

Economic Integration in a Risky Environment: Labor Market Participation and Education Decisions ^{*}

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This version: August 1, 2012

Work in progress

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Abstract

In this paper we contribute to the understanding of how decisions about education and labor market participation interact with international economic integration. Individuals are heterogenous in their skills and trade occurs between sectors characterized by oligopolistic competition. Within this setting, individuals decide on their type of education and on labor market participation subject to the degree of international integration as well as education subsidies and unemployment benefits provided by the government. We derive the impact of various policy changes on education and labor markets, e.g. that the effects of productivity shocks are amplified by trade integration. In an extension with endogenous firm entry, the effectiveness of home education subsidies decreases in economic integration and increases in foreign education subsidies. This allows for policy coordinations mitigating adverse effects of trade integration.

JEL Classification: F12, F16, H52, H53

Keywords: Economic Integration, Trade Costs, Education Policy, Unemployment Benefits, Labor Market Participation

1 Introduction

International economic integration is one of the major forces shaping our economies nowadays. Despite its considerable impact on economic conditions, our knowledge about how economic integration affects individuals' decisions about education and labor market participation is still quite limited. In this paper we contribute to understanding this nexus by proposing a model of international trade in which individuals endogenously choose a level of education and the degree of labor market participation. These decisions are made under uncertainty about the realization

^{*}We would like to thank participants of the 2012 Journées d'Economie Publique Louis-André Gérard-Varet (Marseille) for useful comments and suggestions.

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of a economy-wide productivity shock and thus uncertainty about wages. Furthermore, these decisions are subject to both the degree of economic integration and incentives provided by the governments. Therefore, the size and skill composition of the labor forces are endogenously determined.

Risk plays an important role in our model. Individuals know the distribution of productivity when making their education decisions and the realization of productivity when deciding whether to work or not. Risk generates unemployment among individuals with basic education. The share of the unemployed is the higher the worse the realization of productivity. Second, it allows to replicate important stylized facts about unemployment across educational groups: Since productivity risk is not equally important for all individuals, unemployment is the more prevalent the lower education.

In this paper, we follow several objectives: First, we provide a model which allows to study the effects of falling trade costs on *both* education and labor market participation decisions at the same time. Second, we explicitly allow for government policies to affect these decisions. Third, we study how trade integration interacts with uncertain productivity in changing the effectiveness of these policies.

We present a model of two countries. In each country there are two sectors: In sector 1 firms produce competitively a numeraire consumption good. In a second sector a continuum of varieties are produced in an oligopolistic market with a fixed number of firms (relaxed later). Firms produce output with labor as only input and compete in quantities. Due to oligopolistic competition it is worthwhile for firms in both countries to export to the other market (reciprocal dumping) if iceberg trade costs are not too high. Individuals are heterogeneous in their initial ability/effective labor. Wages per unit of labor are stochastic due to an economy-wide shock. Individuals can first decide on their level of education and then on whether to work or to receive some basic assistance. Governments influence both decisions by subsidizing education and providing basic assistance benefits which are both financed through head taxes. These benefits are at the heart of the mechanism driving our results on labor market participation. The amount of money payed to an unemployed relates to the expenditures made by the employed on differentiated goods and is thus tied to a real consumption basket. This reflects the fact that policymakers in most developed countries have some minimal standard of living in mind when setting these benefits.

Within the framework of this model we analyze the effects of changes in government policies (i.e. education subsidies) and trade costs on both education and labor market decisions. In our baseline model with a fixed number of firms, we show that integration makes it more attractive to choose basic education instead of none and to work regardless of one's type of education. The mechanism behind this result relates to lower prices for differentiated goods due to increased competition. One can only benefit from this effect when working. Second, an increase in the variation of productivity shocks induces more individuals to opt for education, but increases the volatility in employment levels. The former effect is found to be stronger in more integrated economies. This is due to the fact that wages are the inverse of productivity in our model.

Thus, a mean-preserving spread in productivity does not preserve the mean of wages. Third, education subsidies alter only the decision between advanced and basic education. The increase in advanced education is the higher, the larger the volatility in productivity shocks.

This baseline specification is then extended by endogenizing the number of firms. In the modified setting each firm needs to employ a certain amount of workers with advanced education. Whereas the results on the effects of trade integration remain unchanged, the effects of education subsidies become more subtle. Since education subsidies increase competition in the differentiated goods sector, increases in both home and foreign education subsidies raise the benefit from basic education and working. Furthermore, we show that the effectiveness in home subsidies increases in foreign subsidies and decreases in trade integration. The second result suggests that governments need to increase investment into education to achieve the same educational outcomes as before when trade costs fall. However, there are positive spill-overs from foreign educational subsidies. Although these spill-over decrease as trade costs fall, they still help mitigating the detrimental effects from trade integration on educational outcomes. An international coordination of educational policies thus allows to reduce trade barriers without straining the budget or reducing educational participation.

Our approach is complementary to the standard way of modeling the relationship between trade and education as well as labor markets. Both the classical trade theory as well as the recent trade literature (e.g. [Melitz \(2003\)](#), [Yeaple \(2005\)](#), [Chaney \(2008\)](#), or [Neary \(2009\)](#)) treat the effective amount of labor as given and develop the resulting trade patterns. We take the opposite avenue and ask what kind of skill distribution and labor market participation results from a certain degree of trade integration. That is, in a sense we provide an additional building block for developing a unified theory of the interactions between skills and trade.

There exists a quite limited amount of literature dealing with the impact of trade on educational decisions. The two papers which come closest to ours are [Blanchard and Willmann \(2011\)](#) and [Janeba \(2003\)](#). The paper by Blanchard and Willmann focusses on the interaction between trade and educational institutions in individuals education decisions. In their model economic integration generates a polarization in the skill distribution (cf. [Autor, Katz, and Kearney \(2006\)](#)). Blanchard and Willmann then study under which circumstances education subsidies are more effective than tariffs in mitigating the polarizing effects of globalization. Their approach differs from ours in several ways: First, we allow for a continuum of final goods, whereas they model a continuum of intermediated goods used to produce a single final output. Second, we model the differentiated sector to exhibit oligopolistic competition, whereas Blanchard and Willmann have perfectly competitive markets. Third, we allow for unemployment, whereas labor markets always clear in [Blanchard and Willmann \(2011\)](#). Finally, the degree of economic integration is exogenous in our model and partly controlled through tariffs in their work.

The second closely related paper is [Janeba \(2003\)](#). He looks at the effects of either increasing import competition or lowering taxes on skilled workers on the distribution of incomes and finds

that both changes widen income inequality. This paper exhibits several features which distinct it from our approach. First, Janeba models a small open economy, whereas we consider two potentially symmetric countries. Second, in [Janeba \(2003\)](#) unskilled individuals work in a sector which is subject to international competition, whereas the sector of the skilled is not. Hence the incentive to educate. In our model, individuals can work in any sector. Their incentive to educate is to increase their effective amount of labor.

A second strand of literature to which our work relates is the one on international trade and labor markets. A fair share of this literature combines trade models with monopolistic competition and labor market matching models (cf. [Helpman \(2010\)](#), [Helpman, Itskhoki, and Redding \(2010\)](#), [Costinot and Vogel \(2010\)](#), and [Helpman, Itskhoki, Muendler, and Redding \(2011\)](#)) whereas some others resort to the fair wage approach (cf. [Egger and Kreickemeier \(2011\)](#)). Both approaches have in common that they assume a given skill distribution and that trade interacts with labor markets imperfections in generating unemployment. In our model, skills are determined endogenously and labor markets are without frictions. Thus, unemployment is purely voluntary. In that way we stress the importance of incentivising effects of governmental policies in labor market decisions. We do not, however, claim that e.g. search frictions were no additional source of unemployment.

The third strand of literature our work is related to deals with the interaction between trade integration and government policies. One paper which is close to ours in spirit is [Itskhoki \(2008\)](#). In this paper he analyzes how trade integration affects the tax scheme which is optimal to achieve a certain redistributive aim. Though the precise problem which is modeled is quite different from ours, both papers share the focus on the effect of trade integration on the effectiveness of government policies. Another paper which is relevant for our work is [Rodrik \(1998\)](#)¹. Rodrik analyzes how trade integration and external risk interact in shaping size and structure of government budgets. We are also interested in looking at the relationship between risk, trade integration and government policies. However, the source of the risk we are looking at is not necessarily external. Furthermore, since public good spending adjusts in our formulation of the government budget, we can quantify the effects of risk and integration on the structure, but not the size of the government budget.

The paper organizes as follows: First, we present and solve the model with the number of firms exogenously given. We derive comparative statics with respect to trade integration, number of firms, education subsidies, and the volatility of shocks. In section 3 we extend the model by endogenizing the number of firms and discuss how results from comparative statics change in this setting. Afterwards, we conclude and discuss planned extensions.

2 The Model with Fixed Number of Firms

We consider a world economy consisting of two countries. Foreign country variables are indexed by *. In each country there are two *sectors*: In sector 1 firms produce competitively a numeraire

¹cf. [Rodrik \(1997\)](#) and [Epifani and Gancia \(2009\)](#)

consumption good z_0 . In a second sector a continuum of varieties are produced in an oligopolistic market with a fixed number of firms.² Let $z \in [0, 1]$ be an index for a variety in sector 2, also called an industry, and $x(z)$ and $y(z)$ be the consumption and output of a firm for variety z . For each variety there are n firms in home and n^* firms in foreign and all industries are identical (an assumption we intend to relax in the future). Firms produce output with labor as only input and compete in quantities. The coefficient α (α^*) represents the number of units of labor to produce one unit of output in both sectors in home (foreign), and is thus an economy wide productivity measure. Productivity is stochastic with two possible realizations $\alpha^h < \alpha^l$, where h (l) stands for high (low). The probability of a good shock α^h is $q \in [0, 1]$.

Trade within an industry of the second sector takes place if international trade costs are not too large. Trade costs are modeled as iceberg costs and are captured by the parameters $\theta^* \geq 1$ and $\theta \geq 1$. These costs can be interpreted as non-tariff barriers (so that typically $\theta \neq \theta^*$) or simply transportation costs (and then $\theta = \theta^*$). Due to oligopolistic competition it is worthwhile for firms in both countries to export to the other market (reciprocal dumping).

Individuals are heterogeneous in their individual labor productivity (measured by the amount of effective labor) and have quasi-linear preferences over the consumption goods of both sectors. Consumption is financed out of labor income net of taxes and government transfers. Individuals make two types of decisions. They first decide on the level of education, which can be advanced, basic or none. In the latter case individuals are always unemployed. Advanced education provides the individual with a higher amount of effective labor per unit of time (i.e., generates a larger amount of effective labor). Second, educated workers either work and suffer a fixed utility loss γ , or decide to be unemployed and then receive a government transfer B . Not working despite being educated can be optimal due to the stochastic nature of α . Choosing basic education is costless but advanced education costs $c - s$, where c is the market price/production cost of advanced education and s is an education subsidy by the government. This assumption is meant to capture that basic education like secondary schooling is less expensive than tertiary education. Not all workers become educated because individual labor productivity could be too low relative to the disutility of working. Workers are heterogeneous in their effective amount of labor (if they become educated). A worker has ϕ^{-1} units of effective labor under basic education and $\lambda\phi^{-1}$, $\lambda > 1$, under advanced education. More productive individuals have lower values of ϕ .

The government collects a head tax T from all *working* individuals and spends revenues on education subsidies, unemployment benefits and public goods. The marginal rate of transformation between the numeraire good and the public good is one. Due to the stochastic nature of production we assume that public good supply adjusts endogenously to any realization of the shock.

The timing of decisions is as follows:

1. Nature draws individual productivity $\phi \in [\underline{\phi}, \bar{\phi}]$, with $F(\phi)$ being the cumulative distribution function

²This assumption is relaxed in an extension to the basic model.

2. The government sets the education subsidy s , head tax T , and benefits B
3. Workers decide on education (advanced, basic, none)
4. Productivity shock α realizes (α^h or α^l)
5. Workers decide on labor market participation (work or be unemployed)
6. Output produced and consumed, taxes and transfers paid, government public good provided; all markets clear

Our main interest is in studying the effects of economic integration in the form of falling international trading costs (θ and θ^*) and increases in the volatility of economy wide shock (α) on education and labor market decisions. The model is solved by backward induction.

2.1 Stage 6: Production and Consumption

2.1.1 Household behavior

Each individual is indexed by ϕ , $\phi \sim [\underline{\phi}, \bar{\phi}]$ which corresponds to ability $\frac{1}{\phi}$ and determines income $I(\phi)$. The household maximization problem of a *working* individual who was previously educated is

$$\begin{aligned} \max_{x(z), z_0} U[x(z), z_0, \gamma] &= z_0 + \int_0^1 u[x(z)] dz - \gamma & (1) \\ \text{s.t. } p_0 z_0 + \int_0^1 p(z) x(z) dz &= I(\phi) \end{aligned}$$

where $u[x(z)] = ax(z) - \frac{b}{2}[x(z)]^2$ is a quadratic subutility function for each variety, $I(\phi)$ is the income of an individual with ability ϕ after tax T and education cost ($c - s$ for advanced education), and γ is the disutility of labor. We assume $a > 1$ and $b > 0$. Gross income is $(\alpha\phi)^{-1}$ and $\lambda(\alpha\phi)^{-1}$, respectively.

Non-working individuals receive a transfer of B sufficient to buy a share δ of the bundle of differentiated goods as consumed by the employed individuals. This transfer guarantees a fixed real level of consumption for the unemployed if $\delta \in (0, 1]$ (parsimonious welfare state)³ or to participate in lower prices of the differentiated good if $\delta > 1$ (generous welfare state). Furthermore it implies that the differentiated goods should be thought of as necessities whereas the numeraire good represents the luxuries.⁴ Unemployed enjoy utility $u(B)$. There is no decision to be made.

Since z_0 is decreasing in ϕ we assume in the following that given α there exists a critical level of individual productivity $\tilde{\phi}$ such that individuals with lower values of ϕ work, while those with higher values choose to be unemployed. The assumption is verified later.

³Since the computation of the aggregate demand for the differentiated good in the case of $\delta \in (0, 1)$ is somewhat involved, we restrict the analysis to $\delta = 1$ for the parsimonious case. However, all results presented for $\delta = 1$ carry over $\delta \in (0, 1]$.

⁴In Appendix A we show that the main results of this paper are robust to alternative reasonable specifications of transfer B.

Utility maximization of a working individual leads to optimal demand for a variety of the differentiated good

$$x(z) = \frac{a - p(z)}{b}. \quad (2)$$

Inserting (2) into (1) the net surplus of consumption of a variety z is

$$u(x(z)) - p(z)x(z) = \frac{(a - p(z))^2}{2b}.$$

Aggregate demand for variety z in the home country amounts to

$$X(z) = \int_{\underline{\phi}}^{\bar{\phi}} x(z) f(\phi) d\phi = \frac{[a - p(z)]}{b} \quad (3)$$

which in turn gives the inverse demand function

$$p(z) = a - bX(z). \quad (4)$$

The analysis for the foreign country is straightforward and left out.

2.1.2 Firm behavior

The firm optimization problem in the numeraire sector is trivial. Given constant returns to scale, a normalization of the price for the numeraire good to one, and price taking behavior the wage equals productivity

$$w = \alpha^{-1}. \quad (5)$$

For now we use the symbol α to denote the economy wide productivity when not referring to a specific realization. The wage rate must be the same in both sectors because aggregate productivity is the same and labor markets are competitive. The cost per unit of output $w\alpha$ are 1 in both sectors. In the differentiated sector a typical home firm in industry z solves the problem

$$\max_{y_d(z), y_{ex}(z)} \Pi = p(z)y_d(z) + p^*(z)y_{ex}(z) - [y_d(z) + \theta^*y_{ex}(z)]$$

where $y_d(z)$ and $y_{ex}(z)$ stand for domestic sales and exports of the home firm to foreign, respectively. $\theta^* \geq 1$ represents transport costs or import barriers imposed by foreign on home exports. A value of $\theta^* = 1$ means full economic integration as barriers to trade are absent. We assume for the moment interior solutions for domestic and export sales of both home and foreign firms and consider a symmetric equilibrium among firms of the same country. We obtain the reaction

functions

$$\begin{aligned}
y_d(z) &= \frac{(a-1)}{b(n+1)} - \frac{n^*}{n+1} y_{ex}^*(z) \\
y_{ex}(z) &= \frac{a^* - \theta^*}{b(n+1)} - \frac{n^*}{n+1} y_d^*(z),
\end{aligned} \tag{6}$$

and similarly for foreign firms. Substituting the foreign firm's export reaction function for y_{ex}^* into the first line of (6) gives the equilibrium output of home and foreign firms consumed in the home market as

$$\begin{aligned}
y_d(z) &= \left[\frac{a-1+n^*(\theta-1)}{b(n+n^*+1)} \right] \\
y_{ex}^*(z) &= \left[\frac{a-\theta+n(1-\theta)}{b(n+n^*+1)} \right],
\end{aligned} \tag{7}$$

and analogously in the foreign market as

$$\begin{aligned}
y_d^*(z) &= \left[\frac{a^*-1+n(\theta^*-1)}{b(n+n^*+1)} \right] \\
y_{ex}(z) &= \left[\frac{a^*-\theta^*+n^*(1-\theta^*)}{b(n+n^*+1)} \right].
\end{aligned} \tag{8}$$

A home firm's profit equals $\pi = (p-1)y_d + (p^*-\theta^*)y_{ex}$. Aggregate profits are distributed lump sum to consumers such that one randomly chosen consumer or a small group of consumers obtain this profit income, reflecting the concentration of capital income and wealth in most societies. Under this assumption important thresholds for labor market participation and education are not affected by the amount of profits. This allows us to analyze the role of globalization or volatility of productivity shocks via price effects and not through profit income.

2.1.3 Goods market equilibria

In order to describe the goods market equilibrium it is useful to introduce the following notation for home market and foreign market output

$$Y(z) = ny_d(z) + n^*y_{ex}^*(z) \text{ and } Y^*(z) = ny_{ex}(z) + n^*y_d^*(z).$$

Equilibrium in industry z of the home country requires $X(z) = Y(z)$. Substituting the sales in the Home market from (7) and (8) for $Y(z)$ $Y^*(z)$ and using (3) yields the equilibrium prices in the home and foreign markets

$$p(z) = \frac{a+n+n^*\theta}{n+n^*+1} \text{ and } p^*(z) = \frac{a^*+n^*+n\theta^*}{n+n^*+1}. \tag{9}$$

We note that prices are independent of aggregate productivity α and demand depends only on price due to quasi-linearity of the utility function. Finally, an important property we will exploit further below is that prices for differentiated goods are falling with economic integration, which is equivalent to stating

$$\frac{dp(z)}{d\theta} > 0 \text{ and } \frac{dp^*(z)}{d\theta^*} > 0.$$

Note that the home country's net trade position in a differentiated good equals $nex(z) = ny_{ex}(z) - n^*y_{ex}^*(z)$. To support an interior solution we need that quantities computed for exports are positive ($y_{ex}^*(z), y_{ex}(z) > 0$), which requires positive numerators in the export sales expression of (7) and (8), and therefore

$$\frac{a+n}{n+1} > \theta \text{ and } \frac{a^*+n^*}{n^*+1} > \theta^*. \quad (10)$$

Condition (10) represents a restriction on parameter values that allow for positive trade in all industries in both directions. As $a > 1$, an increase in domestic competition (via n) makes trade less likely, as profit margins decline.

The supply of the numeraire good equals the amount of effective labor from workers of both education types not used in the production of the differentiated goods, i.e. **(need to be adjusted)**

$$Z_0^s = \int_{\underline{\phi}}^{\tilde{\phi}_{ad}} \frac{\lambda}{\alpha\phi} f(\phi) d\phi + \int_{\tilde{\phi}_{ad}}^{\tilde{\phi}_b} \frac{1}{\alpha\phi} f(\phi) d\phi - n[y_d(z) + y_{ex}(z)]. \quad (11)$$

Aggregate demand is equal to the sum of profit income received from domestic firms, after tax income and after education expenses income of working individuals minus spending on the numeraire good and demand by unemployed and government consumption. Government budget and trade balance condition must hold.

$$Z_0^d = \left(\int_0^1 [np(z)y_d(z)] dz + \int_0^1 [np^*(z)y_{ex}(z)] dz - wL \right) \quad (12)$$

$$+ \left(wL - \int_0^{\tilde{\phi}} Tf(\phi) d\phi - \int_0^1 [p(z)X(z)] dz \right) - \zeta(c-s), \quad (13)$$

where $\zeta \in \{0,1\}$ is a dummy variable taking on the value of one when the individual got advanced education and zero else.

An equilibrium for this world economy given a policy vector (s, T, B) at home and similar (s^*, T^*, B^*) at foreign is a price vector for each differentiated good $p(z)$ at home and in foreign $p^*(z)$, wages w and w^* , and an allocation of consumption for each individual, an output level for each firm, an education and labor market participation decision for each individual, such that i) each individual maximizes utility by choosing the consumption bundle given prices and income;

ii) firms maximize profits given the output of all firms in the same industry, prices in all other sectors and given wages; iii) the labor market participation of each individual is optimal given the realization of α and the amount of education accumulated, iv) each individual's education decision is optimal given rational anticipation of the labor market and consumption decision in subsequent play, v) the government budget is balanced, vi) all labor and output markets clear, and vii) trade is balanced.

2.2 Stage 5: Labor market participation

At this stage the level of education and the economy wide productivity are given. An individual with ability ϕ and basic education has gross labor income $(\alpha\phi)^{-1}$. Recall that only individuals with education can work and earn income. All others are unemployed. Individuals with *basic* education work when the utility from working is not less than the utility from being unemployed

$$z_0(\alpha, \phi) + \int_0^1 u[x(z)] dz - \gamma \geq u(B). \quad (14)$$

The left hand side gives the utility of consumption of goods from both sectors net of the fixed disutility from work, while the right hand side gives utility from consuming the full bundle of the differentiated good when unemployed. We use $z_0(\alpha, \phi) = \frac{1}{\alpha\phi} - T - E(z)$, where $E(z) = \int p(z)x(z)dz = \int \frac{p(z)(a-p(z))}{b} dz$ is the total expenditure on differentiated goods. Let $\bar{u} := \int_0^1 u[x(z, \alpha)] dz = \frac{a^2 - p^2}{2b}$ denote the utility from differentiated goods consumption (ignoring expenses for those goods). The critical value of individual productivity ϕ of a worker with basic education for which condition (13) is binding is

$$\tilde{\phi}_b(\alpha^j) = \frac{1}{\alpha^j [\gamma + T + E(z) + u(B) - \bar{u}]} = \frac{1}{\alpha^j A}, \quad (15)$$

for shock realizations $j = h, l$ and parameter $A := \gamma + T + E(z) + u(B) - \bar{u}$, where subscript b stands for basic education.

Individuals with advanced education solve the same problem as in (13) with the difference that individual income is $\lambda(\alpha\phi)^{-1}$ rather than $(\alpha\phi)^{-1}$ and education expenses must be taken into account. While the education decision is sunk at the time of labor market participation, the expenditures influence the amount of numeraire good consumption. The same is true, however, for an individual with advanced education who decides not to work but needs to repay the education costs from the government transfer, so that numeraire good consumption equals $B - (c - s)$.

The value of ϕ for which an individual is indifferent between working and being unemployed is therefore

$$\tilde{\phi}_{ad}(\alpha^j) = \frac{\lambda}{\alpha^j [\gamma + T + E(z) + u(B) - \bar{u}]} = \frac{\lambda}{\alpha^j A} > \tilde{\phi}_b(\alpha^j), \quad (16)$$

where the subscript *ad* refers to the decision of a worker with advanced education. The critical

value in (16) is higher than the one for those with basic education (15). For a good realization of α (i.e., $\alpha = \alpha^h$ is small) more individuals work compared to a bad realization.

2.3 Stage 3: Education Decision

Stage 4 is the realization of the productivity shock. Moving to stage 3 individuals can opt for one of three education options each of which has different implications for the labor market:

1. no education: no education cost but unemployed
2. basic education: no education costs, individual productivity $\frac{1}{\phi}$, disutility γ if work ⁵
3. advanced education: education cost $c - s > 0$, productivity $\frac{\lambda}{\phi}$, $\lambda > 1$, disutility γ if work

When making the choice, individuals know the distribution of productivity (i.e. q, α^h, α^l), but not its realization, and fiscal policy parameters s, T, B . Individuals are assumed to maximize expected utility anticipating rationally the outcome of subsequent play.

In the following we assume that individuals with advanced education work regardless of the shock realization. Workers with basic education and low productivity (i.e., relatively high ϕ among basic education workers) are assumed to work only in the good realization of the productivity shock. We show which conditions must be satisfied such that these assumptions are justified. The reason for making these assumptions is to reflect important features of labor markets in many countries: the probability of unemployment is decreasing with education, and workers with basic education have more volatile labor market status than those with advanced education.

2.3.1 Education decisions: Basic vs no education

When the marginal individual works only for the good realization of the productivity shock an individual opts for basic education when the following condition holds:

$$q \left[z_0(\alpha^h, \phi) + \int_0^1 u[x(z)] dz - \gamma \right] + (1 - q)u(B) \geq u(B), \quad (17)$$

where the left hand side is the expected utility under basic education and the right hand side is the utility from staying uneducated. Using the expression for z_0 , the critical productivity level ϕ at the cut-off is given by:

$$\widehat{\phi}_b = \frac{1}{\alpha^h [\gamma + T + E(z) + u(B) - \bar{u}]} = \frac{1}{\alpha^h A}. \quad (18)$$

Note from comparing (15) and (18) that $\widetilde{\phi}_b(\alpha^h) = \widehat{\phi}_b$. In the good state of the world the critical values for getting a basic education and being active in the labor market coincide.

⁵As a tie-breaking rule for those individuals who are indifferent between basic and no education we assume basic education to be associated with a cost $\epsilon > 0$.

2.3.2 Education decisions: Advanced vs basic education

When an individual always works both with advanced and basic education, the disutility of work and the net surplus from consuming differentiating goods are irrelevant for the marginal consumer, as they are constants offsetting each other under basic and advanced education. Therefore individuals opt for advanced education when the expected consumption of the numeraire good is higher under advanced education than under basic education

$$qz_0^{ad}(\alpha^h, \phi) + (1 - q)z_0^{ad}(\alpha^l, \phi) \geq qz_0(\alpha^h, \phi) + (1 - q)z_0(\alpha^l, \phi), \quad (19)$$

where $z_0^{ad}(\alpha^j, \phi) = \frac{\lambda}{\alpha^j \phi} - T - E(z) - (c - s)$ refers to consumption of the numeraire good under advanced education. The condition leads to the cut-off

$$\hat{\phi}_{ad} = \left(\frac{\lambda - 1}{c - s} \right) \left(\frac{q}{\alpha^h} + \frac{1 - q}{\alpha^l} \right), \quad (20)$$

which does not depend on T , B , and γ .

We assumed so far that the marginal individual who is indifferent between advanced and basic education works always under both education levels, and the marginal individual who is indifferent between basic and no education works under the former only in the good state of the world. For this to be correct, the following three conditions need to be met:

- Everybody preferring advanced over basic education is in the set of those preferring basic over no education, i.e. $\hat{\phi}_{ad} < \hat{\phi}_b$. This condition guarantees that there are workers with basic education.
- The individual indifferent between advanced and basic education is willing to work for any realization of productivity, given it has a basic education, i.e. $\hat{\phi}_{ad} < \tilde{\phi}_b(\alpha^l) < \tilde{\phi}_b(\alpha^h) = \hat{\phi}_b(\alpha^h)$. Together with the first requirement this condition implies that under the bad realization of the productivity shock some workers with basic education work, while others don't.
- The individual indifferent between advanced and basic education is willing to work for any realization of productivity, given it has a advanced education, i.e. $\hat{\phi}_{ad} < \tilde{\phi}_{ad}(\alpha^l) < \tilde{\phi}_{ad}(\alpha^h)$.

The third requirement is fulfilled when the second condition holds, as $\tilde{\phi}_{ad}(\alpha^j) > \tilde{\phi}_b(\alpha^j)$. We can guarantee the first two conditions by choosing returns to advanced education λ to be close to one or net costs of higher education $c - s$ to be sufficiently high so that $\hat{\phi}_{ad}$ is small. In this case, individuals with advanced education work for both states of productivity, whereas some but not all individuals with basic education choose to be unemployed in case of a bad productivity shock.⁶

⁶We do not need to consider the decision between advanced and no education because by construction an individual with advanced education prefers this over basic education who in turn gets from this option more utility than from no education. Hence advanced education must be preferred over no education.

2.4 Stage 2: Government

We assume that the government credibly sets the tax T , transfer policy B , and education subsidy s prior to the education decision. Recall the critical values for becoming educated, $\widehat{\phi}_{ad}$ and $\widehat{\phi}_b$, and for participating in the labor market, $\widetilde{\phi}_b(\alpha^j)$ and $\widetilde{\phi}_{ad}$. We assume $\widetilde{\phi} \leq \widehat{\phi}$. The general structure of the government budget constraint then reads :

$$\underbrace{\int_{\frac{\phi}{\widetilde{\phi}_b(\alpha)}}^{\widetilde{\phi}_b(\alpha)} Tf(\phi) d\phi}_{\text{tax revenue from workers}} + \underbrace{D_1 - R \cdot D_0}_{\text{net debt/investment}} = \underbrace{\int_{\widetilde{\phi}_b(\alpha)}^{\bar{\phi}} Bf(\phi) d\phi}_{\text{transfers to unemployed}} + \underbrace{\int_{\frac{\phi}{\widetilde{\phi}_{ad}}}^{\widetilde{\phi}_{ad}} sf(\phi) d\phi}_{\text{cost of education subsidy}} \quad (21)$$

The government is assumed to balance its budget in expectation, i.e. for $\alpha = q\alpha^h + (1 - q)\alpha^l$. To ensure the balance of the budget, governments can issue bonds or make investments (D_1) on perfectly competitive international bond markets, both at an exogenous rate R (small open economy). Governments play exactly the same game in each period and balance their budget in each period in expectation.⁷ Thus, one should think of the game played in this paper as one shot within a series of games where the only link between periods is the issuance of or investment in bonds. Normalizing D_0 to zero (without loss of generality) yields that D_1 is positive when there is a bad productivity draw (issuance of government debt) and negative in the good productivity case (investment/repayment of debt).

2.5 Effects of volatility of productivity shocks

We now examine the role of productivity shocks in more detail. In particular we examine the role of an increasing variance in shocks by defining for some $\Delta \in [0, \alpha)$

$$\begin{aligned} \alpha^h &= \alpha - \Delta \\ \alpha^l &= \alpha + \Delta. \end{aligned}$$

We are interested in the effect of mean preserving spread in productivity and therefore assume that $q = 0.5$. In this case the expected value of productivity is $E[\alpha] = \alpha$ and its variance is $Var(\alpha) = \Delta^2$.

An increase in the variation on shocks moves all education decision cut-offs in the same direction.

$$\frac{\partial \widehat{\phi}_b}{\partial \Delta} = \frac{1}{(\alpha^h)^2 A} > 0 \quad (22)$$

$$\frac{d\widehat{\phi}_{ad}}{d\Delta} = \frac{(\lambda - 1)}{2(c - s)} \left[\frac{1}{(\alpha - \Delta)^2} - \frac{1}{(\alpha + \Delta)^2} \right] > 0, \quad (23)$$

that is, education becomes more attractive as volatility increases.

⁷Due to the law of larger numbers, the government budget is balanced in the long run.

Labor market decisions are made after productivity has realized. Conditional on being either in the good or bad state, the effect of an increase in Δ on labor market participation is

$$\frac{d\tilde{\phi}_b(\alpha^l)}{d\Delta} = -\frac{1}{(\alpha^l)^2 A} < 0 < \frac{1}{(\alpha^h)^2 A} = \frac{d\tilde{\phi}_b(\alpha^h)}{d\Delta}. \quad (24)$$

The threshold for labor market participation $\tilde{\phi}_b(\alpha^j) = (\alpha^j A)^{-1}$ moves in opposite direction with Δ . The threshold increases in good states of the world but decreases in bad states.

Interestingly the previous effect is magnified in the case of basic education but not in the case of advanced education the more open is the economy

$$\frac{\partial^2 \hat{\phi}_b}{\partial \Delta \partial \theta} = -\frac{1}{(\alpha^l)^2 A} x(z) \frac{\partial p(z)}{\partial \theta} < 0. \quad (25)$$

We summarize in

Proposition 1. *An increase in the variance of productivity shocks (holding the mean constant) leads to*

- (a) *an increase in the number of workers of both basic and advanced education ($d\hat{\phi}_j/d\Delta > 0$, for $j = ad, b$),*
- (b) *an increase in the number of workers who work in the good state of the world ($d\tilde{\phi}_b(\alpha^h)/d\Delta > 0$), but*
- (c) *decreases labor market participation in the bad state ($d\tilde{\phi}_b(\alpha^l)/d\Delta < 0$).*
- (d) *The size of the effect on basic education is the larger, the more open is the economy.*

2.6 Effects of Economic Integration

Economic integration (i.e., lower values of θ, θ^* , either unilaterally or bilaterally) affect labor market and education decisions indirectly through their effect on the domestic prices of differentiated goods. We consider here the effect of a change in iceberg trade costs θ , which might capture a reduction in either transportation costs or a non-tariff barrier, and we are mostly interested in the sign of the effect rather than its magnitude.

We consider first the threshold level $\hat{\phi}_b$, i.e., the productivity of the person who is indifferent between getting a basic education or none, which falls with θ

$$\frac{\partial \hat{\phi}_b}{\partial \theta} = -\frac{(a - p(z))}{\alpha^j A^2 b} \frac{\partial p(z)}{\partial \theta} < 0. \quad (26)$$

The reason for this result is that the net surplus from consuming differentiated goods increases when prices fall. By contrast $\hat{\phi}_{ad}$ is not affected by economic integration, that is, the number of individuals with advanced education stays unchanged, because by construction the marginal

worker indifferent between advanced and basic education always works and consumes the differentiated goods. A price change in the differentiated good has no effect.

The effect on labor market participation follows now immediately

$$\frac{\partial \tilde{\phi}_b(\alpha^j)}{\partial \theta} = -\frac{(a - p(z))}{\alpha^j A^2 b} \frac{\partial p(z)}{\partial \theta} < 0. \quad (27)$$

We summarize in

Proposition 2. *More economic integration via a reduction in θ*

- (a) *lowers the number of uneducated individuals ($d\hat{\phi}_b/d\theta > 0$),*
- (b) *increases the number of individuals with basic education ($d\hat{\phi}_b/d\theta > 0$ and $d\hat{\phi}_{ad}/d\theta = 0$),*
and
- (c) *leaves the number of high-skilled individuals unchanged ($d\hat{\phi}_{ad}/d\theta = 0$).*
- (d) *It induces more individuals of any education type to work $d\tilde{\phi}_b(\alpha^j)/\theta > 0$ for $j = h, l$.*
- (e) *Foreign liberalization has no effect.*

Note that in this proposition as well as all following ones we assume fiscal parameters T , B , and where appropriate s to be constant, so that public good spending G adjusts.

The result holds true for multilateral economic integration (where $\theta = \theta^*$ falls) as well as for a unilateral opening of home for foreign products (only θ declines). Since a unilateral opening of foreign for home products (reduction in θ^*) does not affect home prices, there is no effect on home labor market or education decisions in the latter case. To be sure, foreign liberalization does affect the home country in terms of sectoral labor allocation, output, profits, and net trade.

The intuition for the main result in Prop.2 is straightforward. Economic integration increases the net benefits of consuming the differentiated good due to falling prices and thus makes it more attractive to work and get a basic education because the benefits of being unemployed are fixed in real (and not in nominal) terms.

2.7 Education policy

Subsidies for higher education move all education decision cut-offs involving advanced education outwards, i.e. more individuals opt for advanced education as the net costs decrease

$$\frac{\partial \hat{\phi}_{ad}}{\partial s} = \frac{(\lambda - 1)}{(c - s)^2} \left(\frac{q}{\alpha^h} + \frac{1 - q}{\alpha^l} \right) > 0.$$

Moreover, the effect is modified by the volatility of productivity shocks in the following way when $q = 0.5$:

$$\frac{\partial^2 \hat{\phi}_{ad}}{\partial s \partial \Delta} = \frac{(\lambda - 1)}{2(c - s)^2} \left(\frac{1}{(\alpha^h)^2} - \frac{1}{(\alpha^l)^2} \right) > 0.$$

The effect of s is larger the more volatile the productivity shock.

The decision between basic and no education as well as all labor market participation are unaffected. Trade costs have no impact on the effectiveness of education subsidies.

We summarize in

Proposition 3. *An increase in the subsidy for advanced education s*

- (a) *increases the number of individuals with advanced education ($d\hat{\phi}_{ad}/ds > 0$),*
- (b) *reduces the number of individuals with basic education ($d\hat{\phi}_{ad}/ds > 0$, $d\hat{\phi}_b/ds = 0$)*
- (c) *leaves the number of the uneducated unchanged ($d\hat{\phi}_b/ds = 0$).*
- (d) *The mass of individuals active in the labor market is not affected ($d\tilde{\phi}_b/ds = 0$), but they represent*
- (e) *more effective units of labor in the labor market ($d\hat{\phi}_{ad}/ds = 0$).*
- (f) *The effect of education subsidies on the number of advanced skilled is the larger, the larger the volatility of productivity shocks ($d^2\hat{\phi}_{ad}/ds d\Delta > 0$).*

2.8 Effects of the Generosity of Benefits

In this analysis, we distinguish between two types of welfare states: A parsimonious one ($\delta = 1$) provides individuals with just the amount of money needed to buy the same bundle of differentiated goods as consumed by workers. A generous welfare state ($\delta > 1$) provides them with more than that amount of money. In both cases, individuals receive *de facto* a transfer in real terms: As economic integration depresses prices for the differentiated goods, nominal benefits are cut proportionally. However, there is one distinction to be made between the two systems: In the parsimonious case, individuals consume only the differentiated good, i.e. their utility stays constant whatever the changes in the price for the differentiated goods. The generous welfare state provides unemployed individuals with enough money to consume the same bundle of differentiated goods as workers do *plus* some units of the numeraire good. Since the price of the numeraire good is exogenously given, the level of consumption and therefore utility changes when the value of the full differentiated bundle fluctuates: Higher prices for the differentiated good lower the relative price of the numeraire good and thus push an unemployed's consumption possibility frontier outwards.

These changes also affect education and employment decisions. Remember that three out of the four cutoffs contain $A = \gamma + T + E(z) + u(B) - \bar{u}$, where $u(B)$ is the utility derived from the benefit and \bar{u} the utility from consuming the whole bundle of differentiated goods. By definition, these two are equal when $\delta = 1$. When the welfare state is generous ($\delta > 1$), individuals can in addition consume some units of the numeraire good and thus $u(B) > \bar{u}$, and vice versa. Therefore, $u(B) - \bar{u}$ increases in δ . Furthermore, a balanced budget requires to increase head tax T as the welfare system becomes more generous (holding the education

subsidy constant). As a result of these two effects, A increases in δ , i.e. the cutoff for the three education and labor participation decisions move inwards.

We summarize in

Proposition 4. *An increase in the generosity of welfare states δ*

(a) *reduces the number of individuals with basic education ($d\hat{\phi}_b/d\delta < 0$, $d\hat{\phi}_{ad}/d\delta = 0$)*

(b) *reduces the number of workers of basic education ($d\tilde{\phi}_b/d\delta < 0$, $d\hat{\phi}_{ad}/d\delta = 0$)*

(c) *leaves the number of individuals with advanced education unchanged ($d\hat{\phi}_{ad}/d\delta = 0$).*

3 The Model with Endogenous Number of Firms

3.1 Endogenizing the Number of Firms

So far, we have assumed the number of firms n to be exogenously given, leading to pure profits in this sector. In the section, we relax this assumption by allowing for an endogenous adjustment of the number of firms. In this course, we make two changes with respect to the previous setup. First, we assume that each firm in the differentiated goods sector needs to hire a mass ξ of advanced skilled workers to start and operate the firm. Since we maintain the assumption that individuals with advanced education are willing to work for both realizations of the productivity shock, the number of firms is given by

$$n = \frac{1}{\xi} \int_{\underline{\phi}}^{\hat{\phi}_{ad}} \phi f(\phi) d\phi \quad (28)$$

unless the zero profit-condition were binding.

Second, we assume that profits are used to prop up wages of the advanced skilled, i.e. each unit of advanced labor receives an equal share of total profits. In formal terms, this reads as

$$\begin{aligned} \Pi_{unit} &= \frac{\Pi_{total}}{\int_{\underline{\phi}}^{\hat{\phi}_{ad}} \phi f(\phi) d\phi} \\ &= \frac{n[p(z) - 1]y_d(z) + n[p^*(z) - \theta^*]y_{ex}(z)}{\int_{\underline{\phi}}^{\hat{\phi}_{ad}} \phi f(\phi) d\phi} \\ &= \frac{[p(z) - 1]y_d(z) + [p^*(z) - \theta^*]y_{ex}(z)}{\xi} \end{aligned} \quad (29)$$

One should note that this expression still depends on the size of advanced skilled labor through the price effect of the number of firms.

Since firms profits are paid out to the advanced skilled, individuals solve a slightly changed optimization problem when deciding on whether to acquire advanced education and whether

to work given advanced education. The optimality condition for the working decision changes to:

$$\left(\frac{1}{\alpha} + \Pi_{unit}(\alpha)\right) \frac{\lambda}{\phi} - T - E(z) + \int_0^1 u[x(z)] dz - \gamma \geq u(B), \quad (30)$$

what leads to the cut-off value

$$\tilde{\phi}_{ad} = \frac{\lambda \left(\frac{1}{\alpha} + \Pi_{unit}(\alpha)\right)}{\gamma + T + E(z)} \quad (31)$$

This is the same one as before except for that the profit income appears in the numerator. For a positive profit income, more individuals find it optimal to work.

The education decision is now described by:

$$\begin{aligned} q \left[\left(\frac{1}{\alpha^h} + \Pi_{unit}(\alpha^h)\right) \frac{\lambda}{\phi} \right] + (1-q) \left[\left(\frac{1}{\alpha^l} + \Pi_{unit}(\alpha^l)\right) \frac{\lambda}{\phi} \right] - T - E(z) - (c-s) \\ \geq q \left[\left(\frac{1}{\alpha^h}\right) \frac{1}{\phi} \right] + (1-q) \left[\left(\frac{1}{\alpha^l}\right) \frac{1}{\phi} \right] - T - E(z) \end{aligned} \quad (32)$$

Solving for ϕ yields the education cut-off

$$\hat{\phi}_{ad} = \left(\frac{\lambda-1}{c-s}\right) \left(\frac{q}{\alpha^h} + \frac{1-q}{\alpha^l}\right) + \left(\frac{\lambda}{c-s}\right) (q \Pi_{unit}(\alpha^h) + (1-q) \Pi_{unit}(\alpha^l)) \quad (33)$$

This expression, however, describes the cut-off in an implicit way, since the right hand-side depends on $\hat{\phi}_{ad}$ through prices in the profit income.

The interpretation of this expression is similar to the previous one with fixed number of firms. It consists of a probability weighted average of both wage and profit income multiplied by a ratio made up of the *additional* units of labor receiving this income and the net cost of advanced education. Again, more individuals then before find it optimal to opt for advanced education.

Cut-offs for individuals with basic education are affected only indirectly through the effects of prices for differentiated goods. Lower prices make it more attractive to work, i.e. a higher number of firms moves both thresholds for basic-educated outwards.

The two cut-offs for advanced skilled derived above consist both of a part which is the same as above and a new additive component capturing the effects from participation of advanced skilled in firms' profits. By choosing ξ sufficiently low, i.e. increasing the number of firms so that profit income becomes relatively unimportant, one can recover the previous predictions in this setup. However, a closer look at cut-off (31) immediately reveals that effects of changes in most exogenous parameters on the working decision of advanced-skilled are highly non-linear and require numerical approaches.

3.2 Education Policy with Endogenous Number of Firms

In this section we analyze how changes in education subsidies affect decisions on labor market participation and education. In turn, we look at how changes of subsidies in the home country

alter the thresholds at home, how changes in foreign subsidies affect the home thresholds, and to what extent the magnitude of the effect of home subsidies depends on foreign subsidies. For simplicity of exposition, we assume that ξ is chosen such that there are enough firms in the market to neglect the impact of profit income on individuals decision, but that there is still a sufficient amount of market power such that both countries continue exporting.

In the setting with an exogenously given number of firms shown above, the only threshold affected by changes in education subsidy s is the one for advanced education. This direct effect prevails with endogenous firms: subsidizing advanced education increases the number of people opting for it. However, there is now an additional channel through which education subsidies affect education and working choices: the effects of increased competition on prices.

Thus, understanding how education subsidies affect the number of firms in the differentiated sector is key in understanding the impact of both home and foreign education subsidies on education and labor market decisions. The respective derivatives are given by

$$\frac{\partial p(z)}{\partial n} = \frac{(1-a) - n^*(\theta-1)}{(n+n^*+1)^2} < 0 \quad (34)$$

$$\frac{\partial p(z)}{\partial n^*} = \frac{(\theta-a) + n(\theta-1)}{(n+n^*+1)^2} < 0 \quad (35)$$

$$\frac{\partial^2 p(z)}{\partial n \partial n^*} = \frac{(n+n^*+1)[2(a-1) + (n+n^*+1)(\theta-1)]}{(n+n^*+1)^4} > 0 \quad \text{and} \quad (36)$$

$$\frac{\partial^2 p(z)}{\partial n \partial \theta} = \frac{n^*}{(n+n^*+1)^2} > 0 \quad (37)$$

Note that the signs of the two derivatives with n^* hold true for all trade costs θ for which trade occurs.

Knowing how changes in the number of firms affect prices, it is straightforward to derive the derivatives of education and labor market thresholds with respect to education subsidies: The

Table 1: Comparative Statics for Education Subsidies

	endog. n		exog. n		source of effect
	$\frac{\dot{}}{\dot{s}}$	$\frac{\dot{}}{\dot{s}^*}$	$\frac{\dot{}}{\dot{s}}$	$\frac{\dot{}}{\dot{s}^*}$	
$\frac{\partial \tilde{\phi}_b}{\partial s}$	>0	>0	0	0	indirect through p(z)
$\frac{\partial \tilde{\phi}_b}{\partial s^*}$	>0	>0	0	0	indirect through p(z)
$\frac{\partial \tilde{\phi}_{ad}}{\partial s}$	>0	>0	0	0	indirect through p(z)
$\frac{\partial \hat{\phi}_{ad}}{\partial s}$	>0	0	>0	0	direct

sign of the effect depends on the channel through which changes in education subsidies affect the education and labor market decisions. The decision whether to choose basic or advanced education is directly affected by subsidizing advanced education at home, and not by foreign subsidies. Indirect effects through prices play no role, since we abstract from profit income in this decision problem. Hence, endogenizing the number of firms leaves the comparative statics unchanged.

Indirect effects through prices are at the heart of the mechanism behind the other three decision problems. Since unemployment benefits are fixed in real terms, individuals need to work to enjoy the benefits from lower prices for differentiated goods. Therefore, lower prices due to intensified competition (and, of course, due to more skilled labor) increase the value of working relative to unemployment benefits and the value of receiving at least a basic education (what is a prerequisite for entering the labor market). These effects are absent with fixed number of firms.

The effectiveness of domestic education subsidies decreases in the degree of economic integration (cf. derivative 37). That implies that governments need to invest more in education in order to achieve the same educational objectives as economic integration intensifies. However, the indirect effects through prices are intensified by increases in subsidies in the other country, as the cross derivative (36) shows. A coordinated education policy of both countries might thus be a way to mitigate adverse effects on educational outcomes when increasing the degree of economic integration.

Proposition 5. *An increase in the subsidy for advanced education s*

- (a) *increases the number of individuals with advanced education ($d\hat{\phi}_{ad}/ds > 0$),*
- (b) *reduces the number of individuals with no education ($d\hat{\phi}_b/ds > 0$), and*
- (c) *increases labor market participation among both educational groups ($d\tilde{\phi}_{ad}/ds > 0$, $d\tilde{\phi}_b/ds > 0$).*
- (d) *Foreign education subsidies increase labor market participation at home ($d\tilde{\phi}_b/ds^* > 0$) and the number of individuals with basic education ($d\hat{\phi}_{ad}/ds^* = 0$, $d\hat{\phi}_b/ds^* > 0$).*
- (e) *Falling trade costs make education subsidies less effective.*

3.3 Effects of Different Country Sizes

So far, we have assumed home and foreign to be symmetric. In this section, we relax this assumption by allowing for different sizes of the populations in both countries. More specifically, we assume that both countries have skill distributions of the same shape, but that there are k ($\in (0, \infty)$)-times as many individuals in foreign at each value of ability ϕ . This results in two changes: First, the aggregate demand in foreign is scaled up by the factor k , i.e. $X^*(z) = k \frac{a^* - p^*(z)}{b}$. Second, for given education and labor market decisions, there are k times as many advanced skilled as before and, for a given skill requirement ξ^* , also k times as many firms: $n^* = k \cdot n^*(k=1) = k \cdot n_1^*$.

As a result, equilibrium prices in home and foreign goods markets adjust. In the home market, the prices becomes

$$p(z) = \frac{a + n + kn_1^*\theta}{n + kn_1^* + 1} \quad (38)$$

whereas the price in the foreign market changes to

$$p^*(z) = \frac{ka^* + n\theta^* + kn_1^* + a^*(k-1)(n + kn_1^*)}{k(n + kn_1^* + 1)} \quad (39)$$

It can be easily checked that both prices are identical to the expressions derived for countries of same size when $k=1$. Furthermore, it can be shown that the home price decreases in the size of foreign, i.e. $\frac{\partial p(z)}{\partial k} < 0$. Signing the effect of the size of foreign on the foreign price is more involved and depends on taste parameters, the degree of economic integration, and the relative size of foreign.

However, since we can sign the effect on the home price, we can also sign the effect of changes in the size of foreign on home education and labor market participation decisions. Recall again, that the key variable driving these decisions is $A = \gamma + T + E(z) + u(B) - \bar{u}$. One can show that

$$\begin{aligned} \frac{\partial A}{\partial k} &= \frac{\partial E(z)}{\partial k} + \frac{\partial u(B)}{\partial k} \\ &= \underbrace{\frac{\partial E(z)}{\partial p(z)}}_{>0} \underbrace{\frac{\partial p(z)}{\partial k}}_{<0} + \underbrace{\frac{\partial u(B)}{\partial p(z)}}_{>0} \underbrace{\frac{\partial p(z)}{\partial k}}_{<0} \\ &< 0 \end{aligned} \quad (40)$$

That is, when the size of foreign increases relative to home, then the education cutoff for basic education and both labor market participation thresholds move outwards.

We summarize in

Proposition 6. *An increase in the relative size of foreign as measured by the size of its population relative to the population in home*

- (a) *increases the number of individuals with basic education ($d\hat{\phi}_b/dk > 0$, $d\hat{\phi}_{ad}/dk = 0$)*
- (b) *increases the number of workers of basic education ($d\tilde{\phi}_b/dk > 0$, $d\hat{\phi}_{ad}/dk = 0$)*
- (c) *leaves the number of individuals with advanced education unchanged ($d\hat{\phi}_{ad}/dk = 0$).*

3.4 Political Equilibrium: Preferred Policy of the Median Voter

So far, the policy parameters were set exogenously. In this section, we endogenize the choice of the education subsidy via the political process.⁸ More precisely, we analyze how the education subsidy chosen by a median voter changes when a) the economy integrates further with foreign and b) foreign changes its education subsidy unilaterally. Throughout this section, we assume that the median voter is of basic education and working.

⁸We do not endogenize the generosity of the benefit, since there is no explicit trade-off for a median voter. For a working individual, it is always optimal in our model to choose the most parsimonious option.

The utility of the median voter is given by

$$\begin{aligned}
U_m[x(z), z_0, \gamma] &= z_0 + \int_0^1 u[x(z)] dz - \gamma \\
&= \underbrace{\frac{1}{\alpha\phi} + \frac{a^2}{2b} - \gamma}_{const.} + \frac{1}{b} \left[\frac{p^2}{2} - ap \right] - T(s)
\end{aligned} \tag{41}$$

Taking the first derivative with respect to the education subsidy s yields the following first order condition:

$$\begin{aligned}
\frac{\partial U_m[x(z), z_0, \gamma]}{\partial s} &= \frac{1}{b} \left[p \cdot \frac{p(z)}{n} \cdot \frac{n}{s} - a \cdot \frac{p(z)}{n} \cdot \frac{n}{s} \right] - \frac{\partial T(s)}{\partial s} \\
&= \frac{1}{b} (p-a) \underbrace{\left[\frac{(1-a) + n^*(1-\theta)}{(n+n^*+1)^2} \cdot \frac{n}{s} \right]}_{>0} - \underbrace{\frac{\partial T(s)}{\partial s}}_{>0} \\
&\leq 0
\end{aligned} \tag{42}$$

The sign of the effect depends on which part of the FOC dominates: The first one representing the utility gain from lower prices due to higher competition in the market for the differentiated goods, or the second one representing the higher tax burden associated with with more generous education subsidies. The relative strength of these two effects depends on the chosen skill distribution, i.e. the preferred policy of the median voter can be explicitly calculated for a given distribution.

Although the preferred policy cannot be explicitly calculated in general, one can nonetheless analyze how it is affected by changes in economic integration (θ) or the foreign education subsidy (s^*) by applying the Implicit Function Theorem to the FOC. Two results emerge:

First, more economic integration increases the politically chosen education subsidy, i.e. $\frac{\partial s}{\partial \theta} < 0$. Sufficient conditions for the result to hold true are i) a concave relationship between the tax and the home education subsidy and ii) economic integration does not dampen the effect of higher subsidies on taxation too much.

Second, the preferred home education subsidy increases in the foreign subsidy, i.e. $\frac{\partial s}{\partial s^*} > 0$. Sufficient conditions for this effect are i) a concave relationship between the tax and the home education subsidy and ii) that the effect of the home subsidy on home taxation does not decrease too much as the foreign subsidy increases.

We summarize in

Proposition 7. *A median voter who is of basic education and employed chooses an education subsidy s which*

(a) *increases in the degree of economic integration ($\frac{\partial s}{\partial \theta} < 0$) and*

(b) *increases in the education subsidy unilaterally chosen by foreign ($\frac{\partial s}{\partial s^*} > 0$).*

4 Conclusion

to be completed

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A Results from Comparative Statics

In this appendix we compare the implications of several alternative specifications of unemployment benefits. Each of these specifications has its pros and cons and our aim is to show that the qualitative predictions of our model are not sensitive to the chosen specification.

The first specification is the one chosen in the main part of this paper, where we assume that the unemployed receive the same bundle of differentiated goods as consumed by the working individuals. This is the computationally most elegant and standard approach and quite plausible since most unemployment benefits are somehow defined in real terms. However, one typically does not associate differentiated goods with the ones consumed by the unemployed. Thus, we propose an alternative specification, in which unemployed receive a non-tradable fixed amount B of the numeraire good (e.g. food stamps). This specification deals with the shortcoming of the previous one and allows for a more flexible determination of the benefit. The downside of this specification is that the numeraire good is both the very basic and the "luxury" good what might be not entirely convincing.

Solving the production stage of yields very similar results. In the case of benefits in terms of the numeraire good the price is the same as before.

Turning to the cut-offs resulting from education and employment decisions, three out of the four are affected by changes, albeit in the same way. The change concerns the term A in the cut-offs. This term can be generalized to

$$A = \gamma + T + E(z) + u(B) - \bar{u} \quad (43)$$

Each specification of benefits leads to different utility levels from consuming the benefit and thus different values for A . In case, e.g., of the main specification in this paper the utility derived from consuming the unemployment benefit ($u(B)$) and the utility from consuming the whole bundle of differentiated goods (\bar{u}) are equal and thus cancel out. The cut-off from the decision between basic and advanced education is not affected since the decision does not involve unemployment benefits.

In the following tables we compare the results of comparative statics for the two major specifications of the unemployment benefit.

Table 2: Comparative Statics for Changes in Trade Costs

	Benefits	
	num. good	diff. good
$\frac{\partial \hat{\phi}_b}{\partial \theta}$	<0	<0
$\frac{\partial \hat{\phi}_b}{\partial \theta}$	<0	<0
$\frac{\partial \hat{\phi}_{ad}}{\partial \theta}$	<0	<0
$\frac{\partial \hat{\phi}_{ad}}{\partial \theta}$	0	0

Table 3: Comparative Statics for Changes in Education Subsidies

	Benefits	
	num. good	diff. good
$\frac{\partial \tilde{\phi}_b}{\partial s}$	0	0
$\frac{\partial \hat{\phi}_b}{\partial s}$	0	0
$\frac{\partial \hat{\phi}_{ad}}{\partial s}$	0	0
$\frac{\partial \hat{\phi}_{ad}}{\partial s}$	>0	>0

Table 4: Comparative Statics for Changes in Number of Firms

	Benefits	
	num. good	diff. good
$\frac{\partial \tilde{\phi}_b}{\partial n}$	>0	>0
$\frac{\partial \hat{\phi}_b}{\partial n}$	>0	>0
$\frac{\partial \hat{\phi}_{ad}}{\partial n}$	>0	>0
$\frac{\partial \hat{\phi}_{ad}}{\partial n}$	0	0

Table 5: Comparative Statics for Changes in Variation in Productivity Shocks

	Benefits	
	num. good	diff. good
$\frac{\partial \tilde{\phi}_b}{\partial \Delta}$	both	both
$\frac{\partial \hat{\phi}_b}{\partial \Delta}$	>0	>0
$\frac{\partial \hat{\phi}_{ad}}{\partial \Delta}$	both	both
$\frac{\partial \hat{\phi}_{ad}}{\partial \Delta}$	>0	>0