UNIVERSITÄT SIEGEN

Fakultät III
Wirtschaftswissenschaften,
Wirtschaftsinformatik und
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Econ

Volkswirtschaftliche Diskussionsbeiträge

Discussion Papers in Economics

No. 154-12

July 2012

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Universität Siegen
Fakultät III
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Hölderlinstraße 3
D-57068 Siegen
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http://www.uni-siegen.de/fb5/vwl/

ISSN 1869-0211

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Costs and Benefits of Immigration and Multicultural Interaction

Moritz Bonn*

July 27, 2012

Abstract

This paper studies how the existence of a minority culture influences the well-being of the native population and its attitude towards immigrants. In this context, I assume that multicultural interaction can be advantageous for immigrants and natives if intercultural obstacles and communication problems are abolished. It is found that certain shares of the immigrant as well as of the native population have incentives to acquire knowledge of the respective other culture since it enables them to interact with each other. I find that immigrants are more likely to acquire knowledge of the domestic culture than vice versa what I attribute to differences in the respective population size, assortative matching behavior and potentially asymmetric learning costs. The model further predicts that natives who have sufficiently low costs of learning the foreign culture are willing to vote for free migration whereas those who have higher learning costs will be in favor of immigration restrictions.

JEL Classification: F22 · J15 · Z1

Keywords: Immigration, Cultural Interaction, Political Economy

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1 Introduction

Immigration is a crucial topic in most countries all over the world. Whereas some regions face enormous problems in coping with the inflow of illegal economic immigrants or refugees from poor or war-suffering regions, many OECD member states have ageing populations and face an economic need to attract skilled workers from emerging countries such as India or China to maintain their high levels of industrial productivity. Thus, many researchers suggest that immigration guidelines should be restructured in order to attract workers, especially if they are highly qualified.[1]

By contrast, the gains and losses that are related to immigration are much more controversially discussed by the general public, and most OECD countries' governments do not seem to be in favor of a substantial reduction of immigration barriers. The traditional literature on the economics of immigration explains the restrictive attitudes of host countries by focusing on the labor supply and welfare state effects that are caused by immigration. The idea is that immigration leads to a deterioration of wages and employment, especially for workers with lower education. However, there does neither seem to be broad empirical evidence that the labor market effects are significantly large nor that they to a sufficient degree explain the native attitude towards immigrants.[2]

Contrary to this, there seems to be a consensus among empirical researchers that non economic and cultural factors based on ethnocentrism, racism or sociotropic considerations play an important role (Espenshade and Hempstead 1996, Burns and Gimpel 2000, Mayda 2006, O'Rourke and Sinnott 2006, Dustman and Preston 2007, Hainmueller and Hiscox 2007). This is hardly surprising, as it indicates that individuals will not simply regard immigrants as an inflow of homogenous labor, but also as an influx of foreign cultural norms, habits and beliefs as well as potentially different languages and traditions which we will for short summarize as *immigrant culture*. The gains and losses from multiculturalism have widely impacted the political debate and besides immigration cultural integration has become a frequently discussed issue in many countries.

In this paper, I account for the empirical evidence that cultural aspects are important in influencing the individual attitudes towards immigration. More precisely, I analyze the

[1] The advantages that are attributed to high skilled workers are summarized by Chiswick (2007).

[2] Some empirical studies support the theoretical suggestion that the native population's attitude towards immigration is influenced by traditional economic factors (Schewe and Slaughter 2001, O'Rourke and Sinnott 2006, Mayda 2006, Facchini and Mayda 2009), whereas another strand of the recent empirical literature concludes that potential labor supply effects that are generated by an inflow of migrants do not significantly shape the attitudes towards immigration (Espenshade and Hempstead 1996, Citril et al. 1997, Hainmueller and Hiscox 2007, 2010).

costs and benefits that are related to an influx of foreign culture and examine how they affect the domestic view on immigrants. In this context, I do not distinguish between economic and non-economic interaction, but assume that cultural interaction in all spheres affects an individual's well-being, for good or bad. Thus, I see no general difference whether natives and immigrants interact as co-workers in an international company or on the playground where they are attending to their children. In both cases, interaction can be advantageous or disadvantageous for the encountering individuals depending on their mutual willingness and ability to communicate with each other. I do not limit the ability to communicate to the existence of language skills but suppose that people need to find a common culture. This requires knowledge of the differences in cultural customs and taboos, life styles and social norms.

I construct a simple framework where individuals match with individuals from the same or the foreign culture. I suggest that gains of intercultural exchange exist if the matching individuals are of different cultural origin and at least one of the two has knowledge of the other culture. If this is not the case, payoffs shrink to zero since intercultural exchange does not take place. This creates incentives for both, immigrants and natives to acquire knowledge of the respective other culture. However, I assume that "learning" the other culture requires time costs which are heterogeneous among individuals. I find that the incentive for an immigrant (native) to learn the domestic (immigrants') culture decreases with the share of immigrants (natives) in the total population. Migrants have a higher incentive to learn the native culture than vice versa as long as the migrant population is smaller than the native population. Thus, I account for the empirical fact that population size can explain how likely an individual learns about another culture.[3]

Moreover, I use these results to study the domestic attitudes towards immigrants. I find that the individual view on immigrants depends on the individual "learning cost" level. Those whose costs of learning the foreign culture are relatively large will benefit by immigration only if the share of migrants is relatively low. Contrarily, individuals with sufficiently low "learning costs" would support free entry of immigrants since they do not have to fear any communication problems but gain from intercultural exchange.

Additionally, I find that, due to the basic assumptions of the model, the individual with median learning costs is always not "learning" the immigrant culture. By assuming that

[3]With regard to the acquisition of foreign language skills, Chiswick and Miller (1999) find that members of large linguistic minorities perform worse than those of smaller minorities. A main reason for this is that the latter will at a higher probability interact with individuals with different linguistic backgrounds and thus face a higher incentive to learn the country's dominant language. Additionally, individuals that belong to small linguistic minorities anticipate that their mother tongue is learnt by only few individuals of different linguistic origin.

the individual with median "learning cost" is also the decisive median voter, I can conclude that positive immigration quotas are an outcome of a political process. Further, I analyze the impact of assortative matching. Inter alia, the model predicts that increased cultural segregation leads to a reduction of immigrants' cultural learning but potentially increases the probability that a native learns the immigrant culture. Finally, I find that not only asymmetries in the population size but also with respect to learning costs may account for the differences in integration probabilities between natives and immigrants.

The core of the model framework that is provided in this paper is similar to the model used in Lazear (1999a). However, since in Lazear's approach there does not exist any gain of intercultural activity but purely costs in terms of time that needs to be spent for learning the respective other culture, in his model, the existence of a cultural minority group is always harmful for the native majority. Thus, Lazear's framework cannot be used to analyze the impact of cultural interaction on the domestic attitude towards immigration. By inserting a cultural gain in Lazear's core model framework, I combine the theoretical idea of "cultural learning" with the vast theoretical and empirical literature on the gains of multicultural interaction.

The paper is structured as follows: The next section provides an overview over the related literature on the gains and losses of cultural diversity, in section 3, I construct a simple model framework which examines the ambition of the native as well as an immigrant population to learn the other culture, respectively. In section 4, the impacts of the results of section 3 on the attitude of the native population on immigration and the optimal immigration choice from a median voter's perspective are analyzed. In Section 5 and 6, I extend the framework by allowing for assortative matching and asymmetric learning costs. Section 7 concludes.

2 Literature on Cultural Interaction

In recent years, there has been a growing literature dealing with the impact of cultural diversity on economic performance. Many economists conclude that there is a link between a country's cultural heterogeneity and the innovation power of the country's enterprises. For example, Hunt and Gauthier-Loisell (2010) for the U.S. and Niebuhr (2010) for Germany find a significant impact of cultural diversity of the labor force on patent application. Their results partially point at the differences of capabilities and knowledge of workers from different cultures.

Another strand of the economic literature investigates the interaction of different cultures in large cities and metropolitan areas. Based on the traditional view that diversity is an

important feature for the economic performance of geographical regions[4], the vast majority of these research papers finds a positive impact of cultural diversity on the economic outcome of the respective agglomeration (Ottaviano and Peri (2005, 2006) and Bellini et al. (2008)). Similarly, Florida (2002) finds that US cities which are most tolerant towards bohemians and minority cultures are at the same time among the most innovative ones with regard to high tech sectors.

Apart from the studies that investigate innovation on the regional level, there exists a broad literature, mainly from the management and psychological sciences, analyzing the success of culturally heterogeneous teams, for example in sports or in international enterprises. Lazear (1999b) suggests that immigrants and domestic team mates can be regarded as complements in team production since they can take advantage of a larger pool of ideas and experiences due to different cultural or educational backgrounds. In this context, he describes the search for best practices as one example of factor complementarity.[5]

Contrary to the described benefits are the losses which may arise due to communication difficulties among workers as well as cultural and ethnical conflicts or xenophobia among the domestic population. Parts of the negative view on multiculturalism can be explained by the similarity-attraction-paradigm (Byrne 1971) and the identity theory (Tajfel and Turner 1979) which proposes that individuals favor interactions with people who share the same or similar backgrounds, norms and beliefs. For example Ayub and Jehn (2006) regard nationalism as an important feature of an individual's identity which is even emphasized when people from different ethnics or nationalities come together, e.g. in international workgroups. Schiff (2002) mentions the role of social capital which makes people feel closer to individuals with whom they share same or similar values and beliefs which simplify interactions.[6] Finally, there is broad empirical evidence that culturally heterogeneous societies value public goods less, patronage more and collectively care less about fiscal discipline (Easterly and Levine (1997), Alesina et al (1999) and Habyarimani et al. (2007)).

Whether the benefits or the losses from cultural heterogeneity are dominant depends on the underlying context. With regard to team performance, Earley and Mosakowski (2000) suggest a curvilinear relationship between cultural heterogeneity and team performance. They presume that homogenous and highly heterogeneous teams outperform moder-

[4]More general, diversity can exist at the industry, firm or individual level. Empirical studies in general find that diversity of a city has a positive impact on its economic performance. (Jacobs 1969, Bairoch 1988, Glaeser et al. 1992, Sassen 1994)

[5]Berliant and Fujita (2008) also highlight the importance of cultural diversity for knowledge creation and transfer.

[6]Besides, Schiff (2002) stresses the role of social capital to explain why opposition against trade and capital mobility is less likely than opposition against immigration.

ately heterogeneous ones. They argue that after forming ways to interact and communicate, multinational teams are able to create a hybrid team culture which permits efficient use of member talents and information. Lazear (1999b) states three aspects which are essential for a positive effect of complementary skills of members in multinational teams. Besides disjoint information of the cultural heterogeneous participants and the non-existence (irrelevance) of communication costs, he mentions the task relevance of the diverse information sets. With regard to the latter argument, Pratt (2002) proposes that activities for which a good fit between various units is the first concern will need a homogeneous workforce in order to maximize coordination, whereas activities that revolve around exploitation of new opportunities will require a more diverse workforce in order to increase the chance of developing successful innovations.[7]

Fujita and Weber (2004) account for the task relevance on the country level by theoretically analyzing the differences between immigration policies of developed countries. They attribute the low immigration quotas in Japan to the necessity of Japanese firms to be provided with homogenous workers with good language and identical educational skills to guarantee precise production processes and maintain the high quality of the final goods. On the contrary, countries such as the U.S. in which enterprises put a higher value at innovation and creativity are less concerned about the heterogeneity of their workforce. In fact its diversity is regarded to be a trigger of innovation and economic growth.

3 A Simple Model Framework of Cultural Interaction

3.1 Basic Framework

In this paper, I present a simple model framework which examines the causal relationship between multicultural interaction of migrants and immigrants, cultural learning and immigration policy. Figure 1 illustrates the sequence of these actions.

First, the immigration policy determines the stock of migrants which determines the cultural composition of the population. Second, due to the cultural composition, immigrants and natives face incentives to learn the respective other culture. Third, interaction between individuals takes place. I assume that interaction at stage 3 is not a result of individual decision making but due to the structure of the society. The individuals only decide over the optimal level of cultural learning at stage two. Taking this into account, the government

[7]For example, in the sports literature on team performance, the irrelevance of culturally heterogeneous information sets of team members is often mentioned to explain why culturally diverse teams tend to be less successful than cultural homogenous teams (Brandes 2009, Haas and Nüesch 2011).

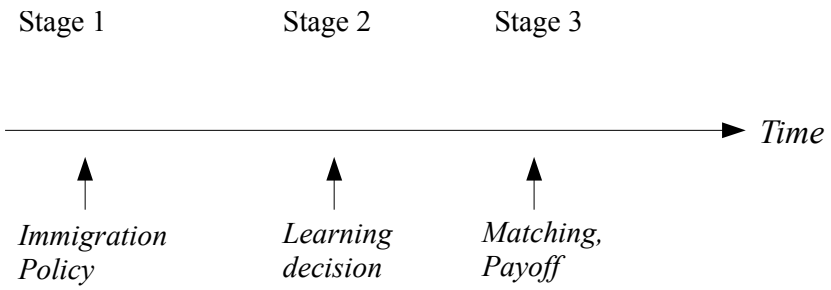

Figure 1: The sequence of actions

chooses the optimal cultural composition by the use of an adequate immigration policy.

In this section, I begin at stage 2 analyzing the ambition of migrants and natives to acquire knowledge of the respective other culture. I construct a simple model in which both, parts of native as well as the immigrant population have incentives to learn the other culture. Thus, I examine short-term cultural learning rather than long-term cultural integration which is mostly assumed to take place over several generations.[8]

By referring to Lazear (1999a), I assume that individuals can learn a new culture without necessarily losing the traditional one. The easiest way to understand this is to think in terms of language which is an important element of every culture. Learning a second language does not mean that an individual has to give up his/her mother tongue.

I set the native population to unity and assume that the immigrant population is equal to m $(0 < m < 1)$. In this section, I keep it simple and abstract from the potential of assortative matching and assume that encounters between individuals are completely random. Thus, the probability that a native (immigrant) individual matches with another native (immigrant) is $q_{n,n} = \frac{1}{1+m}$ $(q_{m,m} = \frac{m}{1+m})$.

Individual welfare depends on the ability to trade (interact) with each other. More precisely, it is derived by the expected payoff from intra- or intercultural exchange. I follow Lazear (1999a) in assuming that there is one period in which each individual randomly interacts with exactly one other individual. Trading requires communication. Thus, at least one of both must have knowledge of the trading partner's culture. This is the case if both are of the same origin or if at least one has learned the respective other culture. Before interaction takes place, each individual must decide whether to learn the other culture or not. Since each individual has only one fixed unit of time, learning the other culture is costly since the time

[8]Long term cultural exchange due to the existence of a nearby population leads either to cultural integration where parts of the individual societies adapt to the other culture (Ashraf and Galor 2007), or cultural hybridization where both cultures melt together (Kuran and Sandholm 2008).

that is spent on learning cannot be used for beneficial trade. The individual costs of learning the other culture depends on the individuals' characteristics such as education, age or prior knowledge which I assume to be heterogeneous among the native as well as the immigrant population.

I now turn to the possible payoffs from intercultural or intracultural exchange. If an encounter takes place between individuals of the same origin, communication problems do not exist, however, there is also no gain of intercultural knowledge exchange. I regard the payoff which both trading partners achieve due to this exchange as a reference value and normalize it to 1.

If the encountering traders have different cultural backgrounds the payoffs largely depend on whether they are able to communicate. I assume that if at least one has learned the respective other culture payoffs will rise to $1+x$ where x indicates the size of the intercultural gain.[9] However, if they are not able to communicate, trading does not work and thus the individual payoffs are 0. The individual welfare of a native and an immigrant is respectively:

$$W_i = \max\left(\left(1-\theta_i\right)\left(q_{n,n}+\left(1-q_{n,n}\right)\left(1+x\right)\right), q_{n,n}+\left(1-q_{n,n}\right)\left(1+x\right)P_{m,n}\right). \tag{1}$$

$$W_j^M = \max\left(\left(1-\theta_j^M\right)\left(q_m+\left(1-q_{m,m}\right)\left(1+x\right)\right), q_{m,m}+\left(1-q_{m,m}\right)\left(1+x\right)P_{n,m}\right). \tag{2}$$

where θ_i describes the learning cost level of native i and θ_j^M the learning cost level of immigrant j. $P_{m,n}$ ($P_{n,m}$) indicates the probability that a randomly chosen immigrant (native) as a potential trading partner has learnt the native (immigrant) culture.

According to (1), a native individual i will decide to learn the immigrant culture if

$$\left(1-\theta_i\right)\frac{1+m\left(1+x\right)}{1+m} \geq P_{m,n}\frac{m\left(1+x\right)}{1+m}+\frac{1}{1+m}. \tag{3}$$

According to (2), an immigrant j will decide to learn the native culture if

$$\left(1-\theta_j^M\right)\frac{1+x+m}{1+m} \geq P_{n,m}\frac{1+x}{1+m}+\frac{m}{1+m}. \tag{4}$$

Rearranging equation (3) and (4) leads to the following benchmarks $\widetilde{\theta}$ for natives and $\widetilde{\theta^M}$ for immigrants, which indicate the minimum cost level at which a native (immigrant) person will learn the immigrant (native) culture.

[9] As has been mentioned in the prior section, this gain can vary across countries and societies because of differences in the task relevance of the shared knowledge pool. For example, if the main industry of a country requires a very homogenous workforce because tasks afford high preciseness, the gain from intercultural exchange is zero.

$$\widetilde{\theta} = (1 - P_{m,n}) \frac{m\,(1+x)}{1 + m\,(1+x)} \tag{5}$$

$$\widetilde{\theta^M} = (1 - P_{n,m}) \frac{1+x}{1+m+x} \tag{6}$$

In the basic framework, I assume that learning costs are the same for the native and the immigrant population and are equally distributed over the learning cost level ranging from 0 to 1.

Due to the assumptions on the distributions of learning costs, one can conclude that the probability that a randomly chosen native (immigrant) will learn the immigrant (native) culture $P_{n,m}$ ($P_{m,n}$) is equal to $\widetilde{\theta}$ ($\widetilde{\theta^M}$). Thus, the probability that a native person will learn the foreign culture can be described as a function of the probability that a migrant is going to learn the native culture and vice versa.

$$P_{n,m} = (1 - P_{m,n}) \frac{m\,(1+x)}{1 + m\,(1+x)} \tag{7}$$

$$P_{m,n} = (1 - P_{n,m}) \frac{1+x}{1+m+x} \tag{8}$$

(7) describes that a native is willing to learn the immigrant culture if immigration is high and if the probability that the immigrant will learn the native culture is low. The gain of cultural exchange positively affects the probability that a native learns the foreign culture. (8) indicates that an immigrant is willing to learn the native culture if immigration is low and if the probability that a native person will learn his culture is also low. The gain of intercultural exchange positively affects the probability that a migrant learns the native culture.

3.2 Equilibrium

By inserting (8) into (7) one achieves the Nash equilibrium probability for both agents learning the other culture, respectively:

$$P^*_{m,n} = \widetilde{\theta^M}^* = \frac{1+x}{(1+x)\,(1+m^2)+m} \tag{9}$$

$$P^*_{n,m} = \widetilde{\theta}^* = \frac{m^2\,(1+x)}{(1+x)\,(1+m^2)+m} \tag{10}$$

Thus, one observes that $P_{n,m} < P_{m,n}$ as long as $m < 1$ which is the normal case where

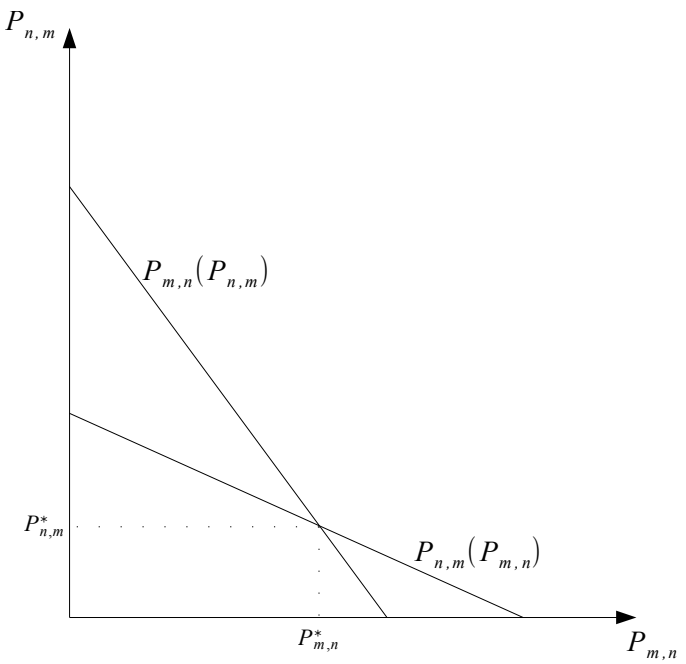

Figure 2: Nash Equilibrium

migrants are a minority in the country. The size of the cultural gain stimulates the incentives for natives and immigrants to learn the other culture. The Nash equilibrium is graphically illustrated by figure 2.

4 The Effect of Immigration on Native Payoffs

4.1 Who Gains and Who Loses?

In this section, I show who of the native population will benefit and who will lose due to the existence of the minority culture. This is important since I suggest that the balancing of advantages and disadvantages that are related to the foreign culture to a large extent shapes the native attitude towards immigrants. Moreover, this can influence the scope of the minority culture if the immigration policy which determines the number of migrants depends on the rational choice of native individuals. In this context, natives have to trade off the gains from an inflow of a foreign culture and the costs that arise from it. By analyzing the individual effects of immigration on native payoffs, I distinguish the native population in those who, due to sufficiently small learning costs, learn the foreign culture (*learners*) from those who do not (*non-learners*).

In the absence of the immigrant culture, the payoff for all native individuals is 1. In case of immigration, a *learner* receives $(1-\theta_i)\,\frac{1+m(1+x)}{1+m}$.

Thus, a *learner* will benefit from immigration if

$$(1-\theta_i)\,\frac{1+m\,(1+x)}{1+m} > 1. \tag{11}$$

Rearranging (11) leads to the conclusion that all *learners* will benefit from immigration if $\theta_i < \widehat{\theta} = \frac{mx}{1+m+mx}$. Therefore, a *learner* will gain by immigration if m and x are high. Keep in mind that an individual i will become a *learner* only if $\theta_i < \widetilde{\theta}^*$. One can conclude that among *learners*, there might be some individuals who lose and some who benefit by immigration. An individual who becomes a *learner* is losing by immigration if $\widehat{\theta} < \theta_i < \widetilde{\theta}^*$.

All *non-learners* will be equally affected by immigration since they all do not learn the foreign culture. Hence, they all lose in the same way due to possible communication problems with migrants but are in the same way positively affected by intercultural exchange. There exists a net gain for *non-learners* if the expected benefit outweighs the expected loss. The expected surplus from immigration is indicated by (12).

$$ES = \left(P^*_{m,n}\,(1+x) - 1\right)\frac{m}{1+m} \tag{12}$$

From (12) one can deduce that immigration is beneficial ($ES > 0$) for *non-learners* if $m < \widehat{m} = \sqrt{\frac{1}{4(1+x)^2} + x} - \frac{1}{2(1+x)}$. Thus, immigration is beneficial if it is relatively low and if the gain through intercultural trade x is relatively high.

Figure 3 illustrates the various areas in (θ, m)-space where native individuals learn the immigrant culture and where they benefit from the existence of the minority culture. The area beneath the $\widetilde{\theta}^*$-curve indicates those native individuals who learn the immigrant culture. Those who do not learn the foreign culture are divided by the $(m = \widehat{m})$-curve in winners (Area B) and losers (Area D) of immigration. Winners and losers are also distinguished among the individuals who learn the foreign culture. Area C (above the $\widehat{\theta}$-curve) represents those who lose by immigration, whereas the beneficiaries of immigration are contained in Area A (beneath the $\widehat{\theta}$-curve).

Individuals in C and D could benefit by a substantial reduction of immigration, however, an increase of m can lead to the case that an individual j with θ_j will learn the immigrant culture and move from Area C into Area A, thus gaining from an increase of immigration. Therefore, at least for some individuals moderate immigration is unfavorable.

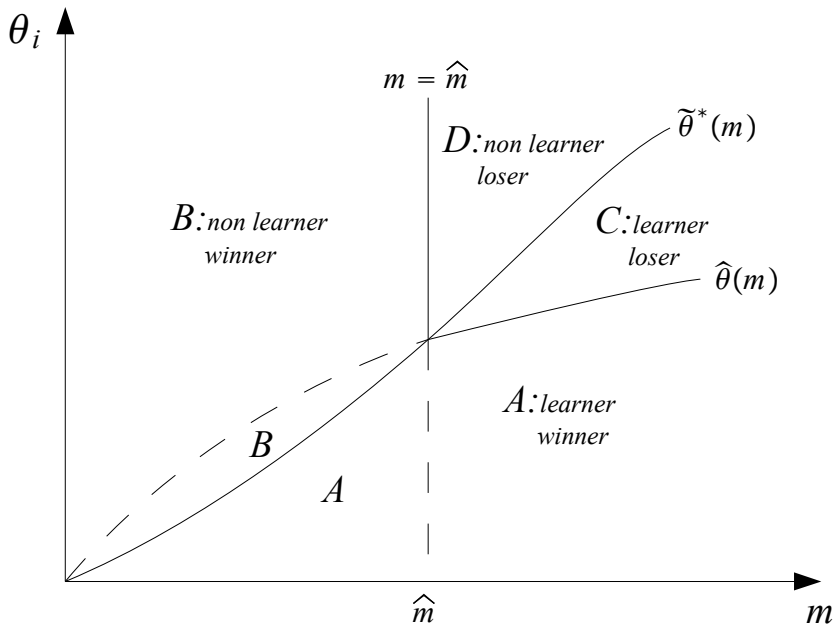

Figure 3: the dividing line between winners and losers of immigration as well as learners and non learners of the immigrant culture

4.2 Median Voter's Choice for an Optimal Scope of Immigrants

In this section, I apply the framework by implementing a median voter's choice over immigration. Therefore, I assume that initially, the total population contains only native individuals who have to decide over an optimal immigration level. Hence, I do not regard immigration as an external inflow but as a factor that is driven by a specific immigration policy. The latter is determined by individual preferences of voters. In order to keep the analysis tractable, I suggest the median voter to be decisive with respect to the election outcome. The assumptions of the model lead to the feasible case that the median voter is always a *non-learners* as long as $0 < m < 1$. This is true since due to the uniform distribution of learning costs between 0 and 1, the median voter's learning cost level θ_{MV} is equal to 0.5. Hence, I can easily calculate that $\theta_{MV} = 0.5 > \frac{m^2(1+x)}{(1+x)(1+m^2)+m} = \widetilde{\theta}^*$.

This simplifies the analysis since all *non-learners* are in the same way affected by immigration. In order to find the median voter's optimal immigration rate, I maximize a *non-learner*'s expected surplus that is achieved by immigration with respect to m. I provide proof that there is an optimal scope of immigration which is between 0 and $\widehat{m}$. It is the root of the first derivative of ES with regard to m.

$$\frac{\partial ES}{\partial m} = \frac{\partial P^*_{m,n}}{\partial m}(1+x)\frac{m}{1+m} + \left(P^*_{m,n}(1+x) - 1\right)\frac{1}{(1+m)^2} = 0 \tag{13}$$

Rearranging of (13) leads to the following equation:

$$1 + m = \frac{A}{\left|\xi_{P^*_{m,n},m}\right|}. \tag{14}$$

where $A = \frac{P^*_{m,n}(1+x)-1}{P^*_{m,n}(1+x)}$ and $\xi_{P^*_{m,n},m}$ is defined as the relative change of the probability that a randomly drawn immigrant is learning the domestic culture $P^*_{m,n}$ due to a relative change of the number of immigrants m. From (9) I can deduce that $\xi_{P^*_{m,n},m} = \frac{\partial P^*_{m,n}}{\partial m}\frac{m}{P^*_{m,n}} = -\frac{(1+x)2m^2+m}{(1+x)(1+m^2)+m}$ is smaller than 0 since an increase of immigration reduces the incentive for immigrants to learn the native culture.

Proposition 1 *There exists exactly one optimal value of m on the interval $[0, \widehat{m}]$ that maximizes the expected surplus through immigration for domestic non-learners.*

Proof. *Examining (14) for m on the interval $[0, \widehat{m}]$ indicates that the left hand side (LHS) is a continuously increasing, positive function with a minimum of 1 and a maximum of $1 + \widehat{m}$, whereas the right hand side (RHS) is a positive, but decreasing function of m with $\lim_{m\to 0} RHS = \infty$ and $RHS = 0$ if $m = \widehat{m}$. This is a sufficient condition to prove that there is exactly one intersection of LHS and RHS and hence exactly one extreme value on the interval $[0, \widehat{m}]$. Since ES is positive only on the interval $]0, \widehat{m}[$ and is zero if $m = 0$ and if $m = \widehat{m}$, the identified extreme value must be a maximum.* ■

This way, I find that there is an optimal immigration rate from the median voter's point of view between 0 and $\widehat{m}$. The intuition is straightforward. An individual who does not learn the foreign culture will gain by immigration due to the intercultural gain. However, only if immigration is relatively low, immigrants to a sufficient extent learn the native culture which is a pre-condition for every $non - learner$ to achieve the intercultural gain. By trading off the positive effects of immigration (enlarged intercultural gain) and drawbacks (decreased integration of immigrants) the median voter finds an optimal immigration level as it is illustrated by figure 4.

One can further examine how the median voter's choice for an optimal immigration rate is affected by the size of the intercultural gain. An increase of x has no effect on the left hand side, yet positively influences the right hand side of equation (14).[10] Graphically, this

[10] This is true because $\frac{dP^*_{m,n}}{dx} > 0$ and $\frac{d\left|\xi_{P^*_{m,n},m}\right|}{dx} < 0$.

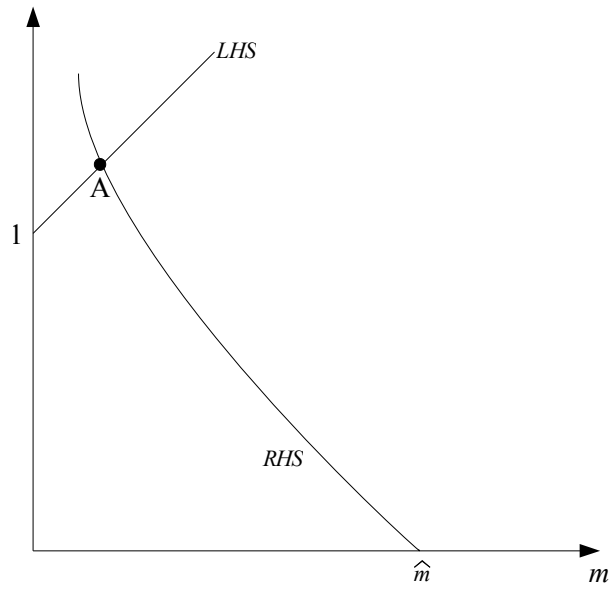

Figure 4: Optimal immigration from median voter's point of view

can be illustrated as an outward shift of the RHS-curve indicating the right hand side of equation (14). An increase of x thus leads to an increase of the immigration rate chosen by the median voter.

5 Assortative Matching

In the former section, I assumed that matching between two individuals is fully random. However, it is feasible that in order to avoid transaction costs, workers prefer to match with individuals of the same culture. This can lead to geographical or vocational segregation, meaning that immigrants live and work in regions where the share of immigrants from the same origin is large. Famous examples are the "china towns" which have developed in many metropolises outside of China within the last 200 years.

I take account of the potential of cultural segregation by implementing a parameter α which describes the level of assortative matching. Similar to Burchardi (2011), I assume that cultural segregation is exogenous from the individual point of view. So assume that individuals with probability α match with individuals of the same cultural origin. With probability $1-\alpha$, they match randomly with an individual from the total population. Therefore, $q_{n,n} = \alpha + \frac{(1-\alpha)}{1+m}$ and $q_{m,m} = \alpha + \frac{(1-\alpha)m}{1+m}$. Thus, $\alpha = 0$ can be thought of as purely random matching like in the prior sections. Conversely, $\alpha = 1$ is equivalent to perfectly assortative matching. Implementing α into equations (1) and (2) leads to:

$$W_i = \max\left((1-\theta_i)\left(\alpha+(1-\alpha)\frac{1+m(1+x)}{1+m}\right), P_{m,n}(1-\alpha)\frac{m(1+x)}{1+m}+\alpha+\frac{(1-\alpha)}{1+m}\right), \quad (15)$$

$$W_j^M = \max\left((1-\theta_j^M)\left(\alpha+(1-\alpha)\frac{m+1+x}{1+m}\right), P_{n,m}(1-\alpha)\frac{1+x}{1+m}+\alpha+\frac{(1-\alpha)m}{1+m}\right). \quad (16)$$

Equivalently to section 3, I form the response functions for natives as well as immigrants:

$$P_{n,m} = (1-P_{m,n})\frac{(1-\alpha)m(1+x)}{1+m+(1-\alpha)mx} \quad (17)$$

$$P_{m,n} = (1-P_{n,m})\frac{(1-\alpha)(1+x)}{1+m+(1-\alpha)x}. \quad (18)$$

The intersection point of (17) and (18) constitute the equilibrium probabilities:

$$P_{n,m}^* = \widetilde{\theta}^* = \frac{(\alpha+m)m(1-\alpha)(1+x)}{(\alpha+m)(1+m+(1-\alpha)mx)+(1-\alpha)(1+x)(1+\alpha m)} \quad (19)$$

$$P_{m,n}^* = \widetilde{\theta^M}^* = \frac{(1+\alpha m)(1-\alpha)(1+x)}{(\alpha+m)(1+m+(1-\alpha)mx)+(1+\alpha m)(1-\alpha)(1+x)} \quad (20)$$

I analyze how sorting affects the probability that natives and immigrants learn the other culture. Intuitively, one might suggest that sorting always reduces the individual incentive to learn the other culture since the probability that individuals from different cultures match is reduced. However, in equilibrium things are more complex, since learning a culture also depends on the probability that the own culture is learned by the respective other population. E.g., an immigrant anticipates that larger segregation will affect natives to be more reluctant in learning the immigrant culture. Hence, there are two effects that work against each other. On the one hand, an increase of sorting leads to a negative *matching probability effect* that reduces the incentive to learn the other culture. On the other hand, an increase of sorting leads to a positive *anticipation effect* which increases the incentive to learn the other culture. For the immigrant population, we can identify that the *matching probability effect* dominates the *anticipation effect* since

$$\frac{\partial P_{m,n}^*}{\partial \alpha} = -\frac{(1+m)(1+x)\left[(1+\alpha m)^2+m(1-m)(1+x)(1-\alpha)^2\right]}{\left[(\alpha+m)(1+m+(1-\alpha)mx)+(1-\alpha)(1+x)(1+\alpha m)\right]^2} < 0. \quad (21)$$

For natives, there is not a unique result since the first derivative of $P_{n,m}^*$ with respect to

α can be positive as well as negative.

$$\frac{\partial P^*_{n,m}}{\partial \alpha} = -\frac{m\,(1+m)\,(1+x)\left[(\alpha+m)^2-(1-m)\,(1+x)\,(1-\alpha)^2\right]}{\left[(\alpha+m)\,(1+m+(1-\alpha)\,mx)+(1-\alpha)\,(1+x)\,(1+\alpha m)\right]^2} \gtrless 0 \qquad (22)$$

(22) indicates that in equilibrium, sorting increases the natives' probability to learn the immigrant culture if $1+x > \frac{(\alpha+m)^2}{(1-m)(1-\alpha)^2}$.[11] Thus, the *anticipation effect* is strong and might outweigh the *matching probability effect* if the gain of intercultural interaction x is large, the stock of immigrants m is small and assortative matching indicated by α is rare.

How will assortative matching influence the natives' attitudes towards migrants? Again I distinguish between *learners* and *non-learners*. According to (11) a *learner* i gains if

$$(1-\theta_i)\,\frac{1+\alpha m+(1-\alpha)\,m\,(1+x)}{1+m} > 1. \qquad (23)$$

Rearranging (23) leads to the conclusion that a *learner* i will benefit from immigration if $\theta_i < \widehat{\theta} = \frac{mx(1-\alpha)}{1+m+mx(1-\alpha)}$. Thus, an increase of sorting will make less *learners* to be in favor of immigration. This can be deduced from the fact that enlarged segregation reduces the potential of intercultural knowledge transfer.

Again I prove that *non-learners* hold the majority in the native population.[12] *Non-learners* will gain from the existence of the minority culture if the gains outweigh the costs. According to (12) we formulate the expected surplus generated by immigration.

$$ES = (1-\alpha)\left(P^*_{m,n}\,(1+x)-1\right)\frac{m}{1+m} \qquad (24)$$

Now I examine the critical value $\widehat{m}$ at which ES is exactly 0. This is the case when $P^*_{m,n}\,(1+x) = 1$. Building the total differential with respect to m and α leads to $\frac{d\widehat{m}}{d\alpha} = -\frac{\frac{\partial P^*_{m,n}}{\partial \alpha}}{\frac{\partial P^*_{m,n}}{\partial m}} < 0$. This means that the maximum number of immigrants which is acceptable for median natives will be lower when assortative matching is frequent.

How is the median voter's choice affected by sorting? One can easily deduce from (24) that the optimal scope of immigration is again determined by (14).[13] In order to examine how the optimal choice of m is influenced by sorting, I refer to the right hand side RHS of (14) and examine whether it is positively or negatively affected by α.

[11] For a more detailed analysis of the two opposing effects see Appendix A.1.

[12] It is still guaranteed that the median voter will not learn the immigrant culture since $P^*_{n,m} < 0.5$.

[13] This is straightforward since $(1-\alpha)$ is a constant factor in (24) that doesn't affect the optimal choice of m.

$$RHS = \frac{A}{\left|\xi_{P^*_{m,n},m}\right|} \tag{25}$$

Keep in mind that $A = \frac{P^*_{m,n}(1+x)-1}{P^*_{m,n}(1+x)}$. By differentiating (25) with respect to α I find that there are potentially two opposing effects.

$$\frac{\partial RHS}{\partial \alpha} = \underbrace{\frac{\partial A}{\partial P^*_{m,n}}}_{>0}\underbrace{\frac{\partial P^*_{m,n}}{\partial \alpha}}_{<0}\underbrace{\frac{1}{\left|\xi_{P^*_{m,n},m}\right|}}_{>0} - \underbrace{\frac{A}{\left(\left|\xi_{P^*_{m,n},m}\right|\right)^2}}_{>0}\underbrace{\frac{\partial\left|\xi_{P^*_{m,n},m}\right|}{\partial \alpha}}_{\lessgtr 0} \lessgtr 0 \tag{26}$$

The numerator of (25) is obviously negatively dependent on α. However, it is uncertain whether the denominator depends negatively or positively on α since $\frac{\partial\left|\xi_{P^*_{m,n},m}\right|}{\partial \alpha} \gtrless 0$[14]. Hence, it is unclear whether the total effect is negative or positive. On the one hand, sorting reduces the probability that immigrants learn the domestic culture which complicates communication and makes *non-learners* further restrict immigration. On the other hand, the argument that an increase of the immigrant population size hampers the cultural learning of immigrants is relativized by sorting. The second effect simply illustrates that population size does not matter as much anymore when assortative matching becomes more frequent.

6 Asymmetric "learning costs" between immigrants and natives

In this section, I alter the framework by allowing for systematically different learning costs between natives and immigrants. This is important since one typically assumes different characteristics of immigrants and natives. I mention three arguments that justify systematic disparities between the two populations in learning the respective other culture. First, natives on average might have higher costs of learning the foreign culture since in many cases, immigration is an outcome of a self-selection process. At least a certain share of immigrants faces the opportunity to immigrate into the host country because their integration costs are low for example if language and cultural skills have already existed before. Second, countries are different in size or international influence. A small or less influential country's population will on average certainly know much more about a population's culture from a large or influential country than vice versa. This applies for example to language skills and historical

[14]See Appendix A.2 for further proof of $\frac{\partial\left|\xi_{P^*_{m,n},m}\right|}{\partial \alpha} \gtrless 0$.

and cultural knowledge. Third, there might be substantial differences between the native and the immigrant population with regard to age, skill, mobility or the level of conservatism that all have an impact on the learning cost level. In general, immigrants are on average younger and more mobile than natives but do not need to have a higher skill level. Moreover, some characteristics can also be required by a specific immigration policy (e.g. the existence of sufficient language skills or a higher educational level).

I insert the feature of systematically different learning costs into the model by assuming that a certain share of immigrants as well as natives will in no case learn the respective other culture. Consider that for this group time costs are larger than 1, so that for these individuals there does not exist any incentive to learn the respective other culture. By denoting ρ to describe the share of immigrants who will never learn the native culture and μ the share of natives who will never learn the immigrant culture, I change equation (7) and (8) to:

$$P_{n,m} = (1 - P_{m,n}) \frac{m(1+x)}{1+m(1+x)} (1-\mu) \tag{27}$$

$$P_{m,n} = (1 - P_{n,m}) \frac{1+x}{1+m(1+x)} (1-\rho). \tag{28}$$

This affects the Nash equilibrium as the intersection of (27) and (28) as indicated by (29) and (30).

$$P^*_{m,n} = \widetilde{\theta^M}^* = \frac{(1+x)(1-\rho)(1+m(1+x)\mu)}{(1+x)(1-\rho)(1+m(1+x)\mu) + (m+(1+x)\rho)(m(1+x)+1)} \tag{29}$$

$$P^*_{n,m} = \widetilde{\theta}^* = \frac{m(1+x)(1-\mu)(m+(1+x)\rho)}{m(1+x)(1-\mu)(m+(1+x)\rho) + (1+x+m)(1+m(1+x)\mu)} \tag{30}$$

By comparing (29) and (30), I find that if $m < 1$ and $\rho < \mu$, the probability that a native individual learns the foreign culture is smaller than the opposite case. Besides the distinctions according to the incentives that arise from the differences in population size, systematic differences in learning costs can be responsible for asymmetries in cultural learning. By concentrating on the self-selection argument, one should suggest that immigrants on average have lower learning costs than natives ($\rho < \mu$). By contrast, in the case when an individual immigrates from a large or influential country into a small and less influential one, immigrants' learning costs could on average also be higher than those of natives ($\rho > \mu$). If this effect is large, it can even outweigh the differences in incentives which arise from different population

sizes between immigrants and natives, leading to a situation where the probability that a native learns the immigrant culture is higher than vice versa. [15]

From (29) and (30) I deduce that in equilibrium an increase of ρ reduces (increases) the probability that an immigrant (native) learns the native (immigrant) culture, whereas an increase of μ reduces (increases) the probabaility that a native (immigrant) learns the immigrant (native) culture.

From the calculated probabilities, it can be examined how the native populations' attitude towards immigration is affected by the systematic difference between learning costs of natives and immigrants.

There is no impact of the asymmetric costs of *learners*, since for them the success of trading does not depend on the probability that the immigrant has learned the domestic culture. This, however, is important for *non-learners*. I can again refer to the root of (12) and check how the critical immigration rate $\widetilde{m}$ is influenced by μ and ρ. Hence, I build the total differential of $P^*_{m,n}(1+x)=1$ with respect to $\widetilde{m}$, μ and ρ and compute that

$$\frac{d\widetilde{m}}{d\mu} = -\frac{\frac{\partial P^*_{m,n}}{\partial \mu}}{\frac{\partial P^*_{m,n}}{\partial m}} > 0, \tag{31}$$

$$\frac{d\widetilde{m}}{d\rho} = -\frac{\frac{\partial P^*_{m,n}}{\partial \rho}}{\frac{\partial P^*_{m,n}}{\partial m}} < 0. \tag{32}$$

(31) and (32) indicate that the maximum immigration level that is accepted by a *non-learner* is positively affected by an increase of ρ and negatively by an increase of μ. The latter is unambiguous since an increase of learning costs for immigrants reduces the probability that they will learn the native culture which reduces the expected surplus of *non-learners*. By contrast, it is surprising that ceteris paribus an average increase in learning costs of natives will make *non-learners* better off. This can be explained by the circumstance that a *non-learner* is an individual that due to high learning costs does not acquire the foreign culture. An increase of ρ means that immigrants are additionally enforced to learn the native culture which makes all *non-learners* better off.

How will the median voter decide over immigration when asymmetric learning costs do exist? First of all, one must check whether the native individual with median learning cost is still not learning the immigrant culture. It could indeed be the case that immigrants have much higher learning costs compared to natives so that natives are so extremely motivated to learn the immigrant culture that the median voter is a *learner*. However, we abstract

[15] More precisely, this is the case if $\rho > \frac{m(1+x)\mu+1-m^2(1-\mu)}{m^2+m+1+x}$.

from this unusual case and assume that the share of immigrants who never learn the native culture is sufficiently low.[16]

Like in the previous section, I examine the right hand sight RHS of equation (14) and study how the optimal immigration rate from a median voter's perspective depends on the cost parameters ρ and μ. I find that the first partial derivative of RHS with respect to ρ is negative:

$$\frac{\partial RHS}{\partial \rho} = \underbrace{\frac{\partial A}{\partial P^*_{m,n}}}_{>0} \underbrace{\frac{\partial P^*_{m,n}}{\partial \rho}}_{<0} \underbrace{\frac{1}{\left|\xi_{P^*_{m,n},m}\right|}}_{>0} - \underbrace{\frac{A}{\left(\left|\xi_{P^*_{m,n},m}\right|\right)^2}}_{>0} \underbrace{\frac{\partial \left|\xi_{P^*_{m,n},m}\right|}{\partial \rho}}_{>0} < 0. \tag{33}$$

All effects on the right hand side of (33) except for the last one are obvious and have been described before. In Appendix A.3, I provide proof that $\frac{d\left|\xi_{P^*_{m,n},m}\right|}{d\rho} > 0$ so that the overall effect is unambiguously negative. Thus, an increase of ρ will decrease the scope of immigration chosen by the median voter. The first partial derivative of of RHS with respect to μ is positive.

$$\frac{\partial RHS}{\partial \mu} = \underbrace{\frac{\partial A}{\partial P^*_{m,n}}}_{>0} \underbrace{\frac{\partial P^*_{m,n}}{\partial \mu}}_{>0} \underbrace{\frac{1}{\left|\xi_{P^*_{m,n},m}\right|}}_{>0} - \underbrace{\frac{A}{\left(\left|\xi_{P^*_{m,n},m}\right|\right)^2}}_{>0} \underbrace{\frac{\partial \left|\xi_{P^*_{m,n},m}\right|}{\partial \mu}}_{<0} > 0 \tag{34}$$

Again, all effects on the right hand side of (34) except for the last one are obvious and have been described before. In Appendix A.3, I additionally show that $\frac{\partial\left|\xi_{P^*_{m,n},m}\right|}{\partial \rho} < 0$ so that the total effect is unambiguously positive. Thus, an increase of μ will lead to an increase of immigration. Whereas it is straightforward that an increase of learning costs of immigrants will be negatively rewarded by the non learning median voter, it is somewhat surprising that an increase of average learning costs of natives increases immigration. The reason is that increasing average costs ceteris paribus influence the immigrants' learning decision. If the politically decisive *non-learner* anticipates that the population as a whole is on average not very efficient in learning the immigrant culture, he or she also anticipates that immigrants will face an enlarged necessity to learn the domestic culture which is positive for all *non-learners*.

[16] More precisely, we assume that $\rho < \frac{1+m+x+\mu m(1+x)(2m+1+x)}{m(1+x)^2(1-\mu)}$.

7 Conclusions

By use of a simple theoretical model framework I studied the various effects that are caused by an influx of a foreign culture on the domestic population. Thereby, I did not distinguish between market and nonmarket interactions but generally analyzed the gains and losses that might be attributed to multicultural interaction. Like in Lazear (1999a), I found that immigrants who were assumed to be the cultural minority face more incentives to acquire specific knowledge of the native culture than vice versa which can be explained by the differences in population size. In equilibrium, I showed that the probability that natives and immigrants learn the respective other culture positively depends on the gain that is achieved by intercultural exchange.

I also analyzed whether individual natives are positively or negatively influenced by the existence of the immigrant culture and thus rather prefer or oppose immigration. I found that natives who are very efficient in learning the immigrant's culture are in favor of free immigration whereas those who have comparably high costs of acquiring knowledge about the foreign culture will vote for limited immigration.

With regard to the empirical literature on the attitudes towards immigrants, one finds large support for the suggestion that those who are rather inefficient in learning another culture on average to the strongest degree oppose immigration. More precisely, it is mainly argued that opposition to immigration is higher if the individual is among the old, uneducated, nationally immobile, patriotic and does not belong to a cultural minority (Espenshade and Hempstead 1996, O'Rourke and Sinnott 2006, Hainmueller and Hiscox 2007, 2010). All the mentioned groups can certainly be assumed to face higher cultural learning costs. Besides the heterogeneity in cultural learning costs, I pointed at the gain of intercultural exchange which shapes the attitude towards immigration and multiculturalism on a country level. From our results, one can propose that countries which are in favor of a multicultural society (due to gains from intercultural interaction) will also be more open for immigration. As has been mentioned by Fujita and Weber (2004), differences according to the task relevance of multicultural exchange can explain differences between immigration policies of the U.S and Japan.

According to the basic framework, I found that the median voter will not learn the immigrant culture. Thus, I expect positive immigration quotas to be a rational outcome of a political process. Even if the median voter is not learning the foreign culture, a circumstance that I expect to be feasible, he/she will not completely shut the borders against immigrants. By trading off the gains through intercultural exchange and the losses from potential communication problems, he/she will find an optimal immigration rate. This highly reflects the

attitudes of large sections of society who are not strictly against immigration but fear a very substantial inflow of people from other countries.

The results remained feasible after I extended the basic model to assortative matching and asymmetric learning costs. I found that enlarged cultural segregation reduces the probability that immigrants learn the native culture so that it influences the native attitude towards migrants, negatively. However, surprisingly, it is not clear whether the median voter's choice of immigration is positively or negatively affected by sorting. With regard to asymmetric learning costs, the results indicate that enlarged learning costs of natives increase the immigrants' necessity to integrate into the native society and thus make the native society to be in favor of an enlarged scope of immigrants.

Of course, the simple model cannot account for all relevant gains and losses from immigration and cultural integration. Hence the influence of immigration on factor proportions and thus wages as well as the fiscal effects has been excluded although they certainly affect the domestic attitude towards immigrants. With regard to cultural interaction, I also assumed that individuals can avoid all the negative aspects of intercultural interaction by simply learning the other culture. However, probably some intercultural problems might be much more complex and cannot be solved so easily even though basic obstacles such as communication barriers have been abolished. Hence, one could also assume that the intercultural gain is smaller than zero. Finally, I concentrated on the existence of one minority culture. It may be interesting for future research to analyze the impact of not only the scope but also of the diversity of the immigrant culture on domestic well-being.

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A Appendix

A.1 The anticipation and the matching probability effect

Recall that (17) and (18) are:

$$P_{n,m} = (1 - P_{m,n})\, F\left(q_{n,m}\right) \tag{35}$$

$$P_{m,n} = (1 - P_{n,m})\, G\left(q_{m,n}\right) \tag{36}$$

where $F\left(q_{n,m}\right) = \frac{(1+x)q_{n,m}}{1+xq_{n,m}}$ and $G\left(q_{m,n}\right) = \frac{(1+x)q_{m,n}}{1+xq_{q_{m,n}}}$ indicate that the learning intensity is increased if matching with the other cultural group becomes more probable. This is true because $\frac{\partial F(q_{n,m})}{\partial q_{n,m}} > 0$ and $\frac{\partial G(q_{m,n})}{\partial q_{m,n}} > 0$. The probabilities to be matched with an individual of the other cultural origin depend negatively on the degree of segregation α since $q_{n,m} = \frac{(1-\alpha)m}{1+m}$ and $q_{m,n} = \frac{(1-\alpha)}{1+m}$.

Total differentiation of (35) and (36) leads to:

$$dP_{n,m} = (1 - P_{m,n})\, \frac{\partial F\left(q_{n,m}\right)}{\partial q_{n,m}} \frac{\partial q_{n,m}}{\partial \alpha} d\alpha - F\left(q_{n,m}\right) dP_{m,n} \tag{37}$$

$$dP_{m,n} = (1 - P_{n,m})\, \frac{\partial G\left(q_{m,n}\right)}{\partial q_{m,n}} \frac{\partial q_{m,n}}{\partial \alpha} d\alpha - G\left(q_{m,n}\right) dP_{n,m}. \tag{38}$$

In equilibrium, one finds that:

$$\frac{dP_{n,m}}{d\alpha} = \frac{\overbrace{(1 - P_{m,n})\, \frac{\partial F\left(q_{n,m}\right)}{\partial q_{n,m}} \frac{\partial q_{n,m}}{\partial \alpha}}^{<0} \overbrace{- (1 - P_{n,m})\, F\left(q_{n,m}\right) \frac{\partial G\left(q_{m,n}\right)}{\partial q_{m,n}} \frac{\partial q_{m,n}}{\partial \alpha}}^{>0}}{1 - F\left(q_{n,m}\right) G\left(q_{m,n}\right)} \tag{39}$$

$$\frac{dP_{m,n}}{d\alpha} = \frac{\overbrace{(1 - P_{n,m})\, \frac{\partial G\left(q_{m,n}\right)}{\partial q_{m,n}} \frac{\partial q_{m,n}}{\partial \alpha}}^{<0} \overbrace{- (1 - P_{m,n})\, G\left(q_{m,n}\right) \frac{\partial F\left(q_{n,m}\right)}{\partial q_{n,m}} \frac{\partial q_{n,m}}{\partial \alpha}}^{>0}}{1 - F\left(q_{n,m}\right) G\left(q_{m,n}\right)}. \tag{40}$$

The denominators of (39) and (40) are positive because $F\left(q_{n,m}\right) < 1$ and $G\left(q_{m,n}\right) < 1$. The numerators respectively however show two oposing effects: the first terms depict the matching probability effect. It states that an increase of segregation reduces the matching probability and thus discourages the individual from learning the other culture. Hence, the effect is negative for both groups. The second effect describes the positive anticipation effect. It states that the individual anticipates that the individual of the other cultural group will also decrease their extent of cultural learning. Since in equilibrium, $P_{m,n} > P_{n,m}$ and $\left|\frac{\partial q_{m,n}}{\partial \alpha}\right| > \left|\frac{\partial q_{n,m}}{\partial \alpha}\right|$, the anticipation effect is much stronger for the native population whereas the matching probability effect is more important for the immigrant population.

A.2 The impact of an increase of the assortative matching parameter α on the elasticity term $\left|\xi_{P^*_{m,n},m}\right|$

I find that the elasticity term $\left|\xi_{P^*_{m,n},m}\right|$ is

$$\left|\xi_{P^*_{m,n},m}\right| = \frac{m}{1+\alpha m}\frac{(1+\alpha m)(1+m+(1-\alpha)mx)+(1+\alpha m)(1-\alpha)(1+x)}{(\alpha+m)(1+m+(1-\alpha)mx)+(1+\alpha m)(1-\alpha)(1+x)}. \tag{41}$$

After some transformations, I achieve:

$$\left|\xi_{P^*_{m,n},m}\right| = \frac{m}{\alpha+m}(1-D). \tag{42}$$

where $D = \frac{\left(1-m^2\right)\left(1-\alpha^2\right)}{(1+\alpha m)^2}P^*_{m,n}$.

The first partial derivative of (42) with respect to α leads us to:

$$\frac{\partial\left|\xi_{P^*_{m,n},m}\right|}{\partial\alpha} = -\frac{m}{\alpha+m}\left(\underbrace{\frac{1-D}{\alpha+m}}_{>0}+\underbrace{\frac{\partial D}{\partial\alpha}}_{<0}\right) \lessgtr 0. \tag{43}$$

A.3 The impact of an increase of the learning cost parameters ρ and μ on the elasticity term $\left|\xi_{P^*_{m,n},m}\right|$

I can infer from (29) that

$$\left|\xi_{P^*_{m,n},m}\right| = \frac{1}{1+m(1+x)\mu}\frac{\mu(1+x)^2m^3+2m^2(1+x)+m\left(1+\rho(1-\mu)(1+x)^2\right)}{\mu(1+x)^2m+(1+m^2)(1+x)+m\left(1+\rho(1-\mu)(1+x)^2\right)}. \tag{44}$$

In order to calculate the marginal effect of an increase of ρ on $\left|\xi_{P^*_{m,n},m}\right|$, I differentiate (44) with respect to ρ.

$$\frac{\partial\left|\xi_{P^*_{m,n},m}\right|}{\partial\rho} = \frac{m\left(1-m^2\right)(1-\mu)(1+x)^3}{\left[\mu(1+x)^2m+(1+m^2)(1+x)+m\left(1+\rho(1-\mu)(1+x)^2\right)\right]^2} > 0 \tag{45}$$

I now prove that $\frac{\partial\left|\xi_{P^*_{m,n},m}\right|}{\partial\mu} < 0$. For illustrative purpose, rewrite (44) to

$$\left|\xi_{P^*_{m,n},m}\right| = B(\mu)\cdot C(\mu) \tag{46}$$

where $B = \frac{1}{1+m(1+x)\mu}$ and $C = \frac{\mu(1+x)^2m^3+2m^2(1+x)+m\left(1+\rho(1-\mu)(1+x)^2\right)}{\mu(1+x)^2m+(1+m^2)(1+x)+m\left(1+\rho(1-\mu)(1+x)^2\right)}$. It is obvious that $\frac{\partial B(\mu)}{\partial \mu} < 0$. Additionally, one finds that

$$\frac{\partial C(\mu)}{\partial \mu} = -\frac{m\left(1-m^2\right)(1+x)^2\left(m(1+x)+1\right)\left(m+\rho(1+x)\right)}{\left[\mu(1+x)^2m+(1+m^2)(1+x)+m\left(1+\rho(1-\mu)(1+x)^2\right)\right]^2} < 0. \tag{47}$$

Thus, differentiation of (46) with respect to μ.leads to

$$\frac{\partial\left|\xi_{P^*_{m,n},m}\right|}{\partial \mu} = \underbrace{\frac{\partial B(\mu)}{\partial \mu}}_{<0}\cdot C + .\underbrace{\frac{\partial C(\mu)}{\partial \mu}}_{<0}\cdot B \; < 0. \tag{48}$$