Immigration Quotas in the Globalized Economy[1]

Masahisa Fujita

Konan University, Kobe, Japan, and the Research Institute of Economy, Trade and Industry, Tokyo, Japan.

and

Shlomo Weber

Department of Economics, SMU, USA, and CEPR.

March 2010 - Revised version.

Abstract

In this paper we consider a model with two industrialized countries facing a flow of high-skilled immigrants from the "rest of the world." The countries, that choose immigration quotas, differ in degree of labor complementarity between the "native" population and immigrants, the population size, and level of cultural friction between the natives and immigrants. We show that total number of immigrants in equilibrium can be excessive, so that coordinated and harmonized immigration policies may improve the welfare of both countries. It is not necessarily true though that both countries would be better off by reducing the number of immigrants. If countries' characteristics are sufficiently diverse, on country could be better off by reducing its immigrant quota, while the other would benefit from a larger number of immigrants.

Key Words: Intra-Country Heterogeneity, Labor Complementarity, Immigration Quota, Policy Harmonization.

JEL Classification Numbers: C72, F22, O3, R1.

[1]We wish to thank Jacques Thisse for useful comments. We are grateful to an anonymous referee for the thorough suggestions which substantially improved the exposition of our results.

1 Introduction

Consider two industrialized countries that face a flow of high-skilled immigrants from the "rest of the world" independently choose their own immigration quotas. The countries are assumed to differ in several aspects, and, in addition to different population sizes, we focus on two important characteristics: the degree of labor complementarity between the "native" population and immigrants, and level of cultural friction between the natives and immigrants.

In addressing the issue of labor complementarity, one immediately notices that production technologies in different countries impose distinct requirements on the level and distribution of labor skills and the workers' interaction with each other. For example, over the years Japan has achieved a very high level of performance in the industries (cars, sophisticated consumer goods) that require a high level of precision and quality control. These industries are characterized by a large number of production stages where technological progress is usually achieved through the series of small but incessant improvements, called "kaizen" (see, e.g., Imai (1989)). This type of production requires not only highly educated and able workers, but also a consistent and extensive level of interaction between them. These demands result in emergence of a labor force that is relatively homogeneous in its educational, cultural, and linguistic background. On the other hand, the "knowledge", and especially, software industries, in the United States rely on talents and abilities of individuals coming from a wide range of vastly different educational and cultural environments. The success of Silicon Valley in the late nineties is often attributed to the diverse backgrounds of scientists, engineers and entrepreneurs who arrived from all corners of the world, such as India, China, Taiwan, Israel, among others. In fact, Saxenian (1999) points out that more than thirty percent of new businesses in Silicon Valley had an Asian-born co-founder.[2] However, the diversity did not prevent, and, in fact, even reinforced the commonality of workers' purpose and goals. Saxenian (1996) describes how workers in Silicon Valley enjoyed frequent and intensive exchange of information through a variety of formal and informal contacts. The exchange was facilitated by frequent moves of workers from one firm to another (the average time spent by an individual in one firm was about two years), and flexible industry structure (it has been often claimed that in Silicon Valley "a firm is simply a vehicle allowing an individual to work.")

The nature of knowledge production indicates the importance of interaction between different workers and, especially, complementarity of their talents and skills, that is quite different from the multi-stage technological process in high-precision manufacturing (see Milgrom and Roberts (1990) and Kremer (1993)). In general, the labor complementarity is based on two sources, *internal heterogeneity*, that describes the diversity of talents within the existing group of workers engaged in a given industry, and *exter-*

[2] Historically, the openness to immigrants is a relatively new phenomena. Chinese immigration (forbidden in the U.S. in 1880) and Japanese immigration (forbidden in 1905) were considered incompatible with American cultural foundations and unwarranted from the economic point of view (Maignan et al. (2003)).

nal heterogeneity, that captures the diversity between the existing group of workers and “newcomers” to the industry. The first type of heterogeneity has been the focus of the Grossman and Maggi (2000) two-country analysis, which introduced a model with a diverse talent pool within each country and examined, among other issues, assignments of different individuals to complementary tasks and their impact on trade patterns between two countries. In our paper we focus on external labor complementarity between “native” population and immigrant workers in domestic industries.

The issue of cultural frictions, and more generally, attitudes of native population towards immigrants have moved to the center of the public debate and active research in industrialized countries in North America, Europe, Asia and Australia.[3] Cultural frictions could themselves in language barriers caused by a difficulty of learning a local language, natives’ bias towards to immigrants, distinct cultural, religious and behavioral attitudes exhibited by natives and immigrants. Different attitudes towards immigrants across various countries can be explained by the web of historical, cultural, linguistic, ethnic, religious, geographic, and economic reasons that are not examined here and we simply accept the fact that various countries exhibit different degrees of cultural friction between natives and immigrant population. It is important to point out that the labor complementarity

[3]For empirical studies on attitudes towards immigration see, e.g., Espenshade and Hempstead (1996), Bauer et al. (2000), Dustmann and Preston (2001), Kessler (2001), O’Rourke and Sinnott (2003), Mayda (2005), Facchini, Mayda and Puglisi (2009), Facchini, Mayda and Puglisi (2009). For a theoretical examination see Chao, Hazari and Laffargue (2007).

and cultural frictions could be related but nevertheless address different phenomena. The labor complementarity is related to purely technological part of production, where individuals from various countries and cultural backgrounds can successfully fit their working skills into the melting pot of the common production process. In the same time, the cultural friction is the concept that describes mostly cultural (in)compatibility between various ethnic, linguistic and religious groups and is often expressed in terms of natives' attitudes towards immigrants (see the growing empirical literature on the topic cited above).

We consider a non-cooperative game between two countries that strategically choose their immigration quotas, while taking into account their differences and the externalities generated through the immigrant wage structure. The latter consists of two parts, the common *world* wage, determined by the total number of immigrants, and the *country-specific* component, which depends on the degree of cultural frictions in the given country. After showing that for any set of parameters of our model there exists a unique pure strategies Nash equilibrium, we discuss a possible coordination and harmonization of immigration policies that may improve the welfare of both countries.

The purpose of examining this game is two-fold. First, we show that the total number of immigrants in two countries in equilibrium could be excessive. Thus, coordinated and harmonized immigration policies may improve the welfare of both countries. It is not necessarily true though that both countries would be better off by reducing the number of immigrants.

If countries' characteristics are sufficiently diverse, on country could be better off by reducing its immigrant quota, while the other would benefit from a larger number of immigrants. While the coordinated reduction of immigration quotas may be beneficial for both countries, one should realize that this conclusion has been stated with respect to equilibrium levels of immigration. In terms of empirical implications, one can justifiably argue that immigration quotas in industrialized countries are far away from the equilibrium levels, and, therefore, a raise of quotas, rather than their reduction, could be a prudent policy recommendation. Our second purpose is to lay down the foundations for the empirical investigation of the levels international strategic interaction and cooperation and their dependence on cultural frictions, based on linguistic and ethnic differences between the native and immigrants' populations (see Fujita, Osang, and Weber (2010) for more details).

Specifically, we consider citizens of two countries, A and B, and immigrants, denoted by I. Since we examine intra-country heterogeneity between A and B in terms of their labor complementarities with the immigrant population, we assume that each of the three groups, A, B, and I is homogeneous in nature and consists of identical individuals. Using the language of Esteban and Ray (1994) in their study of polarization, we focus on heterogeneity across three clusters of individuals and assume complete homogeneity within each of them. In our model there are three parameters that represent the intra-country heterogeneity between countries A and B: (i) degree of *labor* *complementarity* between countries' native population and immigrants; (ii) countries' *population size*; (iii) the magnitude of *cultural friction* between natives and immigrants.

The paper is organized as follows. In the next section we introduce the model. In Section 3 we describe the immigration quota game and state our result on the existence and uniqueness of Nash equilibrium, as well as results on harmonization of immigration policies aimed at the welfare improvement in two countries. Section 4 concludes. The proofs of the results are presented in the Appendix.

2 The Model

There are two "industrialized" countries, A and B, and a flow of immigrants from the "rest of the world". One of the main features of our model is the intra-country heterogeneity in degrees of labor complementarity between native population (natives) and immigrants. Thus, two countries may face different effects of immigrants' contribution towards its production capabilities. More specifically, the production function of country $j = A, B$ is given by:

$$Q_j = (N_j^{\alpha_j} + I_j^{\alpha_j})^{\frac{1}{\alpha_j}}, \tag{1}$$

where N_j is the native population of country j, and I_j is the number of immigrants to country j. The parameter α_j represents a reverse measure of labor complementarity between natives and immigrants in j. We assume that $0 < \alpha_j < 1$, and within this range, the smaller values of α_j reflect a higher degree of labor complementarity. Note also that when $\alpha_j \leq 0$, the complementarity is so strong that the output Q_j tends to zero when the number of immigrants I_j approaches zero. This would imply that the country is unable to survive without the influx of immigrants. In order to avoid this unrealistic situation, we rule out all non-positive values of α_j. On the other hand, when α_j exceeds 1, the iso-quant curves of country j are strictly concave, so that the mix of natives and immigrants is actually harmful for production purposes. This may happen if the cultural gap between two populations is too wide to allow a successful integration of the heterogeneous population into production process. In the case when $\alpha_j = 1$, the mix of two populations has the neutral effect and has neither positive nor negative benefit in production. Summarizing all these arguments, our analysis is focused on an interesting and meaningful case of $0 < \alpha_j < 1$, where natives and immigrants posses a sufficient degree of diversity to enhance the productivity of the industry they engage in. At the same time, the degree of diversity is sufficiently small to allow beneficial integration of two populations into the production process.

The immigrant wages consist of two parts, the *world* wage, which is the same in both countries, and a *country-specific* component that we describe below. As far as the world wage is concerned, the intense world competition for the services of high-skilled immigrants will entice them to immigrate. We assume that the upward-sloping immigrant supply curve will be given by the formula:

$$w_I = c + \gamma I, \tag{2}$$

where c and γ are positive constants, and $I = I_A + I_B$ is the total number of immigrants in countries A and B.

As we alluded above, in addition to their size and labor complementarity parameters, two countries differ in the magnitude of cultural friction between their native populations and immigrants. This type of the intra-country heterogeneity plays an important role in our analysis. In spite of the fact that the immigrant real wages are identical in both countries, the actual wages should take into account different cultural environments in two countries. Indeed, if the linguistic, cultural or religious obstacles faced by immigrants in country B are substantially higher than in country A, then the actual wages required to attract immigrants into country B should be higher than those needed in country A. Formally, we introduce a degree of a country-specific cultural friction, f_j, $j = A, B$ such that the actual wages to be paid to immigrants in country j are given by

$$w_j = w_I + f_j. \tag{3}$$

By representing the welfare of country $j = A, B$ is[4]

$$W_j = Q_j - w_j I_j = Q_j - w_I I_j - f_j I_j. \tag{4}$$

The immigration quota of country $j = A, B$, given by

$$x_j = \frac{I_j}{N_j}, \tag{5}$$

represents the ratio of immigrants and the native population. The production levels in two countries are determined by

$$Q_A = N_A(1 + x_A^{\alpha})^{\frac{1}{\alpha}},\ Q_B = N_B(1 + x_B^{\beta})^{\frac{1}{\beta}}, \tag{6}$$

where, for simplicity of notation, the degrees of complementarity, α_A and α_B, are replaced by α and β, respectively. It is convenient to express the real immigrant wage and the country j's welfare level in terms of immigration quotas:

$$w_I = c + \gamma(N_A x_A + N_B x_B), \tag{7}$$

and

$$W_j = Q_j - w_I N_j x_j - f_j N_j x_j. \tag{8}$$

To provide some examples, consider first a Chinese immigration to the United States and Japan. In general, Chinese immigrants do not easily integrate into production process in Japan that requires a high degree of cultural

[4]Here we implicitly assume a circular flow of migration between country j and the rest of the world (called "temporary migration" (Wong (1995)), when immigrants do not stay in j for "too long". Thus, in absence of voting rights, the welfare of country j is that of its natives only. More generally, we may replace the term $w_I I_j$ by $\theta_j w_I I_j$, where $\theta_j \in [0, 1]$ is a parameter reflecting the degree of integration of immigrants in country j's society. $\theta = 1$ corresponds to our model whereas other extreme case $\theta =$ represents the case of the complete integration of immigrants where their earnings are fully accounted in the country welfare.

homogeneity and an intensive level of interaction and communication within the labor force. Thus, the degree of labor complementarity of Chinese immigrants in Japan is relatively low. The situation is different in the U.S., where, after receiving an appropriate education, Chinese immigrants exhibit a relatively high degree of labor complementarity. As far as cultural friction is concerned, it is commonly recognized that the U.S. are more open to immigration than Japan. In addition, there are also linguistic and historical challenges for Chinese immigrants in Japan. Even though Chinese characters are used in both China and Japan, their pronunciation in two countries is completely different. More importantly, the Chinese language structure is very similar to that of English, while being quite distinct from Japanese. In addition, the lingering memories of painful historical events and relationship between the two countries, one may assume a higher degree of cultural friction faced by Chinese immigrants in Japan than in the U.S.

Note that the patterns of the Indian immigration to the United States and Japan offer a different angle. The mix of heterogeneous populations of Japanese and Indians may be rather harmful in refining the high-quality manufacturing through incessant "kaizen" in the production process. In contrast, mixing appropriately heterogeneous populations of Americans and Indians generates higher complementarity in software development. Thus, the *reversed* degree of complementarity in the U.S. would be lower than the corresponding value in Japan. We may also assume that, in terms of cultural differences, Hindu is equally distant from Christianity and Buddhism. But, given the Indian colonial past, a large number of educated people in India speak English, so that the degree of cultural friction in the U.S. is lower than in Japan.

3 The Quota Game

To proceed with the formal framework, we consider a multidimensional parameter space P, where each point p in P represents degrees of labor complementarity, population size, and cultural frictions in two countries. That is,

$$P \equiv \{p = (\alpha, \beta, N_A, N_B, f_A, f_B) |\ 0 < \alpha, \beta < 1,\ N_A, N_B, f_A, f_B > 0\}. \quad (9)$$

Let vector $p \in P$, that describes the state of the "world economy", be given. We consider a game $\Gamma(p)$ between two countries, A and B, whose strategic choices are their relative immigration quotas, x_A and x_B, respectively. The payoff of country $j = A, B$, is represented by its welfare level, $W_j(x_A, x_B)$, that depend on their production, immigrant wages, and the cultural friction between the native population and immigrants in country j:

$$W_j(x_A, x_B) = Q_j - w_I N_j x_j - f_j N_j x_j. \quad (10)$$

We have our main result:

Proposition 3.1: For every $p \in P$, the immigration quota game $\Gamma(p)$ admits a unique pure strategies Nash equilibrium. Moreover, in equilibrium, both countries choose strictly positive immigration quotas.

The proof of this proposition is relegated to the Appendix. We would like to point out that first we show that the reaction curves of two countries, $x^\star_A(x_B)$ and $x^\star_B(x_A)$, intersect for every choice of p. The reason for uniqueness of the equilibrium is based on the fact that the slopes of the reaction curves, are bounded by 0 and -1.[5] That is, a raise by ϵ of an immigration quota in country A would trigger a less than ϵ decline in immigration quota in B and two reaction curves do not intersect more than once. Together with the existence argument, this guarantees the uniqueness of an equilibrium.

The question whether government policies can enhance the welfare of a country. One may consider policies aimed at reducing of cultural frictions and investment in education aimed at labor complementarity issues. In this paper we do not address these long run policies but ask whether coordinated and harmonized immigration policies of countries A and B may improve their welfare. It turns out that the equilibrium immigration levels yield an excessive number of immigrants. This result clearly calls for a need for coordinated immigration policies that might be beneficial for both countries. To reinforce this point, we show that a harmonized reduction of equilibrium immigration levels, both in relative and absolute terms, would raise the welfare in both countries.

For every point p in the parameter space P, consider the cooperative outcome $(x^c_A(p), x^c_B(p))$ that maximizes the joint welfare of two countries.

[5] A similar argument is often used in the study of uniqueness of a Cournot equilibrium, see Tirole (1988), Chapter 5.

That is, for a given $p \in P$, the countries attempt to find:

$$\max_{(x_A, x_B) \in \Re^2_{++}} \{W_A(x_A, x_B) + W_B(x_A, x_B)\}. \tag{11}$$

First, we show that, regardless of degree of heterogeneity in size, cultural friction and labor complementarity between natives and immigrants, the total number of immigrants into two countries in equilibrium is always "excessive."

Proposition 3.2: For every point $p \in P$ the total number of immigrants in the non-cooperative equilibrium is larger than under joint welfare maximization:

$$N_A x_A^c(p) + N_B x_B^c(p) < N_A x_A^e(p) + N_B x_B^e(p). \tag{12}$$

It is important to point out that Proposition 3.2 does not imply that the equilibrium immigration quota is excessive for *each* country. It claims only that the total number of immigrants in two countries is excessive. Indeed, it is possible that if the countries possess sharply distinct characteristics, one of the countries should raise its immigration quota under cooperative outcome. It is not the case for two countries with similar characteristics,[6] where the immigration quota of each country is excessive with respect to the cooperative solution:

Proposition 3.3: Let point $p = (\alpha, \alpha, N, N, f, f) \in P$ represent two countries with identical characteristics. Then there exists a positive number

[6] In general, in symmetric games, where strategies are strategic complements, each player chooses a larger value of her strategic variable than that compatible with the joint welfare maximization.

ϵ such that for every point $p' \in P$, satisfying $\|p - p'\| < \epsilon$, the inequality $x_j^c(p') < x_j^e(p')$ holds for every $j = A, B$.

We complete this section by analyzing how the countries can increase their welfare by implementing harmonized immigration policies. We consider two approaches, harmonized relative reduction and harmonized absolute reduction. Under the first policy, both countries reduce their immigration levels by the same percentage point. Alternatively, they may agree on the same number of immigrants eliminated from their respective equilibrium quotas.

Proposition 3.4: Let point $p \in P$ be given.

(i) - *Relative Reduction.* There is a number $\lambda, < \lambda < 1$ such that for all $\lambda' \in (\lambda, 1)$:

$$W_A(\lambda' x_A^e(p), \lambda' x_B^e(p)) > W_A^e(p), \quad \text{and} \quad W_B(\lambda' x_A^e(p), \lambda' x_B^e(p)) > W_B^e(p). \tag{13}$$

(ii) - *Absolute Reduction.* There is $\mu >$ such that for all $\mu' \in (, \mu)$:

$$W_A(x_A^e(p) - \mu', x_B^e(p) - \mu') > W_A^e(p), \quad \text{and} \quad W_B(x_A^e(p) - \mu', x_B^e(p) - \mu') > W_B^e(p). \tag{14}$$

4 Concluding Remarks

In this paper we consider a model with two industrialized countries and a mass of high-skilled immigrants. The countries' characteristics may vary with respect to their population size, degree of cultural friction toward immigrants, and labor complementarity between native population and immigrants. The latter is an outcome of distinctive production processes in two countries: one (e.g., software industry) is rooted in a heterogeneous labor force with a wide range of cultural, ethnic and educational backgrounds, and the other (e.g., high-precision manufacturing) is based on homogeneity and a high degree of interaction between workers.

We consider a non-cooperative game between two countries where each of them makes a strategic decision by choosing its immigration quota. We first show that our game admits a unique pure strategies Nash equilibrium and then study the welfare implications of countries' choices. It turns out that a country with a higher degree of production basis and a higher level of tolerance towards immigrants would allow a larger immigration quota. In addition, we show that while a more populous country allows more immigrants, it would establish a lower ratio between immigrants and natives. We also argue that both countries can benefit by coordinating their strategies, and our results call for harmonized immigration policies aimed at improving the welfare of both countries.

To focus our analysis on difference in labor complementarity between the native population in countries A and B, we assumed a complete homogeneity within each of the three groups, natives in A and B, and immigrants. The next natural step, left for the future research, is to generalize this model by allowing heterogeneity, both across countries and within the immigrant population. It is especially important in analysis of high-tech knowledge industries, where ethnic, cultural, and social diversity plays even more important role. Indeed, as Florida and Gates (2001) and Florida (2002) show in their studies of metropolitan areas in the U.S., the population diversity is a strong indicator of metropolitan areas' high-technology success. These papers argue that a high percentage of gay population, number of artists and "bohemians", a high concentration of foreign-born residents are closely linked with the area's high-technology concentration and growth (see also Saxenian (1999)). Another important direction of future research is an investigation of international trade consequences between countries as a function of their distinct industrial specialization and distribution of skills and talents within their working force (for the latter see Grossman and Maggi (2000), Grossman (2002), Das (2004)).

5 Appendix

Proof of Proposition 3.1: We have the following expressions for countries' payoffs in terms of immigration quotas:[7]

$$W_A(x_A,x_B) = N_A(1+x_A^{\alpha})^{\frac{1}{\alpha}} - [c+\gamma(N_Ax_A+N_Bx_B)]N_Ax_A - f_AN_Ax_A, \quad (15)$$

$$W_B(x_A,x_B) = N_B(1+x_B^{\alpha})^{\frac{1}{\alpha}} - [c+\gamma(N_Ax_A+N_Bx_B)]N_Bx_B - f_BN_Bx_B. \quad (16)$$

Since the payoff functions of country A are continuously differentiable and concave in x_A for any x_B, we determine the best response of country A to

[7] Since the welfare of each country is decreasing in immigration quota of the other, it follows that the immigration quotas are, in fact, *strategic substitutes* (Bulow, Geanakoplos and Klemperer (1985)).

the immigration quota x_B of country B (and vice versa) by solving the first order conditions:

$$\frac{\partial W_A(x_A, x_B)}{\partial x_A} = N_A \left(g(\alpha, x_A) - c - \gamma(2N_A x_A + N_B x_B) - f_A \right) = 0 \quad (17)$$

and

$$\frac{\partial W_B(x_A, x_B)}{\partial x_B} = N_B \left(g(\beta, x_B) - c - \gamma(2N_B x_B + N_A x_A) - f_B \right) = 0, \quad (18)$$

where the function $g : (0,1) \times \Re_{++} \to \Re_{++}$ is defined by

$$g(\delta, x) \equiv (1 + x^{\delta})^{\frac{1}{\delta}-1} x^{\delta-1} = (1 + x^{-\delta})^{\frac{1}{\delta}-1}. \quad (19)$$

for every $\delta \in (0,1)$ and a positive x. It is easy to see that for every $\delta \in (0,1)$, the function $g(\delta, \cdot)$ is decreasing on $\Re_{++}$, $\lim_{x \to 0} g(\delta, x) = +\infty$, and $\lim_{x \to +\infty} g(\delta, x) = 1$.

It follows, therefore, that the solutions of the first order conditions (18) and (19), $x_A^\star(x_B)$ and $x_B^\star(x_A)$, are well-defined, positive-valued, continuous and strictly decreasing in the other country's quota choice. Moreover, they approach zero when the immigration quota of the other country tends to infinity and are finite-valued if the quota of the other country is set to zero. Thus, the best response functions of two countries intersect, yielding the existence of a Nash equilibrium.

Note that equation (18) implies that the best response of country A is given by

$$\frac{dx_A^\star}{dx_B} = -\frac{\gamma N_B}{(1-\alpha) x_A^{-\alpha-1} (1 + x_A^{-\alpha})^{\frac{1-2\alpha}{\alpha}} + 2\gamma N_A}. \quad (20)$$

Similarly, the best response of country B, given by (19), is determined by

$$\frac{dx_B^\star}{dx_A} = -\frac{\gamma N_A}{(1-\beta)x_B^{-\beta-1}(1+x_B^{-\beta})^{\frac{1-2\beta}{\beta}} + 2\gamma N_B}. \tag{21}$$

Note that the inverse of the right side of equation (21)

$$-\frac{(1-\alpha)x_A^{-\alpha-1}(1+x_A^{-\alpha})^{\frac{1-2\alpha}{\alpha}} + 2\gamma N_A}{\gamma N_B} \tag{22}$$

represents the slope of the reaction curve of country A with respect to x_A axis. However, the expression in (22) is greater than $-\frac{N_A}{2N_B}$, whereas the expression in (23) is smaller than $-\frac{2N_A}{N_B}$. That is, the reaction curve of country B on the x_A axis is everywhere flatter than that of country A. Thus, two reaction curves do not intersect more than once, which, together with the existence argument, yields a unique Nash equilibrium. Since the intersection occurs at the interior point of the positive orthant, this completes the proof of the proposition.$\square$

Proof of Proposition 3.2: Take a point $p = (\alpha, \beta, N_A, N_B, f_A, f_B) \in P$. The cooperative outcome, $(x_A^c(p), x_B^c(p))$ satisfies the following first order conditions:

$$\frac{\partial(W_A + W_B)}{\partial x_A} = \frac{\partial(W_A + W_B)}{\partial x_B} = 0. \tag{23}$$

Expressions (16) and (17) imply that the cooperative outcome satisfies the following:

$$g(\alpha, x_A) - 2\gamma N_A x_A = c + 2\gamma N_B x_B + f_A, \tag{24}$$

$$g(\beta, x_B) - 2\gamma N_B x_B = c + 2\gamma N_A x_A + f_B. \tag{25}$$

Notice that (25) and (18) are special cases of the following equation

$$g(\alpha, x_A) - 2\gamma N_A x_A - c - qN_B x_B - f_A = 0. \tag{26}$$

Indeed, if $q = \gamma$, (27) becomes (18), and if $q = 2\gamma$, (27) it turns into (25). Similarly, (26) and (19) are special cases of the equation:

$$g(\beta, x_B) - 2\gamma N_B x_B - c - qN_A x_A - f_B = 0. \tag{27}$$

Denote the solutions of (27) and (28) by x_A^q and x_B^q, respectively. It suffice to show that the function $N_A x_A^q + N_B x_B^q$ declines in q on the interval $[\gamma, 2\gamma]$.

By the Implicit Functions Theorem we have:

$$\frac{dx_A^q}{dq} = -\frac{-N_B x_B^q (g_2(\beta, x_B^q) - 2\gamma N_B) - qN_A N_B x_A^q}{\Delta}, \tag{28}$$

where

$$\Delta = (g_2(\alpha, x_A^q) - 2\gamma N_A)(g_2(\beta, x_B^q) - 2\gamma N_B) - q^2 N_A N_B, \tag{29}$$

and g_2 is the derivative of the function g with respect to the second argument. Since this derivative is negative and $q \leq 2\gamma$, it follows that $\Delta > 0$.

Similarly,

$$\frac{dx_B^q}{dq} = -\frac{-N_A x_A^q (g_2(\alpha, x_A^q) - 2\gamma N_A) - qN_A N_B x_B^q}{\Delta}. \tag{30}$$

Finally,

$$\frac{d(N_A x_A^q + N_B x_B^q)}{dq} = -\frac{N_A N_B \{[-g_2(\alpha, x_A^q) x_B^q - g_2(\beta, x_B^q) x_A^q] + (2\gamma - q)[N_A x_A^q + N_B x_B^q]\}}{\Delta}. \tag{31}$$

Again, since the values of g_2 are negative, the inequality $2\gamma - q \geq 0$ implies that the last expression is negative. $\square$

Proof of Proposition 3.3: Let $\bar{p} = (\alpha, \alpha, N_A, N_A, f_A, f_A) \in P$. Proposition 3.2 implies that $x_A^c(\bar{p}) = x_B^c(\bar{p}) < x_A^e(\bar{p}) = x_B^c(\bar{p})$. By the continuity argument, these relations will be preserved around the point $\bar{p}$. That is, there is a neighborhood $U(\bar{p}) \subset P$ such that $x_A^c(p) < x_A^e(p)$ and $x_B^c(p) < x_B^e(p)$ for every $p \in U(\bar{p})$. $\square$

Proof of Proposition 3.4: (i) Consider the function $W_A(\lambda x_A, \lambda x_B)$, where λ is a positive number. By (16),

$$W_A(\lambda x_A, \lambda x_B) = N_A(1 + x_A^{\alpha})^{\frac{1}{\alpha}} - [c + \gamma(N_A x_A + N_B x_B)]N_A x_A - f_A N_A x_A. \tag{32}$$

By differentiating with respect to λ we have:

$$\frac{dW_A(\lambda x_A, \lambda x_B)}{d\lambda} = N_A(1+(\lambda x_A)^{\alpha})^{\frac{1}{\alpha}-1} x_A^{\alpha} \lambda^{\alpha-1} - [c+2\lambda\gamma(N_B x_B + N_A x_A)]\lambda N_A x_A - \lambda f_A N_A x_A. \tag{33}$$

The value of the last expression at $\lambda = 1$ and $(x_A^e(p), x_B^e(p))$ is:

$$x_A^e(p)(g(\alpha, x_A^e(p)) - 2\gamma N_A x_A^e(p) - 2\gamma N_B x_B^e(p) - c - f_A, \tag{34}$$

which, by (18), is negative. Thus, a sufficiently small increase in λ would raise the welfare of country A. The argument for country B proceeds along the same lines.

(ii) Consider the function $W_A(x_A+\varepsilon, x_B+\varepsilon)$, where ε is a real number. By (16), we have

$$W_A(x_A+\varepsilon, x_B+\varepsilon) = N_A(1+(x_A+\varepsilon)^\alpha)^{\frac{1}{\alpha}} - [c+\gamma(N_A(x_A+\varepsilon)+N_B(x_B+\varepsilon)]N_A(x_A+\varepsilon) - f_A N_A(x_A+\varepsilon). \tag{35}$$

By taking the derivative of this welfare function with respect to ε at $\varepsilon = 0$, we obtain:

$$N_A(1+x_A^\alpha)^{\frac{1}{\alpha}-1}x_A^{\alpha-1} - [c+2\gamma(N_B x_B + N_A x_A)]N_A x_A - f_A N_A. \tag{36}$$

Equation (18) implies that the last expression is negative at the point $(x_A^e(p), x_B^e(p))$. Thus, a sufficiently small increase in ε would raise the welfare of country A. The argument for country B proceeds along the same lines.$\square$

6 References

Bauer, T.K. Lofstrom, M., and K.F. Zimmermann (2000), "Immigration policy, assimilation of immigrants and natives' sentiments towards immigrants: evidence from 12 OECD countries", *Swedish Economic Policy Review* 7, 11-53.

Dustmann, C and I. Preston (2001), "Racial and economic factors in attitudes to immigration", IZA Discussion Paper, #189.

Bulow, J., Geanakoplos, J, and P. Klemperer (1985), "Multimarket oligopoly: strategic substitutes and complements", *Journal of Political Economy* 93, 488-511.

Chao, C-C, Hazari, B. and J-P Laffargue (2007), A simple theory of the optimal number of immigrants", Chinese University of Hong Kong Discussion Paper.

Das, S. P. (2004) "Vertical diversity and equilibrium growth", Indian Statistical Institute Discussion Paper, New Delhi, June 2004.

Espenshade, T.J. and K. Hempstead (1996) "Contemporary American attitudes towards U.S. immigration", *International Migration Review* 30, 535-570.

Esteban, J.M. and D. Ray (1994) "On the measurement of polarization", *Econometrica* 62 (4), 819-851.

Facchini, G., and A.M. Mayda (2009), "Individual attitudes towards skilled migration: an empirical analysis across countries", CEPR Discussion Paper #7592.

Facchini, G, Mayda, A.M. and R. Puglisi (2009), "Illegal immigration and media exposure: evidence on individual attitudes", CEPR Discussion Paper #7593.

Florida, R. (2002), "Bohemia and economic geography", *Journal of Economic Geography* 2, 55-71.

Florida, R. and G. Gates (2001), "Technology and tolerance: the importance of diversity to high-tech growth", Brookings Institute Discussion Paper, Washington, DC.

Fujita, M. and J.-F. Thisse (2003), "Does economic agglomeration foster economic growth? And who gains and looses from it?" *Japanese Economic*

Review, 54, 121-145.

Fujita, M., Osang, T. and S. Weber (2010), "Immigration policies, Labor Complementarity, and Cultural Frictions: Theory and Evidence" SMU Working Paper.

Grossman, G. and G. Maggi (2000), "Diversity and growth", *American Economic Review* 90 (5), 1255-1275.

Grossman, G. (2002), "The distribution of talent and the pattern and consequences in international trade", CESifo Working Paper #745.

Imai, M. (1989), *Kaizen: the key to Japan's competitive success*, McGraw-Hill, New York, NY.

Kessler, A. (2001), "Immigration, economic insecurity and the "ambivalent" nAmerican public", The Center for Comparative Immigration Studies, University of California at San-Diego, Discussion Paper #41.

Kremer, M. (1993), "O-Ring theory of economic development", *Quarterly Journal of Economics* 18, 551-575.

Lucas, R.E. (1988), "On the mechanics of economic development", *Journal of Monetary Economics* 22, 3-42.

Maignan, C., Ottaviano, G. and D. Pinelli (2003), Economic growth, innovation, cultural diversity. What are we all talking about? A critical survey of the state-of-the-art, The Fondazione Eni Enrico Mattei Working Paper #12.2003.

Mayda, A.M. (2005), 'Who is against immigration? A cross-country investigation of individual attitudes towards immigrants", Georgetown University Discussion Paper.

Milgrom, P. and J. Roberts (1999), “The economics of modern manufacturing: technology, strategy, and organization” *American Economic Review* 71, 845-858.

O’Rourke, K. H. and R. Sinnott (2003), “Migration flows, political economy of migration and the empirical challenges”, Trinity College Dublin Economic Paper #20036.

Saxenian, A. (1996), *Regional advantage: culture and competition in Silicon Valley and Route 128*, Harvard University Press, Cambridge, MA.

Saxenian, A. (1999), *Silicon Valley’s New Immigrant Entrepreneurs*, Public Policy Institute of California, San Francisco, CA.

Tirole, J. (1988), *The Theory of Industrial Organization*, The MIT Press, Cambridge, Massachusetts.

Wong, K. (1995), *International trade in goods and factor mobility*, MIT University Press, Cambridge, MA.