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Abstract

Many countries pursue an immigration policy that is targeted at attracting high skilled workers. Borjas (1995) has shown that assuming perfect labor markets immigration leads to a welfare gain for the native population, the so-called immigration surplus. Thus, as the labor market for high skilled workers exhibits few frictions, high skilled immigration should lead to a welfare gain. Nevertheless, this argumentation implicitly assumes that immigration has no influence on the qualification structure of natives. In this paper I show that if natives anticipate high skilled immigration, fewer natives acquire a high education level. In labor markets that are not frictionless this effect can be such strong that high skilled immigration leads to a welfare loss for natives. Moreover, if high skilled migration is expected but not realized, this expectation generates a welfare loss.

JEL Codes: H62, J24, J61.
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1 Introduction

Public opinion commonly regards high skilled immigration as beneficial for the domestic economy. Many developed countries, especially Anglo-Saxon ones, pursue an immigration policy that is targeted at attracting high skilled immigrants. For instance, in 2002 the UK has launched the Highly Skilled Migrant Programme (HSMP) that grants free entry for high skilled immigrants, independent of an employment contract.[1] Most economists also regard immigration, and especially high skilled immigration, as welfare enhancing. Building on the seminal results of Berry and Soligo (1969), Borjas (1995) has shown that under not too restrictive assumptions immigration into a perfect labor market leads to a welfare gain for the native population as a whole. Thus, as the market for high skilled labor in does not exhibit large frictions, high skilled immigration should have a positive effect on native welfare.[2] Empirical evidence on the effects of immigration is however mixed.[3]

These results rely on the assumption that immigration has no influence on the qualification structure of natives. If immigration occurs in a single, unexpected wave, this assumption is feasible, as the qualification structure of natives is very rigid. Generally, people decide about their qualification level when they are young and hardly change it later on. Hence, a spontaneous inflow of migrants has only an effect on the qualification level of the youngest cohort, if at all. In the real world immigration occurs in most cases as a steady inflow of people and not as a spontaneous shock. Under such conditions choosing their education level natives can build expectations about future immigration. Nevertheless, these expectations need not coincide with the immigration that ultimately occurs, but may well be above or below it.

Up to now the effects of immigration, or expectations on immigration respectively,

[1]Zaletel (2006) gives an overview over the HSMP and various other immigration programs for high skilled.

[2]Kemnitz (2009) shows that with certain labor market distortions high skilled immigration can also lead to a welfare loss. However, the real world is probably better represented in Borjas (1995) than in Kemnitz (2009). Moreover, changes in international trade due immigration can also reduce the immigration surplus (see Felbermayr and Kohler (2007)).

[3]As discussed in Longhi et al. (2005) estimated wage effects of immigration vary substantially over different studies.

on the qualification structure in the destination country has not gained much interest by economic research.[4] This is surprising, as there is a large literature that analyzes the effect of migration on the qualification structure in the source country.[5] It has been shown that high skilled emigration, the so-called "brain drain", need not be detrimental. The option to emigrate gives natives an additional incentive to acquire a higher qualification level. The positive welfare effect of the increase in the average education level can overcompensate the negative effect of emigration. The effects in countries that send and receive migrants are not mirror-inverted; nevertheless, the reasoning of this literature suggests that migration has also an effect on the education structure in the receiving country.

In this paper I analyze the effects of immigration on native welfare, considering that natives build expectations about future immigration, when they decide about their education. In a first step I assume that natives can perfectly foresee future immigration. Rational expectations are a necessary condition for this. Nevertheless, if there is a steady inflow of immigrants with a similar education structure, the expectations of natives are probably not too far away from reality. In the second step I analyze what happens if the expected immigration lies above the ultimately realized, or if immigration is expected but does not occur respectively. In both cases the expectation of high skilled immigration lowers the share of high skilled natives by the following reasoning: On the one hand, the higher supply of high skilled workers decreases their wages. On the other hand, it increases the wages of low skilled workers, or at least does not decrease them to the same extent. This in turn means that the expected income of low skilled workers increases relative to the income of high skilled workers. Thus, it becomes less attractive for natives to acquire a high qualification level.

I find that immigration into a perfect labor market still has a positive welfare effect, although it is (correctly) anticipated by natives deciding about their education level;

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[4] Fuest and Thum (2001) analyze the welfare effects of an adjustment of the native education structure to low skilled immigration in a unionized labor market. As long as the degree of unionization does not change, they find no welfare effect of the adjustment of native education. Lumpe and Weigert (2009) analyze high skilled immigration in a search-theoretic framework and find that it increases the average education level of natives. Ramcharan (2002) shows empirically that unskilled immigration from Europe had an effect on the education structure in the United States in the early 20th century.

[5] see for instance Docquier and Rapoport (2007), Mountford (1997), Stark and Wang (2002) and Vidal (1998)

however, the effect is in general smaller than in the case without adjustment. If natives expect high skilled immigration deciding about their education level but the immigration does not occur, this expectation has a negative welfare effect. In a labor market that is not frictionless the effects of an adjustment of the native education structure can still be stronger. With a fixed minimum wage the welfare effect of a correctly anticipated high skilled immigration is positive without and can become negative with an adjustment of the native education structure. To get a more comprehensive picture of these effects I specify a CES-type production function and calibrate my model. For the calibration three different assumptions on migration are used: The first is that immigration is expected and occurs, the second that immigration occurs but is not expected and the third that immigration is expected but does not occur. I find that in the case of perfect labor markets the immigration surplus is only moderately affected by the adjustment of the education structure of natives. However, with a minimum wage educational adjustment leads to a large welfare loss.

The paper is organized in the following way: In the second chapter I present the baseline assumptions of the model and derive the results in the case of perfect labor markets. In chapter 3 I analyze the model under the assumption of fixed minimum wage. The fourth chapter gives an overview over my calibrations and their results. Chapter 5 deals with the policy implications and chapter 6 concludes.

2 Immigration effects with perfect labor markets

My analysis is based on a simple overlapping generations model. The population consists of two cohorts, young and working age people;[6] at each point in time only one cohort is in the labor market. People decide about their education when they are young; at this stage they have already rational expectations about the educational decision of other natives. I define the share of natives in a cohort who acquire a high skill level as c_t and the size of the cohort as N_t; thus, the number of high skilled natives in a cohort is c_tN_t. To acquire a high education level teaching is necessary, whereas a low education level is

[6] Adding a cohort of old people would have no influence on the results.

reached without teaching.[7] The time spent in the labor market is not affected by the education level and the same for all people.[8] The overall teaching necessary to qualify the high skilled people of one cohort is $E(c_t N_t)$. Teachers are high skilled people from the previous cohort. During his working age the teaching effort of one teacher is E'. Thus, the number of teachers H_{Et} in a cohort is:

$$H_{Et} = \frac{E(c_{t+1}N_{t+1})}{E'} \tag{1}$$

High skilled people can freely change between different jobs, thus all high skilled people of cohort t earn the same wage w_{Ht}. Overall education expenditures of cohort t are thus given by:

$$w_{Ht}H_{Et} = w_{Ht}\frac{E(c_{t+1}N_{t+1})}{E'} \tag{2}$$

Education costs have to be beard by the educated people. When they are young, people do not have any income; thus, a high education level can be financed by credit at market interest rate r (capital markets are assumed to be perfect). This credit is repaid in the second period.

Innate ability of people follows some distribution, that does not depend on the cohort size and is not further specified;[9] the higher the innate ability of a person the less teaching she necessitates to become high skilled. Hence, if it pays off for a person with a certain level of innate ability to become high skilled, it also pays off for all people with higher education levels. As there is one single high skilled wage and one single low skilled wage, the amount of the education costs is the only factor that differs over persons. Analogously, if it pays off for an individual with a certain level of innate ability to remain low skilled, it also pays of for all persons with lower levels of innate abilities. Thus, the higher the

[7]In developed countries a low education level is neither reached without teaching. Nevertheless, assuming a uniform teaching requirement for all people to acquire a low education level does not change the results.

[8]Most other papers assume that the teaching intensity for high and low skilled people does not differ, but that high skilled people enter the labor market later than low skilled people. Dropping the assumption that all people of one cohort enter the labor market at the same time would enormously complicate my model. Especially as the necessary teaching for a high education differs over individuals, the two-cohort structure would not be feasible anymore; obviously, even teacher and student could then belong to the same cohort. Not being able to use different education times is a disadvantage of my model; however, in exchange it allows me to consider the education market explicitly.

[9]This modeling follows Razin and Sadka (1995).

share of people that become high skilled, the higher are the education costs for the person with the lowest innate ability that still becomes high skilled. The education costs EC of the last, critical person c that becomes high skilled are:

$$EC_{ct} = w_{Ht} \frac{1}{E'} \frac{\partial E\left(c_{t+1} N_{t+1}\right)}{\partial\left(c_{t+1} N_{t+1}\right)} = w_{Ht} \frac{e\left(c_{t+1} N_{t+1}\right)}{E'} \tag{3}$$

The following picture illustrates this: All natives of a certain cohort stand in a line sorted after their innate abilities. Now a certain level of teaching costs (w_{Ht}/E') is given. Beginning with the person with the highest ability people decide following the row if they become high skilled or not; all people up to the last person for whom it pays off to become high skilled will choose a high education level, whereas all people behind this person choose a low education level. The costs to qualify one additional individual equal the education costs of the last person that is qualified (or the first person that is not qualified respectively). Additionally, from these considerations it is clear that $\partial e\left(c_{t+1} N_{t+1}\right) / \partial c_{t+1} \geq 0$ has to hold; by the assumption that cohort size has no effect on the distribution of innate ability $\partial e\left(c_{t+1} N_{t+1}\right) / \partial N_{t+1} = 0$.

Production of all goods except of education follows production function F. It refers to the total production of one cohort and fulfills the Inada conditions. It depends on the input of high skilled labor, H_{ft}, and of low skilled labor, L_t; the input of high skilled labor equals the total amount of high skilled labor less the number of teachers: $H_{ft} = H_t - H_{Et}$. I assume that low and high skilled people are not perfect substitutes and that labor supply is perfectly inelastic. The supply of other potential production factors is fixed. The composition of produced goods and of the demand for all goods except of education are fix; thus the price level can be used as numeraire.

Person i chooses to become high skilled, if the expected difference between high and low skilled wage covers her education costs:

$$\left(w_{Ht+1}^{exp}\right) - (1+r)\, EC_i \geq \left(w_{Lt+1}^{exp}\right) \tag{4}$$

If the difference does not cover her education costs the person stays low skilled. As discussed above the education costs of the last person for whom it is optimal to become high skilled are given in (3). Thus

$$\left(w_{Ht+1}^{exp}\right) - (1+r)\, w_{Ht} \frac{e\left(c_{t+1} N_{t+1}\right)}{E'} \geq \left(w_{Lt+1}^{exp}\right) \tag{5}$$

has to hold. If the cohort size is large and the dispersion of innate abilities is not to large, the left and the right hand side of (5) are approximately equal. Moreover, wages are equal to the marginal product in production of the respective type of labor.[10] Assuming that deciding about their education people have rational expectations and perfect information (5) can be rewritten as:

$$\frac{\partial F_{t+1}}{\partial H_{ft+1}} - (1+r)\frac{\partial F_t}{\partial H_{ft}}\frac{e\left(c_{t+1}N_{t+1}\right)}{E'} = \frac{\partial F_{t+1}}{\partial L_{t+1}} \tag{6}$$

This equality determines the share of individuals c_{t+1} that acquire a high education level. If the share of high skilled individuals c_{t+1} was smaller than the equilibrium level, the right hand side of the equation would be larger than the left hand side.[11] However, this would mean that the low skilled person with the highest ability could improve her expected income acquiring a high skill level. Until the equilibrium level of c_{t+1} is reached, there would be low skilled people that should optimally choose a high skill level.

Assume that people have perfect information and rationale expectations about all other economic factors but cannot perfectly foresee future high skilled immigration.[12] They have to build expectations on immigration and all else equal (6) becomes:

$$\frac{\partial F_{t+1}\left(EM_{Ht+1}\right)}{\partial H_{ft+1}} - (1+r)\frac{\partial F_t}{\partial H_{ft}}\frac{e\left(c_{t+1}N_{t+1}\right)}{E'} = \frac{\partial F_{t+1}\left(EM_{Ht+1}\right)}{\partial L_{t+1}} \tag{7}$$

with $F_{t+1}\left(EM_{Ht+1}\right)$, the expected total production given the expected high skilled immigration EM_{Ht+1}. The expected low skilled wage increases and the expected high skilled wage decreases in the expected number of high skilled people (Inada-Conditions) and thus also in EM_{Ht+1}. Thus, if the expected high skilled immigration is higher than the realized one, the share of high skilled natives is actually to low. Inserting this "equilibrium" share of high skilled c_{t+1} in (5) the left hand side is larger than the right hand side. Nevertheless, as immigration is not realized until period $t+1$ and education takes place in t, people cannot correct their wrong education choice. The effect of expected immigration on the share of high skilled natives is summarized in the first proposition:

Proposition 1 *The expectation of high skilled immigration leads to a decrease in the share of high skilled natives, if* $\frac{\partial^2 F_t}{\partial H_{ft}^2} < \frac{\partial^2 F_t}{\partial H_{ft}\partial L_t}$ and $\frac{\partial^2 F_t}{\partial L_t^2} + \frac{\partial^2 F_t}{\partial H_{ft}^2} < 2\frac{\partial^2 F_t}{\partial H_{ft}\partial L_t}$ *holds. The expectation of low skilled immigration increases the share of high skilled natives, if* $\frac{\partial^2 F_t}{\partial L_t^2} <$

[10] The wage of teachers equals the high skilled wage in production, see above.

[11] This can easily be verified differentiating the equation with respect to c_{t+1}. As derived in the prove to proposition 1 the derivative is generally negative.

[12] The case of low skilled immigration is analogous.

$\frac{\partial^2 F_t}{\partial H_{ft}\partial L_t}$ and $\frac{\partial^2 F_t}{\partial L_t^2} + \frac{\partial^2 F_t}{\partial H_{ft}^2} < 2\frac{\partial^2 F_t}{\partial H_{ft}\partial L_t}$ *holds.*

Proof Assuming in a first step that natives perfectly foresee future immigration, the effect of high skilled immigration on the share of high skilled natives can be found by implicit differentiation of

$$\frac{dc_{t+1}}{dM_{Ht+1}} = -\frac{\frac{\partial \Lambda}{\partial M_{Ht+1}}}{\frac{\partial \Lambda}{\partial c_{t+1}}} \tag{8}$$

$$\Lambda = \frac{\partial F_{t+1}}{\partial H_{ft+1}} - (1+r)\frac{\partial F_t}{\partial H_{ft}}\frac{e\left(c_{t+1}N_{t+1}\right)}{E'} - \frac{\partial F_{t+1}}{\partial L_{t+1}} \tag{9}$$

The denominator is given by:

$$\begin{aligned}\frac{\partial \Lambda}{\partial M_{Ht+1}} &= \frac{\partial^2 F_{t+1}}{\partial H_{ft+1}^2}\frac{\partial H_{ft+1}}{\partial H_{t+1}}\frac{\partial H_{t+1}}{\partial M_{Ht+1}} - \frac{\partial^2 F_{t+1}}{\partial L_{t+1}\partial H_{ft+1}}\frac{\partial H_{ft+1}}{\partial H_{t+1}}\frac{\partial H_{t+1}}{\partial M_{Ht+1}} \\ &= \frac{\partial^2 F_{t+1}}{\partial H_{ft+1}^2} - \frac{\partial F_{t+1}}{\partial L_{t+1}\partial H_{ft+1}}\end{aligned} \tag{10}$$

The simplification follows as $H_t = c_tN_t + M_{Ht}$, $L_t = (1-c_t)N_t + M_{Lt}$ and $H_{ft} = H_t - H_{Et}$. For $\frac{\partial^2 F_t}{\partial H_{ft}^2} < \frac{\partial^2 F_t}{\partial H_{ft}\partial L_t}$, the denominator is smaller than zero. The nominator can be rewritten as:

$$\begin{aligned}\frac{\partial \Lambda}{\partial c_{t+1}} =& \frac{\partial^2 F_{t+1}}{\partial H_{ft+1}^2}\frac{\partial H_{ft+1}}{\partial H_{t+1}}\frac{\partial H_{t+1}}{\partial c_{t+1}} + \frac{\partial^2 F_{t+1}}{\partial H_{ft+1}\partial L_{t+1}}\frac{\partial L_{t+1}}{\partial c_{t+1}} - \frac{\partial^2 F_{t+1}}{\partial L_{t+1}\partial H_{ft+1}}\frac{\partial H_{ft+1}}{\partial H_{t+1}}\frac{\partial H_{t+1}}{\partial M_{Ht+1}} \\ & -\frac{\partial^2 F_{t+1}}{\partial L_{t+1}^2}\frac{\partial L_{t+1}}{\partial c_{t+1}} - (1+r)\frac{\partial F_t}{\partial H_{ft}}\frac{1}{E'}\frac{\partial e\left(c_{t+1}N_{t+1}\right)}{\partial c_{t+1}}N_{t+1} \\ & -(1+r)\frac{\partial^2 F_t}{\partial H_{ft}^2}\frac{e\left(c_{t+1}N_{t+1}\right)}{E'}\frac{\partial H_{ft}}{\partial H_{Et}}\frac{\partial H_{Et}}{\partial c_{t+1}} \\ =& \frac{\partial^2 F_{t+1}}{\partial H_{ft+1}^2}N_{t+1} - 2\frac{\partial^2 F_{t+1}}{\partial H_{ft+1}\partial L_{t+1}}N_{t+1} + \frac{\partial^2 F_{t+1}}{\partial L_{t+1}^2}N_{t+1} \\ & -(1+r)\frac{\partial F_t}{\partial H_{ft}}\frac{1}{E'}\frac{\partial e\left(c_{t+1}N_{t+1}\right)}{\partial c_{t+1}}N_{t+1} \\ & +(1+r)\frac{\partial^2 F_t}{\partial H_{ft}^2}\left(\frac{e\left(c_{t+1}N_{t+1}\right)}{E'}\right)^2 N_{t+1}\end{aligned} \tag{11}$$

with $\frac{\partial H_{Et}}{\partial c_{t+1}} = \frac{e(c_{t+1}N_{t+1})}{E'}N_{t+1}$, see (1). $\frac{\partial \Lambda}{\partial c_{t+1}} < 0$ holds, if

$$\begin{aligned}2\frac{\partial^2 F_{t+1}}{\partial H_{ft+1}\partial L_{t+1}} >& \frac{\partial^2 F_{t+1}}{\partial H_{ft+1}^2}N_{t+1} + \frac{\partial^2 F_{t+1}}{\partial L_{t+1}^2} - (1+r)\frac{\partial F_t}{\partial H_{ft}}\frac{1}{E'}\frac{\partial e\left(c_{t+1}N_{t+1}\right)}{\partial c_{t+1}} \\ & +(1+r)\frac{\partial^2 F_t}{\partial H_{ft}^2}\left(\frac{e\left(c_{t+1}N_{t+1}\right)}{E'}\right)^2\end{aligned} \tag{12}$$

or as the last two terms in (12) are negative, *a fortiori* if $\frac{\partial^2 F_t}{\partial L_t^2} + \frac{\partial^2 F_t}{\partial H_{ft}^2} < 2\frac{\partial^2 F_t}{\partial H_{ft}\partial L_t}$.

The effect of low skilled immigration is analogously:

$$\frac{dc_{t+1}}{dM_{Lt+1}} = -\frac{\frac{\partial \Lambda}{\partial M_{Lt+1}}}{\frac{\partial \Lambda}{\partial c_{t+1}}} \tag{13}$$

with

$$\frac{\partial \Lambda}{\partial M_{Lt+1}} = \frac{\partial^2 F_{t+1}}{\partial L_{t+1}^2}\frac{\partial L_{t+1}}{\partial M_{Lt+1}} - \frac{\partial^2 F_{t+1}}{\partial L_{t+1}\partial H_{ft+1}}\frac{\partial L_{t+1}}{\partial M_{Lt+1}} = \frac{\partial^2 F_{t+1}}{\partial L_{t+1}^2} - \frac{\partial^2 F_{t+1}}{\partial L_{t+1}\partial H_{ft+1}} \tag{14}$$

For $\frac{\partial^2 F_t}{\partial L_t^2} < \frac{\partial^2 F_t}{\partial H_{ft}\partial L_t}$, (14) and therefore also (13) are smaller than zero.

If *ceteris paribus* natives cannot foresee future immigration, the effect of expected immigration on the share of high skilled natives equals the effect of actual immigration under perfect foresight. The explanation is quite simple: All terms above that refer to $t+1$ are actually expectations in period t. These expectations are still perfectly rationale, except of the fact that they are based on a wrong immigration; this means that now (7) instead of (6) should be analyzed. As the production function does not change, the effect of expected immigration on the share of high skilled natives in (7) obviously equals the the effect of actual immigration in (6). The ultimately realized immigration does not affect the education structure of natives, as it does not occur until $t+1$ and thus after natives have their choice about education in t. *

If high and low skilled labor are perfect substitutes and low skilled labor has a lower factor productivity than high skilled labor, $\partial^2 F_t/\partial H_{ft}\partial L_t \geq \partial^2 F_t/\partial L_t^2$ does not hold anymore. As shown in the appendix in this case the expectations of high skilled as well as low skilled immigration lead to a decrease in the share of high skilled natives. The economic rationale behind this is simple. As well high as low skilled immigration lead to a downward pressure on the wage per productivity unit of labor. Nevertheless, the relation between the productivities of high and low skilled labor does not change. Thus, the absolute difference between high and low skilled wages decreases and the difference covers the education costs for less natives.

Leaving the adjustment of the native education structure apart, the effect of immigration on native welfare is defined as the increase in total domestic production $Y_t = F(H_{ft}, L_t, \ldots)$ due to immigration, less the wage sum paid to immigrants. This is the so-called immigration surplus IS_t. For high skilled immigration it can be written as:

$$IS_t = F(H_{ft}^1, \ldots) - F(H_{ft}^0, \ldots) - \frac{\partial F(H_{ft}^1, \ldots)}{\partial H_{ft}^1} M_{Ht} \tag{15}$$

with $H_{ft}^1 = c_t N_t - H_{Et}$[13] and$H_{ft}^1 = H_{ft}^0 + M_{Ht} - H_{Et}$. As by the Inada conditions F is strictly monotonic increasing in H, (5) can be rewritten as:

$$IS = \frac{\partial F(H_{ft}^y, \ldots)}{\partial H_{ft}^y} M_{Ht} - \frac{\partial F(H_{ft}^1, \ldots)}{\partial H_{ft}^1} M_{Ht} \tag{16}$$

with $H_{ft}^y = H_{ft}^0 + y(H_{ft}^1 - H_{ft}^0)$, $0 \leq y \leq 1$. As $\partial^2 F_t / \partial H_{ft}^2 < 0$, IS is positive; in the marginal case it is zero. For low skilled immigration the argumentation is analogous. The effect of additional low skilled immigration on the immigration surplus due to high skilled immigration is ambiguous; if high and low skilled labor are close substitutes, $\partial^2 F_t / \partial H_{ft} \partial L_t < 0$, it is positive (see appendix).

Proposition 2 *The marginal effects of correctly anticipated high and low skilled immigration on native welfare are zero. The effects of expected high or low skilled immigrations that are not realized are negative.*

Proof First consider the effect of correctly anticipated high skilled immigration. In $t+1$ the welfare effect dW_{t+1}^* consists of the increase in production due to high skilled immigration less the wages paid to the immigrants:

$$\begin{aligned} dW_{t+1}^* &= \frac{\partial F_{t+1}}{\partial M_{Ht+1}} dM_{Ht+1} - \frac{\partial F_{t+1}}{\partial H_{ft+1}} dM_{Ht+1} \\ &= \frac{\partial F_{t+1}}{\partial H_{ft+1}} \frac{\partial H_{ft+1}}{\partial H_{t+1}} \frac{\partial H_{t+1}}{\partial M_{Ht+1}} dM_{Ht+1} + \frac{\partial F_{t+1}}{\partial H_{ft+1}} \frac{\partial H_{ft+1}}{\partial H_{t+1}} \frac{\partial H_{t+1}}{\partial c_{t+1}} \frac{\partial c_{t+1}}{\partial M_{Ht+1}} dM_{Ht+1} \\ &\quad + \frac{\partial F_{t+1}}{\partial L_{t+1}} \frac{\partial L_{t+1}}{\partial c_{t+1}} \frac{\partial c_{t+1}}{\partial M_{Hr+1}} dM_{Hr+1} - \frac{\partial F_{t+1}}{\partial H_{ft+1}} dM_{Ht+1} \\ &= \frac{\partial F_{t+1}}{\partial H_{ft+1}} N_{t+1} \frac{\partial c_{t+1}}{\partial M_{Ht+1}} dM_{Ht+1} - \frac{\partial F_{t+1}}{\partial L_{t+1}} N_{t+1} \frac{\partial c_{t+1}}{\partial M_{Hr+1}} dM_{Ht+1} \end{aligned} \tag{17}$$

Additionally, high skilled immigration in $t+1$ has a positive effect on native welfare in t. As it reduces the number of high skilled natives in $t+1$, less teachers are necessary; thus the number of high skilled production workers H_{ft} increases. The welfare effect in t is given by:

$$\begin{aligned} dW_t^* &= \frac{\partial F_t}{\partial M_{Ht+1}} dM_{Ht+1} = \frac{\partial F_t}{\partial H_{ft}} \frac{\partial H_{ft}}{\partial H_{Et}} \frac{\partial H_{Et}}{\partial c_{t+1}} \frac{\partial c_{t+1}}{\partial M_{Ht+1}} dM_{Ht+1} \\ &= -\frac{\partial F_t}{\partial H_{ft}} \frac{e\,(c_{t+1} N_{t+1})}{E'} N_{t+1} \frac{\partial c_{t+1}}{\partial M_{Ht+1}} dM_{Ht+1} \end{aligned} \tag{18}$$

[13] The demand for teachers does not change, as immigration does not affect the education structure of the succeeding cohort.

The overall welfare effect, discounted to period t, is thus:

$$dW_t = \left(\frac{1}{1+r}\frac{\partial F_{t+1}}{\partial H_{ft+1}} - \frac{\partial F_t}{\partial H_{ft}}\frac{e\left(c_{t+1}N_{t+1}\right)}{E'} - \frac{1}{1+r}\frac{\partial F_{t+1}}{\partial L_{t+1}}\right) N_{t+1}\frac{\partial c_{t+1}}{\partial M_{Ht+1}} dM_{Ht+1} \quad (19)$$

From equation (6), the term in brackets equals zero. Analogously, it can be shown that the welfare effect of correctly anticipated low skilled immigration is also zero.

An expected immigration that does not occur dEM_{Ht+1} has also welfare effects in t and $t+1$. The welfare effect in t is again:

$$dW_t^* = -\frac{\partial F_t}{\partial H_{ft}}\frac{e\left(c_{t+1}N_{t+1}\right)}{E'} N_{t+1}\frac{\partial c_{t+1}}{\partial EM_{Ht+1}} dEM_{Ht+1} \quad (20)$$

In $t+1$ no immigration occurs; nevertheless, the change in the skill structure of the native population has an effect on native welfare:

$$\begin{aligned} dW_{t+1}^* &= \frac{\partial F_{t+1}^*}{\partial H_{ft+1}}\frac{\partial H_{ft+1}}{\partial H_{t+1}}\frac{\partial H_{t+1}}{\partial c_{t+1}}\frac{\partial c_{t+1}}{\partial EM_{Ht+1}} dEM_{Ht+1} \\ &\quad + \frac{\partial F_{t+1}^*}{\partial L_{t+1}}\frac{\partial L_{t+1}}{\partial c_{t+1}}\frac{\partial c_{t+1}}{\partial EM_{Ht+1}} dEM_{Ht+1} \\ &= \frac{\partial F_{t+1}^*}{\partial H_{ft+1}} N_{t+1}\frac{\partial c_{t+1}}{\partial EM_{Ht+1}} dEM_{Ht+1} - \frac{\partial F_{t+1}^*}{\partial L_{t+1}} N_{t+1}\frac{\partial c_{t+1}}{\partial EM_{Ht+1}} dEM_{Ht+1} \quad (21) \end{aligned}$$

One has to regard that expected immigration has no direct effect on production; F_{r+1}^* refers $F_{r+1}(c_{t+1}N_{t+1})$ and not $F_{r+1}(c_{t+1}N_{t+1} + M_{Hr+1})$. The overall welfare effect is

$$dW_t = \left(\frac{1}{1+r}\frac{\partial F_{r+1}^*}{\partial H_{ft+1}} - \frac{\partial F_r}{\partial H_{ft}}\frac{e\left(c_{t+1}N_{t+1}\right)}{E'} - \frac{1}{1+r}\frac{\partial F_{r+1}^*}{\partial L_{t+1}}\right) N_{t+1}\frac{\partial c_{t+1}}{\partial EM_{Hr+1}} dEM_{Hr+1} \quad (22)$$

As $\frac{\partial c_{t+1}}{\partial EM_{Ht+1}} < 0$, the resulting c_{t+1} is smaller than the actual equilibrium value. As the term in the bracket decreases in c_{t+1}, $\frac{\partial \Lambda}{\partial c_{t+1}} < 0$, for a c_{t+1}that is actually too small the bracket becomes positive. Thus the overall effect is negative. For low skilled immigration analogously

$$dW_t^* = \left(\frac{1}{1+r}\frac{\partial F_{t+1}^*}{\partial H_{ft+1}} - \frac{\partial F_r}{\partial H_{ft}}\frac{e\left(c_{t+1}N_{t+1}\right)}{E'} - \frac{1}{1+r}\frac{\partial F_{r+1}^*}{\partial L_{t+1}}\right) N_{t+1}\frac{\partial c_{t+1}}{\partial EM_{Lt+1}} dEM_{Lt+1} \quad (23)$$

results. As $\frac{\partial c_{t+1}}{\partial EM_{Lt+1}} > 0$, the actual c_{t+1}now is larger than the equilibrium value. For a c_{t+1} that is to large the bracket and thus the overall effect is negative. This result holds also for the non-marginal case, as the negative adjustment effect has not to be seen alongside a positive immigration surplus.*

In the non marginal case the increase in production is not equal to the wage sum paid to immigrants. In the appendix the immigration surplus for high skilled immigration is derived. Unfortunately, in the general setup it cannot be shown in an unambiguous way that the effect of the adjustment of native education lowers the immigration surplus. However, as shown in the calibration, under realistic further assumptions the adjustment of native education really lowers the immigration surplus.

3 Immigration effects with a fixed minimum wage

In the previous chapter I have dealt the effects of migration into perfect labor markets. However, in the real world, especially in Europe, labor markets are not frictionless. In this chapter I analyze the effects of immigration with a fixed minimum wage. The aim of this chapter is not to model the welfare effects of immigration into a specific country, but to show that the effect of education adjustment can be substantially stronger with labor market frictions. With frictions on the labor market labor market an adjustment of the native education structure can make an *ex-ante* positive welfare effect of high skilled immigration negative.

I assume that there is one fixed minimum wage, w_t^* in period t. The marginal productivity of low skilled labor is lower than this minimum wage, $\partial F_t/\partial L_t < w_t^*$, whereas the marginal productivity of high skilled labor is higher than it, $\partial F_t/\partial H_t > w_t^*$. This means that only for low skilled workers the minimum wage is binding. The marginal productivity of employed low skilled labor L_{ft} has still to correspond to its wage, $\partial F/\partial L_{ft} = w_t^*$. Thus, the minimum wage leads to low skilled unemployment of the size $U_t = L_t - L_{ft}$. In this framework low skilled labor supply has no direct effect on employed low skilled labor. By the Inada conditions an increase in employed low skilled labor due to an increase in labor supply would decrease its wage, but this is ruled out by the minimum wage. However, an increase in high skilled labor can potentially increase employed low skilled labor.

In addition, I assume that the amount of unemployment benefits is equal to the minimum wage. Such a constellation is also achieved if the state does not set a minimum wage but only a benefit level (profit-maximizing people are willing to work for wages below the benefit level). The results also hold, if only natives receive unemployment benefits and low skilled immigration is not too large. In this case low skilled immigrants are willing to work for wages below the minimum wage. However, as long as the low skilled immigrant labor force does not cover the demand for low skilled labor at the minimum wage level, the resulting wage for low skilled immigrants is only marginally below the minimum wage.

All low skilled immigrants find work and all unemployed people are low skilled natives.

Assuming a balanced state budget the state has to collect taxes to finance its expenditures for unemployment benefits. Income taxes generally have a distorting effect on the wage structure. Thus, as I am not interested in the effects of the tax system, I use a lump sum tax, τ, that is paid by all people, including immigrants and unemployed persons. The budget constraint is then:

$$\tau_t \left(N_t + M_{Ht} + M_{Lt}\right) = w_t^* \left(L_t - L_{ft}\right) \Longleftrightarrow \tau_t = \frac{w_t^* \left(L_t - L_{ft}\right)}{N_t + M_{Ht} + M_{Lt}} \tag{24}$$

The income of low skilled persons equals in any case the minimum wage; hence, equilibrium condition (6) now becomes:

$$\Lambda' = \frac{\partial F_{t+1}}{\partial H_{ft+1}} - (1+r) \frac{\partial F_t}{\partial H_{ft}} \frac{e\left(c_{t+1} N_{t+1}\right)}{E'} - w_{t+1}^* = 0 \tag{25}$$

τ does not enter equation (25), as it has to be subtracted on both sides and cancels out. The effect of immigration on the education structure of natives is different to the perfect labor market case, as low skilled wages do not adjust to changes in labor supply.

Proposition 3 *If the minimum wage is binding for low skilled workers, the expectation of high skilled immigration reduces the share of high skilled natives, as long as* $\frac{\partial^2 F_{t+1}}{\partial H_{ft+1}^2} < \frac{\partial^2 F_{t+1}}{\partial L_{ft+1} \partial H_{ft+1}} \frac{\partial L_{ft+1}}{\partial H_{ft+1}}$ *holds. The expectation of low skilled immigration does not affect the qualification structure of natives. Under the same condition, an (expected) increase in the minimum wage also reduces the share of high skilled natives.*

Proof Implicit differentiation of (25) gives the effect of high skilled immigration:

$$\frac{dc_{t+1}}{dM_{Ht+1}} = -\frac{\frac{\partial \Lambda'}{\partial M_{Ht+1}}}{\frac{\partial \Lambda'}{\partial c_{t+1}}} \tag{26}$$

The denominator

$$\begin{aligned} \frac{\partial \Lambda'}{\partial M_{Ht+1}} &= \frac{\partial^2 F_{t+1}}{\partial H_{ft+1}^2} \frac{\partial H_{ft+1}}{\partial H_{t+1}} \frac{\partial H_{t+1}}{\partial M_{Ht+1}} + \frac{\partial^2 F_{t+1}}{\partial L_{ft+1} \partial H_{ft+1}} \frac{\partial L_{ft+1}}{\partial H_{ft+1}} \frac{\partial H_{ft+1}}{\partial H_{t+1}} \frac{\partial H_{t+1}}{\partial M_{Ht+1}} \\ &= \frac{\partial^2 F_{t+1}}{\partial H_{ft+1}^2} + \frac{\partial^2 F_{t+1}}{\partial L_{ft+1} \partial H_{ft+1}} \frac{\partial L_{ft+1}}{\partial H_{ft+1}} \end{aligned} \tag{27}$$

is smaller than zero, if $\frac{\partial^2 F_{t+1}}{\partial H_{ft+1}^2} < \frac{\partial^2 F_{t+1}}{\partial L_{ft+1} \partial H_{ft+1}} \frac{\partial L_{ft+1}}{\partial H_{ft+1}}$ holds. The nominator

$$\begin{aligned}
\frac{\partial \Lambda'}{\partial c_{t+1}} &= \frac{\partial^2 F_{t+1}}{\partial H_{ft+1}^2} \frac{\partial H_{ft+1}}{\partial H_{t+1}} \frac{\partial H_{t+1}}{\partial c_{t+1}} + \frac{\partial^2 F_{t+1}}{\partial H_{ft+1} \partial L_{ft+1}} \frac{\partial L_{ft+1}}{\partial H_{ft+1}} \frac{\partial H_{ft+1}}{\partial H_{t+1}} \frac{\partial H_{t+1}}{\partial c_{t+1}} - \\
&\quad - (1+r) \frac{\partial F_t}{\partial H_{ft}} \frac{1}{E'} \frac{\partial e\left(c_{t+1} N_{t+1}\right)}{\partial c_{t+1}} N_{t+1} - (1+r) \frac{\partial^2 F_t}{\partial H_{ft}^2} \frac{e\left(c_{t+1} N_{t+1}\right)}{E'} \frac{\partial H_{ft}}{\partial H_{Et}} \frac{\partial H_{Et}}{\partial \partial c_{t+1}} \\
&= \frac{\partial^2 F_{t+1}}{\partial H_{ft+1}^2} N_{t+1} + \frac{\partial^2 F_{t+1}}{\partial H_{ft+1} \partial L_{ft+1}} \frac{\partial L_{ft+1}}{\partial H_{ft+1}} N_{t+1} - (1+r) \frac{\partial F_t}{\partial H_{ft}} \frac{1}{E'} \frac{\partial e\left(c_{t+1} N_{t+1}\right)}{\partial c_{t+1}} N_{t+1} \\
&\quad + (1+r) \frac{\partial^2 F_t}{\partial H_{ft}^2} \left(\frac{e\left(c_{t+1} N_{t+1}\right)}{E'} \right)^2 N_{t+1} \qquad (28)
\end{aligned}$$

is also smaller than zero, if $\frac{\partial^2 F_{t+1}}{\partial H_{ft+1}^2} < \frac{\partial^2 F_{t+1}}{\partial L_{ft+1} \partial H_{ft+1}} \frac{\partial L_{ft+1}}{\partial H_{ft+1}}$ holds, as the last two terms in (28) are smaller than zero. These results also indicate that, if migration is not perfectly foreseen, an increase in the expected high skilled immigration lowers the share of high skilled natives; the reasoning is the same as in the proof to proposition 1.

The effect of low skilled immigration on the share of high skilled natives

$$\frac{dc_{t+1}}{dM_{Lt+1}} = -\frac{\frac{\partial \Lambda'}{\partial M_{Lt+1}}}{\frac{\partial \Lambda'}{\partial c_{t+1}}} \qquad (29)$$

equals zero, as $\frac{\partial \Lambda'}{\partial M_{Lt+1}} = 0$ (M_{Lt+1} has only an effect on L_{t+1}, and L_{t+1} does not affect production). The effect of an (expected) increase in the minimum wage w^* is given by:

$$\frac{dc_{t+1}}{dw_{t+1}^*} = -\frac{\frac{\partial \Lambda'}{\partial w_{t+1}^*}}{\frac{\partial \Lambda'}{\partial c_{t+1}}} \qquad (30)$$

As $\frac{\partial \Lambda'}{\partial w_{t+1}^*} = -1$ the overall effect is negative, as long as the nominator is negative.*

Without adjustment of the education structure of natives the effect of high skilled immigration on native welfare consist of the increase in production plus the taxes paid by immigrants less their wages:

$$dW_{t+1} = \frac{\partial F_{t+1}}{\partial M_{Ht+1}} dM_{Ht+1} + \tau_{t+1} dM_{Ht+1} - \frac{\partial F_{t+1}}{\partial H_{ft+1}} dM_{Ht+1} \qquad (31)$$

Changes in the taxes paid by natives and in the unemployment benefits need not to be considered. An increase in the tax rate raises the welfare of the state and decreases the welfare of the tax payers; however, as native welfare consists of the welfare of the state and the tax payers, the effect cancels out. Rearranging (31) leads to:

$$\begin{aligned}
dW_{t+1} &= \frac{\partial F_{t+1}}{\partial H_{ft+1}} dM_{Ht+1} + \frac{\partial F_{t+1}}{\partial L_{ft+1}} \frac{\partial L_{ft+1}}{\partial H_{ft+1}} dM_{Ht+1} + \tau_{t+1} dM_{Ht+1} - \frac{\partial F_{t+1}}{\partial H_{ft+1}} dM_{Ht+1} \\
&= \left(\tau_{t+1} + \frac{\partial F_{t+1}}{\partial L_{ft+1}} \frac{\partial L_{ft+1}}{\partial H_{ft+1}} \right) dM_{Ht+1} > 0 \qquad (32)
\end{aligned}$$

As low skilled immigration does not increase production, its welfare effect is:

$$dW_{t+1} = \tau_{t+1} dM_{Lt+1} - w^*_{t+1} dM_{Lt+1} < 0 \tag{33}$$

This is obviously negative, as $\tau_{t+1} = w^*_{t+1}$ would result if all people were unemployed.

Allowing for an adjustment of the education structure of natives changes the effect of high skilled immigration. The decrease in high skilled wages makes it for less people attractive to acquire a high education level. Thus, more natives stay low skilled and become unemployed. in addition, production is lower than in the case without adjustment of the education structure.

Proposition 4 *The marginal effect of correctly anticipated high skilled immigration on native welfare depends on the pattern of innate abilities of natives. If the teaching that a person requires to become high skilled and the dispersion of innate abilities are both small* ($e\left(c_{t+1}N_{t+1}\right)/E' \to 0$ *and* $\partial e\left(c_{t+1}N_{t+1}\right)/\partial c_{t+1} \to 0$)*, high skilled immigration has a substantial negative effect. The effect of an expected high skilled immigration that is ultimately not realized is unambiguously negative. (Correctly anticipated) Low skilled immigration has a negative effect on native welfare, whereas an expected low skilled immigration that is not realized has no effect.*

Proof As in the perfect labor market case, correctly anticipated high skilled immigration affects native welfare in t and $t+1$. The welfare effect in $t+1$ consists of the increase in production due to immigration plus the taxes paid by the immigrants less the wages paid to them:

$$\begin{aligned}
dW^*_{t+1} &= \frac{\partial F_{t+1}}{\partial M_{Ht+1}} dM_{Ht+1} + \tau_{t+1} dM_{Ht+1} - \frac{\partial F_{t+1}}{\partial H_{ft+1}} dM_{H_{t+1}} \\
&= \frac{\partial F_{t+1}}{\partial H_{ft+1}} dM_{Ht+1} + \frac{\partial F_{t+1}}{\partial L_{ft+1}} \frac{\partial L_{ft+1}}{\partial H_{ft+1}} dM_{Ht+1} + \frac{\partial F_{t+1}}{\partial H_{ft+1}} N_{t+1} \frac{\partial c_{t+1}}{\partial M_{Ht+1}} dM_{Ht+1} \\
&\quad + \frac{\partial F_{t+1}}{\partial L_{ft+1}} \frac{\partial L_{ft+1}}{\partial H_{ft+1}} N_{t+1} \frac{\partial c_{t+1}}{\partial M_{Ht+1}} dM_{Ht+1} + \tau_{t+1} dM_{Ht+1} - \frac{\partial F_{t+1}}{\partial H_{ft+1}} dM_{Ht+1} \\
&= \tau_{t+1} dM_{Ht+1} + \frac{\partial F_{t+1}}{\partial L_{ft+1}} \frac{\partial L_{ft+1}}{\partial H_{ft+1}} dM_{Ht+1} \\
&\quad + \left(\frac{\partial F_{t+1}}{\partial H_{ft+1}} + \frac{\partial F_{t+1}}{\partial L_{ft+1}} \frac{\partial L_{ft+1}}{\partial H_{ft+1}} \right) N_{t+1} \frac{\partial c_{t+1}}{\partial M_{Ht+1}} dM_{Ht+1}
\end{aligned} \tag{34}$$

As in the perfect labor market case, the effect in period t is:

$$dW^*_t = -\frac{\partial F_t}{\partial H_{ft}} \frac{e\left(c_{t+1}N_{t+1}\right)}{E'} N_{t+1} \frac{\partial c_{t+1}}{\partial M_{Hr+1}} dM_{Hr+1} \tag{35}$$

The overall effect discounted to period t is then:

$$dW_t = \left(\frac{1}{1+r}\frac{\partial F_{t+1}}{\partial H_{ft+1}} - \frac{\partial F_r}{\partial H_{ft}}\frac{e\left(c_{t+1}N_{t+1}\right)}{E'} + \frac{1}{1+r}\frac{\partial F_{t+1}}{\partial L_{ft+1}}\frac{\partial L_{ft+1}}{\partial H_{ft+1}}\right) N_{t+1}\frac{\partial c_{t+1}}{\partial M_{Ht+1}}dM_{Ht+1} + \frac{1}{1+r}\tau_{t+1}dM_{Ht+1} + \frac{1}{1+r}\frac{\partial F_{t+1}}{\partial L_{ft+1}}\frac{\partial L_{ft+1}}{\partial H_{ft+1}}dM_{Ht+1} \quad (36)$$

The sign of dW_t is ambiguous, as $\partial c_{t+1}/\partial M_{Ht+1} < 0$ holds. If $e\left(c_{t+1}N_{t+1}\right)/E' \to 0$ and $\partial e\left(c_{t+1}N_{t+1}\right)/\partial c_{t+1} \to 0$, $\partial c_{t+1}/\partial N_{t+1} \to -1/N_{t+1}$(see (28) and (29)). In this case (36) can be simplified to

$$dW_t^* = \left(\frac{1}{1+r}\tau_{t+1} - \frac{1}{1+r}\frac{\partial F_{t+1}}{\partial H_{ft+1}}\right) dM_{Ht+1} \quad (37)$$

The effect is smaller than zero, as the lump sum tax τ_{t+1} is smaller than the high skilled wage (see (24)).

The effect of an anticipated migration EM_{Ht+1} that is not realized in period $t+1$ is given by:

$$dW_{t+1}^* = \frac{\partial F_{t+1}}{\partial H_{ft+1}}N_{t+1}\frac{\partial c_{t+1}}{\partial EM_{Ht+1}}dEM_{Ht+1} + \frac{\partial F_{t+1}}{\partial L_{ft+1}}\frac{\partial L_{ft+1}}{\partial H_{ft+1}}N_{t+1}\frac{\partial c_{t+1}}{\partial EM_{Ht+1}}dEM_{Ht+1} \quad (38)$$

The effect in period t equals the effect of a correctly anticipated migration; thus the overall effect is:

$$dW_t = \left(\frac{1}{1+r}\frac{\partial F_{t+1}}{\partial H_{ft+1}} - \frac{\partial F_r}{\partial H_{ft}}\frac{e\left(c_{t+1}N_{t+1}\right)}{E'} + \frac{1}{1+r}\frac{\partial F_{t+1}}{\partial L_{ft+1}}\frac{\partial L_{ft+1}}{\partial H_{ft+1}}\right) N_{t+1}\frac{\partial c_{t+1}}{\partial EM_{Ht+1}}dEM_{Ht+1} \quad (39)$$

The effect is smaller than zero as $\partial c_{t+1}/\partial EM_{Ht+1} < 0$.

As low skilled immigration does not change the education structure of natives, expected low skilled immigration that is not realized has no effect on native welfare. As neither production increases, the welfare effect of realized low skill immigration is

$$dW_t = \frac{1}{1+r}\tau_{t+1}dM_{Lt+1} - \frac{1}{1+r}w_{t+1}^*dM_{Lt+1} \quad (40)$$

By (24) this is smaller than zero.*

In the non marginal case the effect of high skilled immigration on native welfare crucially depends on the change in the number of employed workers in the economy. If the teaching that a person requires to become high skilled and the dispersion of innate abilities are both small, the number of workers will not increase; for each additional high skilled immigrant one otherwise high skilled native will become low skilled.[14] As an increase in

[14] $e\left(c_{t+1}N_{t+1}\right)/E' \to 0$, $\partial e\left(c_{t+1}N_{t+1}\right)/\partial c_{t+1} \to 0 \Rightarrow \partial c_{t+1}/\partial M_{Ht+1} \to -1/N_{t+1}$.

low skilled labor supply does not increase production, there is neither potential immigration surplus. If the dispersion of education costs is large ($\partial e\left(c_{t+1}N_{t+1}\right)/\partial c_{t+1} \rightarrow \infty$); the education structure of natives does not change. In this case high skilled immigration leads to an immigration surplus. As shown above, without adjustment of the native education structure the marginal effect of high skilled immigration is positive.

4 Calibration of the model

For the calibration of the model a production function has to be specified. Following Borjas (2003) I use a Cobb-Douglas Production function depending on capital K and labor input LI; LI is a CES function of high and low skilled labor:

$$\begin{aligned} Y_{t+1} &= AK_{t+1}^{\alpha} LI_{t+1}^{1-\alpha} \\ LI_t &= \left[\beta H_{ft+11}^{\rho} + (1-\beta) L_{ft+1}^{\rho}\right]^{1/\rho} \end{aligned} \tag{41}$$

The resulting wages are:

$$w_{Ht+1} = A(1-\alpha)\left(\frac{K_{t+1}}{LI_{t+1}}\right)^{\alpha}\left[\beta H_{ft+1}^{\rho} + (1-\beta)L_{ft+1}^{\rho}\right]^{1/\rho-1}\beta H_{ft+1}^{\rho-1} \tag{42}$$

$$w_{Lt+1} = A(1-\alpha)\left(\frac{K_{t+1}}{LI_{t+1}}\right)^{\alpha}\left[\beta H_{ft+1}^{\rho} + (1-\beta)L_{ft+1}^{\rho}\right]^{1/\rho-1}(1-\beta)L_{ft+1}^{\rho-1} \tag{43}$$

Education expenditures are specified as:

$$w_{Ht}E(c_{t+1}N_{t+1}) = w_{Ht}\frac{(c_{t+1}N_{t+1})^{\epsilon}}{E'} \tag{44}$$

For the calibration of the model the various parameters have to be specified. Unfortunately, for most of the parameters no standard values exist,[15] so that they have been set arbitrarily. Table 1 gives an overview over the chosen parameter values. Moreover, for simplicity I use a fix value for w_{Ht} instead of the equilibrium value; as w_{Ht} is only affected by the change in the number of teachers in t, this should not have much effect.

So far I have assumed that the supply of all production factors except for labor is fixed. Nevertheless, in the long run capital is likely to adjust to increase in labor supply. In the theoretic part I have not allowed for capital adjustment, as this makes a number

[15] ρ is an exception; $\rho = 0.3$ follows the estimation results of Card and Lemieux (2001).

Table 1: Parameter values in the calibrations

Number of natives	40mio
Immigration	0.1mio,
either all high or all low skilled	
Interest rate	0.1
Teachers in $t+1$	10,000
Production function:	
$Y_{t+1} = AK_{t+1}^{\alpha} LI_{ft+1}^{1-\alpha}$	
$LI_{ft+1} = \left[\beta H_{ft+1}^{\rho} + (1-\beta) L_{ft+1}^{\rho}\right]^{1/\rho}$	
TFP, A	0.1mio
β	0.55
α	0.33
ρ	0.3
Capital (if capital stock is fix)	14.0mio
Capital labor ratio K/LI (if capital adjusts)	0.7
Education expenditures:	
$w_{Ht} E(c_{t+1} N_{t+1}) = w_{Ht} \frac{(c_{t+1} N_{t+1})^{\epsilon}}{E'}$	
E'	200
ϵ	1.2
High skilled wage in t, w_{Ht}	16,000
Minimum wage (if applies)	13,400

of additional assumptions necessary and does not lead to additional insights. However, as the aim of the calibration is to assess the quantitative effects of immigration, capital adjustment should be considered here.

Table 2 gives the calibration results for six immigration scenarios under the assumption of perfect capital adjustment. The first scenario is an immigration of 100,000 high skilled persons, that is anticipated by the natives. In the second scenario the same immigration occurs spontaneously, so that natives cannot adjust their education levels. In the third scenario natives expect that 100,000 high skilled people immigrate when they decide about their education, but no immigration occurs. In scenarios 4-6 instead of 100,000 high skilled immigrants 100,000 low skilled immigrants are considered. In table 3 the same scenarios are calibrated under the assumption of a fixed capital stock. Table 4 gives the results for

Table 2: Calibration results; perfect labor market, capital adjustment

*R*eference case (no immigration):			
Share of high skilled nativesc_{t+1}	49.96%	High skilled wage w_{Ht+1}	16,413
Value added in Prod. in $t+1$ in mio	886,442	Low skilled wage w_{Lt+1}	13,367
Average education costs in t	2,308		
1. Correctly anticipated immigration of 100,000 high skilled people:		*4. Correctly anticipated immigration of 100,000 low skilled people:*	
Share of high skilled natives c_{t+1}	49.84%	Share of high skilled natives c_{t+1}	50.08%
Value added in Prod. in $t+1$ in mio	888,670	Value added in Prod. in $t+1$ in mio	888,657
High skilled wage w_{Ht+1}	16,413	High skilled wage w_{Ht+1}	16,414
Low skilled wage w_{Lt+1}	13,368	Low skilled wage w_{Lt+1}	13,366
Average education costs in t	2,307	Average education costs in t	2,309
Welfare effect in t in mio	134.91	Welfare effect in t in mio	-134.09
Welfare effect in $t+1$ in mio	586.94	Welfare effect in $t+1$ in mio	878.54
Total welfare effect in mio $(t+1)$	735.35	Total welfare effect in mio $(t+1)$	731.04
2. Unexpected immigration of 100,000 high skilled people:		*5. Unexpected immigration of 100,000 low skilled people:*	
Share of high skilled natives c_{t+1}	49.96%	Share of high skilled natives c_{t+1}	49.96%
Value added in Prod. in $t+1$ in mio	888,890	Value added in Prod. in $t+1$ in mio	888,435
High skilled wage w_{Ht+1}	16,387	High skilled wage w_{Ht+1}	16,439
Low skilled wage w_{Lt+1}	13,393	Low skilled wage w_{Lt+1}	13,341
Average education costs in t	2,308	Average education costs in t	2,308
Welfare effect in t in mio	0.00	Welfare effect in t in mio	0.00
Welfare effect in $t+1$ in mio	809.08	Welfare effect in $t+1$ in mio	659.02
Total welfare effect in mio $(t+1)$	809.08	Total welfare effect in mio $(t+1)$	659.02
3. Immigration of 100,000 high skilled people expected but not realized:		*6. Immigration of 100,000 low skilled people expected but not realized:*	
Share of high skilled natives c_{t+1}	49.84%	Share of high skilled natives c_{t+1}	50.08%
Value added in Prod. in $t+1$ in mio	886,219	Value added in Prod. in $t+1$ in mio	886,660
High skilled wage w_{Ht+1}	16,439	High skilled wage w_{Ht+1}	16,388
Low skilled wage w_{Lt+1}	13,342	Low skilled wage w_{Lt+1}	13,392
Average education costs in t	2,307	Average education costs in t	2,309
Welfare effect in t in mio	134.91	Welfare effect in t in mio	-134.09
Welfare effect in $t+1$ in mio	-223.38	Welfare effect in $t+1$ in mio	218.29
Total welfare effect in mio $(t+1)$	-74.98	Total welfare effect in mio $(t+1)$	70.79

Table 3: Calibration results; perfect labor market, fixed capital stock

Reference case (no immigration):			
Share of high skilled natives c_{t+1}	49.96%	High skilled wage w_{Ht+1}	16,413
GDP in $t+1$ in mio	886,442	Low skilled wage w_{Lt+1}	13,367
Average education costs in t	2,308		
1. Correctly anticipated immigration of 100,000 high skilled people:		*4. Correctly anticipated immigration of 100,000 low skilled people:*	
Share of high skilled natives c_{t+1}	49.83%	Share of high skilled natives c_{t+1}	50.07%
Value added in Prod. in $t+1$ in mio	887,927	Value added in Prod. in $t+1$ in mio	887,918
High skilled wage w_{Ht+1}	16,400	High skilled wage w_{Ht+1}	16,402
Low skilled wage w_{Lt+1}	13,355	Low skilled wage w_{Lt+1}	13,355
Average education costs in t	2,307	Average education costs in t	2,309
Welfare effect in t in mio	141.46	Welfare effect in t in mio	-127.57
Welfare effect in $t+1$ in mio	-154.95	Welfare effect in $t+1$ in mio	140.97
Total welfare effect in mio $(t+1)$	0.65	Total welfare effect in mio $(t+1)$	0.64
2. Unexpected immigration of 100,000 high skilled people:		*5. Unexpected immigration of 100,000 low skilled people:*	
Share of high skilled natives c_{t+1}	49.96%	Share of high skilled natives c_{t+1}	49.96%
Value added in Prod. in $t+1$ in mio	888,081	Value added in Prod. in $t+1$ in mio	887,777
High skilled wage w_{Ht+1}	16,373	High skilled wage w_{Ht+1}	16,427
Low skilled wage w_{Lt+1}	13,381	Low skilled wage w_{Lt+1}	13,331
Average education costs in t	2,308	Average education costs in t	2,308
Welfare effect in t in mio	0.00	Welfare effect in t in mio	0.00
Welfare effect in $t+1$ in mio	2.04	Welfare effect in $t+1$ in mio	1.77
Total welfare effect in mio $(t+1)$	2.04	Total welfare effect in mio $(t+1)$	1.77
3. Immigration of 100,000 high skilled people expected but not realized:		*6. Immigration of 100,000 low skilled people expected but not realized:*	
Share of high skilled natives c_{t+1}	49.83%	Share of high skilled natives c_{t+1}	50.07%
Value added in Prod. in $t+1$ in mio	886,285	Value added in Prod. in $t+1$ in mio	886,581
High skilled wage w_{Ht+1}	16,441	High skilled wage w_{Ht+1}	16,388
Low skilled wage w_{Lt+1}	13,342	Low skilled wage w_{Lt+1}	13,390
Average education costs in t	2,307	Average education costs in t	2,309
Welfare effect in t in mio	141.46	Welfare effect in t in mio	-127.57
Welfare effect in $t+1$ in mio	-157.00	Welfare effect in $t+1$ in mio	139.20
Total welfare effect in mio $(t+1)$	-1.40	Total welfare effect in mio $(t+1)$	-1.13

Table 4: Calibration results; minimum wage, fixed capital stock

Reference case (no immigration):			
Share of high skilled natives c_{t+1}	44.75%	High skilled wage w_{Ht+1}	16,380
Value added in Prod. in $t+1$ in mio	791,774	Unemployment rate in $t+1$	10.71%
Average education costs in t	2,258		
1. Correctly anticipated immigration of 100,000 high skilled people:		*4. Correctly anticipated immigration of 100,000 low skilled people:*	
Share of high skilled natives c_{t+1}	44.52%	Share of high skilled natives c_{t+1}	44.75%
Value added in Prod. in $t+1$ in mio	791,940	Value added in Prod. in $t+1$ in mio	791,774
High skilled wage w_{Ht+1}	16,377	High skilled wage w_{Ht+1}	16,380
Unemployment rate in $t+1$	10.90%	Unemployment rate in $t+1$	10.93%
Average education costs in t	2,255	Average education costs in t	2,258
Welfare effect in t in mio	249.84	Welfare effect in t in mio	0.00
Welfare effect in $t+1$ in mio	-1,325.40	Welfare effect in $t+1$ in mio	-1,193,53
Total welfare effect in mio $(t+1)$	-1,050.57	Total welfare effect in mio $(t+1)$	-1,193,53
2. Unexpected immigration of 100,000 high skilled people:		*5. Unexpected immigration of 100,000 low skilled people:*	
Share of high skilled natives c_{t+1}	44.75%	Share of high skilled natives c_{t+1}	44.75%
Value added in prod. in $t+1$ in mio	793,921	Value added in prod. in $t+1$ in mio	791,774
High skilled wage w_{Ht+1}	16,341	High skilled wage w_{Ht+1}	16,380
Unemployment rate in $t+1$	10.59%	Unemployment rate in $t+1$	10.71%
Average education costs in t	2,258	Average education costs in t	2,258
Welfare effect in t in mio	0.00	Welfare effect in t in mio	0.00
Welfare effect in $t+1$ in mio	654.26	Welfare effect in $t+1$ in mio	-1,193.53
Total welfare effect in mio $(t+1)$	654.26	Total welfare effect in mio $(t+1)$	-1,193.53
3. Immigration of 100,000 high skilled people expected but not realized:		*6. Immigration of 100,000 low skilled people expected but not realized:*	
Share of high skilled natives c_{t+1}	44.52%	Share of high skilled natives c_{t+1}	44.75%
Value added in Prod. in $t+1$ in mio	789,789	Value added in Prod. in $t+1$ in mio	791,774
High skilled wage w_{Ht+1}	16,417	High skilled wage w_{Ht+1}	16,380
Unemployment rate in $t+1$	11.03%	Unemployment rate in $t+1$	10.71%
Average education costs in t	2,255	Average education costs in t	2,258
Welfare effect in t in mio	249.84	Welfare effect in t in mio	0.00
Welfare effect in $t+1$ in mio	-1,985.43	Welfare effect in $t+1$ in mio	0.00
Total welfare effect in mio $(t+1)$	-1,710.60	Total welfare effect in mio $(t+1)$	0.00

a fixed capital stock and a fixed minimum wage that is financed by a lump-sum tax.[16]

What can we learn from these calibrations? In the case of perfect labor markets the following points are remarkable. If capital does not adjust to an increase in labor, the immigration surplus is quite small (this corresponds to the findings of Borjas, 1995). However, with capital adjustment the immigration surplus can become substantial. My results indicate that with capital adjustment the immigration surplus is by a factor of 1000 larger. Thus, in a long run perspective the effects of immigration on native welfare are not negligible. An adjustment of the native education structure lowers the immigration surplus, at least the one from high skilled immigration.[17] Nevertheless, my calibrations indicate, that the effect still has the same order of magnitude. Furthermore, the expectation of high skilled immigration can lead to a substantial negative welfare effect, if this immigration ultimately is not realized.

The calibration with a fixed minimum wage shows the following: Both high and low skilled immigration lead to a large loss of native welfare, if they are anticipated. However, if immigration is unexpected only low skilled immigration has a negative welfare effect, whereas high skilled immigration generates a substantial immigration surplus. If natives expect high skilled immigration when they decide about their education, this already has a strong negative welfare effect; an expectation of low skilled immigration has no effect. Overall this makes clear that, if there are frictions on the labor market, the expectations of natives about future immigration have strong welfare effects.

5 Policy implications

In the previous chapters I have shown that the effect of immigration on native welfare does not only depend on the extent of the immigration that is ultimately realized. It also depends on the expectations that natives have about it. An adjustment of the education structure of natives can lower the potential positive effects of high skilled immigration;

[16]Without further restrictions, the model is not solvable for capital adjustment and minimum wage; thus, there are no calibration results for this combination.

[17]This does not hold in the case of low skilled immigration and capital adjustment, because adjustment of native education leads to a higher LI, and this in turn leads to more capital. Here capital adjustment overcompensates the negative effect from proposition 2.

nevertheless, the welfare effect of high skilled immigration still tends to be positive.

The expectations that young natives have about future immigration will generally not coincide with the immigration that really occurs. My calibrations indicate that, if the expected high skilled immigration is larger than the realized immigration, this can lead to a substantial welfare loss. An expectation below the actual immigration has no negative effect. This means that immigration policies should be designed in a way that natives do not overestimate future high skilled immigration. Thus, an immigration policy that is targeted at attracting high skilled foreigners at all costs can be dangerous. It tends to lead natives to expect a relatively large inflow of high skilled people. If the expected inflow is not realized, the native population suffers a welfare loss.

In reality the native population does not only consist of two types of workers. Hence, immigration can affect the native education structure in multiple ways. A simple example for this is the following. Assume that there are three education levels: low skilled, skilled in the technical sector and skilled in the administrative sector. Moreover, people now cannot choose if they become low skilled or high skilled workers, but high skilled workers can decide if they acquire technical or administrative skills. In addition, it is nearby that a technical training is more expensive than an administrative training and that capital adjusts more to technical than to administrative labor. Under these assumptions high and low skilled labor in my model can be replaced by technical and administrative labor (except for the part with the minimum wage). My model would then predict that the import of foreign persons with technical skills reduces the potential number of natives with technical skills.

Designing an immigration policy these adjustment effects have to be taken into account. At first sight a program that is targeted at attracting high skilled foreigners, for instance engineers, may be very attractive. Already in the short run it will lead to an immigration surplus. Moreover, if the state finances higher education at least to a certain degree, it can save costs importing engineers who have been trained abroad. Nevertheless, the immigration of these engineers lowers the potential income of native engineers, who compete with them. This effect is *a priori* not bad; however, the lower potential income makes engineer studies less attractive compared to for instance business administration or law for young natives choosing their studies. Thus, less young natives will opt for engineer studies.

The political and economic situation in the home countries of the foreign engineers may improve. In this case, some of the foreign engineers back-migrate and less engineers from these countries are willing to come. The number of immigrant engineers in the immigration country then lies below the expected number; thus, my model predicts a welfare loss. In addition, the negative effects of the too low number of native engineers can still be stronger, if this leakage has a negative effect on economic growth.[18] Of course, one could argue that native engineers would also have an incentive to emigrate, when the wages abroad increase. Nevertheless, in general it is *ceteris paribus* much more attractive for people to re-migrate to a certain country than to emigrate there.

6 Conclusions

The welfare effects of immigration depend on the expectations of natives. Rational natives adjust their educational decision to their expectation about future immigration. The expectation of high skilled immigration into perfect labor markets leads to a decrease in the share of high skilled natives, whereas the expectation of low skilled immigration increases it. If there are frictions on the labor market, the situation can be different. In the case of a fixed minimum wage expected high skilled immigration decreases the share of high skilled natives, whereas expected low skilled immigration leaves it unchanged. This adjustment of the education structure of natives reduces the potential immigration surplus from high skilled immigration. In the case of perfect labor markets there exists still a native welfare gain; however, in the case of a fixed minimum wage the marginal effect of high skilled immigration on native welfare can become negative. In addition, an expected high skilled immigration that ultimately is not realized leads in both cases to a welfare loss.

Up to now, economic research on immigration has generally treated the education structure of natives as exogenous. Nevertheless, if immigration does not occur as a singular shock, natives will consider immigration when they decide about their education. In this paper I have shown that considering the adjustment of the native education structure to (expected) immigration can substantially change results on the (welfare) effects of immigration. To get a comprehensive picture of the effects of immigration on the native education structure further research is necessary. This research may substantially change

[18] Drinkwater et al. (2007) analyze the welfare effects of immigration in a general equilibrium model with endogenous growth. They find that the growth effect of immigration can be substantial.

our contemporary view of the effects of immigration.

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7 Appendix

Effects of immigration on the education structure of natives, if high and low skilled labor are perfect substitutes:

High and low skilled workers are perfect substitutes and the factor productivity of low skilled labor is lower. The relation between high and low skilled labor is then $L_t = qH_t$; with q the relative productivity of one low skilled worker compared to one high skilled worker. q is assumed to be a fix value that is not affected by other economic factors and $q < 1$ should hold. As wages follow the factor productivity, (6) becomes:

$$\frac{1}{1+r}\frac{\partial F_{t+1}}{\partial H_{ft+1}} - \frac{\partial F_t}{\partial H_{ft}}\frac{e\left(c_{t+1}N_{t+1}\right)}{E'} = \frac{q}{1+r}\frac{\partial F_{t+1}}{\partial H_{ft+1}} \tag{45}$$

Implicit differentiation of this equation gives the effect of high skilled immigration:

$$\frac{dc_{t+1}}{dM_{Ht+1}} = -\frac{(1-q)\,\frac{\partial^2 F_{t+1}}{\partial H_{ft+1}^2}}{(1-q)^2\,\frac{\partial^2 F_{t+1}}{\partial H_{ft+1}^2}N_{t+1} - (1+r)\,\frac{\partial F_t}{\partial H_{ft}}\frac{1}{E'}\frac{\partial e(c_{t+1}N_{t+1})}{\partial c_{t+1}} + (1+r)\,\frac{\partial^2 F_t}{\partial H_{ft}^2}\left(\frac{e(c_{t+1}N_{t+1})}{E'}\right)^2} < 0 \tag{46}$$

The square in the denominator results, as now $H_{t+1} = c_{t+1}N_{t+1} + q(1-c_{t+1})N_{t+1} + M_{Ht+1}$ holds. Moreover, as one unit of low skilled labor equals q units of high skilled labor:[19]

$$\frac{dc_{t+1}}{dM_{Lt+1}} = q\frac{dc_{t+1}}{dM_{Ht+1}} < 0 \tag{47}$$

[19] One could also do these calculations using L_{t+1} instead of H_{ft+1} as benchmark. However, then one has to keep in mind that in this case $\partial L_{t+1}/\partial c_{t+1} = (1/q-1)N_{t+1}$ is larger than zero

.

Immigration surplus for simultaneous immigration of high and low skilled people (no adjustment of the native education structure):

As in the case of one type of immigrants, the immigration surplus is given by the increase in production less the wages paid to immigrants:

$$\begin{aligned} IS_t &= F(H^1_{ft}, L^1_t, \ldots) - F(H^0_{ft}, L^0_t, \ldots) - \frac{\partial F(H^1_{ft}, L^1_t, \ldots)}{\partial H^1_{ft}} M_{Ht} - \frac{\partial F(H^1_{ft}, L^1_t, \ldots)}{\partial L^1_t} M_{Lt} \\ &= F(H^1_{ft}, L^1_t, \ldots) - F(H^0_{ft}, L^1_t, \ldots) + F(H^0_{ft}, L^1_t, \ldots) - F(H^0_{ft}, L^0_t, \ldots) \\ &\quad - \frac{\partial F(H^1_{ft}, L^1_t, \ldots)}{\partial H^1_{ft}} M_{Ht} - \frac{\partial F(H^1_{ft}, L^1_t, \ldots)}{\partial L^1_t} M_{Lt} \end{aligned} \tag{48}$$

with $H^0_{ft} = c_t N_t - H_{Et}$, $H^1_{ft} = H^0_{ft} + M_{Ht}$, $L^0_t = (1 - c_t)N_t$ and $L^1_t = L^0_t + M_{Lt}$. As F is strictly monotonically increasing in H and L, (48) can be rewritten as:

$$\begin{aligned} IS_t &= \frac{\partial F(H^y_{ft}, L^1_t, \ldots)}{\partial H^y_{ft}} M_{Ht} + \frac{\partial F(H^0_{ft}, L^z_t, \ldots)}{\partial L^z_t} M_{Lt} - \frac{\partial F(H^1_{ft}, L^1_t \ldots)}{\partial H^1_{ft}} M_{Ht} \\ &\quad - \frac{\partial F(H^1_{ft}, L^1_t \ldots)}{\partial L^1_t} M_{Lt} \end{aligned} \tag{49}$$

$$\begin{aligned} &= \frac{\partial F(H^y_{ft}, L^1_t, \ldots)}{\partial H^y_{ft}} M_{Ht} - \frac{\partial F(H^1_{ft}, L^1_t \ldots)}{\partial H^1_{ft}} M_{Ht} + \frac{\partial F(H^1_{ft}, L^z_t, \ldots)}{\partial L^z_t} M_{Lt} \\ &\quad - \frac{\partial F(H^1_{ft}, L^1_t \ldots)}{\partial L^1_t} M_{Lt} + \frac{\partial F(H^0_{ft}, L^z_t, \ldots)}{\partial L^z_t} M_{Lt} - \frac{\partial F(H^1_{ft}, L^z_t \ldots)}{\partial L^z_t} M_{Lt} \end{aligned} \tag{50}$$

with $H^y_{ft} = H^0_{ft} + y(H^1_{ft} - H^0_{ft})$, $L^z_t = L^0_t + z(L^1_t - L^0_t)$ and $0 \leq y, z \leq 1$. The first two terms on the right hand side equal the immigration surplus in the case that only the high skilled migration had been realized. Nevertheless, it is measured with a higher endowment of low skilled labor. The second two terms give the immigration surplus in the case that only the low skilled immigration had been realized (measured with a higher endowment of low skilled labor). The last two terms give the interaction between both types of immigration. If low skilled wages increase (decrease) in H, $\partial^2 F_t / \partial H_{ft} \partial L_t > (<) 0$, this term is negative (positive); a negative effect implies that pure high or low skilled migration increases native welfare more than mixed migration.

Immigration surplus with adjustment of the native education structure in the non marginal case:

In the following the welfare effect of a correctly anticipated high skilled immigration is analyzed; the effects of an expected high skilled migration that is not realized and of low skilled immigration can be derived analogously. As in the marginal case, high skilled immigration affects native welfare in t and $t+1$. The effect in $t+1$ consists of the increase in production less the wages paid to the immigrants :

$$\begin{aligned} IS_{t+1}^{*} &= F(H_{ft+1}^{1}, L_{t+1}^{1}, \ldots) - F(H_{ft+1}^{0}, L_{t+1}^{0}, \ldots) - \frac{\partial F(H_{ft+1}^{1}, L_{t+1}^{1}, \ldots)}{\partial H_{ft+1}^{1}} M_{Ht+1} \\ &= F(H_{ft+1}^{1}, L_{t+1}^{1}, \ldots) - F(H_{ft+1}^{0}, L_{t+1}^{1}, \ldots) + F(H_{ft+1}^{0}, L_{t+1}^{1}, \ldots) \\ &\quad - F(H_{ft+1}^{0}, L_{t+1}^{0}, \ldots) - \frac{\partial F(H_{ft+1}^{1}, L_{t+1}^{1}, \ldots)}{\partial H_{ft+1}^{1}} M_{Ht+1} \qquad (51) \\ &= \frac{\partial F(H_{ft+1}^{y}, L_{t+1}^{1}, \ldots)}{\partial H_{ft+1}^{y}} (M_{Ht+1} - \tilde{L}_{t+1}) + \frac{\partial F(H_{ft+1}^{0}, L_{t+1}^{z}, \ldots)}{\partial L_{t+1}^{z}} \tilde{L}_{t+1} \\ &\quad - \frac{\partial F(H_{ft+1}^{1}, L_{t+1}^{1}, \ldots)}{\partial H_{ft+1}^{1}} M_{Ht+1} \qquad (52) \end{aligned}$$

with H_{ft+1}^{0} and L_{t+1}^{0} the numbers of workers in the case without migration and $H_{ft+1}^{1} = H_{ft+1}^{0} + M_{Ht+1} - \tilde{L}_{t+1}$ and $L_{t+1}^{1} = L_{t+1}^{0} + \tilde{L}_{t+1}$; $\tilde{L}_{t+1}$ is the change in the number of low skilled workers due to the adjustment of the native education structure.

In period t overall production increases, as less high skilled people work as teachers and more in production:

$$IS_{t}^{*} = F(H_{ft}^{1}, L_{t}^{0}, \ldots) - F(H_{ft}^{0}, L_{t}^{0}, \ldots) = \frac{\partial F(H_{ft+1}^{x}, L_{t}^{0}, \ldots)}{\partial H_{ft}^{x}} \tilde{H}_{ft} \qquad (53)$$

$\tilde{H}_{ft}$, the difference between H_{ft}^{0} and H_{ft}^{1}, equals the decrease in the number of teachers due to the decrease in the number of high skilled natives. By (1) this can be rewritten as:

$$\begin{aligned} IS_{t}^{*} &= \frac{\partial F(H_{ft+1}^{x}, L_{t}^{0}, \ldots)}{\partial H_{ft}^{x}} \left(\frac{E\left(c_{t+1}^{1} N_{t+1}^{1}\right)}{E'} - \frac{E\left(c_{t+1}^{0} N_{t+1}^{0}\right)}{E'} \right) \\ &= \frac{\partial F(H_{ft+1}^{x}, L_{t}^{0}, \ldots)}{\partial H_{ft}^{x}} \frac{e\left(c_{t+1}^{u} N_{t+1}^{u}\right)}{E'} \tilde{L}_{t+1} \qquad (54) \end{aligned}$$

The second equality follows, as the difference between $c_{t+1}^{1} N_{t+1}^{1}$and $c_{t+1}^{0} N_{t+1}^{0}$is the increase in the number of low skilled natives due to immigration.

Combining IS_{t}^{*} and IS_{t+1}^{*} the overall effect of immigration is

$$\begin{aligned} IS_{t} &= \frac{1}{1+r} \left(\frac{\partial F(H_{ft+1}^{y}, L_{t+1}^{1}, \ldots)}{\partial H_{ft+1}^{y}} - \frac{\partial F(H_{ft+1}^{1}, L_{t+1}^{1}, \ldots)}{\partial H_{ft+1}^{1}} \right) M_{Ht+1} \\ &\quad + \left(\begin{array}{c} \frac{1}{1+r} \frac{\partial F(H_{ft+1}^{0}, L_{t+1}^{z}, \ldots)}{\partial L_{t+1}^{z}} + \frac{\partial F(H_{ft+1}^{x}, L_{t}^{0}, \ldots)}{\partial H_{t}^{x}} \frac{e\left(c_{t+1}^{u} N_{t+1}^{u}\right)}{E'} \\ - \frac{1}{1+r} \frac{\partial F(H_{ft+1}^{yy}, L_{t+1}^{1}, \ldots)}{\partial H_{ft+1}^{y}} \end{array} \right) \tilde{L}_{t+1} \qquad (55) \end{aligned}$$

The first bracket equals the immigration surplus in the case without adjustment of the education structure of natives and is larger than zero; however, as the difference between $H^0_{ft+1}$and H^1_{ft+1} is smaller than in the case without adjustment of native education, the term in the bracket is also smaller. The second bracket is analogous to stability condition (5). However, the derivatives are built at different amounts of the input factors, so that the sign of the bracket cannot be derived in a general way.

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