European Integration and Educational Standards*

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Abstract

European regions set educational standards for students who then face a partially integrated labor market. We analyze the incentives to set higher or lower standards when there is competition between regions and show that integration raises (lowers) standards if these are strategic complements (substitutes), which in turn depends on the quality signals. Using data from the European Union Labor Force Survey we test whether standards are indeed strategic substitutes or complements. Finally, we show that in equilibrium there is convergence of educational standards only in the case of strategic complements.

Keywords: Educational standards; Strategic complements; European integration

JEL Class.: I23 (Higher Education • Research Institutions), J24 (Human Capital • Skills • Occupational Choice • Labor Productivity)

1 Introduction

Educational standards define the minimum requirements (in terms of knowledge, skills) that students should achieve at each educational level, for instance, a secondary education degree (Weiss, 1988) or a college degree (Costrell, 1994, 1997).

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Educational standards set goals for teaching and learning. The level of educational standards determines not only how difficult or easy it is to get a degree or a credential, but also the effort made by the students, how much they learn, and therefore conditions their future productivity in the labor market. Sometimes standards are set at the national or regional level, although governments are not the only institutions setting standards: Schools, colleges or universities may set their own standards.

In this paper, we look at the problem of standards setting when there is interaction between regions. If we consider standards at the national level, European labor market integration implies that standards set in one country may affect the graduates of other countries.[1] The type of interaction between standards will be determined by the labor market and in particular by how the market perceives the degrees and to what extent the market is able to distinguish the degree of one region from another.[2] We consider two cases: The *free-riding case*, where the market is not able to distinguish between degrees so that free-riding is possible, and the *competition case*, where the market receives a quality signal from the degrees.

Educational standards are important because they affect the students' effort (Figlio and Lucas, 2004). When standards are very low students do not need to exert effort to get the degree. A low effort leads to lower qualification and productivity in the labor market and as a result lower GDP.[3] On the contrary, if standards are so high that for most students it is almost impossible to get the degree, then it may not be worth it to exert effort, and average students' qualification will also be low (see Spence, 1973). At the optimal level of the standard, the students acquire on average a high qualification and productivity.

The level of human capital in a country affects GDP and one possibility is to select educational standards so as to maximize GDP.[4] The decision maker may also care about inequality (how income is distributed) and in this paper we will assume some degree of inequity aversion when setting the optimal educational

[1]If we consider standards set by universities (or schools) interaction is more apparent, since graduates will compete in the same labor market.

[2]Educational standards are often devised by organizations that support certain specific disciplines such as mathematics, arts, etc. In the absence of nationally mandated standards, subject-area professional associations have taken over this role. Under the presence of nationally mandated standards subject-area professional associations complement this role.

[3]See Gundlach, Woessmann and Gmelin (2001) on schooling productivity. However, Benos and Zotou (2014) using meta-analysis show that there is selection bias toward a positive impact of education and growth and highly depends on differences in education measurement.

[4]See Barro, 2013, who finds how growth is positively related to the starting level of average years of school attainment of adult males at the secondary and higher levels which suggests its role for the diffusion of technology in the development process. Besides, growth is also related to years of school attainment of females at the secondary and higher levels.

standards (Costrell, 1994).

Previous literature has focused on education as a production function. Educational inputs are crucial for the outcome of education, for example parents' education, teachers qualifications, years of schooling, school resources (see Ciccone and García-Fontes, 2009). But institutions are also an important factor for educational performance as they set the incentives for the participants in the educational process (see Fuchs and Weissmann, 2007). Institutional factors include, among others, whether the provision of education is private or public, the degree of decentralization, financing, and external or school standards. In this paper we focus on one institutional aspect of the educational system not previously considered, the effect of labor market integration and competition.

Closely related to our research are the pioneering papers by Costrell (1994) and Betts (1998), who look at academic achievement and the incentives provided by the educational system, in particular the degree of centralization of the standards and more or less egalitarian preferences of the decision maker. Costrell (1994) shows that regional decentralization would lower educational standards below the centralized level. Our analysis adds the idea that how the labor market values the degrees of different regions is crucial for the result. If the labor market values as equivalent the degrees from different regions, then Costrell's result follows. However, if the degrees contain signals that the labor market can evaluate, then we find that decentralization may bring more competition and higher standards. , We introduce explicitly competition between several regions in the standards they set. We find that standards may be strategic substitutes or strategic complements, depending on the quality signals sent by the academic degrees to the labor market, and we check the effect of competition on the level of the standards.

We apply the model to the case of educational standards in Europe. We collect data from the European Union Labour Force Survey to shed light on whether educational attainment in each country are strategic substitutes or complements. Our empirical approach consists of testing for differences in wage between nationals and non-nationals (other EU countries and non-EU countries as well) after controlling for exogenous covariates that also affect labour income. We find significant differences in labour income distribution within groups of nationals and non-nationals. Our results are closer to the strategic complementariry of educational standards but call fo further research.

The paper is organized as follows. In Section 2, we present the model and discuss the no-competition case, when there is no interaction among regions in standard setting. In Section 3 we discuss the effect of integration on educational standards (at regional, national or international level). Section 4 contains our empirical startegy using the European labor market. Section 5 presents our results. We conclude with some policy implications of integration and standards and directions for further research to strengthen the conclusions of the study.

2 The model

We build on the model developed by Costrell (1994), where students' productivity comes from the effort made at school and the quality of education, but there is no intrinsic difference in students' productivity. Let's assume that firms only observe whether the students graduated or not. Therefore, there are only two levels of wage: graduate and non-graduate. Define $\widehat{y}$ as the graduate wage and y_o as the non-graduate wage; the positive difference between $\widehat{y}$ and y_o reflects the increase in productivity due to education. The higher the standard, the higher the productivity and the wage, and the higher the difference with the non-graduate wage. For simplicity, the educational standard will also be denoted $\widehat{y}$.[5]

At the individual level, student i's utility function is $u_i(y,e)$, where e denotes effort, $\frac{\partial u_i(y,e)}{\partial e} < 0$, and y denotes income, $\frac{\partial u_i(y,e)}{\partial y} > 0$. Under a standard $\widehat{y}$, there is a minimum effort $\widehat{e}$ necessary to graduate (to achieve productivity $\widehat{y}$) which is the same for all students. Then, the student's decision is whether to graduate or not. Therefore, student i will graduate as long as:

$$u_i(\widehat{y},\widehat{e}) \geq u_i(y_o,0)$$

We assume that the cost of effort, or preferences for leisure, differ across students. Once the standard $\widehat{y}$ is fixed, hence induced by the distribution of the cost of effort, there will be two groups of students, one of size $1-F(\widehat{y})$, earning the graduate wage $\widehat{y}$ and exerting effort $\widehat{e}$, and the other of size $F(\widehat{y})$ earning the non-graduate wage y_o and exerting no effort. It holds$F'(\widehat{y}) > 0$, that is increasing the standard increases the fraction of individuals who do not exert the required effort to achieve the standard.

Standards are set by different regions, and these may be linked by a labor market with some integration level that we denote as λ. First, we set up the problem of an individual region inthe absence of interaction and then in Section 3 we look at how interaction in standards can be modelled. We consider that regardless of considering isolated or partially-integrated markets, there exists a social planner that sets standards using a certain preference for equality function.

2.1 No interaction in educational standards

In this subsection, we assume there is no interaction in standard setting. The social planner may decide the standard $\widehat{y}$ to maximize total income or use a concave

[5]We could consider that wage is a non-decreasing function of the standard and still obtain the same qualitative results. We decided to keep the model as simple as possible.

function $h(y)$ such that $h'(y) > 0$ and $h''(y) < 0$, to evaluate the social value function, $V(y)$, given by:

$$V(\widehat{y}) = [1 - F(\widehat{y})]\, h(\widehat{y}) + F(\widehat{y})h(y_o)$$

The first order condition of social value maximization, $V'(\widehat{y}) = 0$, yields

$$[1 - F(\widehat{y})]\, h'(\widehat{y}) - F'(\widehat{y})\, [h(\widehat{y}) - h(y_o)] = 0$$

The marginal benefit of an increase in the standards comes from the fact that people who graduate have a higher income and this increases planners utility: $h'(\widehat{y})$. The marginal loss is that less people graduate when the standard increases: $F'(\widehat{y}) > 0$.[6]

Standards are related to available resources to eduction. We denote θ the resources spent on education and $F_\theta(\widehat{y})$ the family of distribution functions parameterized by θ.[7] We will assume this family has the *Monotone Likelihood Ratio* (*MLR*) property: When more money is spent on education, $\theta_2 > \theta_1$, then $\frac{f_{\theta_2}(\widehat{y})}{f_{\theta_1}(\widehat{y})}$ is increasing in $\widehat{y}$. The *MLR* property also implies that $\frac{f_{\theta_2}(\widehat{y})}{1-F_{\theta_2}(\widehat{y})} \leq \frac{f_{\theta_1}(\widehat{y})}{1-F_{\theta_1}(\widehat{y})}$ (the hazard rate is decreasing in θ) and that $F_{\theta_2}(\widehat{y}) \leq F_{\theta_1}(\widehat{y})$ for all $\widehat{y}$ (i.e. $F_{\theta_2}(\widehat{y})$ first-order stochastically dominates $F_{\theta_1}(\widehat{y})$). This means that if the distribution $F_{\theta_2}(\widehat{y})$ is first-order stochastically dominant over $F_{\theta_1}(\widehat{y})$ then no matter the standard of education, $F_{\theta_1}(\widehat{y})$ always has a greater probability mass in the lower tail than $F_{\theta_2}(\widehat{y})$. The inputs to education have an effect on students' performance but they also change the marginal costs and benefits of standards so that their optimal level changes, as the following proposition shows:

Proposition 1.- (No interaction in educational standards)

(i) Assuming $F_\theta(\widehat{y})$ has the MLR property, an increase in resources increases the optimal educational standards.

(ii) (Costrell, 1994) A more egalitarian decision maker choses lower standards.

Proof.- See the appendix.

Proposition 1 shows the effect on the optimal standards of more resources invested in education when the MLR property holds in the family of $F_\theta(\widehat{y})$. The marginal cost of standards is lower and the marginal benefit is higher, so that the optimal level increases and society as a whole reaches a higher value. The same result obtains if instead of financial resources, we refer to other inputs in the educational process such as parents' education. In countries where parents'

[6]In the Appendix we show that $F''(\widehat{y}) \geq 0$ is a sufficient condition for $V''(\widehat{y}) < 0$.

[7]The parameter θ includes not only funding in education but also parents' efforts towards educating children.

education is higher, standards would also be higher.[8] Proposition 1 also shows that when the social planner chooses a more egalitarian approach, the optimal educational standard is lower. This is the result of putting more weight on the income loss of those who do not achieve the standard than on the gains derived from those who meet it.

As a conclusion, in the absence of interaction a country must decide its optimal standards taking into account only the effect on its own labor market; we have shown that the resources spent in education and egalitarian objectives work in opposite directions.

2.2 A particular case: The Weibull distribution and the CRRA utility function

Consider the two parameters Weibull distribution function:

$$F(\widehat{y}) = 1 - \exp\left(-\left(\frac{\widehat{y}}{\eta}\right)^{\beta}\right),$$

where $\beta > 0$ is the shape parameter (the Weibull slope), and $\eta > 0$ is the scale parameter. The Weibull distribution has the MLR property in η but not in β. Note that η can be interpreted as a measure of funding and other inputs to education. The planner values the standard $\hat{y}$ with a constant relative rate of aversion (CRRA) utility function parameterized as

$$h(y) = \frac{y^{1-r} - 1}{1-r}.$$

From the first order condition, we obtain the value of the optimal standard:

$$\widehat{y} = \eta\left(\frac{1-r}{\beta}\right)^{\frac{1}{\beta}}.$$

Note that as predicted: (i) $\partial\hat{y}/\partial\eta > 0$; increasing educational inputs increases the standard; (ii) $\partial\hat{y}/\partial r < 0$; a more egalitarian social planner chooses lower standards. Finally, we illustrate the results. Figure 1 depicts the value function $V(y)$ for the parameter values $\beta = 5$, $\eta = 1$ and $r = 1$; and another objective function denoted $W(y)$ with the same parameter values but $r = 1/2$ (inequality concerns). It illustrates that the optimal standards are higher when the planner has no inequality concerns.

[8] This result is also in line with Costrell (1994) for the median voter's optimal standard.

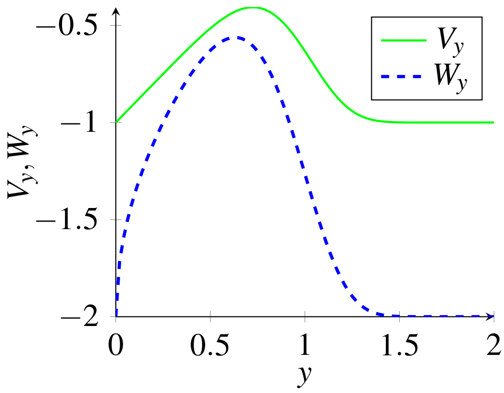

Figure 1: Objective function with, V(y), and without inequity concerns, W(y).

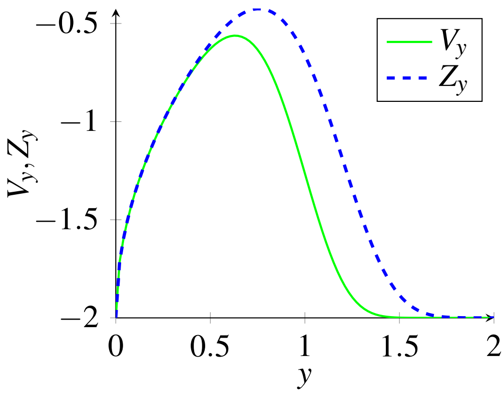

Figure 2: Objective function with more educational resources, Z(y).

Figure 2 represents $V(y)$ for the parameter values $\beta = 5$, $r = 1/2$ and $\eta = 1$ and another objective function denoted $Z(y)$ for $\eta = 1.2$. It illustrates that the optimal standards are higher when funding and other educational inputs are higher .

In the next section, we introduce some degree of integration between regions to consider the effects of one region's educational standards decisions on another region's labor market; this introduces strategic interaction between regions. In Europe, efforts are being made to increase labor market integration and we would expect higher integration in the future; this implies that changes in the standards in one country may affect the way the market perceives graduates from the common market.[9] We analyze the effect of an increasing integration on educational standards.

[9]This is not the unique debate opened on the effects of educational standards and market integration. In the US, there is a debate between of common core national standard setting.

3 Strategic interaction in educational standards

How standards in one country would affect other countries where labour markets are linked? We will see that higher standards in one region may decrease or increase the wage of graduates in other regions depending on whether the national labor market perceives the differences between graduates or not. We start with the case of symmetric countries.

3.1 Integration of symmetric countries

When different regions share (up to a certain limmit impose by regulatory issues) a common labor market, their educational standards will affect productivity and wage level in that market. We model the domestic wage, y, as a weighted average of the domestic, $\widehat{y}$, and foreign, $\widehat{x}$, educational standards, respectively:

$$y = (1-\lambda)\widehat{y} + \lambda\widehat{x}$$

or equivalently expressed as

$$y = \widehat{y} + \lambda(\widehat{x} - \widehat{y})$$

where $|\lambda| \in (0,1)$ is the measure of the level of integration. When $\lambda > 0$, higher foreign standards increase domestic wage ($\partial y/\partial \hat{x} > 0$ given $\hat{y}$), but foreign standards may also decrease domestic wage if $\lambda < 0$ ($\partial y/\partial \hat{x} < 0$, given $\hat{y}$). A positive λ can be interpreted as domestic graduates earning the weighted average of the productivity of all graduates; domestic and foreign. We call this the **free-riding case**, a country free-rides on the standards of the other, and this corresponds to the market not being able to distinguish between the degrees of different regions. When λ is negative, higher foreign standards decrease domestic wage, and we call this the **competitive case**. This corresponds to the case where the market is able to perceive the quality of the degrees of different regions and therefore when one region increases its standards its graduates are in higher demand and obtain higher salaries while the wage of the other region's graduates decreases. When countries are symmetric $|\lambda| = 1/2$ corresponds to full integration; in the case of a small region full integration with a larger region could correspond to $|\lambda|$ higher than 1/2, since foreign standards could have a stronger effect than domestic ones, and for the other region $|\lambda'|$ lower than 1/2. In the case of two asymmetric countries we assume that $|\lambda| + |\lambda'| < 1$.

When there is influence of foreign standards on the domestic graduates' wage, the social planner takes into consideration this information and the objective function becomes:

$$V(\widehat{y},\widehat{x}) = [1 - F(\widehat{y},\widehat{x})]\, h(y) + F(\widehat{y},\widehat{x}) h(y_o)$$

where $y=\widehat{y}+\lambda(\widehat{x}-\widehat{y})$. We continue to assume that $F_{\widehat{y}}(\widehat{y},\widehat{x})>0$, that is, higher domestic standards imply that a lower number of people graduate. In the free-riding case it holds that $F_{\widehat{x}}(\widehat{y},\widehat{x})<0$; An increase in the foreign standards increases the income of the domestic graduates and therefore more students will find it worthwhile to make the effort and graduate, so the number of people who graduate increases and $F(\widehat{y},\widehat{x})$ decreases (non-graduates). In the competitive case, the reverse holds, $F_{\widehat{x}}(\widehat{y},\widehat{x})>0$; increasing the foreign standards decreases the income of the domestic graduates and as a result less students find it worth it to graduate.

We further assume that $|F_{\widehat{x}}(\widehat{y},\widehat{x})|<|\frac{\lambda}{(1-\lambda)}F_{\widehat{y}}(\widehat{y},\widehat{x})|$; this condition implies that the own standards have more influence on the number of domestic graduates than the foreign standards; when the level of integration goes to zero (λ small), the right hand side tends to zero, but the left hand side is always smaller (with almost no integration the effect of foreign standards also tends to zero). Finally, we assume $F_{\widehat{y}\widehat{x}}(\widehat{y},\widehat{x})=0$, that is, the level of the foreign standard does not affect the marginal effect of the domestic standard.

Next, we examine the nature of strategic interaction between the countries. For a given $\widehat{x}$, the domestic social planner chooses $\widehat{y}$ that solves:

$$V_{\widehat{y}}(\widehat{y},\widehat{x})=[1-F(\widehat{y},\widehat{x})]\,h'(y)(1-\lambda)-F_{\widehat{y}}(\widehat{y},\widehat{x})\,[h(y)-h(y_o)]=0$$

This equation yields the standard $\widehat{y}$ that is the best response to $\widehat{x}$. The slope of the reaction function is $R'_{\widehat{y}}(\widehat{x})=d\widehat{y}/d\widehat{x}|_{V_{\widehat{y}}(\widehat{y},\widehat{x})=0}=-\frac{V_{\widehat{y}\widehat{x}}}{V_{\widehat{y}\widehat{y}}}$, where $V_{\widehat{y}\widehat{y}}<0$ by the second order condition (See Appendix A.1), and the stability condition implies that the inequality $V_{\widehat{x}\widehat{x}}V_{\widehat{y}\widehat{y}}-V_{\widehat{y}\widehat{x}}V_{\widehat{x}\widehat{y}}>0$ holds, so that *sign* $R'_{\widehat{y}}(\widehat{x})=$ *sign* $V_{\widehat{y}\widehat{x}}$. In Proposition 2, we characterize $\widehat{y}$ and $\widehat{x}$ in terms of their strategic interaction between the two countries (see Bulow et al., 1985).

Proposition 2.- Under free riding, educational standards are strategic substitutes, $V_{\widehat{y}\widehat{x}}<0$. Under competition, standards are strategic complements, $V_{\widehat{y}\widehat{x}}>0$.

Proof.- See the appendix.

Next we look at how the degree of integration (larger $|\lambda|$ affects competition between countries. In the next result we show how reaction functions move to the left when standards are strategic substitutes (free-riding) and to the right when they are complements (competition).

Proposition 3.- In the symmetric case, under free-riding ($\lambda>0$) a higher labor market integration of symmetric countries lowers educational standards. However, under competition ($\lambda<0$) higher integration implies higher educational standards.

Proof.- See the appendix.

In the first order condition for the domestic country:

$$V_{\widehat{y}} = [1 - F(\widehat{y}, \widehat{x})]\, h'(y)(1-\lambda) - F_{\widehat{y}}(\widehat{y}, \widehat{x})\, [h(y) - h(y_o)] = 0,$$

we can see the effects of integration on the marginal cost and on the marginal benefit, starting from a symmetric equilibrium $\widehat{y} = \hat{x}$:

(a) Since $F_{\hat{y}\lambda} > 0$, an increase in λ would increase the marginal cost of standards $F_{\widehat{y}}(\widehat{y}, \widehat{x})\, [h(y) - h(y_o)]$. Thus, in the free riding case more integration increases marginal cost but in the competition case it decreases marginal cost.

(b) Effect of integration on the marginal benefit. To see the effect on the marginal benefit, consider the case of free-riding, $\lambda > 0$; if the initial situation is symmetric so that $\hat{y} = \hat{x}$ then a larger $\lambda > 0$ would decrease the marginal benefit unambiguously (through the effect of $(1-\lambda)$). In the competition case, more integration increases $(1-\lambda)$ and therefore the marginal benefit is higher.

It follows that under free-riding integration of symmetric countries would imply lower marginal benefit and higher marginal cost, so that both reaction functions shift to the left resulting in lower standards in equilibrium. On the contrary, in the competition case, then a lower $\lambda < 0$ (more integration) would imply a higher marginal benefit (through the effect of $(1-\lambda)$) and it follows that under competition integration of symmetric countries would imply that both reaction functions shift to the right resulting in higher standards in equilibrium.

To summarize, when countries are symmetric we would expect that integration lowers the standards in the free-riding case but rises them in the competition case. The intuition for this result is clear, in the free-riding case, each country does not obtain all the benefits of high standards, part of the benefits go to the foreign graduates. This decreases the incentives to set high standards. On the contrary, in the competitive case, countries obtain a higher marginal benefit (compared to no integration) when they set high standards, so standards will be higher in equilibrium.

Proposition 4.- In the symmetric case, under free-riding, if a country becomes more egalitarian, its standards decrease and the foreign country's increase; under competition, the foreign country's standards decrease. If a country devotes more resources to education, the foreign country would lower standards under free-riding and increase them under competition.

Proof.- See the appendix.

3.2 The two-country Weibull distribution and CRRA utility function

Assume the cost of reaching an educational standard $\hat{y}$ in country Y is linear, $C_Y(\hat{y}) = \alpha\hat{y}$. The benefit of reaching such standard is the income, y. The net utility function for any individual is a separable function of utility of inome income and cost of effort of the form:

$$U(y,\hat{y}) = y - \alpha\hat{y}$$

where labour income y is a linear combination of national and foreign standards, $y = \hat{y} + \lambda(\hat{x} - \hat{y})$. An individual i may decide not to exert the effort necessary to reach $\hat{y}$, then her income is y_0 and there is no cost of effort. We normalize $y_0 = 0$. Therefore, individual i decides not to graduate when $y_0 - [\hat{y} + \lambda(\hat{x} - \hat{y}) - \alpha_i\hat{y}] \geq 0$. Therefore, for $\alpha \in [0,\infty)$ there exists a threshold $\tilde{\alpha} = \frac{y}{\hat{y}} = (1-\lambda) + \lambda\frac{\hat{x}}{\hat{y}}$such that if $\alpha_i \geq \tilde{\alpha}$then the individual does not graduate and ontains the normaized utility level of zero, and if $\alpha_i < \tilde{\alpha}$then the individual does graduate and reaches utility level $U_i(y,\hat{y}) = y - \alpha_i\hat{y}$. Thus, the distribution of α induces a distribution of the utility of the individuals. Assume students' cost of effort is distributed according to a Weibull distribution of the form.

$$W(\alpha) = 1 - \exp\left(-\left(\frac{\alpha}{\eta}\right)^{\beta}\right),$$

where β is the shape parameter (the Weibull slope), $\eta \in (0,\infty)$ is the scale parameter, and the integration parameter is$|\lambda| \in (0,1)$. The parameter η is a measure of funding and other educational inputs. Therefore, the number of people who find it worthwhile to graduate is $W(\tilde{\alpha})$ which can be written as a function of the standards in the domestic country, $\hat{y}$,and the foreign country, $\hat{x}$:

$$W(\widehat{y},\widehat{x}) = 1 - \exp\left(-\left(\frac{\widehat{y} + \lambda(\widehat{x} - \widehat{y})}{\eta\widehat{y}}\right)^{\beta}\right)$$

Note that $W(\widehat{y},\widehat{x}) = 1 - F(\widehat{y},\widehat{x})$.i.e. the nmber of people who graduate. Therefore, the number of people who do not graduate are,

$$F(\widehat{y},\widehat{x}) = \exp\left(-\left(\frac{\widehat{y} + \lambda(\widehat{x} - \widehat{y})}{\eta\widehat{y}}\right)^{\beta}\right)$$

First, it holds that $F_{\widehat{y}}(\widehat{y},\widehat{x}) > 0$; more people do not graduate when the standards are higher. Second, in the free-riding case, increasing $\hat{x}$ increases income and as a result the fraction of individuals graduating also increases, $F_{\widehat{x}}(\widehat{y},\widehat{x}) > 0$ if $\lambda > 0$. The opposite result happens in the competitive case, $F_{\widehat{x}}(\widehat{y},\widehat{x}) < 0$ if $\lambda < 0$.

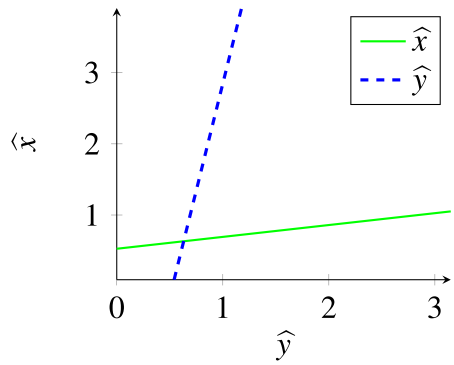

Figure 3: Reaction functions in the symmetric case, $\beta = 5$, $\eta = 1$, $r = 0.5$ and $\lambda = -0.2$.

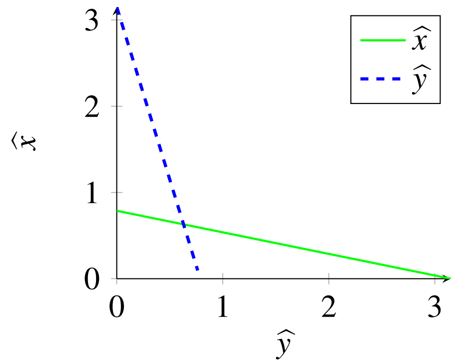

Figure 4: Reaction functions in the symmetric case, $\beta = 5$, $\eta = 1$, $r = 0.5$ and $\lambda = 0.2$.

The social planner of each country chooses the national standard to maximize the social value. From the first order conditions we obtain the reaction function of $\hat{y}$ as a function of $\hat{x}$. Figure 3 presents a linear approximation of the reaction functions for the symmetric case, and parameter values $\beta = 5$, $\eta = 1$, $r = 0.5$ and $\lambda = -0.2$, while figure 4 considers the same parameter values but $\lambda = 0.2$. In the next subsection we analyze the effect of asymmetries.

As shown in Figures 2a and 2b, when the foreign country becomes more egalitarian, its reaction function shifts to the left, that is, it lowers standards for any level of standards of the other country. Under free-riding, the domestic country reacts by increasing standards, but under competition, the foreign country would decrease its standards.

When the foreign country devotes more resources to education, the reaction function shifts outwards (see Figures 3a and 3b). Hence, under free-riding domestic country decreases standards and under competition the domestic country also increases standards.

4 Empirical implementation and results

In this section we provide some evidende on whether educational standards of European countries are strategic substitutes or complements. The main objective is to see the likely effect of the increasing labor market integration on educational standards.

4.1 Data

We use data from the European Union Labor Force Survey (EULFS). It is a large household sample survey providing quarterly results on labour participation of people aged 15 and over as well as on persons outside the labour force. It is conducted for the EU28 countries by the national statistical institutes, although available data depends on the accession date. We restrict our analysis to the EU15 (Austria, Belgium, Denmark, Germany, Finland, France, Greece, Ireland, Italy, Luxembourg, The Netherlands, Portugal, Spain, Sweden, and United Kingdom) and the period 2009 until 2017.

4.2 Labor market integration indicator

First, we define a measure for labor market integration. The available micro-level information does not allow us to know the country of origin of each individual i. Therefore, we first take as the reference group EU15. For each country i in EU15, we observe how many citizens of other EU15 countries are working in country i. We denote L_i the total labor force in country i, L_{EU15} the total labor force in EU15, $L_{i,EU15}$ the number of foreign workers from other EU15 countries working in country i. Our measure of the level of labor market integration of country i is simply the number of foreign workers from EU15, EU28 and EU28 plus over the total number of workers in country i at each peeriod t:

$$I_t\left(i,j\right) = \frac{\left(L_{i,j}\right)_t}{\left(L_i\right)_t}$$

for $j = \{EU15, EU28, EU28 - PLUS\}$ and $I_t\left(i,j\right) \in \left(0,1\right)$. In principle, total integration of i in EU15 would correspond to $I_t = 1 - x_i$, where x_i is the proportion of domestic workers in the total number of EU15 workers, and no integration to $I_t = 0$. A worker is considered as a worker of country i if she was born in country i

or altenatively, if i was her the country of residence the previous year. Since labor is heterogeneous and labor markets for some activities may be more integrated than for others, we calculate the index $I_t(i,j)$ for each educational level and field of study.

Figure 1 presents for the four largest economies in the EU, UK ($I_t(UK,EU15)$), Germany ($I_t(DE,EU15)$),France ($I_t(FR,EU15)$) and Italy ($I_t(IT,EU15)$) the evolution of the aggregate (for all the educational levels and all the education fields) labor market integration of individual coming from EU15, EU28, and EU28 plus other European countries in the period 2004-2017.

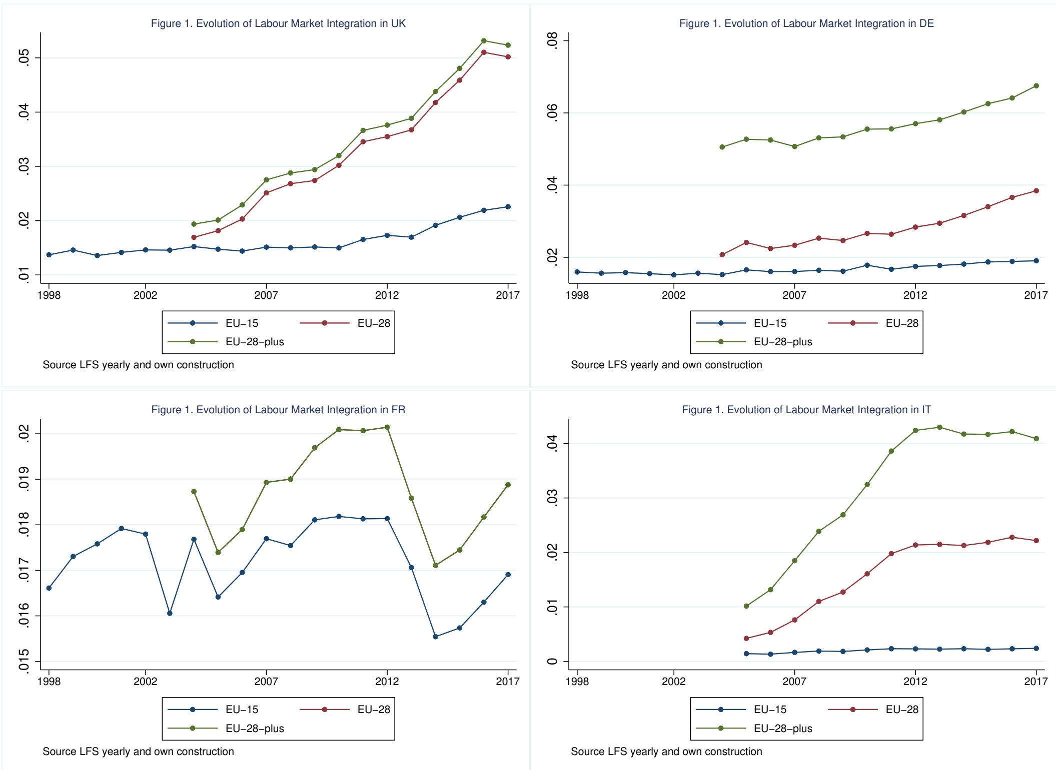

Figure 1.

There are differences across markets and along time in the level of integration of non-nationals in the labour market. UK is the country where the level of integration has increased the most, with 5% of its labor force in 2017 coming from other countries in EU28, higher than in Germany (3.8%) and in France (1.9%). In the UK 2.3% of the workers in 2017 come from EU15, higher than in Germany (1.9%) and France. (1.7%).[10]Germany and UK keep a sustained growth of integration of EU15 and EU28 workers in the labor force, respectively. These workers

[10]According to United Nations estimates in 2017 about 14.8% of the German population are immigrants (from EU28 and outside).

represent more than 5% of the total labor force whereas in the case of France it remains below 2%. Besides, in UK the fraction of EU15 citizens is larger than in Germany. This number is clearly superior in the case of labour force from outside the EU28 in Germany.[11]

Integration may differ by education level or field of competences. Figure 2 shows the level of integration for 3 levels of education: H; high or individuals with tertiary education, M; medium or individuals with secondary education, and L; low or individuals with primary education.

Figure 2.

There are differences across countries of the share of each education level. In UK and Italy the fraction of labour force with high education level is larger than the other two, whereas in Germany and France integrates a larger fraction of labour force with low education level. This trend can be interpreted in line with Figure 1.

[11] Table A1 in the appendix shows the values of the index $I_t\left(i, EU15\right)$ and$I_t\left(i, EU28\right)$ for all countries in EU28.

4.3 Test for strategic complements or strategic substitutes

Free-riding hypothesis: The academic degrees of country *i* and other countries in EU15 **are not distinguished in the labor market.**

To test this hypothesis we look at the labour income data. If, for a given educational level and field, foreign EU15 and domestic workers earn the same labor income, that shows that the labor market values their productivity at the same level.

Competition hypothesis: The degrees of country *i* and other countries in EU15 **are distinguished in the labor market.**

To test this hypothesis we look at the labor income data for the diferent levels of education. If, for a given educational level and field, foreign and domestic workers in a given country do not earn the same labor income, that shows that the labor market does not value their productivity at the same level.

Thus, we test theses hypotheses for each country, each education level, and year. abour income data refers to monthly pay from main job and it is acomplusory recorded after 2009. Labour income data is not comparable between countries since it is only reported the decile of the labour income in which each individual is. Therefore, this is a panel for each country: data on many individuals (but only domestic workers and EU15 foreigners for each country, not other immigrants) for a number of years but not for all the countries. Table 1 reports p-values of theKolmogorov-Smirnov test for differences in the distribution of the income by country, education level and years 2009, 2013 and 2017. Taking as significance value α=0.01, any p-value below that indicates rejection of the null hypothesis of equality between distribution functions.

Table 1. Equality of distributions test									
	H			M			L		
	2009	2013	2017	2009	2013	2017	2009	2013	2017
AT	0.000	0.000	.	0.000	0.003	.	0.000	0.000	.
BE	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
DE	0.000	0.000	0.000	0.030	0.000	0.000	0.000	0.000	0.000
DK	0.000	0.000	0.000	0.004	0.001	0.000	0.000	0.000	0.000
ES	0.000	0.000	.	0.179	0.069	.	0.000	0.001	.
FI	0.183	0.022	0.050	0.045	0.010	0.007	0.002	0.000	0.001
FR	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000
GR	0.000	0.390	0.010	0.355	0.002	0.001	0.160	0.000	0.000
IE	0.000	0.000		0.000	0.000		0.000	0.000	
IT	0.000	0.000		0.000	0.000		0.000	0.000	
LU	0.000	0.000		0.000	0.000		0.000	0.000	
NL	.	0.000		.	0.000		.	0.000	
PT	0.000	0.000		0.049	0.000		0.000	0.000	
SE	.	.		.	.		.	.	
UK	0.000	0.000		0.000	0.000		0.000	0.000	

In red color are reported those p-values where the null hypothesis of equality is not rejected. In most of the EU-15 countries the null hypothesis of equal distribution of labour income for individuals with the same level education is rejected. However, in four countries (Spain, Finland, Greece and Portugal) we find some remarkable differences. In Spain, there are no significant differences for individuals who are working and have medium level education. A similar pattern can be found in Greece and Portugal only for 2009 and 2010. This is the result that in these countries having only secondary education is not sufficient to discriminate with respect to similar individuals from other EU15 countries. Many times, this group comprises school leavers who then face social disadvantage (Vallejo and Dooly, 2013).

There are several covariates that can shift the distribution of labour income decile for each group. We analyze the relation between labour income and individual characteristics such, sex, age, education level, field of education and living in a rural or urban region. We explain in detail each variable and the expected sign of the estimation:

Table 2: Covariates	
Covariate	**Description (variable name)**
Education level	H: Third level; M: Upper secondary; L: Up to lower secondary
Education Field	Field of education following ISCED 2009and 2016
Nationality	1: National; 2: EU15; 3: EU28; 4: Rest of the world
Sex	1: Male; 2: Female
Years of residence	1: Born; 2: 01-10; 3: More than 10
Urbanisation	Degree of urbanisation: 1: Cities; 2: Towns; 3: Rural

We compute summary statistics of the covariates by each country for the whole sample period. Frequencies are reported for each covariate.

Table 3: Summary statistics						
Covariate	**Covariate**	**DE**	**ES**	**FR**	**IT**	**UK**
Education level	H	0.203	0.210	0.187	0.094	0.243
	M	0.485	0.161	0.318	0.282	0.319
	L	0.183	0.482	0.313	0.492	0.212
Nationality	National	0.921	0.949	0.946	0.933	0.929
	EU15	0.018	0.007	0.017	0.002	0.018
	EU28 non EU15	0.043	0.012	0.007	0.035	0.021
	Rest of the World	0.018	0.032	0.030	0.030	0.032
Years of residence	01-10	0.028	0.033	0.031	0.033	0.053
	More than 10	0.051	0.037	0.074	0.046	0.060
Urbanisation	Cities and Towns	0.774	0.699	0.703	0.726	0.849
	Rural	0.226	0.301	0.297	0.274	0.151

There are differences across countries in the frequency of the different covariate values. In Germany and UK the share of highly educated in important and much above that low educated individuals. In Spain a similar figure arises although it is quite remarkable how the largest percentage corresponds to low educated people jointly with Italy. Nationals are majority in the sample as it is expected, and once again the percentage of EU15 workers is larger than in Southern European countries. Individuals mostly work in urban areas.

We perform an order probit regression with 10 different ordered values of the labour income corresponding to each decile of the distribution. Our estimation equation is

$$Prob\left(I_i = j\right) = Prob\left(k_{j-1} < \beta_1 X_{1i} + ... + \beta_K X_{Ki} + u_j \leq k_j\right)$$

for each individual in the sample of each country (intercept has been dropped as identification constraint). We evaluate the probability that an individual defined by a vector of characteristics is within a certain decile of labour income, Table

3 presents the results for the five largest countries within the EU15. All the observations are pooled from 2009 until 2017. All regressions include time specific effects.

Table 4. Ordered probit results

	DE	ES	FR	IT	UK
H	1.733***	1.046***	1.1767***	1.117***	0.964***
M	0.785***	0.358***	0.347***	0.429***	0.226***
EU15	0.050***	-0.076***	0.074***	0-143***	0.050***
EU28	-0.206***	-0.572***	-0.459***	-0.653***	-0.234**
NONEU	-0.404***	-0.501***	-0.629***	-0.695***	-0.163***
SEX	0.808***	0.658***	0.655***	0.758***	0.751***
YRESID	0.004***	-0.011***	0.005***	-0.002***	0.002**
URBAN	0.016***	0.158***	0.092***	0.061***	-0.018***
k_1	-0.197	-0.662	-0.548	-0.696	0.121
k_2	0.316	-0.174	-0.060	-0-207	0.813
k_3	0.696	0.183	0.281	0.159	1.348
k_4	1.023	0.499	0.593	0.455	1.750
k_5	1.332	0.792	0.879	0.752	2.086
k_6	1.644	1.095	1.166	1.032	2.371
k_7	1.978	1.416	1.481	1.346	2.667
k_8	2.374	1.792	1.851	1.721	2.991
k_9	2.924	2.324	2.367	2.238	3.430
No. Obs.	1,336,175	248,708	348,312	1,423,539	195,931
Prob>chi2	0.000	0.000	0.000	0.000	0.000

*** Significant at 1%. ** Significant at 5%.

Across countries, all the estimated coefficients for high and medium education level, being a national citizen, an EU-15 citizen and living in an urban area are positive and significant. An individual with high education will lead to an increase in the z-score in favour of a higher labour income decile status by 1.537 points. This number reduces to 0.785 points in case of medium level education. An indivual living in an urban area also leads to an increase in the z-score but the magnitude of the effect is very small. Particular attention deserves the nationality covariate. Clearly, being EU15 citizen increases z-score, however this is not necessarily the case neither by national or EU28 citizens.

The yearly regressions by country (see Appendix 2) reveals that there has been a process of convergence of labour income distribution of national individuals

An additional difficulty to test our hypothesis is that even if the market makes a distinction between academic degrees, if a country has the same level as the average EU15, then our test will not identify the differences. Therefore, in some instances we may reject the hypothesis even when differences are present. If we reject the hypothesis, we may still want to see the relationship between labor income and educational standards.

5 Concluding Remarks

In this paper we analyze competition between regions that decide on educational standards. If the market does not distinguish between the academic degrees, that is, it values at the same price graduates from different regions then we are in the free riding case: the graduate wage with integration is an average of the productivities of the different graduates. Then, standards are too low compared to the standards that a central planner would set. When there is competition between regions, standards are higher than those a central planner would set. In the short run after integration, the free-riding case is more likely. The market may take a while to distinguish between graduates from different countries. In the long run, the competition case is more likely to happen than free-rinding.

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Appendix 1

A.1.1 Second Order Condition in the No Interaction case.
The second derivative of $V(\widehat{y})$ is,

$$V''(\widehat{y}) \;=\; [1-F(\widehat{y})]\,h''(\widehat{y}) - F''(\widehat{y})\,[h(\widehat{y})-h(y_o)] - 2F'(\widehat{y})h'(\widehat{y})$$

Since $h'(\widehat{y})>0$, $h''(\widehat{y})<0$ and $F'(\widehat{y})>0$, then $F''(\widehat{y})\geq 0$ is a sufficient condition for $V''(\widehat{y})<0$.■

A.1.2 Proof of Proposition 1 (No interaction in educational standards)
(i) Denote $\widehat{y}^*$ the optimal standard with a budget θ_1. Then, from the FOC

$$[1-F_{\theta_1}(\widehat{y}^*)]\,h\prime(\widehat{y}^*) - F'_{\theta_1}(\widehat{y}^*)\,[h(\widehat{y}^*)-h(y_o)] = 0\,.$$

If the budget in education increases from θ_1 to θ_2, evaluating the FOC at $\widehat{y}^*$,

$$\begin{aligned} signV'(\widehat{y}^*) &= sign\left\{[1-F_{\theta_2}(\widehat{y}^*)]\,h\prime(\widehat{y}^*) - f_{\theta_2}(\widehat{y}^*)\,[h(\widehat{y}^*)-h(y_o)]\right\} \\ &= sign\left\{h\prime(\widehat{y}^*) - \frac{f_{\theta_2}(\widehat{y}^*)}{[1-F_{\theta_2}(\widehat{y}^*)]}\,[h(\widehat{y}^*)-h(y_o)]\right\} \end{aligned}$$

which is positive since the *MLR* property implies $\frac{f_{\theta_2}(\widehat{y})}{1-F_{\theta_2}(\widehat{y})} \leq \frac{f_{\theta_1}(\widehat{y})}{1-F_{\theta_1}(\widehat{y})}$. Therefore, the optimal standard with budget θ_2 must be larger than with budget θ_1.■

(ii) Denote $\widehat{y}^*$ the standard that maximizes $V(\widehat{y})$ when $h(\widehat{y})=\widehat{y}$, that is

$$[1-F(\widehat{y}^*)] - F'(\widehat{y})\,[\widehat{y}^*-y_o] = 0. \tag{1}$$

If the planner becomes more egalitarian and considers a concave function $h(y)$ instead of y in the value function, then evaluating the FOC at $\widehat{y}^*$ and substituting (1) we have:

$$\begin{aligned} signV'(\widehat{y}^*) &= sign\left\{[1-F(\widehat{y}^*)]\,h'(\widehat{y}^*) - F'(\widehat{y}^*)\,[h(\widehat{y}^*)-h(y_o)]\right\} \\ &= sign\left\{F'(\widehat{y}^*)\,[\widehat{y}^*-y_o]\,h'(\widehat{y}^*) - F'(\widehat{y}^*)\,[h(\widehat{y}^*)-h(y_o)]\right\} \end{aligned}$$

Therefore, given that $F'(\widehat{y}^*)>0$,

$$signV'(\widehat{y}^*) = sign\left\{[\widehat{y}^*-y_o]\,h'(\widehat{y}^*) - [h(\widehat{y}^*)-h(y_o)]\right\}$$

which is negative due to the strict concavity of $h(y)$.■

A.1.3 Proof of Proposition 2 (Strategic substitutes and Strategic Complements)

Taking the derivative of $V_{\widehat{y}}$ with respect to $\widehat{x}$:

$$V_{\widehat{y}\widehat{x}} = [1 - F(\widehat{y},\widehat{x})](1-\lambda)h''(y)\lambda - h'(y)(1-\lambda)F_{\widehat{x}}(\widehat{y},\widehat{x}) - F_{\widehat{y}}(\widehat{y},\widehat{x})h'(y)\lambda - [h(y) - h(y_o)]F_{\widehat{y}\widehat{x}}(\widehat{y},\widehat{x})$$

Noting that $F_{\widehat{y}\widehat{x}}(\widehat{y},\widehat{x}) = 0$ this can be written as:

$$V_{\widehat{y}\widehat{x}} = h''(y)\lambda(1-\lambda)[1 - F(\widehat{y},\widehat{x})] - h'(y)\left[(1-\lambda)F_{\widehat{x}}(\widehat{y},\widehat{x}) + \lambda F_{\widehat{y}}(\widehat{y},\widehat{x})\right]$$

Taking into account that $h'(y) > 0$, $h''(y) < 0$, $F_{\widehat{y}}(\widehat{y},\widehat{x}) > 0$, and $|F_{\widehat{x}}(\widehat{y},\widehat{x})| < |\frac{\lambda}{(1-\lambda)}F_{\widehat{y}}(\widehat{y},\widehat{x})|$, for any $|\lambda| \in (0,1)$, then:

Under free-riding, $\lambda > 0$:

$$h''(y)\lambda(1-\lambda)[1 - F(\widehat{y},\widehat{x})] - h'(y)\left[(1-\lambda)F_{\widehat{x}}(\widehat{y},\widehat{x}) + \lambda F_{\widehat{y}}(\widehat{y},\widehat{x})\right] < 0$$

since $F_{\widehat{x}}(\widehat{y},\widehat{x}) < 0$. Thus, reaction functions are downward sloping and standards are strategic substitutes.

Under competition, $\lambda < 0$:

$$h''(y)\lambda(1-\lambda)[1 - F(\widehat{y},\widehat{x})] - h'(y)\left[(1-\lambda)F_{\widehat{x}}(\widehat{y},\widehat{x}) + \lambda F_{\widehat{y}}(\widehat{y},\widehat{x})\right] > 0$$

since $F_{\widehat{x}}(\widehat{y},\widehat{x}) > 0$. Thus, reaction functions are upward sloping and standards are strategic complements.■

A.1.4 Proof of Proposition 3 (Labor market integration)

See Costrell (1994) for the case $\lambda > 0$.

First, note that y decreases with $\lambda > 0$ when $\hat{y}>\hat{x}$, increases with $\lambda > 0$ when $\hat{y}<\hat{x}$, and does not change with λ at the symmetric equilibrium $\hat{y}=\hat{x}$. For $\lambda < 0$, y increases with λ for $\hat{y} > \hat{x}$, and increases with λ for $\hat{y}<\hat{x}$. As a consequence, F increases with $\lambda > 0$ when $\hat{y}>\hat{x}$, decreases with $\lambda > 0$ when $\hat{y}<\hat{x}$, and does not change withλ at the symmetric equilibrium $\hat{y}=\hat{x}$. For $\lambda < 0$, F decreases with λ for $\hat{y}>\hat{x}$, and increases with λ for $\hat{y}<\hat{x}$.

Second, we show that for a fixed $\hat{x}$, more integration (higher $\lambda > 0$ or lower $\lambda < 0$) makes $F_{\hat{y}}$ higher (lower) in the free-riding (competition) case, that is $F_{\hat{y}\lambda} > 0$.

The number of people who decide to graduate $(1-F)$ depends on the return to effort, that is, $y = \hat{y} + \lambda(\hat{x} - \hat{y})$, so that the higher the return y the lower the value of F. Consider a low and a high levels of integration, $\underline{\lambda} > 0$ and $\bar{\lambda} > 0$, respectively. For a given $\hat{x}$, when $\hat{y}<\hat{x}$, for the low standards country the income with$\bar{\lambda}$ is higher than the income with $\underline{\lambda}$, so that for low values of the domestic standard F with $\bar{\lambda}$ is lower than F with $\underline{\lambda}$. However, when $\hat{y}>\hat{x}$, the opposite is true. When $\hat{y} = \hat{x}$, F with $\bar{\lambda}$ is equal to F with $\underline{\lambda}$. This shows that the positive slope $F_{\hat{y}}$ is larger for $\bar{\lambda}$

than for $\underline{\lambda}$, thus $F_{\hat{y}\lambda} > 0$. For the competition case, $\bar{\lambda} < \underline{\lambda} < 0$. For a given $\hat{x}$, when $\hat{y} < \hat{x}$, for the low standards country the income with $\bar{\lambda}$ is lower than the income with $\underline{\lambda}$, so that for low values of the domestic standard F with $\bar{\lambda}$ is higher than F with $\underline{\lambda}$. However, when $\hat{y} > \hat{x}$, the opposite is true and again when $\hat{y} = \hat{x}$, F with $\bar{\lambda}$ is equal to F with $\underline{\lambda}$. This shows that the positive slope $F_{\hat{y}}$ is larger for $\underline{\lambda}$ than for $\bar{\lambda}$, and considering that $\bar{\lambda} < \underline{\lambda} < 0$, we have $F_{\hat{y}\lambda} > 0$.
■

A.1.5 Proof of Proposition 4

The proof easily follows from Proposition 3. Suppose the domestic country becomes more egalitarian. From Proposition 1, for every $\widehat{x}$ then $\widehat{y}$ decreases. Therefore,

(i) Under free-riding, $\lambda > 0$, the reaction function of the domestic country shifts inwards. Hence, in the new equilibrium $\widehat{y}$ decreases and, on the contrary, $\widehat{x}$ increases.

(ii) Under competition, $\lambda > 0$, the reaction function of the domestic country shifts inwards. Hence, in the new equilibrium $\widehat{y}$ decreases and $\widehat{x}$ decreases as well.■

The proof easily follows from Proposition 3. Suppose the domestic country spends more money in education. From Proposition 2 for every $\widehat{x}$ then $\widehat{y}$ increases. Therefore,

(i) Under free-riding, $\lambda > 0$, the reaction function of the domestic country shifts outwards. Hence, in the new equilibrium $\widehat{y}$ increases and, on the contrary, $\widehat{x}$ decreases.

(ii) Under competition, $\lambda > 0$, the reaction function of the domestic country shifts outwards. Hence, in the new equilibrium $\widehat{y}$ increases and $\widehat{x}$ increases as well.■