

Qirjo, Dhimitri

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ORIGINAL ARTICLE

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Monitoring, endogenous comparative advantage, and immigration

Dhimitri Qirjo

Correspondence: dqirj001@fiu.edu
Department of Economics &
Finance, SUNY Plattsburgh, School
of Business & Economics, 329 Au
Sable Hall, 101 Broad Street,
Plattsburgh, NY 12901, USA

Abstract

We propose a theory of free movement of goods and labor between two economies in the presence of moral hazard. Each country produces two final goods where the productive efforts of workers cannot be perfectly observed, or verified only in the complex industry. We show that national institutional quality and the system of the early childhood care and education determine the pattern of international trade. However, individuals' decisions to emigrate depend only on the national institutional quality, where the country with more developed institutions serves as the host country of immigrants. We conclude that international labor movement promotes international trade.

JEL classification: B52, I21, F10, F16, F22, J24.

Keywords: Comparative advantage, Occupational choice, Education, Institutions, Immigration, Moral hazard, Organization of production

1 Introduction

A number of recent political developments have intensified the free movement of goods and labor. According to Hatton and Williamson (2005), over the last 30 years the ratio of exports of goods to GDP has doubled in many countries. Also, in terms of world population, immigrants' proportion has increased. The United Nations estimates that international migrants constituted 3 percent of the world population in 2005. The tendency toward the international labor liberalization influences the human capital accumulation in any country, which in turn can change the dynamics of international trade in the world.

A new, but growing literature reports the importance of national institutional development on the pattern and effects of international trade. There are also plenty of theoretical and empirical papers that investigate the role of educational quality on the pattern of international labor movement. Moreover, there is a history of theoretical and empirical exploration into the existence of a relationship between international trade and international migration. However, researchers have not paid much attention to the effect of national institutional development on the pattern and consequences of international labor movement. We find it essential to focus on this gap in the literature for several reasons. First, not comprehending the effect of national institutional quality on the pattern and aftermath of international labor migration may lead to an underestimation of the benefits of a creation of a common labor market area. For instance,

we find that international migration boosts international trade. This result is more profound when the country with the most developed institutions has the worst national early childhood care and educational system (henceforth, ECCE). Moreover, we find that a creation of a common labor market increases the intensity of human capital accumulation in the world.

This paper offers a theoretical understanding of the role that ECCE and the national institutional development play in a country's accumulation and distribution of human capital in the presence of moral hazard under free movements of goods and labor. In this sense, we explore the existence of a mechanical linkage between immigration and trade. We treat national institutional quality and ECCE as exogenous.¹

Our paper presents a simple two-country-Ricardian-trade model under free trade and immigration. Countries export either a high-skill intensive (complex) good or a low-skill intensive (simple) good. Exogenous national institutional quality is complementary to agents' training acquisitions because more developed national institutions are associated with lower monitoring costs, which attracts workers willing to provide relatively high productive efforts, which is more important in producing the complex good. This is the main force driving the sorting of agents in our model. Ultimately, since relatively higher national institutional quality attracts skilled immigrants, the country with the more developed institutions exports the complex good. The quality of the exogenous ECCE also generates the underlying individuals' training distribution across countries. In two otherwise similar economies, the one with the best ECCE will export the complex good. When a country obtains relatively better ECCE such that individuals acquire high training levels, but national institutional quality is low such that agents' training levels are underutilized, out-migration toward the country with better institutions occurs.

This paper is a generalization of Vogel (2007) to allow for immigration and ECCE. In order to motivate the international movement of labor, countries are given differential training endowments, which are endogenously determined by the existence of the exogenous national quality of institutions and ECCE. This drives the additional mechanism that departs from Vogel (2007). Our model shows that differences in relative national institutional quality and underlying training endowments will not straightforwardly drive migration. We find that because migration will be selective on individuals' training levels, it will alter the pattern of comparative advantage in international trade.

Our approach presents an opportunity to understand international trade, immigration and education simultaneously in a single model. Each country has a large number of firms grouped into two industries, a simple and a complex one. There are two final goods produced using only labor. In the simple sector, individuals work alone and produce a simple good. In the other sector, production of a complex good is determined by collaboration between a worker and a manager. If a manager is able to measure perfectly a worker's efforts, then the second has no incentive to provide unproductive efforts. But the manager is unable to identify perfectly worker's efforts. The level of unproductive efforts depends not only on the worker's wage that she receives, but also on the degree of imperfectability of the labor contracts. We assume that the latter is related to the development of national institutions. The more developed national institutions, the lower worker's unproductive effort levels will be.

Individuals have the same homothetic preferences toward accumulation of human capital, but they possess different natural ability levels. The higher their ability, the

lower their cost of acquiring high training levels. The more trained workers are, the less their unproductive effort levels. An individual knows that it is costly for her to acquire training subject to her natural ability and efforts subject to her training. However, a better trained manager under more developed national institutions is compensated more for her ability to reduce moral hazard in the complex sector. An efficient matching process takes place, where the most talented workers pair up with the most talented managers and enter in the complex sector. The least talented individuals enter in the simple sector.

In some sectors it is impossible for a manager of a firm to perfectly observe the productive efforts of her employees who engage in a team project during the production process. For example, in an interdisciplinary research project conducted from two researchers that are specialized in two distant academic subjects, if one of the researchers is the manager, and the other the worker, it is hard for the former to evaluate the latter because the manager can judge her part of the research but is unable to perfectly evaluate the part of the research conducted by the worker. She therefore cannot perfectly measure the value of their interdisciplinary research project. However, the manager has perfect information about the training levels of her employee but imperfect information about her productive efforts during the production process. She can design a wage contract that values her employee's work subject to certain norms that are perfectly measured and verified such as the quality of her employees' ideas and determination in the working process. Managers with higher training levels can better evaluate a performance measure of their employees.

No matter how skillful a manager is, there are still outside factors, such as the broad national institutional development that could encourage employees to increase their individual productive efforts in the team production. We assume that better developed national institutions provide a higher quality of the performance and verifiability measures of the firms that operate in the complex sector.

ECCE is another factor that influences individuals' decision about their skill level. Two individuals who are born with the same natural ability, but live in countries with different ECCE, will acquire different skill levels. It is easier for the one who lives in the country with the best ECCE to accumulate more skills and, therefore, to exert more productive effort levels in the complex industry. One may imagine a different label for ECCE, such as a natural cultural identity that promotes ECCE independent of the evolution of the national institutional development. For example, Japan has better ECCE than the USA, at least according to the survival rate to grade 5,² but the USA has better national institutions than Japan, as proxied by the rule of law index taken from Kaufmann et al. (2010), which measures, among other factors, the quality of contract enforcement. In Table 1, we present the above indexes, where the ECCE index is taken from UNESCO EFA (2010) and the rule of law index is taken from Kaufmann et al. (2010).³

In our model, countries are assumed to vary only in the development of their institutions and ECCE. Under free trade, the country with the best ECCE and the most developed institutions contains more highly skilled individuals who seek employment in the complex industry, and therefore, these countries export the complex good. In a common labor market regime, the country with the best developed institutions is the host country of immigrants. Only the most talented individuals prefer to emigrate toward

the country with the best developed institutions because there they capture higher incomes for their training levels. National institutional quality acts as the sole determinant of the pattern of international labor movement.

We show that immigration promotes international trade especially in a scenario when the country with the most developed institutions has the worst ECCE. According to Table 1, one can find a plethora of countries that satisfy these conditions. For example, Croatia, Democratic Republic of Korea, Slovenia, Italy, Belarus, Spain, and Japan have better ECCE than USA, but the latter has more developed institutions than all the above countries. Thus, if these countries differ only in the development of their national level of institutions and ECCE, then according to our theory their autarky prices could quite possibly be the same, providing no incentives for international trade. However, under a common market area, we observe a movement of labor from the country with the least developed institutions (Italy) toward the country with the most developed ones (USA). Immigration changes the division of labor in both countries, giving unequivocal comparative advantage in the complex good to the country with the most developed institutions (USA). Thus, international labor movement creates international trade. This is true not only in the above scenario, but as long as there are national institutional differences, independent of the ECCE.

We also examine the effects of international students on trade, assuming that countries also differ in their national training systems. It follows that the country with the best ECCE, training system and more developed institutions exports the complex good. However, when international students must return to their country of origin after graduation, we show that it is possible that the host country will eventually export the simple good under the scenario that the latter has a better quality of institutions and training systems, but worse ECCE.

This paper contributes to the recent and growing literature on institutions and international trade. It argues that the quality of institutions and ECCE act as independent sources of comparative advantage in a country. This result is consistent with Vogel (2007); Costinot (2009); Grossman (2004); Levchenko (2007); Matsuyama (2005); and Nunn (2007). We follow Vogel (2007) by developing a simple theoretical game in which each individual chooses her sector of employment, training level, production team, and efforts. Our model differs from all of the above because we allow for immigration and ECCE. A distinct contribution of our model is to make ECCE the sole determinant of the pattern of international trade in the presence of moral hazard.

This paper adds to literature on international trade and the allocation of talent similar to Vogel (2007); Ohnsorge and Trefler (2007); Rosen (1981); and Lucas (1978). This paper is different from the above in the definition of talent, which is defined as something that an individual with given natural ability develops through the interaction of the national institutional development and ECCE.

This paper also contributes to the literature on economics of immigration. It shows that only the most skilled individuals immigrate in the country with the most developed institutions. This is consistent with Abowd and Freeman (1991); Blanchard and Katz (1992); Borjas (1987, 1992, 1993); Freeman (1993); and Jensen (1988). Our paper differs notably in terms of the mechanism through which the incentives of individuals to emigrate are determined. It sheds light on a separate channel, the national institutional development, which resolves the pattern of international labor migration.⁴

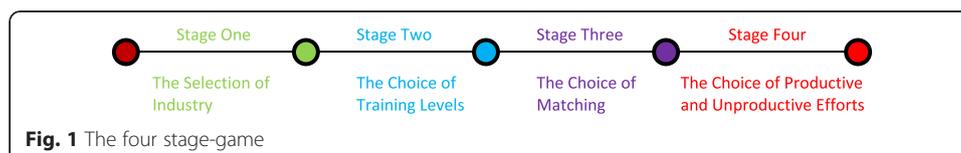
Finally, this paper adds to the literature that explores the linkage between immigration and international trade. In a classical paper, Mundell (1957), using a basic Heckscher-Ohlin model, shows that international trade and immigration are substitutes. Markusen (1983) claims that there exists complementarity between immigration and trade for low barriers' costs using a typical Heckscher-Ohlin framework. However, if the barriers' costs related to international trade or/and international factor movements are too large, his conclusions are reversed.⁵ The result of our model is consistent with Markusen in that immigration promotes international trade, but we use a Ricardian trade model. Our paper differs from Markusen (1983) when barrier costs are too large. In such a case, our model predicts that international trade and immigration still complement each other because individuals with the highest natural ability find it beneficial to emigrate toward the country with the most developed institutions, since they will be rewarded for reducing moral hazard. To the best of our knowledge, this work is the first one that links immigration and trade using a simple Ricardian model in the presence of moral hazard.

The rest of the paper is organized into seven sections. In Section II, we describe a five-stage theoretical game in a two sector economy. In Section III, we solve the five-stage theoretical game for a symmetric subgame perfect equilibrium in a closed economy in the presence of moral hazard. Section IV investigates the pattern of international trade. Section V explores human capital accumulation in both countries under a common labor market area. Section VI allows for temporary or permanent migration of individuals in pursuit of their studies, and section VII concludes. The proofs of all propositions and corollaries are provided in Appendix C. See Additional file 1: Appendix C.

2 The model

The economy has two sectors (X and Y). In the Y sector, individuals work alone. They own their own firm where they produce good y . For convenience, we call this sector "the simple sector."⁶ In the X sector, production of the final good is determined as a result of a team work between a manager (the firm's owner) and a worker, where the manager is unable to identify perfectly worker's efforts presenting incentives to the latter to provide unproductive efforts. We assume that the unproductive efforts are related to the country's institutional quality and to the level of a worker's and manager's ability. We refer to the X sector as the "complex sector".

We illustrate the timing of the four stage game in Fig. 1. An individual is born with a certain level of natural ability that she uses together with the benefits from ECCE to choose the industry in which she will seek employment. Then, she decides the optimal level of her industry-specific training. Throughout this paper, college/university education refers to industry-specific training. Using her training under perfect information on the development of national institutions, she picks the appropriate production team. Finally, she chooses the level and the nature of effort to supply in her work. The above four-stage game is solved for a symmetric, subgame-perfect equilibrium using backward induction, where the utility of an individual, who consumes C_l units of the final good l ,



with natural ability q , and sector-specific training t , who supplies an amount of productive efforts a , and an amount of unproductive efforts d , under a ECCE b , is given by

$$U = u(C_x, C_y) - \frac{1}{2t}(a^2 + d^2) - \frac{1}{2bq}t^2 \tag{1}$$

Individuals have identical and homothetic preferences represented by $u(C_x, C_y) = C_x^\beta C_y^{1-\beta}$ and the income of an individual is $I = x + py$, where p is the relative price of good y , thus, x is the numeraire. Each individual maximizes her utility function subject to her income level, giving the following

$$V(a, d) = RI - \frac{1}{2t}(a^2 + d^2) - \frac{1}{2q}t^2 \tag{2}$$

where $R \equiv \beta^\beta(1-\beta)^{1-\beta}p^{-\beta}$. There are many competitive firms in each sector. Each firm in the simple sector consists of one individual who exerts (a) effort levels. Each firm in the complex sector consists of a manager and a worker, where the manager exerts a_m productive efforts, while the worker exerts a_w productive and d_w unproductive efforts. Each type of effort is costly, but only the productive efforts increase firm's output. The production functions in both sectors exhibit constant returns to scale, as described in the following two equations

$$y(a) = a \quad x(a_w, a_m) = 2\sqrt{a_w a_m} \tag{3}$$

In the Y sector, an individual who provides one unit of labor exerting effort (a) gets in return (a) units of final good y . In the X sector, the final good is produced as a result of matched efforts of a manager and a worker. We follow the assumption of complementarities in production. A firm with a manager who provides one unit of labor exerting effort (a_m) and a worker who exerts productive effort (a_w) and unproductive effort (d_w) produces $2\sqrt{a_w a_m}$ units of final good x .

In the fourth stage, in sector Y , an individual provides the effort level that maximizes her firm's profit. In the complex sector, a manager exerts the amount of effort that maximizes the firm's profit, while a worker exerts the amount of effort that maximizes her income defined in the performance measure, where the latter is defined as follows

$$K(\theta, t_m, a_w, d_w) \equiv t_w + \left(\frac{e^{1-\theta} - 1}{t_m}\right)d_w, \tag{4}$$

where t_m denotes the training level obtained by a manager; a_w and d_w respectively denote the amount of unobservable productive and unproductive efforts of the worker w paired with the manager m . Thus, since $\theta \in [0, 1]$ denotes the national institutional quality, the higher θ , or/and the higher the t_m , the better the manager's monitoring of the worker's unproductive efforts.

In the third stage, in the complex sector, individuals choose their production team. Potential managers offer a contract based on a potential workers' performance measure as defined above. Managers observe and verify workers' training levels, but they are unable to monitor perfectly the level of effort that workers put into the production process. Also, workers accept the contract after observing managers' training levels. In the equilibrium, workers and managers pair up, subject to their training levels.

In the second stage, which only in the simple sector is the same as the third stage, an individual chooses her level of training that maximizes her firm's profit. In the complex sector, a manager chooses her optimal level of training in order to maximize her firm's profit and a worker decides on her optimal level of job training that maximizes her wage, which is determined in the third stage.

In the first stage we determine individuals' choice of industry, where they cannot be employed simultaneously in both sectors. We assume that individual's natural abilities and ECCE are both exogenous, where $q_i \in [q_{min}, q_{max}]$, $q_i > 0$, & $b \geq 1$. Please note that we drop the underscript (i) when necessary for notation simplicity.

3 Labor distribution and moral hazard

This section describes the equilibrium in a closed economy with two sectors. First, we focus in sector Y , where on the fourth stage an individual's optimal productive efforts are $a = Rpt$. Thus, the utility of an individual who works in the simple sector with optimal effort levels is

$$V_y = \frac{1}{2}(Rp)^2 t - \frac{1}{2bq_y} t^2 \quad (5)$$

We skip the third stage, since for simplicity individuals work alone in this sector. In the second stage, an individual's optimal levels of training are $t = \frac{1}{2}(Rp)^2 bq_y$. These lead to

$$V_y = \frac{1}{8}(Rp)^4 bq \quad (6)$$

In the complex sector, in the last stage, a manager endowed with t_m units of training, who provides a_m productive efforts, pairs up with a worker endowed with t_w units of training, who supplies a_w productive and d_w unproductive efforts. Manager's income comes from her firm's profit which are $\Pi = x - wK$, where her homothetic preferences are $V_m = R\Pi - \frac{1}{2t_m} a_m^2 - \frac{1}{2bq_m} t_m^2$. A worker's homothetic preferences are $V_w = RKw - \frac{1}{2t_w} (a_w^2 + d_w^2) - \frac{1}{2bq_w} t_w^2$. The optimal unproductive effort levels exerted by a worker are $d_w = Rwt_w \frac{e^{1-\theta} - 1}{t_m}$. More developed institutions and more trained managers increase the verifiability of a worker's productive efforts. The optimal productive effort levels for a worker are $a_w = Rwt_w$ indicating that they are a monotonically increasing function of her training levels and wage.

In the third stage, a manager presents a wage to a worker after observing the worker's training levels. The worker decides on whether to accept it knowing the manager's training levels. A manager (worker) maximizes her profits (income) by designing (accepting) a contract that corresponds to her's (manager's) and the worker's levels of training, subject to the quality of institutions. We maximize the aggregate post-training utilities of a worker and a manager who work together in a team and denoted with Λ , which represents the total post-training utility derived from matching a manager with training t_m with a worker with training t_w . Maximizing Λ over the wage, we find the optimal wage

$$w = \left(\frac{t_m}{t_w} \Psi^3 \right)^{\frac{1}{4}} \tag{7}$$

where $\Psi \equiv \left[\frac{t_m^2}{t_m^2 + (e^{1-\theta} - 1)^2} \right]$ shows the quality of the monitoring ability of a manager with training t_m and national institutional development level θ . The more developed the national institutions, or/and the more skilled a manager, the higher the quality of a manager’s monitoring ability will be. Substituting the wage with the optimal wage in the aggregate post-training utility of the firm, we show that the manager and the worker must have the same training level in equilibrium in order to maximize their own utilities.⁷ Thus, the optimal wage after the matching process is $w = \Psi^{\frac{3}{4}}$.

In the second stage, we find the optimal levels of training for an individual who works in the complex sector in an implicit way defined by

$$t_x^* = \frac{R^2 \Psi^{1/2} b}{2} \left(\frac{2(e^{1-\theta} - 1)^2 + t_x^{*2}}{t_x^{*2} + (e^{1-\theta} - 1)^2} \right) q_x \tag{8}$$

Note that $\frac{\partial t_x^*}{\partial q_x} > 0$, individuals with high natural ability obtain high training levels. Also, $\frac{\partial t_x^*}{\partial b} > 0$, the better the ECCE, the higher her optimal training levels will be. Thus, the utility of an individual with optimal training and q_x skill levels, who works in sector X is

$$V_x = V_m = V_w = \frac{1}{4} R^2 \Psi^{3/2} t_x^* \tag{9}$$

Individuals who work in the complex sector get a higher level of satisfaction for a higher quality of the manager’s monitoring ability, which is positively related to the national development of institutions.

In the first stage, an individual chooses her sector of employment. Combining (6) with (9) implies that she is indifferent when choosing a sector only if $V_x = V_y$.

In sector X , the higher an individual’s training levels, the more developed national institutions are, the higher a manager’s ability of the performance measure, or the better ECCE, the higher an individual’s level of satisfaction will be. We summarize the above results with the help of the following three propositions.

3.1 Proposition 1

In a closed economy with $\theta \in [0, 1)$ there exists a $q^ \in [q_{min}, q_{max}]$, such that individuals join the complex sector if and only if $q > q^*$.*

Individuals with higher levels of natural ability have more incentives to obtain higher level of training because it is relatively easier for them. They join the complex sector. Since there is a positive relationship between individuals’ training levels and their natural ability, there must exist a unique level of natural ability. Individuals who possess higher levels of natural ability than the threshold level will enter into the complex sector. The uniqueness of q^* is determined by the relationships of optimal training levels and natural ability levels. Then, corollary 1 follows.

3.2 Corollary 1

The following inequalities hold: i) $\frac{\partial q^}{\partial \theta} < 0$; & ii) $\frac{\partial q^*}{\partial b} < 0$.*

Part i) indicates that better national institutions increase the incentives of individuals to join the complex sector since V_x is increasing in the quality of institutions, but V_y is independent of the institutional quality [see (6), (8) and (9)]. The second part states that better ECCE provide extra incentives for individuals to seek employment in the complex sector. From proposition 1, we know that individuals who obtain relatively high level of training work in the complex sectors. The more trained individuals are those with relatively high natural ability. This is formalized in proposition 2.

3.3 Proposition 2

In a closed economy, in the presence of moral hazard:

- 1) $\forall q \geq q^*, t_x(q)$ is convex in q ;
- 2) $\forall q \geq q^*, t_x(q) > t_y(q)$;

Proposition 2 shows that any individual with a natural ability greater than the threshold level (q^*) accumulates a higher level of training if she enters into the complex sector. In our model, this statement is obvious because an individual’s level of training is a strictly convex function of her natural ability for all individuals who enter into the complex sector, X , while it is a linear function of her natural ability for those who enter into the simple sector, Y . We illustrate the statements of part 1) and 2) of proposition 2 in Fig. 2, where in the vertical axes we plot the values of all individuals’ levels of training [$t_i(q^*)$] as a function of their natural ability (q). An individual optimizes her utility and therefore enters into the simple sector only if her natural ability is strictly smaller than the threshold level, and she enters into the complex sector if her natural ability is equal or greater than the threshold level. As one can observe from Fig. 2, there is a jump point in levels of training right at the threshold level of utility. The red curve represents the t_x function for all $q \geq q^*$ and the blue line illustrates t_y function for all $q \geq q^*$, where $\theta \in [0, 1)$ and $q^* \in [q_{min}, q_{max}]$.

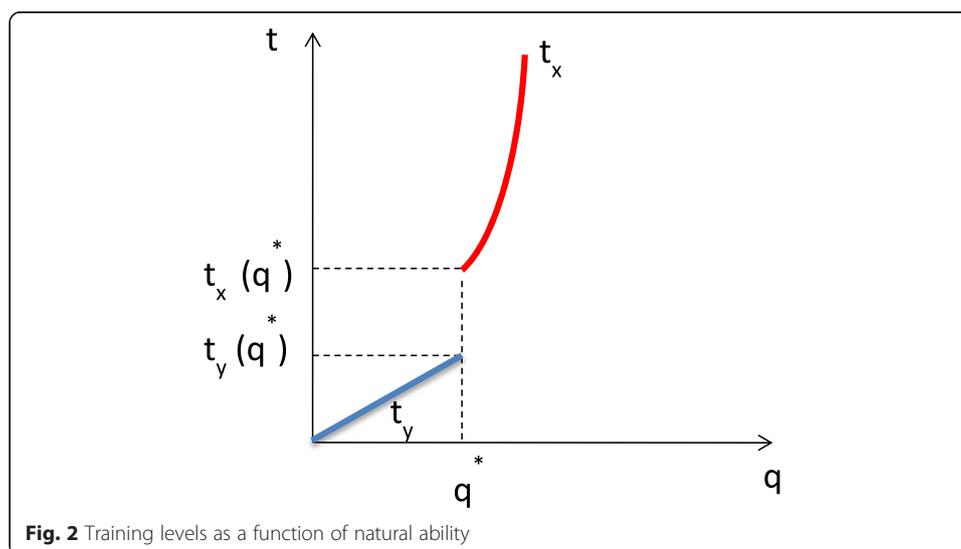


Fig. 2 Training levels as a function of natural ability

3.4 Proposition 3

In a closed economy, where $\theta \in [0, 1)$, the income of an individual who works in the complex sector is strictly higher than that of an individual who works in the simple sector for all $q > q^$.*

Proposition 3 states that individuals who have greater natural ability than the threshold are strictly richer if they enter into the complex sector than they would have been had they entered the simple one. Their utility is higher in the complex sector as compared to the simple sector, while their utility cost of obtaining training is strictly higher in the complex sector. Therefore, their income must be strictly higher.

4 The effects of international trade in two large economies

In this section, we associate the existence of a trade pattern with the differences on the distribution of training levels in the labor force of each country. The allocation of training levels in the labor force is determined by the distribution of natural ability levels, ECCE, and development of national institutions. We assume there are two countries (H & O) with two sectors each, a simple and a complex one. Both countries are the same in all aspects except the quality of their institutions and ECCE.

We first assume that both countries have institutions of identical quality, but H offers a better ECCE than O . Under free trade, we can determine the distribution of training levels in their labor force and, therefore, predict the pattern of international trade. We assume that even after free trade each country is incompletely specialized in the production of both goods. Also, for convenience, suppose that the distributions of the natural ability levels in both countries are exactly the same; however, H offers a better ECCE for all its citizens as compared to O . Using our notation, $b^H > b^O$, then proposition 4 follows.

4.1 Proposition 4

In each country in the presence of moral hazard, where $\theta^j = \theta$, $j \in (O, H)$, there exists a unique $(q^)^j$, such that individuals enter into the complex sector if and only if $q^j > (q^*)^j$. Thus, the assumption that $b^H > b^O$ implies that*

$$1) (q^*)^H < (q^*)^O \quad \forall q > 0$$

$$2) (q^*)^O \geq q_{min} \text{ and } (q^*)^H \leq q_{max}$$

Part 1 of proposition 4 states that the country with the best ECCE obtains a labor force that consists of more highly skilled individuals. It is cheaper to produce the complex good in H . Thus, H exports the complex good to O in exchange for imports of the simple good from O . The main implication of proposition 4 is that it considers the ECCE as a unique, independent source of comparative advantage in the presence of moral hazard. Assuming that both countries have the same ECCE, but H has more developed institutions than O , proposition 5 follows.

4.2 Proposition 5

In each country with $\theta < 1$, where $b^j = b$, there exists a unique $(q^*)^j$, such that individuals enter into the complex sector if and only if $q^j > (q^*)^j$. Thus, $\theta^H > \theta^O$ implies that

- 1) $(q^*)^H < (q^*)^O \quad \forall q^j > 0$
- 2) $(q^*)^O \geq q_{min}$ and $(q^*)^H \leq q_{max}$

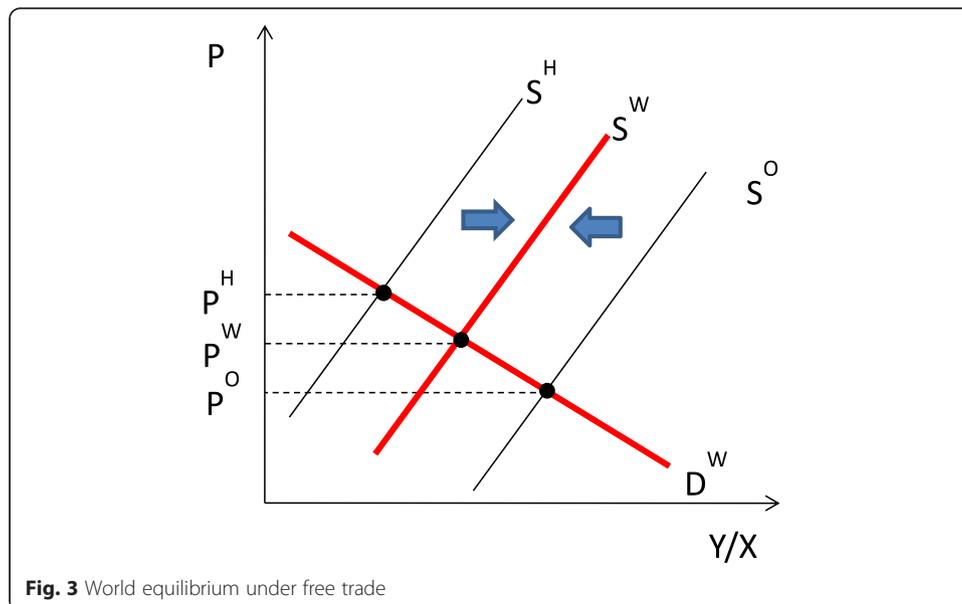
The quality of national institutions acts as an independent source of comparative advantage. Country *H* exports the complex good as a result of having a labor force that consists of more talented individuals because it has better developed institutions as compared to country *O*. Thus, relatively more individuals of country *H* seek employment into the complex sector, where they obtain higher levels of training, and therefore provide more productive efforts in order to gain higher income levels. Thus, corollary 2 follows.

4.3 Corollary 2

Under free trade, with $\theta < 1$, where $b^j = b$ & $\theta^H > \theta^O$ (or $\theta^j = \theta$ & $b^H > b^O$)

- 1) $t_x(q)^H > t_x(q)^O \quad \forall q > (q^*)^H$
- 2) $I_x(q)^H > I_x(q)^O \quad \forall q > (q^*)^H$

We illustrate the situations presented in both propositions in Fig. 3. In the vertical axes, we plot the values of the relative price of the simple good, and in the horizontal axes we plot the values of the relative quantity of the simple good. Since individuals have identical and homothetic preferences, the relative demand line is the same for



both countries. But, in autarky, RS^O lies in the right of RS^H because the labor force of O consists of relatively less highly trained workers. Thus, the relative autarky price of the simple good in O is lower than in H . Hence, O should export the simple good to H and import the complex good from H . Therefore, the world relative price of the simple good post-trade should be between the relative autarky prices of O and H . In summary, propositions 4 & 5 indicate that under free trade, the country that has a better ECCE or/and more developed institutions exports the complex good and imports the simple good.

5 The effects of emigration in two large economies

In this section, we associate individuals' decision to emigrate with their income difference, subject to their natural ability, which exists between the two countries. We assume that there exist fixed costs of immigration, such as language and culture barriers. Suppose that both countries only differ in the quality of their institutions and their ECCE. Let's first assume that H has more developed institutions ($\theta^H > \theta^O$), but has identical ECCE with O ($b^H = b^O$). Therefore, according to proposition 5, H will export the complex good to O . If two countries enter in a common labor market area, we can predict the pattern of international labor movement with the help of the following proposition.

5.1 Proposition 6

Under free international movement of labor:

- 1) *In each country with $\theta < 1$, where $b^j = b$ and $\theta^H > \theta^O$, there exists a unique $(q^*)^j$, such that individuals enter into the X sector if and only if $q^j > (q^*)^j$*
- 2) *$(q^*)^O \geq q_{min}$ and $(q^*)^H \leq q_{max}$*
- 3) *$(q^*)^H < (q^*)^O \quad \forall q^j > 0$ and $I_x(q)^H > I_x(q)^O \quad \forall q > q^*$*
- 4) *H is the host and O the origin country of immigrants if and only if there exists a \tilde{q} such that $I_x(q)^H > [I_x(q)^O + c] \quad \forall q > \tilde{q}$, where $\tilde{q} > (q^*)^H$ and $0 < c < (q^*)^O - (q^*)^H$*

Part 1), 2) and 3) of proposition 6 replicate proposition 5 and corollary 2, but for open labor markets, where \tilde{q} denotes the migration threshold level. The main implication of proposition 6 is related to part 4), which states that national institutional quality acts as an independent source of the international migration, where c denotes the fixed costs of immigration. This states that H will continue to export the complex good as a result of having more highly trained individuals than O because H has more developed institutions. Thus, most individuals in H seek employment in the complex sector where they are compensated more. Individuals who have the exact same natural ability and work in the complex sector but live in different countries obtain dissimilar levels of income due to differences in the development of the national institutions. There will be no emigration of any individual who works in the simple sector because the quality of national institutions is not related to their income levels. However, an individual who works in the complex sector in country H enjoys a higher income as compared to the

income of an individual who works in the same sector in country O and has exactly the same natural ability levels. Therefore, proposition 7 follows.

5.2 Proposition 7

Under free movements of goods and labor, where $b^j = b$ and $\theta^H > \theta^O$

- 1) *Only the most talented individuals of country O will emigrate toward H .*
- 2) *There exists a \bar{q} that corresponds to a \bar{c} such that individuals with $\bar{q} < q^O < (q^*)^O$ from O will immigrate in H to enter in the complex sector. They would have never entered into the complex sector in the absence of a common labor market.*

Part 1) of proposition 7 states that because country H has better institutions, the income of an individual who works in the complex sector in H is strictly higher than the income of an individual who possesses an identical skill level but works in the complex sector in O . Thus, such an individual of O has an incentive to immigrate in H only if her difference of income due to immigration exceeds the fixed costs of immigration. Part 2) of proposition 7 implies that with the opening of the labor markets, there will be an increase in production of the complex good because some individuals from O [those with $\bar{q} < q^O < (q^*)^O$] will immigrate in H for low fixed costs of immigration [$\bar{c} < (q^*)^O - \bar{q}$]. Therefore, the relative world price of the simple good increases. We illustrate this situation in Fig. 4, where we borrow the world relative demand and supply from Fig. 3. According to proposition 7, in a world with free movements of goods and labor, the number of highly trained individuals in the world will increase, enhancing the production of the complex good. RS^W should shift to the left in the $(p, Y/X)$ space when we move in a common labor market. Consequently, the world relative price of the simple good should be higher than before. This is indicated by $(p^{W*} > p^W)$ in our graph.

Let's assume that H has an identical quality level of institutions ($\theta^j = \theta$), but offers a better ECCE ($b^H > b^O$) than O . In a free trade world according to proposition 4, H

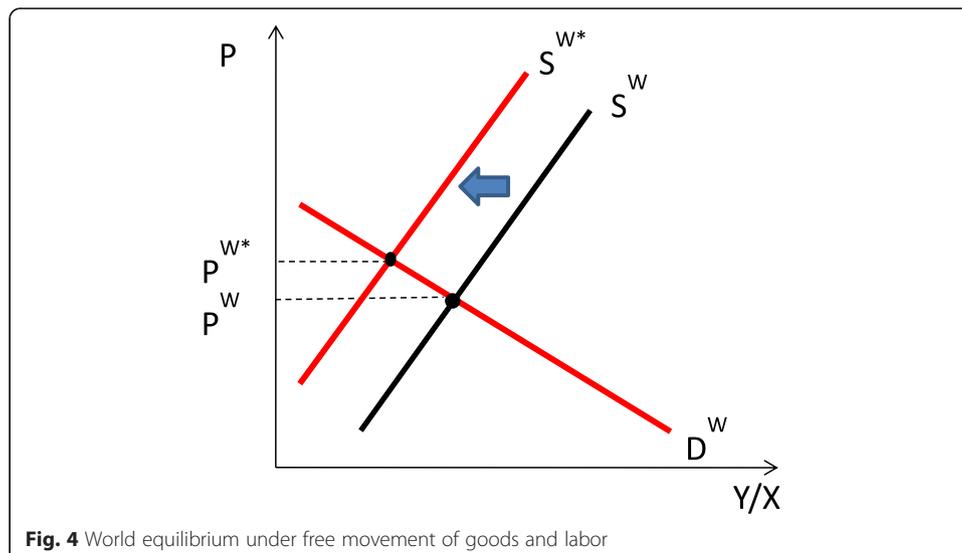


Fig. 4 World equilibrium under free movement of goods and labor

exports the complex good to O and imports the simple good from O . In a common labor market, no one has an incentive to emigrate because there are no differences in income among individuals with identical training levels who work in different countries. Thus, institutional quality is the sole determinant of international labor flows.

Let's consider a third and final scenario where H has better institutions, but O has a better ECCE. This means that both countries could have the same cutoff, q^* , which indicates that they will produce the same amount of both goods. Put differently, the host country of immigrants has more developed institutions, and despite its weak ECCE, its citizens will invest more in their training and put in more productive effort since they get rewarded more for reducing moral hazard as compared to individuals with the exact same levels of natural ability who live in the country with the least developed institutions. On the other hand, since the country with the least developed institutions offers the best ECCE, many of its individuals will seek employment in the complex sector because it is easier for them to obtain more training and, therefore, put in more productive effort even though they are rewarded less as compared to the same able individuals who live in the host country of immigrants. Therefore, it is fairly feasible that both countries have the same prices in autarky. Consequently, in this case, if both countries create a common trade area, there will be no trade between them. However, if both countries decide to liberalize their labor markets, we would observe emigration only in one direction, from country O into H , since as demonstrated in proposition 7, the national institutional difference between the two countries is the only force that derives international migration in the presence of moral hazard. All immigrants will seek employment in the complex industry in the host country because only in the X industry are they are rewarded more, as compared to their country of origin, for reducing moral hazard. It could be possible, as shown in proposition 7, that for low fixed costs of immigration $[\bar{c} < (q^*)^O - \bar{q}]$, some emigrants of O (those with $q^{H*} < q < q^{O*}$) who were working in the simple sector under free trade in their country of origin will seek employment in the complex sector in the host country of immigrants because of the existence of the institutional differences between the two countries. This in turn, will change the world production of both goods and will create international trade between the two countries. Thus, corollary 3 follows.

5.3 Corollary 3

In a free trade world that consists of two large economies, in the presence of moral hazard, where $b^O > b^H$, and $\theta^O < \theta^H$, and with autarky prices $p^H = p^O$, there will be no international trade between the two countries. However, if both countries create a common labor market area, it is profitable for both countries to engage in international trade only for low fixed costs of immigration $(\bar{c} < (q^)^O - \bar{q})$.*

The above corollary is an important contribution of the paper because it highlights the fact that immigration promotes trade. In Table 1, we can find countries where the development of their national institutions is not accompanied with better ECCE. For example, the USA has more developed institutions than Japan, but the latter has better ECCE than the former because, among other things, the Japanese society has developed

a natural cultural identity that promotes ECCE where most of the young Japanese mothers pay their fullest attention to the education of their children at their young age. We can also compare the USA with Croatia, the Republic of Korea, Slovenia, Belarus, Italy, and Spain. The former has more developed institutions than each of the latter countries, but all these countries have better ECCE than the USA. Therefore, according to corollary 3, if these countries only differ in the development of their national institutions and ECCE, in the absence of a common labor market area, it is quite possible to see trade between each of them and the U.S. However, in our model, if we allow the international movement of labor, the U.S. will be the host country of the most highly trained immigrants because it has the most developed institutions. Thus, we introduce a new explanation (which is the quality of national institutions) for the existence of the flow of the most trained international migrants from other countries into the USA. Moreover, according to corollary 3, the creation of a common labor market area among the above countries will increase the bilateral trade between USA and each of the above countries.

We can observe from Table 1, that Germany has more developed national institutions, but worse ECCE than Spain, Italy, Slovenia, Croatia, France, Portugal, Poland, Hungary, Bulgaria, Romania, Belgium, Estonia, and Lithuania. Thus, according to proposition 7, Germany will be the host country of the most highly trained immigrants, assuming that countries only differ in their ECCE and the development of national institutions. Moreover, according to corollary 3, the existence of the common labor market area, such as EU, directly boosts bilateral international trade between Germany and each of the above EU members.

However, this highly specialized example as presented in corollary 3 is created to clarify the intuition behind the complementarity of immigration and international trade in our model. It should be obvious to the reader that all is needed for immigration to promote trade in this model is to assume that the host country possesses more developed institutions than the origin country of immigrants.

6 The effects of international students in two large economies

So far, we have assumed that individuals are not allowed to migrate to acquire training, which in our model refers to formal college/university education. In what follows we focus on effects that the presence of international students have in both economies. First, we assume that all international students can become permanent immigrants in the host country after graduation and then assume instead that international students must return back to their country of origin after training in the host country.

Using each of the above assumptions, we can write the utility of each individual as shown in (1) as

$$U = u(C_x, C_y) - \frac{1}{2st}(a^2 + d^2) - \frac{1}{2bq}t^2 \quad (10)$$

where $s \geq 1$ denotes the system of training in a country. Thus, in countries with a high quality of training, maybe because of tradition or/and historical accident, $s \geq 1$ implies that it is easier for an individual to obtain higher training levels maybe due to a positive

spillover or environmental effect that a better national system of training creates. Thus, individuals will acquire international training in the country with higher s if they can afford the fixed cost of international training such as language and cultural barriers. Therefore, the country with better ECCE and a national system of training and more developed institutions will export the complex good. Analogously to proposition 4, *ceteris paribus*, the national system of training will act as an independent source of comparative advantage.

The analysis of this section is interesting under the scenario that the host country has the more developed institutions and the best quality of training, but the origin country has the best ECCE.⁸ When international students are allowed to immigrate into the host country after graduation, the complex sector in the host country will expand because the most able students of the origin country that would have entered in the complex sector in their country of origin would pursue their training in the host country and remain there. Moreover, there would be more individuals in the world that will seek employment in the complex sector because analogously to proposition 7, there would be some individuals of the origin country that will enter in sector X basically because now they have the option of obtaining better training in the host country. Therefore, the pattern of trade would be the same as in the previous sections, and international students will promote further trade between countries because all international students who will seek employment in the complex sector will remain in the host country where they are rewarded more for reducing moral hazard as compared to their country of origin, which has the worst quality of national institutions.

If international students must return back to their country of origin after the completion of their training, the pattern of trade may change.⁹ In the absence of international students, the free movement of goods and labor similar to proposition 7 will assure that the country with the best developed national institutions and training system but worse ECCE to be the host country of immigrants and export the complex good. However, if we allow individuals to acquire international training, especially in an extreme scenario when the differences over the development of national institutions in both countries is low $\{(\theta^H - \theta^O) \simeq 0\}$, but the differences of national training systems and the differences on ECCE are large $\{(s^H - s^O) \simeq \infty; (b^O - b^H) \simeq \infty\}$, the pattern of trade may change, but the pattern of labor movements remains the same. The country with the best institutions and system of training will host the international students. However, now trade and the cross-border movement of students are substitutes. An individual with the high natural ability who is born in the country with better ECCE will acquire training in the foreign country with a better training system and, therefore, obtain a higher level of training than the native with the same natural ability. If her natural ability in her country of origin is higher than the threshold level (as shown in proposition 1), she will seek employment in the complex sector because her wage/profit there will be higher (as shown in proposition 3). Thus, it is quite possible that the inflow of international students who must leave the country with the best institutions and training system after the completion of their training to change the pattern of trade in both countries, shifting the comparative advantage in the complex good towards the country with the best ECCE, which will have a better trained workforce.

7 Conclusions

In this paper, we analyze a general equilibrium model in the presence of moral hazard between two large economies that have two sectors. In the complex sector, firms produce a complex good where managers cannot perfectly observe or/and verify the productive efforts of workers. In the simple sector, the productive efforts of workers and firms' outputs are perfectly observable and verifiable. We develop a four-stage game similar to Vogel (2007), but we introduce ECCE and allow for immigration. In our model the distribution of labor is endogenously determined by individuals' choices subject to the ECCE and national institutional development.

We show that individuals with the highest levels of natural ability prefer to work in the complex sector where the most trained workers team up with the most trained managers. The remaining individuals join the simple sector. The country with the best ECCE or/and quality of institutions obtains a labor force that consists mainly of highly trained individuals. Thus, in a free trade world, it exports the complex good. In a common labor market area, the country which exports the complex good is the host country of immigrants. Only the most talented individuals emigrate toward the country with the best developed institutions because there they capture higher incomes for their training.

We present a scenario where the country with the most developed institutions has the worst ECCE. For example, according to Table 1, Germany has more developed institutions than Poland, but the latter has better ECCE than the former. In such a case, it is fairly feasible that the autarky prices of both countries are the same, providing no incentives for international trade. However, if both countries enter a common labor market area, we observe a movement of labor from the country with the least developed institutions (Poland) toward the country with the most developed institutions (Germany). Thus, immigration changes the division of labor in both countries. In other words, a creation of a common labor market area enhances international trade. Even though this is an extreme scenario, it is created to clarify the intuition behind the complementarity of immigration and trade.

When we allow the cross-border movement of students to acquire better training, we show that the country with the best quality of national institutions, training system and ECCE exports the complex good. However, if international students are not allowed to immigrate in the country where they completed their studies, it is possible that the host country will eventually import the complex good if it has better quality of institutions and training system, but worse ECCE.

While we hope our approach provides some interesting insights on the questions of talent development and immigration, as well as international trade and immigration, it does not tackle an important number of dimensions. For instance, the positive assortative matching between a worker and a manager relies on the assumption of complementarities in the production of the complex good. Thus, a possible extension of the model is to solve the four stage game developed here under the assumption of substitutabilities in the production of the complex good. Another possible interesting extension of the model is to include certain spillover effects associated with the availability of the most talented individuals in a country.

We assume that individuals' training decisions are made in a common labor market area. It could be interesting to analyze the case where individuals do not anticipate the

Table 1 National Institutional Quality Index (RL) and ECCE index (ECCE)

Countries/Territories	RL	ECCE	Countries/Territories	RL	ECCE
ALBANIA	-0.44	0.952	LUXEMBOURG	1.83	0.964
ALGERIA	-0.75	0.950	MACAO SAR, CHINA	0.70	0.989
ARGENTINA	-0.62	0.954	MALTA	1.44	0.835
ARMENIA	-0.47	0.977	MAURITIUS	0.86	0.980
AUSTRALIA	1.76	0.990	MEXICO	-0.58	0.960
AZERBAIJAN	-0.85	0.964	MONGOLIA	-0.39	0.941
BELARUS	-1.04	0.997	MOROCCO	-0.16	0.939
BELGIUM	1.37	0.965	NAMIBIA	0.19	0.915
BOSNIA AND HERZEGOVINA	-0.37	0.987	NETHERLANDS	1.81	0.990
BOTSWANA	0.67	0.966	NEW ZEALAND	1.87	0.990
BULGARIA	-0.10	0.974	NORWAY	1.92	0.995
CROATIA	0.17	0.991	PANAMA	-0.10	0.946
CUBA	-0.66	0.970	PERU	-0.60	0.932
CYPRUS	1.20	0.954	POLAND	0.66	0.980
DENMARK	1.90	0.997	PORTUGAL	1.04	0.990
EGYPT, ARAB REP.	-0.12	0.972	QATAR	0.95	0.955
ESTONIA	1.13	0.988	ROMANIA	0.04	0.971
FIJI	-0.85	0.943	RUSSIAN FEDERATION	-0.77	0.961
FINLAND	1.98	0.997	SAMOA	0.65	0.964
FRANCE	1.51	0.990	SAUDI ARABIA	0.26	0.939
GEORGIA	-0.21	0.964	SERBIA	-0.40	0.986
GERMANY	1.62	0.962	SLOVENIA	0.98	0.996
HUNGARY	0.75	0.977	SPAIN	1.16	0.997
ICELAND	1.70	0.990	SURINAME	-0.10	0.941
IRELAND	1.77	0.993	SWAZILAND	-0.49	0.962
ISRAEL	0.90	0.990	SWEDEN	1.96	0.995
ITALY	0.38	0.996	SWITZERLAND	1.77	0.990
JAMAICA	-0.50	0.961	SYRIAN ARAB REPUBLIC	-0.50	0.946
JAPAN	1.33	1.000	TUNISIA	0.12	0.961
KOREA, DEM. REP.	0.99	0.994	TURKEY	0.12	0.918
KUWAIT	0.60	0.960	UKRAINE	-0.81	0.977
KYRGYZ REPUBLIC	-1.28	0.976	UNITED KINGDOM	1.76	0.990
LEBANON	-0.69	0.953	UNITED STATES	1.63	0.990
LITHUANIA	0.75	0.983	VENEZUELA, RB	-1.64	0.938

RL is the Rule of Law index, which reflects perceptions of the extent to which agents have confidence in and abide by the quality of contract enforcement, the courts, etc... $-2.5 \leq RL \leq 2.5$ (Rule of Law) index is taken from Kaufmann, Kray and Mastruzzi (2010), Available online at: <http://info.worldbank.org/governance/wgi/index.aspx#reports>.

Kaufmann et al. (2010) construct the RL index as a weighted average of other indexes and indicators from sources such as: World economic forum global competitiveness survey, Global integrity index, World bank country policy and institutional assessments, Institute for management development world competitiveness yearbook, Global insight business risk and conditions, Economist intelligence unit, etc... We present the RL index for those countries that we can make cross-country comparisons, meaning that for each pair-wise comparison of RL index across countries, 90% confidence intervals do not overlap, signaling statistically significant differences in the RL index across countries.

ECCE denotes the best available proxy for the quality of ECCE, and it is measured by the survival rate to grade 5. $0 \leq ECCE \leq 1$ (survival rate to grade 5) index is taken from "Education for all, Global Monitoring Report, - 2012 Youth, Skills & Work. Available online at: <http://www.unesco.org/new/en/education/themes/leading-the-international-agenda/efareport/statistics/efa-development-index/ECCE-index> (survival rate to grade 5) is considered the best proxy available for measuring the quality of national ECCE system. In the absence of comparable indicators on ECCE quality, the survival rate is used as proxy because of its positive correlation with average international learning assessment scores. For more, see: Mullis et al. (2009), Martin et al. (2008, 2012, 2013), and Education for all, Global Monitoring Report (2012)

We have data only for 64 countries because of the mismatch on data availability from both sources.

All the data are for the year 2010 (ECCE for the school year ending in 2010) because this is the latest year that we can get the data from both sources.

labor market integration. Individuals with high natural ability levels who choose to work in the complex sector may invest less in their training simply because they did not anticipate the creation of a common labor market area with the country with the most developed institutions.

More importantly, throughout this paper, we do not discuss a fully factor market integration. We describe the development of talent in a world where goods and labor move freely, however, also capital can move freely from one country to the next. The process of multinationalization and foreign direct investment is another dimension which is clearly at the heart of talent development, especially for developing countries. Allowing for such a channel, labor will move toward the country with better developed institutions, but firms may want to locate in countries where labor is cheaper.

Endnotes

¹The assumption of the exogeneity of national institutional quality is widely used in the recent literature of international trade. For example, Vogel (2007) and Costinot (2009) among others show that the quality of national institutions play an important role in the determination of international trade patterns. Also, the assumption of the exogeneity of ECCE is present in the labor and human capital literature. For example, Heckman (2000) provides a summary of the human capital literature and concludes that subsequent investment in skills and trainings is contingent on ECCE because *“learning begets learning.”* Therefore, better ECCE makes individuals’ learning easier, promoting academic progress which in turn makes them more productive, so they enjoy higher earnings. Moreover, Anderson et al. (4) and Schweinhart et al. (1993) provide empirical evidence indicating that good early childhood interventions have lasting positive effects on learning, motivation and future earnings.

²For more, see UNESCO EFA (2003/4, 2010, 2013/4); Mullis (2007), and Martin and Mullis (2013).

³Our assumption that ECCE is exogenous might seem contentious, assuming that parents do not respond to incentives when investing in their child development. However, this is precisely the case in the U.S., at least according to Heckman (2000), who states (p.25): *“It is remarkable in a society as committed to consumer sovereignty and choice in most aspects of economic and social life as the American society, that there is so much resistance to permitting choice and instituting incentives in education. The conventional argument of the educational planners is that parents and students are not able to make wise choices.”* On the other hand, in Japan, ECCE is very closely supervised by Japanese mothers. In particular, a mother is evaluated mostly by the high school that her child enrolls in, and then the university to which her child is admitted. Sociologists show that Japanese mothers are expected by society to make sacrifices for their children who, in return, are expected to perform well in school (White 1998). See also OECD (2010). Therefore, we believe that this cultural, non-institutional environment may explain the gap between their ECCE indexes despite the fact that the U.S. has better developed institutions (for example more competent judicial system) than Japan. See Table 1.

⁴In our model we assume that there exist complementarities in production between a manager and a worker in the complex sector, following Kremer (1993). In

section V, our results rely on the assumption of complementarities in production between immigrants and natives. This is not an uncommon assumption in the labor and immigration literature. For example, Lazear (1999) builds a theoretical model and provides empirical evidence that immigrants and natives who work in the same team increase a firm's productivity due to the existence of complementary factors in its production function, where immigrants bring information which is complementary to that of the natives. Markusen and Trofimenko (2009) show theoretically and empirically using plant-level data from Columbia that there are complementarities in production in firms that hire highly skilled foreign managers and highly skilled native workers. Foged and Peri (4), using a dataset of individuals and establishments in Denmark over the period 1991–2008, show, among other things, that there are complementarities in production among immigrants and native workers in the service-complex sectors. Ottaviano and Peri (2012) show theoretically and empirically that in equilibrium the inflow of immigrants creates a positive effect on natives due to complementarities in production. Peri (2012), using three main data sources (U.S. Census, IPUMS & GSP), finds that immigrants promote task efficient specialization in the native country. See also Peri and Sparber (2009, 2011) for similar results.

⁵Iranzo and Peri (2009) show that international migration and trade complement each other in an application to the Eastern-Western European Integration. Peri and Requena-Silvente (2010), using micro data on individual trade transactions from Spanish provinces between 1995 and 2008 and data on Spanish stock of immigrants, show that immigration promotes international trade mostly because it reduces the fixed costs of trade, especially for differentiated goods.

⁶The assumption that in the *Y* sectors individuals work alone is done solely for presentation purposes. However, all the results of this paper hold if we assume that in the *Y* sector, each firm has a worker and a manager with a complementary production function as in sector *X*, but in the absence of moral hazard. For more details see Additional file 1: Appendix A.

⁷For more, see the detailed solution of stage 3 in Additional file 1: Appendix B.

⁸This is not a theoretical assumption. The U.S. may enter in this category. For example, Hoxby (1999) concludes that ECCE and K-12 public schools in the USA, in particular the inner-city ECCE and K-12 public schools, act as a monopoly, but the U.S. university system is highly competitive. This is the reason why the higher educational system is considered successful in the U.S., but there is poor performance of the U.S. ECCE and K-12 public school system as compared to foreign countries.

⁹For example, in the real world, many international students accept scholarships to pursue their studies in countries with better college/university system such as the U.S. and the U.K. under the condition that they must to return back to their own countries of origin after graduation and work there for at least one decade.

Additional file

Additional file 1: Appendix A, B, and C. (DOCX 53 kb)

Competing interests

The IZA Journal of Migration is committed to the IZA Guiding Principles of Research Integrity. The author declares that he has observed these principles.

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