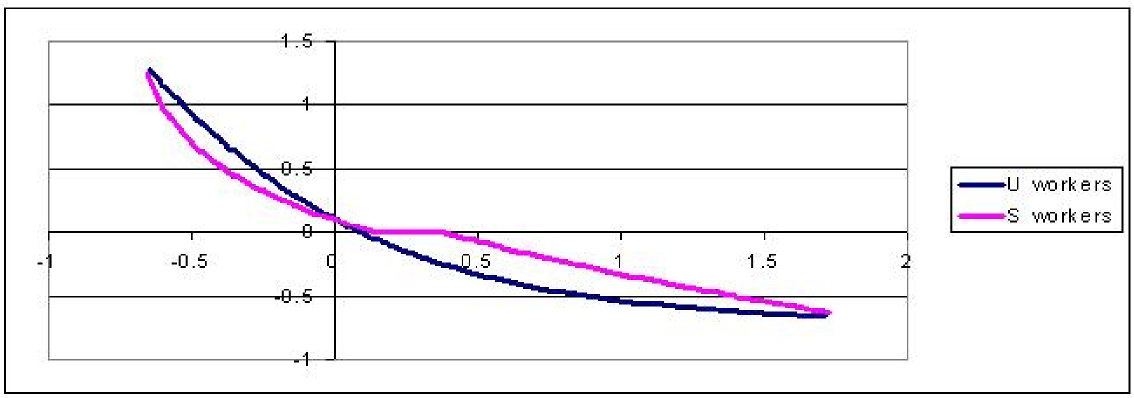
Equilibrium 3:



Equilibrium 4a:



Equilibrium 4b:



In the appendix I will develop each of these four equilibria, and show how they can be determined. Here I will concentrate on the unskilled movement equilibrium.

3.2.1 The unskilled movement equilibrium

In this case we will analyze a situation in which the cost of the unskilled migrants is low enough to make them change from the second sector to the first. A note of warning might be useful here. Rybczynski would tell us that when there are no costs, the second sector will expand. This is the case because the relative costs (in terms of production opportunities) makes it more attractive to expand one sector rather than the other. However, at the individual level, and without the movement of the skilled to the sector that it is expanding, this is no longer the case. In fact, the unskilled from the sector 2 will have incentives to look for a better wage in sector 1, since immigration will reduce their wage, as has been argued previously. The relevant condition now will be $W_{u2} = W_{u1}/E_U$. This case is somehow a mirror of the Equilibrium 2(see Appendix), and it can take place with the same conditions than the previous equilibrium as it will be discussed later into a greater extent.

To solve for the equilibrium, we first have to find the cut-off value for which there will be no incentives to move (assuming E_S sufficiently large). In particular, using $W_{u2} = W_{u1}/E_U$, we obtain:

$$E_U^* = p\frac{\alpha}{\beta}(\frac{S_1}{U_1})^{1-\alpha}(\frac{U_2 + I}{S_2})^{1-\beta} \tag{7}$$

Above this value the equilibrium will be the no-movement equilibrium. Below this value there will be some unskilled moving to the first sector. Note that, the higher the immigration, the higher the cut-off value.

The next step is to assume that $E_U < E_U^*$.By imposing $W_{u2} = W_{u1}/E_U$ and letting N be the number of unskilled moving from sector 2 to sector 1, we can implicitly find out this value N:

$$E_U p^{-1}\frac{\beta}{\alpha}\frac{S_2^{1-\beta}}{S_1^{1-\alpha}} = \frac{(U_2 - N + I)^{1-\beta}}{(U_1 + N)^{1-\alpha}} \tag{8}$$

Thus,

Proposition 3.8[12]: If $E_U < E_U^*$ there will be some skilled workers leaving the second sector to the first one. The higher the immigration the higher the number of movers.

Now we have to find the minimum cost that, given N unskilled movers, will make the skilled workers stay in their sector. In particular, using $W_{s1} = W_{s2}/E_S$, we obtain:

$$E_S^{**} = p^{-1}\frac{1-\alpha}{1-\beta}(\frac{S_1}{U_1 + N})^{1-\alpha}(\frac{U_2 - N + I}{S_2})^{1-\beta} \tag{9}$$

Above this value the equilibrium will be the the unskilled movement equilibrium. Below this value there will be some unskilled moving to the first sector. Note that, like in the cut-off for the skilled, the higher the immigration, the higher the cut-off value. Finally, it is also worth noting that E_S^{**} depends on N or E_U. If unskilled costs of moving from one sector to the other are smaller then the number of movers increases. This higher number of movers reduces the incentives of the skilled to move, so they will move only in case their costs are sufficiently small.

[12]The number of the propositions follow the enumeration of the Appendix, where the full set of results is depicted

Let's examine now what are the effects of such movements in the wages, welfare and production. Among the unskilled there will be three different groups, while only two for the skilled [13]. In particular, for the unskilled:

1. Those who stay in sector 2
2. Those who move to the first sector
3. Those who were in sector 1

The wages will be negatively affected in each of these groups (relative to the non-immigration equilibrium). In particular, the wages of groups 2 and 3 will be the same, and higher than those of group 1. In terms of welfare, groups 1 and 2 will be equalized, and more harmed by immigration than group 3. Thus,

Proposition 3.9: The unskilled in both sectors will loose in terms of welfare and wage.

Contrary to the previous section, the skilled will win both in terms of wage and welfare thanks to the greater number of unskilled in the economy, though differently across sector.

Proposition 3.10: The skilled in both sectors will win in terms of welfare and wage.

In terms of the production, we will see that there are more unskilled workers in each of the two sectors. Thus, both sectors will expand their production, through an increase in the ratio of unskilled to skilled workers. Which one of the two sectors will expand more is uncertain, and it heavily depends on the factor intensity use and the costs of changing from one sector to the other.

Proposition 3.11: Both sectors will expand. Moreover, both sectors will use more unskilled labor than before, showing that there will be "within industry" and "between industry" absorption.

This closes this equilibrium.

3.2.2 Comments

[13] With the other equilibria we are in very similar situations

The equilibrium that we reach depends mainly on what are the costs of moving from one sector to the other, given the initial allocation of workers. One can summarize the different conditions as follows:

Theorem 3.1: Given (E_S, E_U) we will have:

- *Equilibrium 1* If $(E_S, E_U) \in \{E_S > E_S^*\} \cap \{E_U > E_U^*\}$
- *Equilibrium 2* If $(E_S, E_U) \in \{E_S < E_S^*\} \cap \{E_U > E_U^{**}\}$
- *Equilibrium 3* If $(E_S, E_U) \in \{E_U < E_U^*\} \cap \{E_S > E_S^{**}\}$
- *Equilibrium 4* If $(E_S, E_U) \in (\{E_S < E_S^*\} \cap \{E_U < E_U^{**}\}) \cup (\{E_U < E_U^*\} \cap \{E_S < E_S^{**}\})$

Where equilibrium 1, 2, 3 and 4, refer to the no-movement equilibrium, the skilled movement equilibrium, the unskilled movement equilibrium and the unskilled-skilled movement equilibrium respectively.

It is worth noting that Equilibrium 2, 3 and 4 can happen with the same costs of changing from one sector to the other. That is, the condition for $E_S^{**} < E_S^*$ is equivalent to $N > 0$[14] and the condition $E_U^{**} < E_U^*$ is equivalent to $M > 0$. Thus, it is possible to have (E_U, E_S) such that both conditions hold. More precisely, the skilled movement equilibrium is characterized by:

1. $E_S < E_S^*$
2. $E_U > E_U^{**}$

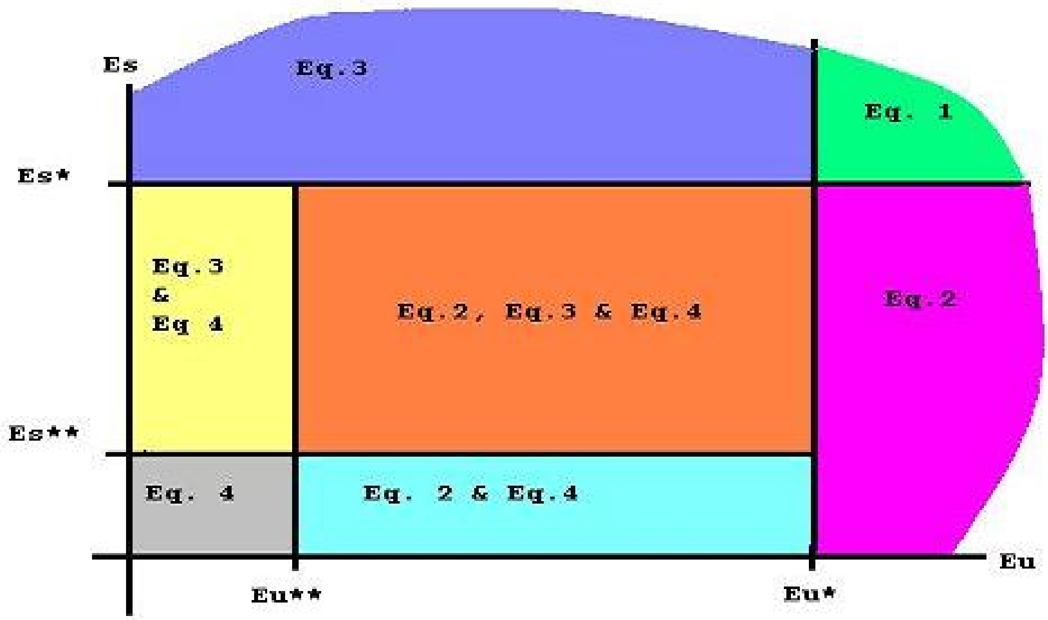
And the unskilled movement equilibrium is characterized by:

1. $E_U < E_U^*$
2. $E_S > E_S^{**}$

And these two conditions can be satisfied simultaneously. Whether the economy will move to equilibrium 2 or 3 in this situation is undetermined. This can be represented graphically:

Figure 3: Equilibria

[14]Remember that N is the number of skilled movers



This model allow us a great number of predictions. The first important result is to explain why immigration has been absorbed in a way that the H-O model does not predict. In the H-O model the way immigration is absorbed is by increasing the size of the sector that uses the immigrated factor more intensively so as to accommodate this new endowment without affecting the factor prices. However, if we introduce costs of changing from one sector to the other this implication completely breaks down. In fact, what happens in this new paradigm, is that the representative firms in each of the sectors increase the number of the immigrated factor use even if we rule out the possibility of changing its technology. The reason is again quite simple. Since wages slightly decrease for the immigrated factor, firms can hire more of this factor (in our case the unskilled workers) and produce using more of this factor. This way of absorbing immigration is in line with the empirical research that has been done in recent years, as has been argued throughout the paper.

The second important result of the paper is that immigration affects native workers' wage dispersion. When there are costs of moving from one sector to the other, there will be some natives that, even if they have incentives to move to another sector, they will stay in the sector they were, despite receiving a lower wage. Natives of their same skill level working in the other sector will see their wage increased (in relative terms). The same will happen with unskilled workers. Moreover, we will see how the wage gap between the skilled and the unskilled increases more in the sector receving immigration than in the other sector, and the more so, the higher the costs of moving.

The third important point of the model is how production reacts to an inflow of a certain type of factor. The model shows that production does not necessarily react the way Rybczynski predicts, and it can go even against it. Such a result is not new in the literature (Opp, Tombazos and Sonnenschein, 2008), but the way it is reached is novel[15]. In any case, what this shows is the fragility of one of the classical results of international economics.

So, summarizing, we can test empirically the following two results:

Result 0: The model explains how immigration can be absorbed both "between industries" and "within industries" of the workers in the economy, and, at the same time, reconcile the fact that the wage is unaffected on average, but decreases for the unskilled[16].

Result 1: When there is (unexpected) immigration, then we should observe both $Var(w_u) > 0$ and $Var(w_s) > 0$. Moreover, this variance increases with the costs of moving from one sector to the other and with the number of movers induced by immigration.

Result 2: When there is (unexpected) immigration entering the U-sector, we should expect to see $\frac{w_s^s}{w_u^s} < \frac{w_s^u}{w_u^u}$.

Before testing results 1 and 2, let me discuss briefly the implications of the model presented above, that I will call the sluggish movement model (SM M) with the standard 2x2 Small Open Economy model (SOE M or H-O model) in some detail and, more generally with the 2x2 Closed Economy Model (CE M) and the data. To follow the discussion one can use the following table:

Table 1: The impact of (unskilled) Immigration

[15] In their case the main departure from the standard theory is that, in a context of two countries, preferences are not identical in both countries. In particular they are biased to the good each country exports.

[16] Though much less than in a closed economy and with higher dispersion

	H-O M	CE M	Data	SM M
Wage	No impact	Negative	Negative est., but not significant	Negative,
Absorption	Between	Between and Within	Between, mostly Within	Between, mostly Within
U-wage	No	Yes, very significant	Yes, marg. significant	Yes, depending on sectors
$Var(wage)$	No	No	Yes	Yes
Wage Gap	No	Increases in any sector	Increases more in ↑ immigration	Increases more in ↑ immigration
Sector Expansion	Unskilled	Both equally	Skilled (?)	Depends on costs of changing sector

References: Altonji and Card, 1991; Borjas 1994; Borjas 1995;

Card, 1990; Friedberg and Hunt 1995; Friedberg, 2001;

Ottaviano and Peri, 2006; Borjas et al. 1997; Borjas, 2003; Wagner, 2008

Hanson and Slaughter, 2002; Lewis, 2003;

González and Ortega 2007; Dustmann and Glitz 2008

Let's start with wages by answering what is the increase of wages when an a small open economy receives unskilled immigration. In other words how do $\{\Delta ln(W_{U1}), \Delta ln(W_{S1}), \Delta ln(W_{U2}), \Delta ln(W_{S2})\}$ change? In the SOE M there will be no changes at all.This will be completely different in the SM

Model. In particular the wage changes will be as follows:

$$U_1 \longrightarrow (1-\alpha)ln(\frac{S_1U_1 - MU_1}{S_1U_1 + NS_1})$$

$$S_1 \longrightarrow \alpha ln(\frac{S_1U_1 + NS_1}{S_1U_1 - MU_1})$$

$$U_2 \longrightarrow (1-\beta)ln(\frac{S_2U_2 - MU_2 + I(S_2 - M)}{S_2U_2 + (N+I)S_2})$$

$$S_2 \longrightarrow \beta ln(\frac{S_2U_2 + (N+I)S_2}{S_2U_2 - MU_2 + I(S_2 - M)})$$

This means that the wages in the second (unskilled) sector will decrease for the unskilled workers and will increase for the skilled, and the opposite will happen in the skilled sector. Another relevant aspect is how will behave the mean and the variance of these wages. In the H-O Model we will have $\bar{W_U}$ unchanged, $Var(W_U) = 0$,$\bar{W_S}$ unchanged and $Var(W_S) = 0$. In contrast in the SM Model:

$$\bar{W_U} = \frac{\alpha(U_1+N)^{\alpha}(S_1-M)^{1-\alpha} + \beta(U_2+I-N)^{\beta}(S_2+M)^{1-\beta}}{U+I}$$

$$\bar{W_S} = \frac{(1-\alpha)(U_1+N)^{\alpha}(S_1-M)^{1-\alpha} + (1-\beta)(U_2+I-N)^{\beta}(S_2+M)^{1-\beta}}{S}$$

The variance depends on the movers but we always have:

$$ln(W_{S2}) - ln(W_{S1}) \geq ln(E_S)$$

$$ln(W_{U1}) - ln(W_{U2}) \geq ln(E_U)$$

Still with wages, one can consider what happens with the wage gap in more detail and compare the H-O model with the SM model. In the H-O model W_S/W_U is unchanged in both sectors. In constrast, in SM Model we have:

$$\frac{W_{S1}}{W_{U1}} = \frac{\alpha}{1-\alpha}(\frac{S1 - M}{U1 + N})$$

$$\frac{W_{S2}}{W_{U2}} = \frac{\beta}{1-\beta}(\frac{S2+M}{U2+I-N})$$

And we can prove that $\frac{W_{S2}}{W_{U2}} > \frac{W_{S1}}{W_{U1}}$.

Finally we can compare how immigration is absorbed in both models. In H-O Model the Rybczynski Theorem holds, so: There will be skilled and unskilled workers moving to the unskilled sector and the factor intensities use will not change. In contrast in the SM Model: Depending on the costs there will be movements of M unskilled workers from U_2 to U_1 and N skilled workers from S_1 to S_2. $\Rightarrow$ Either the S-sector will expand or the U-sector will expand most. If E_S are high (Eq. 3 or 4) then the skilled sector will expand more, and the relative use of unskilled workers will increase more in the U-sector than in the S-sector. So, there will be more "within industry" than "between industry" absorption.

4. Empirical Results

With the model presented in the previous section one can look at the data from a different perspective. In particular, the model is very useful to understand the results found in previous literature (Lewis, 2004; González and Ortega, 2007 and Dustmann and Glitz 2008). In this section I will test Result 1 and Result 2 and argue that can be understood with the model. First I will briefly describe the data, and then I will present some regressions to support my claims.

4.1 Data

In this section I briefly describe the data. To analyze what has happened in US during the decades that go from 1980 to 2000 I use data from the US Census 1960, US Census 1970, US Census 1980, US Census 1990 and US Census 2000, provided by the IPUMS-USA (2004). In particular I use the 1% samples of the entire census, mainly due to the size of the other samples available, the 5% ones. Previous to the analysis, I clean the data by droping observations of people that are not in the labor force or that have zero income wage. The dataset has, in the end, more than 2,000,000 observations. Using this micro level observations I then construct the database by sectors and states that I use to show the different results.

More specifically, the variable I use for the industry classification is that of 1990, because it is the only classification available for all these census years. It consists on 237 different industries, disaggregated at a three digit level. From these 237 industries there are cases in which a certain industry has almost no observations for some of the years. This is especially true, for example, when using the available data from 1960 or 1970. Depending on the regressions I will present below, I can use more or less industries.

The second variable of interest in the regressions I present below is constructed by using the migration status of the US Census sample. If an individual appears as foreign-born in the year 1980 it will count as an immigrant. From this variable I distinguish immigrants from natives in all the regression I present below. Moreover, since what I am most interested in is in the level of immigration I consider the immigration density, or immigration proportion, as the number of immigrants over the total of the population.

More details on this data set can be found, for example, in Lewis (2004).

4.2 Results

4.2.1 Testing Result 1

It is not an easy task to test Result 1, mainly because of the endogeneity problems. As Borjas pointed out in his 1987 paper unskilled migrants tend to go to those places where the standard deviation of the income distribution is lowest. The reason is quite simple. Even if they are going to be in the lower tail, the fact that the standard deviation is lower means that they are more likely to earn relatively more than in their home country. Borjas points this fact when comparing the income distribution of countries such as Mexico and US or Germany and US (Borjas, 1987; Roy, 1951). In the first case, Mexico has a flatter income distribution, meaning that unskilled Mexicans are the ones more likely to migrate to the US. In the latter case, is the US that has a flatter distribution than Germany, implying that skilled Germans will migrate to US.

If we think in those terms but considering different states within the US, we should see how low skilled migrants tend to go wherever the income distribution has the lowest standard deviation. This is a force that goes against the one identified in this paper, namely that immigration contributes to the increase in the wage dispersion. In any case, there might be endogeneity problems, that will try to be addressed by using an instrument. For the moment, however, it is interesting to see how the OLS regressions looks like. The regression model is the following:

$$Sd^{US}_{est} = \alpha + \beta * ImmigrationProportion_{est} + \delta_t + \delta_e + \epsilon_{est} \quad (10)$$

Where the variables are:

$ImmigrationProportion_{est} \equiv \frac{NumberOfMigrants_{est}}{TotalPopulation_{est}}$

$Sd^{US}_{est} \equiv$ The Standard Deviation of the US workers hourly (real) wage

And the subscripts represent education (e), state (s) and time (t).

It is important to note that we are looking at the standard deviation of the wage of US workers only, since otherwise this variable would capture the possible imperfect substitutability between immigrants and natives. To understand the purpose of this regression, we have to note that the data points vary in education, state and time. This is, for each state, time and education group (in this case 3 groups, representing skilled workers, medium skilled workers and low skilled workers) we compute the standard deviation of the wages of all the workers belonging to this category. So, imagine we have N workers in state S at time T then, using these N observations I would calculate the standard deviation of the wages of these N workers belonging to the group. I do this calculation for the three education groups, the fifty states and the three times that I have, having a total of $3x3x50 = 450$ observations. Since there are some of these observations with too few workers to have a good estimate of the standard deviation, I drop all the observations having a standard deviation 4 times above or below the national average (using the weighted least squares this is not necessary, but I still do it because I think is a better point estimate the one we get by dropping these outliers[17]). This results in the 405 observations appearing in the table. Another aspect that is taken into account is that this methodology implies that there could be autocorrelation of the observations that share state, that is, the error of the observation for the low skilled workers in state S could be correlated with that of the medium skilled in the same state. This could give more significant estimates than when assuming that there is no autocorrelation. To address this issue I report clustered standard errors, clustered by state.

The results are as follows:

[17] Without weighting the observations and without dropping any observation, I still get the same results under most of the specifications presented here

Table 2: The effect of immigration on the standard deviation of natives' wage

	(1) sdwage (OLS)	(2) sdwage (OLS)	(3) sdwage (RE)	(4) sdwage (OLS)
percentageofimm	25.19***	15.75**	15.64***	13.04+
	(4.84)	(2.20)	(3.96)	(1.51)
Year FE	No	Yes	Yes	Yes
Education FE	No	Yes	Yes	Yes
Education State FE	No	No	Yes	Yes
_cons	12.43***	28.07***	28.08***	24.42***
	(25.56)	(25.15)	(29.80)	(22.11)
N	405	405	405	405

t statistics in parentheses

$^{+}$ $p < 0.15$, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: se reported are robust and clustered by state in (1)-(2) and (4)

These regressions show that there seems to be a positive and significant effect of immigration on the wage dispersion of US workers, as predicted by the model. Note the conceptual difference one can make between the regression including the state fixed effects and those without. The former is capturing changes in the immigration level along the time in each state, while the latter is comparing changes across states. The significance of the regression with the full set of fixed effects is only at a 13%, showing that this is the least robust predicton of the model. To try to see if indeed this marginal significance is a problem I run a Hausman test, comparing a specification that is not biased but inefficient (the regression with the full set of fixed effects, with a specification that might be biased but is efficient (the random effect in column (3)). With a 99% confidence the hausman test confirms the null hypothesis by which the difference in the two coefficients is not systematic.

These regressions, however, are not weighted by the size of each state, and as we can see in the next table, this can be driving some of the estimates in Table 2. Next table shows the same regressions but weighting the "cells" by the population in each of them. The fact that we get better estimates might indicate that the immigration phenomenon in the US is driven mainly by big and big receiving states such as Florida or California. Note that, the higher the number of observations the better will be the standard (none biased) estimate of the standard deviation of the US wages within states and education groups. The next table reports the weighted least squares (WLS) regressions:

Table 3: The effect of immigration on the standard deviation of natives' wage, weighting the observation by the population in each state

	(1) sdwage (WLS)	(2) sdwage (WLS)	(3) sdwage (WLS)
percentageofimm	25.19***	32.58***	32.11**
	(4.84)	(4.11)	(2.11)
Year FE	No	Yes	Yes
Education FE	No	Yes	Yes
Education State FE	No	No	Yes
_cons	12.43***	30.53***	21.88***
	(25.56)	(28.36)	(22.84)
N	405	405	405

t statistics in parentheses

$^{+}$ $p < 0.15$, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: the standard errors reported are robust and clustered by state

As pointed out earlier, there is a reasonable concern that there are endogeneity problems. To address them, I will instrument the percentage of immigration variable by the percentage of immigration in previous years, namely 1970 and 1960 (the instrument used in the literature since Altonjii and Card (1991). The idea behind this instrument is that migrants tend to chose not only according to economic conditions but also to where their relatives have gone to. Thus, over time, networks become an important part of the immigration decision. In the following table I report the IV regressions. Columns (1)-(2) use the 1970 Immigration Proportion as the Instrument, while column (3) uses the 1960 and column (4) both:

Table 4: The effect of immigration on the standard deviation of natives' wage instrumented by Immigration Networks

	(1) sdwage (IV)	(2) sdwage (IV)	(3) sdwage (IV)	(4) sdwage (IV)
percentageofimm	12.28*	19.67**	19.70**	19.65***
	(1.85)	(2.66)	(2.43)	(2.70)
Year FE	No	Yes	Yes	Yes
Education FE	No	Yes	Yes	Yes
Instrument	Networks 70s	Networks 70s	Networks 60s	Both
_cons	13.64***	28.90***	28.90***	30.73***
	(23.44)	(26.54)	(25.45)	(28.90)
N	373	373	373	373

t statistics in parentheses

$^{+}$ $p < 0.15$, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: se reported are robust and clustered by state

These results are in line with the OLS regressions: they are both positive and significant and in quantitative terms, very similar to the OLS. This seems to confirm that immigration is, indeed, affecting the US wage dispersion. In quantitative terms, this results are saying that an inflow of a 10% of the population would increase the standard deviation of the US workers hourly real wage by around 2$. This is precisely around a 10% of the average wage of US workers. This results is surprisingly close to the what is argued by Borjas (2003) about the unskilled workers, since he states that an inflow of a 10% of the population would reduce unskilled workers wage by a 9%.

The model is more precise than that, since it points at the channels through which immigration increases such dispersion, namely through the education premium and the industry premium. These various channels can be identified using the appropriate methodology and will be the subject of future research.

4.2.2 Testing Result 2

The second prediction of the model is that the sectors receiving unskilled migrants (or more generally unskilled labor shocks) will be those that have a higher gap between the high skilled workers and the low skilled workers. One way to look at this result is by splitting the population between skilled and unskilled, using as the cut-off the university. In this set up, a high skilled worker would be an individual that has finished high school and a low skilled worker would be an individual that has not finished high school. However, I will maintain the three educational groups. The reason for that is that the highest impact of immigration is on the high-school drop-outs group (the least skilled group in the society) and much of the literature has focused its attention on them. Using this three groups I will have high-skilled, medium-skilled and low-skilled as explained before. I will define the wage premium as the wage of the high-skilled over the wage of the less skilled, or alternatively, the difference in its log. Due to the fact that I only use a 1% of the US Census data I will consider variation accross industries and time only. An alternative, that is left for future research, is to consider variation accross industries, states and time.

For the second result I will use the following regression:

$$WagePremium_{jt} = \alpha + \beta percentageofimm_{jt} + \delta_t + \epsilon_{jt} \tag{11}$$

Where $WagePremium_{jt} \equiv w_{Sjt}/w_{Ujt}$ of US workers.

And the $percentageofimm$ variable is like before but measured across industries.

In this case, I calculate the average wage of all the US workers working in the industry j that are high skilled and the average wage of all the workers working in the same industry j that are low skilled (remember that there were three different groups of education). I then divide both averages to have the wage premium in the industry j. I do this for the three years, the subscript t, and I look whether theses wage premia have increased most in industries receiving more immigration. Note that this is done by considering the workers in industry j at a national level. This explains why I should have $237x3 = 711$ observations, that, after dropping the industries that do not have workers at one of the years I look at, become 627 observations. Another possibility could be to consider the same but per state. Something that will be done in future research. Note that there might also be a problem of endogeneity. In this case the instrument is again previous immigrants working in the same sectors as new immigrants. The idea, is that new immigrants, through immigration networks will start working in the same sector than previous immigrants, not because of economic reasons but rather because they now people already there that facilitate that the end up working in the same sectors as they relatives or friends. The next table reports both the OLS results and the IV.

Table 5: The effect of immigration on the wage premium:

	(1) WagePremium (OLS)	(2) WagePremium (OLS)	(3) WagePremium (WLS)	(4) WagePremium (IV)	(5) WagePremium (IV)
percentageofimm	0.51^{***}	0.67^{**}	0.51^{*}	1.41^{***}	1.42^{***}
	(4.35)	(2.74)	(2.28)	(5.64)	(5.80)
Year FE	No	Yes	Yes	No	Yes
Instrument	No	No	No	Networks 70s	Both
_cons	1.37^{***}	1.26^{***}	1.34^{***}	1.21^{***}	1.10^{***}
	(50.20)	(18.66)	(18.27)	(23.35)	(14.03)
N	627	627	627	408	408

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Note: the standard errors reported are clustered by state in (1)-(3)

The results show that sectors with higher immigration levels see a higher gap between the unskilled wage and the skilled wage, again as predicted by the model. The IV regressions show that if anything the point estimated of the OLS is downward biased. Note that we have less observations for the IV because there is less data for the 1970 and 1960 data sets.

Another possible strategy to test result 2 is consider the variation at the state level as well. That is, consider the following regression:

$$WagePremium_{sjt} = \alpha + \beta percentageofimm_{sjt} + \delta_t + \delta_{js} + \epsilon_{sjt} \quad (12)$$

All the variables and all the subscripts are as before. The following table reports the results, which are consistent with the model presented above:

Table 6: The effect of immigration on the wage premium, by states:

	(1) WagePremium (OLS)	(2) WagePremium (OLS)	(3) WagePremium (OLS)	(4) WagePremium (OLS)
percentageofimm	4.15^{***}	4.39^{***}	2.92^{***}	7.76^{***}
	(5.55)	(5.28)	(4.77)	(2.33)
Year FE	Yes	Yes	Yes	Yes
Industry FE	No	No	Yes	Yes
State FE	No	Yes	No	Yes
_cons	-0.90^{**}	-1.19^{**}	-1.21^{**}	-3.13^{+}
	(-2.15)	(-2.17)	(-2.30)	(-1.49)
N	1168	1168	1168	1168

t statistics in parentheses

$^{+}$ $p < 0.15$, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: the standard errors reported are clustered by state and industry

5. Discussion and Conclusion

In conclusion, the main insight of this paper has been to reconcile empirical evidence coming from the analysis on how wages are affected by immigration with evidence on how immigration is absorbed. Far from being surprising, the most natural way in which unskilled immigration should be absorbed is by increasing the ratio of unskilled to skilled workers, once we introduce some costs of moving from one sector to the other, even in a small open economy framework. Moreover, this approach enables, at the same time, new predictions as to how wages should react in the presence of immigration. There are essentially two new results: 1) Immigration should increase the wage dispersion of US workers, both skilled and unskilled and 2) Unskilled Immigration should increase the wage difference between high skilled workers and low skilled workers. These predictions are tested empirically using the US Census data for the year 1980, 1990 and 2000.

To reach these conclusions, I have analyzed the literature trying to understand the effects of immigration on the host country. There is some evidence pointing at negative effects on wages due to immigration for certain types of workers (Borjas et al., 1997; Borjas, 2003; or Borjas, Grogger and Hanson, 2008) though there are reasonable doubts on the strength of such effects on the average wage (Ottaviano and Peri, 2006 for recent evidence; Fiedberg and Hunt, 1995 for an early survey). What some authors have argued is that the highest effect of immigration on local economies is a shift on the way industries produce in order to absorb the recent immigration waves (Lewis, 2004; González and Ortega, 2007 and Dustmann and Glitz, 2008). Rather than having workers moving from one industry to the other, or having increased unemployment rates, what seems to better explain the relatively good absorption of migrants is changes in the way goods are produced or what has been called within industry absorption.

This way in which immigration has been absorbed was a puzzle from the standard international economics literature. Standard Rybczynski effects seemed to play a minor role while firms seemed to somehow take advantage of the new labor force by proportionally hiring more workers of the abundant types (that is the ones “hit” by immigration). However and without ruling out these points of view, I have argued that the evidence presented could be explained differently. First of all, it seems that the difficulty that native workers might have in changing from one sector to another has been somehow overlooked. By adding them we observe that what these papers find is a natural consequence of such a small change in the standard theories. This change, moreover, is consistent with practically zero effects of immigration on wages, as well as negative effects for some segments of the society.

A second important implication of the paper has been tested: namely the fact that immigration increases wage dispersion. In the paper we have seen that this seems to be the case, by running a time series regressions, instrumented in order to control for the possible endogeneity. A more careful analysis should shed still more light into the different channels that the model points out affecting wage dispersion. This aspect of immigration can, moreover, potentially explain some of the negative attitudes toward it, something that should also be investigated more carefully.

The third main contribution of the paper has been to show that a second effect of immigration is that it increases the wage gap in certain sectors (those receiving more immigrants) more than others (those receiving less immigrants). Moreover, the paper tests this prediction, finding supporting results for this view. In other models, without costs, even if workers could not work in some sectors, because of language or legal problems, this would not affect the wage gap of US workers more directly in these sectors, precisely because US workers would be able to "escape" from those sectors with higher immigration.

What still remains to be investigated is the role of capital. A very similar model could be done to try to capture the effects of capital in the assimilation of immigration. For instance, the costs of changing from one sector to the other could also capture the financial development of the economy. This would enable to test whether there are Rybczynski or reverse-Rybczynski effects when considering the classical H-O theory. A second aspect that remains to be investigated is the long run effects of immigration or how immigration affects growth. This static model can be interpreted as a long run model. The costs could be interpreted as the costs for the sons to work on different sector than their parents. This reinterpretation could be developed and could be very fruitful to see the effect of immigration in the long run, but further than that it is silent on any dynamics.

6. Bibliography

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7. Appendix

In this appendix I develop the model already presented, but with greater detail. I will concentrate on the equations rather than on the explanations and intuitions behind them, something that I have hopefully done in the paper.

2.1 Preferences

They will be Cobb-Douglas over the two goods available in the economy and they will discount the cost of getting education:

In general, $U(C_1, C_2) - G(e) = \eta lnC_1 + (1-\eta)lnC_2 - ln(e)$, where e is effort

$MaxC_1^{\eta}C_2^{1-\eta}$, subject to their earnings (Y)

So demand is:

$C_1 = \frac{Y\eta}{p_1}$ and $C_2 = \frac{Y(1-\eta)}{p_2}$

The indirect utility function will be $V(Y(e), p) - G(e) = \eta ln\frac{Y\eta}{p_1} + (1-\eta)ln\frac{Y(1-\eta)}{p_2} - ln(e) = lnY - ln(e) + \eta ln(\eta) + (1-\eta)ln(1-\eta) - \eta lnp_1 - (1-\eta)ln(p_2) \cong lnY - ln(e)$

Since we are using the ideal price index: $p_1^{\eta}p_2^{1-\eta} = 1$, $p = \frac{p_1}{p_2}$, $p_1 = p^{1-\eta}$ and $p_2 = p^{-\eta}$

2.2 Production

The two sectors will produce with Cobb-Douglas technologies:

$Q_1 = U_1^{\alpha}S_1^{1-\alpha}$

and

$Q_2 = U_2^{\beta}S_1^{1-\beta}$

And will maximize their profits. We can think without loss of generality that $\beta > \alpha$. Profit maximization is the same as cost minimization in this context.

So, $MinW_u + W_s$ s.t. $U_1^{\alpha}S_1^{1-\alpha} \geq Q_1$

And we obtain, $C_1(W_u, W_s, Q_1) = Q_1\theta_1 W_u^{\alpha}W_s^{1-\alpha}$

and, similarly for the other sector, $C_2(W_u, W_s, Q_2) = Q_2\theta_2 W_u^{\beta}W_s^{1-\beta}$

With $\theta_i = (\frac{1-\alpha_i}{\alpha_i})^{\alpha_i} + (\frac{1-\alpha_i}{\alpha_i})^{\alpha_i - 1}$

The unit cost functions are:

$c_1(W_u, W_s) = \theta_1 W_u^{\alpha}W_s^{1-\alpha}$

$c_2(W_u, W_s) = \theta_2 W_u^{\beta}W_s^{1-\beta}$

So since prices are given by international markets (and cannot be influenced by the production of this small economy):

$$p^{1-\eta} = \theta_1 W_u^{\alpha} W_s^{1-\alpha} \tag{13}$$

$$p^{-\eta} = \theta_2 W_u^{\beta} W_s^{1-\beta} \tag{14}$$

2.3 Equilibrium wages

Combining (1) and (2) we can derive the wages in equilibrium:

$$W_s = p^{1-\eta+\frac{\alpha}{\beta-\alpha}} \theta_1^{\frac{-\beta}{\beta-\alpha}} \theta_2^{\frac{\alpha}{\beta-\alpha}} \tag{15}$$

$$W_u = p^{1-\eta+\frac{\alpha-1}{\beta-\alpha}} \theta_1^{\frac{1-\beta}{\beta-\alpha}} \theta_2^{\frac{\alpha-1}{\beta-\alpha}} \tag{16}$$

Another useful equation is $\frac{W_u}{W_s} = p^{\frac{-1}{\beta-\alpha}} (\frac{\theta_1}{\theta_2})^{\frac{1}{\beta-\alpha}}$

2.4 Equilibrium allocation of workers

In this section I determine the amount of workers working in each sector and skill

Labor market clearing imposes that:

$S_1 + S_2 = S$

$U_1 + U_2 = U$

Note here that we are exogenously assuming the total amount of S and U workers

First, using the *Shepard's lemma* I can use the cost function to determine the allocation of workers, depending on the output produced:

$$\frac{\partial C_1}{\partial W_u} = U_1 = \alpha \tilde{p}^{1-\alpha} \tilde{\theta}_1^{\beta-1} \tilde{\theta}_2^{1-\alpha} Q_1 \tag{17}$$

$$\frac{\partial C_1}{\partial W_s} = S_1 = (1-\alpha) \tilde{p}^{-\alpha} \tilde{\theta}_1^{\beta} \tilde{\theta}_2^{-\alpha} Q_1 \tag{18}$$

$$\frac{\partial C_2}{\partial W_u} = U_2 = \beta \tilde{p}^{1-\beta} \tilde{\theta}_1^{\beta-1} \tilde{\theta}_2^{1-\alpha} Q_2 \tag{19}$$

$$\frac{\partial C_2}{\partial W_s} = S_2 = (1-\beta) \tilde{p}^{-\beta} \tilde{\theta}_1^{\beta} \tilde{\theta}_2^{-\alpha} Q_2 \tag{20}$$

Where $\tilde{x} = x^{1/(\beta-\alpha)}$

Using these expressions on the labor market clearing, one can determine the output:

$$Q_1 = \frac{\beta}{\beta-\alpha} \hat{S} \tilde{p}^{\alpha} - \frac{1-\beta}{\beta-\alpha} \hat{U} \tilde{p}^{\alpha-1} \tag{21}$$

$$Q_2 = \frac{1-\alpha}{\beta-\alpha}\hat{U}\tilde{p}^{\beta-1} - \frac{\alpha}{\beta-\alpha}\hat{S}\tilde{p}^{\beta} \quad (22)$$

Where $\hat{S} = S\frac{\tilde{\theta}_2^{\alpha}}{\tilde{\theta}_1^{\beta}}$ and $\hat{U} = U\frac{\tilde{\theta}_1^{1-\beta}}{\tilde{\theta}_2^{1-\alpha}}$

Finally, using the output produced by each of the sectors we can determine the amount of workers in each of the sector-skill groups:

$$U_1 = \frac{\alpha\beta}{\beta-\alpha}\tilde{p}\frac{\tilde{\theta}_2}{\tilde{\theta}_1}S - \frac{\alpha(1-\beta)}{\beta-\alpha}U \quad (23)$$

$$S_1 = \frac{(1-\alpha)\beta}{\beta-\alpha}S - \frac{(1-\alpha)(1-\beta)}{\beta-\alpha}\tilde{p}^{-1}\frac{\tilde{\theta}_1}{\tilde{\theta}_2}U \quad (24)$$

$$U_2 = \frac{(1-\alpha)\beta}{\beta-\alpha}U - \frac{\alpha\beta}{\beta-\alpha}\tilde{p}\frac{\tilde{\theta}_2}{\tilde{\theta}_1}S \quad (25)$$

$$S_2 = \frac{(1-\alpha)(1-\beta)}{\beta-\alpha}\tilde{p}^{-1}\frac{\tilde{\theta}_1}{\tilde{\theta}_2}U - \frac{\alpha(1-\beta)}{\beta-\alpha}S \quad (26)$$

Going through equations (3)-(4) and (9)-(14) we obtain the following classical results[18]:

Proposition 2.1: The *Stolper-Samuelson theorem*, by which if the price of the good that uses the factor relatively more intensively increases then the price of that factor increases more than proportionally and the other decreases.

Proposition 2.2: The *Rybczynski theorem*, by which if the endowment of one of the factors increases then the production of the industry that uses it more intensively expands more than proportionally, while the other contracts.

So far is the equilibrium and the results of the classical small open economy model

3.1 The general set-up

In the second period a distribution $\{FU_1, FS_1, FU_2, FS_2\}$ of immigrants arrive.

It can be interpreted as:

1) This distribution is unexpected by natives in the first period (for example because there is a change in the law)

In future research I will relax this assumption by allowing to attach some probabilities to the arrival of immigrants

The arrival of immigrants will change the wages:

[18] Assuming Cobb-Douglas production we are clearly in a case where there are no factor intensity reversals

$$W'_{u1} = \alpha p_1 (\frac{S'_1}{U'_1})^{1-\alpha} \tag{27}$$

$$W'_{s1} = (1-\alpha) p_1 (\frac{S'_1}{U'_1})^{-\alpha} \tag{28}$$

$$W'_{u2} = \beta p_2 (\frac{S'_2}{U'_2})^{1-\beta} \tag{29}$$

$$W'_{s2} = (1-\beta) p_2 (\frac{S'_2}{U'_2})^{-\beta} \tag{30}$$

Giving incentives to change to another sector (paying a cost)

Where S'_i, is the new amount of workers workers employed in the skill-sector group.

3.2 Equilibrium shifts of employment by sectors and education levels due to immigration: a special case

I will consider here the special case:

Assumption 2: $FU_1 = FS_1 = FS_2 = 0$ and $FU_2 \neq 0$

Moreover,

- I will assume that workers can change sector (at a cost) but not their skill.
- However there will be already a distribution of people in the society meaning that the reservation value is the wage W'_{u2}.

Note finally that the arrival of FU_2 immigrant will increase the wage of the S_2 natives and decrease the wage of the U_2.

These two groups will be the ones having incentives to change their job.

In such a case we will have that the equilibrium condition is: $W'_{s1} \geq W'_{s2}/E_S$ and $W'_{u2} \geq W'_{u1}/E_U$.

There will be four possible equilibriums:

1. The no-movement equilibrium
2. The skilled movement equilibrium
3. The unskilled movement equilibrium
4. The skilled-unskilled movement equilibrium

These four equilibriums will depend on whether the inequalities are equalities or not.

3.2.1 The no-movement equilibrium

Instead, equations (1) and (2) are now:

$$p^{1-\eta} = \theta(\alpha) W_{u1}^{\alpha} W_{s1}^{1-\alpha} \tag{31}$$

$$p^{-\eta} = \theta(\beta) W_{u2}^{\beta} W_{s2}^{1-\beta} \tag{32}$$

To find out what are the wages we can use the the profit maximization decisions of the firms in each of the sectors:

$$W_{u1} = \frac{\alpha}{1-\alpha}\frac{S_1}{U_1} W_{s1} \tag{33}$$

$$W_{u2} = \frac{\beta}{1-\beta}\frac{S_2}{U_2+I} W_{s1} \tag{34}$$

Combining the equations for each sector we obtain that:

$$W_{s1} = p^{1-\eta}\theta_1^{-1}(\frac{\alpha}{1-\alpha}\frac{S_1}{U_1})^{-\alpha} = p^{1-\eta+\frac{\alpha}{\beta-\alpha}}\theta_1^{\frac{-\beta}{\beta-\alpha}}\theta_2^{\frac{\alpha}{\beta-\alpha}} \tag{35}$$

$$W_{u1} = p^{1-\eta}\theta_1^{-1}(\frac{\alpha}{1-\alpha}\frac{S_1}{U_1})^{1-\alpha} = p^{1-\eta+\frac{\alpha-1}{\beta-\alpha}}\theta_1^{\frac{1-\beta}{\beta-\alpha}}\theta_2^{\frac{\alpha-1}{\beta-\alpha}} \tag{36}$$

Thus,

Proposition 3.1: Wages in the first sector are not affected by immigration if the costs of moving from one sector to the other tend to infinity.

Combining the equations for the second sector we obtain that:

$$W_{s2} = p^{-\eta}\theta_2^{-1}(\frac{1-\beta}{\beta}\frac{U_2}{S_2} + \frac{1-\beta}{\beta}\frac{I}{S_2})^{\beta} \tag{37}$$

$$W_{u2} = p^{-\eta}\theta_2^{-1}(\frac{1-\beta}{\beta}\frac{U_2}{S_2} + \frac{1-\beta}{\beta}\frac{I}{S_2})^{\beta-1} \tag{38}$$

Thus,

Proposition 3.2: Wages in the second sector are affected by immigration if the costs of moving from one sector to the other tend to infinity. In particular, the wage of the skilled increases, while the wage of the unskilled decreases, when immigration is unskilled.

Since the amount of people does not change in sector, the output in sector 1 will remain exactly the same.

The output in sector 2 will increase since there will be more unskilled workers.

In particular it will be: $Q_2 = (U_2 + I)^{\beta} S_2^{1-\beta}$.

Thus,

Proposition 3.3: Output in the first sector rests unchanged, while the second sector expands (between industry absorption). Moreover, the ratio of unskilled to skilled remains unchanged for the first sector but it increases in the second sector (within-industry absorption).

This closes the model when costs of moving from one sector to the other tend to infinity.

3.2.2 The skilled movement equilibrium

In this case we will analyze a situation in which the cost of the skilled migrants is low enough to make them change from the first sector to the second.

Note that if there are no intra-sectoral movements, the skilled natives will earn more in the second sector than in the first.

Thus there will be some natives willing to pay the cost of moving from one sector to the other (if it is not too high).

In particular we will have the extra condition that $W_{s1} = W_{s2}/E_S$

The first thing one might one to find is the cut-off value for which a skilled migrant would be indifferent to stay or move to the second sector

This can be found by imposing that without any movements, $W_{s1} = W_{s2}/E_S$.

The cut-off value is:

$$E_S^* = p^{-1}\frac{1-\beta}{1-\alpha}(\frac{S_2}{U_2+I})^{-\beta}(\frac{S_1}{U_1})^{\alpha} \tag{39}$$

Above this value the equilibrium will be the no-movement equilibrium.

Below this value there will be some skilled natives moving to the second sector.

The next step is to assume that $E_S < E_S^*$ and E_U sufficiently large and find out how many skilled workers will move to the second sector

Again we have to impose that $W_{s1} = W_{s2}/E_S$, but now wages have to take into account the M skilled workers that will move from sector 1 to sector 2.

In particular we have that:

$$E_S p\frac{1-\alpha}{1-\beta}\frac{U_1^{\alpha}}{(U_2+I)^{\beta}} = \frac{(S_1-M)^{\alpha}}{(S_2+M)^{\beta}} \tag{40}$$

Thus,

Proposition 3.4: If $E_S < E_S^*$ there will be some skilled workers leaving the first sector to the second one. The higher the immigration the higher the number of movers.

The second step is to find out the minimum costs for the unskilled in order to make them stay in the sector they are, given that the costs for the skilled are E_S, or that there will be M skilled movers.

This can be found by imposing that with the M movements, $W_{u2} = W_{u1}/E_U$. The cut-off value is:

$$E_U^{**} = \frac{\alpha}{\beta} p(\frac{S_1 - M}{U_1})^{1-\alpha}(\frac{S_2 + M}{U_2 + I})^{\beta - 1} \quad (41)$$

Below this value the equilibrium will be the skilled-unskilled movement equilibrium.

Above this value we will be in the skilled movement equilibrium

It is worth noting that the cut-off value E_U^{**} depends on the number of movers M or E_S

In particular, $\frac{\partial E_U^{**}}{\partial M} < 0$ or $\frac{\partial E_U^{**}}{\partial E_S} > 0$

Let's examine now what are the effects of such movements in the wages, welfare and production.

The welfare of the skilled can be separated in three groups of people, while the unskilled in only two.

The skilled:

1. Skilled from the sector 1 that do not move
2. Skilled from sector 1 that move to sector 2
3. Skilled from sector 2

And their wages will be:

$$W_s^1 = p^{1-\eta}(1-\alpha)\frac{S_1 - M}{U_1})^{-\alpha} \quad (42)$$

$$W_s^2 = p^{1-\eta}(1-\alpha)\frac{S_1 - M}{U_1})^{-\alpha} E_S \quad (43)$$

$$W_s^3 = p^{-\eta}(1-\beta)(\frac{S_2 + M}{U_2 + I})^{-\beta} \quad (44)$$

Note that $W_s^2 = W_s^3$.

In terms of welfare:

$$V_s^1 = lnW_s^1 \quad (45)$$

$$V_s^2 = lnW_s^1 \quad (46)$$

$$V_s^3 = lnW_s^3 \quad (47)$$

Thus,

Proposition 3.5: The skilled in both sectors will gain in terms of welfare and wage.

On the contrary the low skilled immigration will lose in general.

In particular, wages will move as follows:

$$W_{u1} = p^{1-\eta}\alpha(\frac{S_1 - M}{U_1})^{1-\alpha} \tag{48}$$

$$W_{u2} = p^{-\eta}\beta(\frac{U_2 + I}{S_2 + M})^{\beta-1} \tag{49}$$

Proposition 3.6: The unskilled in sector 1 will see both their wage and welfare reduced (due to some skilled leaving the sector). On the other hand, depending on how many skilled arrive to the second sector unskilled workers from this sector would either win or loose (depending on whether $M \geq I\frac{S_2}{U_2}$ or not).

Finally it is worth mentioning that the sector 1 will contract and the sector 2 will expand

In particular,

Proposition 3.7: The sector 1 will contract but not as much as without costs of moving from one sector to the other, while the second sector will expand but less than predicted by Rybcszynki. Moreover, the ratios unskilled-skilled will also change, into more unskilled intensity. Thus, there will be both within absorption and between absorption or Rybczynski effects.

3.2.3 The unskilled movement equilibrium

In this case we will analyze a situation in which the cost of the unskilled migrants is low enough to make them change from the second sector to the first.

A note of warning might be useful here.

Rybczynski would tell us that when there are no costs, the second sector will expand. This is the case because the relative costs (in terms of production opportunities) makes it more attractive to expand one sector rather than the other.

However, at the individual level, and without the movement of the skilled to the sector that it is expanding, this is no longer the case.

In fact, the unskilled from the sector 2 will have incentives to look for a better wage in sector 1, since immigration will reduce their wage.

The relevant condition now will be $W_{u2} = W_{u1}/E_U$

Like before we first have to find the cut-off value for which there will be no incentives to move (assuming E_S sufficiently large) .

In particular, using $W_{u2} = W_{u1}/E_U$, we obtain:

$$E_U^* = p\frac{\alpha}{\beta}(\frac{S_1}{U_1})^{1-\alpha}(\frac{U_2 + I}{S_2})^{1-\beta} \tag{50}$$

Above this value the equilibrium will be the no-movement equilibrium.

Below this value there will be some unskilled moving to the first sector.

Note that, like in the cut-off for the skilled, the higher the immigration, the higher the cut-off value.

The next step is to assume that $E_U < E_U*$

By imposing $W_{u2} = W_{u1}/E_U$ and letting N be the number of unskilled moving from sector 2 to sector 1, we can implicitly find out this value:

$$E_U p^{-1} \frac{\beta}{\alpha} \frac{S_2^{1-\beta}}{S_1^{1-\alpha}} = \frac{(U_2 - N + I)^{1-\beta}}{(U_1 + N)^{1-\alpha}} \tag{51}$$

Thus,

Proposition 3.8: If $E_U < E_U^*$ there will be some skilled workers leaving the second sector to the first one. The higher the immigration the higher the number of movers.

Now we have to find the minimum cost that, given N unskilled movers, will make the skilled workers stay in their sector.

In particular, using $W_{s1} = W_{s2}/E_S$, we obtain:

$$E_S^{**} = p^{-1} \frac{1-\alpha}{1-\beta} (\frac{S_1}{U_1 + N})^{1-\alpha} (\frac{U_2 - N + I}{S_2})^{1-\beta} \tag{52}$$

Above this value the equilibrium will be the the unskilled movement equilibrium.

Below this value there will be some unskilled moving to the first sector.

Note that, like in the cut-off for the skilled, the higher the immigration, the higher the cut-off value.

Finally, it is also worth noting that E_S^{**} depends on N or E_U.

Let's examine now what are the effects of such movements in the wages, welfare and production.

Among the unskilled there will be three different groups, while only two for the skilled.

In particular, for the unskilled:

1. Those who stay in sector 2
2. Those who move to the first sector
3. Those who were in sector 1

The wages of these three groups will be as follows:

$$W_u^1 = p^{-\eta} \beta (\frac{U_2 - N + I}{S_2})^{\beta - 1} \tag{53}$$

$$W_u^2 = p^{-\eta} \beta (\frac{U_2 - N + I}{S_2})^{\beta - 1} E_U \tag{54}$$

$$W_u^3 = p^{1-\eta} \alpha (\frac{S_2}{U_1 + N})^{1-\alpha} \tag{55}$$

Again, note that $W_u^2 = W_u^3$

In terms of welfare the first and second groups will have the same welfare, while the other a different one

$$V_u^1 = lnW_u^1 \tag{56}$$

$$V_u^2 = lnW_u^1 \tag{57}$$

$$V_u^3 = lnW_u^3 \tag{58}$$

Thus,

Proposition 3.9: The unskilled in both sectors will loose in terms of welfare and wage.

In this case the skilled will "suffer" in the same way the unskilled did in the previous section

Their wages will be affected by the immigrants and movers:

$$W_{s1} = p^{1-\eta}(1-\alpha)(1-\alpha\frac{S_1}{U_1+N})^{-\alpha} \tag{59}$$

$$W_{s2} = p^{-\eta}(1-\beta)(\frac{S_2}{U_2-N+I})^{-\beta} \tag{60}$$

Thus,

Proposition 3.10: The skilled in both sectors will win in terms of welfare and wage.

In terms of the production we will have more unskilled in both sectors and the same skilled in each sector.

Thus,

Proposition 3.11: Both sectors will expand. Moreover, both sectors will use more unskilled labor than before, in an example of pure "within industry absorption".

A note on how the costs have to be in order to have the unskilled or the skilled movement equilibrium is important here:

The skilled movement equilibrium is characterized by:

1. $E_S < E_S^*$
2. $E_U > E_U^{**}$

And the unskilled movement equilibrium is characterized by:

1. $E_U < E_U^*$
2. $E_S > E_S^{**}$

Thus, it is possible to have (E_U, E_S) such that both conditions hold, since $E_U^{**} < E_U^*$ and $E_S^{**} < E_S^*$. In this case the equilibrium will be either skilled or unskilled.

3.2.4 The unskilled-skilled movement equilibrium

The final equilibrium we have to analyze is the unskilled-skilled movement equilibrium

We are assuming $E_S < E_S^*$ and $E_U < E_U^{**}$ or $E_U < E_U^*$ and $E_S < E_S^{**}$

We have now:

$$p^{1-\eta} = \theta_1 W_{u1}^{\alpha} W_{s1}^{1-\alpha} \tag{61}$$

$$p^{-\eta} = \theta_2 W_{u2}^{\beta} W_{s2}^{1-\beta} \tag{62}$$

And we have to add the following two:

$$W_{u2} = W_{u1}/E_U \tag{63}$$

$$W_{s1} = W_{s2}/E_S \tag{64}$$

These four equations on four unknowns allow us to find the wages:

$$W_{s1} = p^{1-\eta+\frac{\alpha}{\beta-\alpha}} \theta_1^{\frac{-\beta}{\beta-\alpha}} \theta_2^{\frac{\alpha}{\beta-\alpha}} \frac{\tilde{E}_S^{\alpha(1-\beta)}}{\tilde{E}_U^{\beta\alpha}} \tag{65}$$

$$W_{u1} = p^{1-\eta+\frac{\alpha-1}{\beta-\alpha}} \theta_1^{\frac{1-\beta}{\beta-\alpha}} \theta_2^{\frac{\alpha-1}{\beta-\alpha}} \frac{\tilde{E}_U^{\beta(1-\alpha)}}{\tilde{E}_S^{(1-\alpha)(1-\beta)}} \tag{66}$$

$$W_{s2} = p^{1-\eta+\frac{\alpha}{\beta-\alpha}} \theta_1^{\frac{-\beta}{\beta-\alpha}} \theta_2^{\frac{\alpha}{\beta-\alpha}} \frac{\tilde{E}_S^{\beta(1-\alpha)}}{\tilde{E}_U^{\beta\alpha}} \tag{67}$$

$$W_{u2} = p^{1-\eta+\frac{\alpha-1}{\beta-\alpha}} \theta_1^{\frac{1-\beta}{\beta-\alpha}} \theta_2^{\frac{\alpha-1}{\beta-\alpha}} \frac{\tilde{E}_U^{\alpha(1-\beta)}}{\tilde{E}_S^{(1-\alpha)(1-\beta)}} \tag{68}$$

Proposition 3.12: In this context immigration has ambiguous effects on wages, depending on the costs of changing from one sector to the other. In particular it increases the wages of the skilled and it decreases the wages of the unskilled.

Again, using the *Shepard's lemma* we can derive the allocations of workers depending on the output produced

$$\frac{\partial C_1}{\partial W_{u1}} = U_1 = \alpha \tilde{p}^{1-\alpha} \tilde{\theta}_1^{\beta-1} \tilde{\theta}_2^{1-\alpha} \frac{\tilde{E}_S^{(1-\alpha)(1-\beta)}}{\tilde{E}_U^{\beta(1-\alpha)}} Q_1 \tag{69}$$

$$\frac{\partial C_1}{\partial W_{s1}} = S_1 = (1-\alpha)\tilde{p}^{-\alpha}\tilde{\theta}_1^{\beta}\tilde{\theta}_2^{-\alpha}\frac{\tilde{E}_U^{\alpha\beta}}{\tilde{E}_S^{(1-\beta)\alpha}}Q_1 \tag{70}$$

$$\frac{\partial C_2}{\partial W_{u2}} = U_2 = \beta\tilde{p}^{1-\beta}\tilde{\theta}_1^{\beta-1}\tilde{\theta}_2^{1-\alpha}\frac{\tilde{E}_S^{(1-\alpha)(1-\beta)}}{\tilde{E}_U^{(1-\beta)\alpha}}Q_2 \tag{71}$$

$$\frac{\partial C_2}{\partial W_{s2}} = S_2 = (1-\beta)\tilde{p}^{-\beta}\tilde{\theta}_1^{\beta}\tilde{\theta}_2^{-\alpha}\frac{\tilde{E}_U^{\beta\alpha}}{\tilde{E}_S^{(1-\alpha)\beta}}Q_2 \tag{72}$$

Using the labor market clearing condition one can determine the actual output of each of the two sectors

If we call $s_1 = S_1/Q_1$, $u_1 = U_1/Q_1$, $s_2 = S_2/Q_2$ and $u_2 = U_2/Q_2$ we can obtain an easy expression for the output in terms of the workers per output:

$$Q_1 = \frac{u_2}{u_2 s_1 - u_1 s_2}S - \frac{s_2}{u_2 s_1 - u_1 s_2}(U+I) \tag{73}$$

$$Q_2 = \frac{s_1}{u_2 s_1 - u_1 s_2}(U+I) - \frac{u_1}{u_2 s_1 - u_1 s_2}S \tag{74}$$

First of all we should note that $u_2 s_1 - u_1 s_2$ can be either positive or negative.

It actually depends on whether $\beta(1-\alpha)\frac{\tilde{E}_U^{\alpha(2\beta-1)}}{\tilde{E}_S^{(1-\beta)(2\alpha-1)}} - \alpha(1-\beta)\frac{\tilde{E}_U^{\beta(2\alpha-1)}}{\tilde{E}_S^{(1-\alpha)(2\beta-1)}}$ is positive or negative

Note that if there are no costs this condition pins down to $\beta > \alpha$

The second thing one should consider is that both $(\partial s_1/\partial E_S, \partial u_1/\partial E_S)$ and $(\partial s_1/\partial E_U, \partial u_1/\partial E_U)$ have the same sign

And similarly for the other sector.

This allows to conclude that

Proposition 3.12: Depending on how are the costs of changing from one sector to the other and the immigration levels, the equilibrium will be more like the skilled-movement equilibrium or the unskilled-movement equilibrium, always mitigated by the fact that both skilled and unskilled change sectors. Thus there will be one sector expanding and the other contracting or the two expanding. In terms of the within industry absorption it will always happen.

Summarizing,

Proposition 3.13: Immigration has ambiguous effects on the allocation of workers to each of the sectors. There are two forces:

1. It gives incentives to the unskilled migrants affected by immigration to move to the other sector to mitigate the decrease of their wages and it attracts skilled natives to the sector that is hit by immigration, or more generally, Rybczynski effects that specialize the economy toward the more abundant factor

2. The costs of moving from one sector to the other is a force contrary to the previous one, that curbs and even gains the Rybczynski effects. The idea is that if it is too costly for the skilled natives to go to the U-sector they will stay, and possibly some migrants will go to that sector, expanding the S-sector instead of the U-sector.

In any case, immigration increase the ratio of unskilled to skilled in each of the sectors, except for the case with zero costs of changing from one sector to the other.

More specifically, given (E_S, E_U) we will have:

Equilibrium 1 If $E_S > E_S^*$ and $E_U > E_U^*$

Equilibrium 2 If $E_S < E_S^*$ and $E_U > E_U^{**}$

Equilibrium 3 If $E_U < E_U^*$ and $E_S > E_S^{**}$

Equilibrium 4 If $E_S < E_S^*$ and $E_U < E_U^{**}$ or $E_U < E_U^*$ and $E_S < E_S^{**}$

It is worth noting that Equilibrium 2 and 3 can happen with the same costs of changing from one sector to the other.