WORKING PAPER
DIPARTIMENTO DI ECONOMIA PUBBLICA

Working Paper n.138

Debora Di Gioacchino e Paola Profeta

Lobbying for Education in a Two-sector Model

Roma, Dicembre 2010

SAPIENZA
UNIVERSITÀ DI ROMA

Lobbying for Education in a Two-sector Model*

Debora Di Gioacchino

Paola Profeta

Sapienza Università, Roma, Italy

Università Bocconi, Milan, Italy

December 2010

---

*Debora Di Gioacchino, Sapienza Università di Roma, Via del Castro Laurenziano 9, 00161 Roma, Italy, debora.digioacchino@uniroma1.it; Paola Profeta, Università Bocconi, Via Roentgen 1, 20136 Milan, Italy, paola.profeta@unibocconi.it. We thank Maurizio Franzini, Francesco Vona and an anonymous referee for useful comments. We thank Elena Pisano for excellent research assistance.

Abstract

Modern economies devote a relevant share of their resources to education. However, even among industrialised countries, there are differences in the traits of the education system and in its outcome in terms of human capital composition. The question we pose in this paper is why the composition of human capital is so diversified. The answer we propose is that the education system responds to the economy's structure of production. Skills are required by firms according to their needs and are supplied through the education system. We analyse the political economy of education in a two-period model in which heterogeneous firms, specialised in two different sectors, try to induce the government to finance the type of education which is complementary to their production. In the first period, the policy-maker decides the skill composition of new-workers which will determine the supply of skills in the second period. Firms may lobby to obtain their preferred skill composition. We show that in the political equilibrium in which firms in both sectors get organised, the policy-maker chooses the same skill composition that would be chosen by the social planner. Moving to endogenous lobbying, we are able to show that, if there are no costs of lobbying, then both sectors will lobby in equilibrium. However, in the more realistic case in which if lobbying is costly it may be that only one sector will find it profitable to offer monetary contribution; which sector gets organised depends on sectors' share in total output, relative productivity and prices of the two sectors.

Keywords: Endogenous lobbying, human capital composition, structure of production.

JEL Classification: I2, D72.

1 Introduction

Modern economies devote a relevant share of their resources to education. However, even among OECD countries there are differences not only in share of GDP devoted to education, but also in the composition of education expenditures, in the graduation rate and in the distribution of graduates by level of education (primary/secondary vs tertiary), by program orientation (vocational vs general) and by field of education (cfr. tables 1 and 2). In countries such as the United States, United Kingdom and Canada, the education system is mainly oriented towards general rather than vocational programmes. Differently, Germany, Finland, Italy, and many others, have a relevant share of students enrolled in vocational programmes. As for the share of graduates by field of education, countries such as Korea, Finland and Sweden have a high share of graduates in engineering, while the United States, Luxemburg, Australia and New Zeland have a high share of students graduating in business.¹

The question we pose in this paper is why the composition of human capital is so diversified. As suggested by previous literature, a key factor is to be found in the economy's structure of production. Skills are required by firms according to their needs and are supplied through the education system whose outcome is a composition of human capital by level, field and program orientation. In a rapidly changing economy there is high demand for workers equipped with general skills which are more mobile and can be easily re-employed from declining sectors to new sectors. Analogously, the distribution by field of education should reflect the sectoral composition of the economy. Economies endowed with a higher share of human resources for science and technology are in a better position

---

¹Looking at more disaggregated data than what reported in table 2, one can see that, in Sweden 17% of students in 2008 graduated in engineering, manufacturing and construction; of those, 78% graduated in engineering. Analogously, in the United States, 40% of students graduated in social science, business and law; of those 54% graduated in business. Even more striking are the differences obtained looking at the shares of graduates by field of education relative to total population. In the United States, of the relatively low number of graduates for 1000 inhabitants (7,7) 3 graduated in social science business and law (SSBL) and 0,5 in engineering, manufacturing and construction (EMC). In Korea, with 8,2 graduates for 1000 inhabitants, 1,9 graduated in SSBL and 1,9 in EMC.

to innovate and expand production in high-tech sectors. On the other hand, if a relevant share of firms is specialised in high tech production, demand for graduates in science and engineering is correspondingly high. As it is well recognised in the empirical literature, the direction of causality is difficult to identify and the relationship is probably not one-way.

Table 3 reports, for the year 2006, the sectoral composition of production for 30 OECD countries. Countries such as Korea, Finland and to a certain extent also Ireland and Japan, have a high share of production in manufacturing, focused on high and medium-high tech, and a relatively lower share of value added in services. On the other hand, United States, United Kingdom and France have high share of production in services, mainly in finance insurance and business services.

As shown in figure 1 and 2, there appears to be a positive correlation between countries productive specialization and the composition of graduates by field of study. Figure 1 plots the shares of graduates in science and engineering in association with the share of value added in high tech sectors. Figure 2 plots the share of graduates in social science, business and law in association with the share of value added in finance, insurance and business services. However, the two diagrams, and the value of R-squared, also indicate that a relevant fraction of the variance remains unexplained. This suggests that there is something missing in the relationship between the composition of human capital and the economy's structural composition.

In this paper we ask whether the missing ingredient may be related to politics and to political economy aspects. We start from the observation that lobbying activity may be very intensive in some country. In the US. for instance (but similarly in Canada), universities, companies, labor unions, and other organizations spend billions of dollars each year to lobby Congress and federal agencies. In 2010 total lobbying spending was \$ 2.61 billion with a total number of 12488 lobbyists (Open Secrets, 2010). Among the numerous lobbying activities, some group has also focused on the improvement of education and degrees awarded by students in specific fields, such as maths, engineering and science (Carlson, 2005). This piece of evidence suggests that lobbying activity may play a role in shaping the relation between the type of education and the structure of production.

We analyse the political economy of education in a setting in which heterogeneous

firms, specialised in (two) different sectors, try to induce the government to finance the type of education which is complementary to their production. In our two-period model, there is a continuum of firms specialised in one of the two sectors. In each sector, firms use a production-input labour of a given skill-type. In the first period, the policy-maker decides the skill composition of new-workers which will determine the supply of skills in the second period. Education is financed through a lump-sum tax on firms' profit. Thus, given the available resources, the policymaker can only choose the skill composition, but not the level of education. Firms may lobby to obtain their preferred skill composition. Following Bernheim and Winston's (1986) common agency approach, firstly applied in economics by Grossman and Helpman (1994), we assume that firms can offer monetary contribution to the policy-maker conditional on the skill composition chosen. We show that in the political equilibrium in which firms in both sectors get organised, the policy-maker chooses the same skill composition that would be chosen by the social planner. We then turn to endogenous lobbying and check whether the two-lobby is an equilibrium of the lobbying game. We are able to show that, if there are no costs of lobbying, then both sectors will lobby in equilibrium. However, if lobbying is costly it may be that only one sector will find it profitable to offer monetary contribution. This is the sector with a higher relative weight, measured by the sector's share of total output, relative productivity and relative price. Thus, the lobbying activity may contribute to explain differences in educational systems across economies.

The rest of the paper is organised as follows: in the next section we review the related literature; in section 3 we present the model and in section 4 we derive the political equilibrium; section 5 extends the analysis to a repeated dynamic game and section 5 concludes. All proofs are in the appendix.

2 Related literature

Our paper contributes to two different strands of the literature. First, it contributes to the political economy of education by investigating the possibility that education policy responds to the interest of firms exerting pressure on the policy-makers in order to obtain

their favourite human-capital composition. The political economy approach has mainly focused on the redistributive role of education and on income distribution as the main determinant of educational policy. In this paper, we abstract from education's redistributive role and focus on its effect on the "production" of skills. Thus, the conflict of interest is not among income groups but between firms active in different sectors and interested in the supply of different skills.

Second, our paper complements previous theoretical and empirical work on the link between human capital, technology and the structure of production. Since Nelson and Phelps' 1966 seminal paper, it has been recognised that a more educated labour force would adopt new technologies faster and, at the same time, the demand for skill would increase as new technologies are introduced (Acemoglu, 2002). The literature points out the possibility of multiple equilibria. One equilibrium is characterised by high levels of human capital, faster adoption of new technologies and high share of production in high-tech industries, while the other equilibrium depicts low levels of human capital, higher distance from the "technological frontier" and production specialized in traditional sectors.

With few notable exceptions, the empirical literature, as well as the theory, focus on the level of human capital, measured by the average years of schooling, and do not consider the composition of human capital by level of education, by field or program orientation. A few papers have recently addressed the role of educational structure for economic performances, in particular in relation with growth. Vandenbussche et al. (2006) develop a model showing that the growth-enhancing effects of skilled human capital is higher for economies whose level of technological development is relatively high. In the empirical part of the paper, distinguishing between primary/secondary and tertiary education, they provide evidence that education has heterogeneous effects, even among OECD countries and that tertiary education is a source of economic divergence. The importance of distinguishing between different types of human capital has been stressed by Murphy et al. (1991). They provide a model in support of the idea that the allocation of talent has significant effects on the growth rate of an economy. The reason is that economies which reward entrepreneurship more than rent seeking activities attract talented people in the more productive sectors. Using data on college enrolment in law as a measure of talent allo-

cated to rent seeking activities, and on college enrolment in engineer as a measure of talent allocated to entrepreneurship, their empirical evidence confirms that countries with high proportion of engineers grow faster than countries with high proportion of lawyers. The relation between educational structure and growth has been addressed also by Krueger and Kumar (2004). In a model of growth by technological adoption with two types of human capital, they demonstrate that an economy whose policies favour skill-specific, vocational education, will grow slower than an economy whose policies favour general education. Moreover, the gap between their growth rates will increase with the growth rate of the available technology. Thus, they interpret Europe's "technological deficit", relative to the United States, as the result of European focus on vocational education, as opposed to general education, in periods of fast technological change. Along the same lines, Janiak (2005) argues that, since education systems adjust slowly to economic conditions, when the structure of production changes if the education system is focused on vocational education then it becomes difficult to reallocate labour from old to new sectors. Although these results are in line and support some of our arguments on the role of the educational structure, in this paper we will not focus on the relationship between educational structure and economic growth, nor on the role of the technological progress in directing education spending towards general versus vocational types. We rather emphasize the link between the educational system and the structure of production.

This focus closely relates our paper to recent contributions that have stressed the role of social conflicts behind the educational system. Bertocchi and Spagat (2004) argue that the focus on vocational as opposed to general education is the result of a social conflict in shaping the educational system. The idea that the educational structure is functional to the interest of the capitalist class can be found in Bowles (1978) and more recently in Galor and Moav (2006). They argue that due to capital-skill complementarities, the accumulation of physical capital in the process of industrialization increased the importance of human capital and generated incentives for capitalists to support the provision of universal education. Our paper is tightly related to Galor and Moav (2006); as in their work, we view the educational system as the upshot of political and economic conflicts; however, we assume heterogeneity in the human capital used in different industries and thus allow for a

conflict of interests among capitalists. However, differently from previous contributions, we use lobbying to characterize the political process and we develop an endogenous lobbying model.

3 The model

The economy is populated by workers and firms. Firms are a continuum of measure one, live indefinitely and in each period they pay a lump-sum to finance education of new workers (N) that will be added, in the next period, to the current labour force. Workers live for two periods. In the first period, they receive skill-specific education and in the second period they work in the sector that uses as input the skill they have acquired. We restrict attention to a two-sector and two-education type economy. Let γ be the fraction of firms in the low-technology sector (l) and using workers with low-technology education (L) and $1 - \gamma$ be the complementary set of firms, producing in the high technology sector (h) and using high-technology human capital (H). For simplicity we assume that each firm uses only labour as a production input. In what follows, to simplify notation, we will omit the indication of time. Thus, for each representative firm in the two sectors output is respectively:

$$x_l = A_l L^\alpha \quad (1)$$

$$x_h = A_h H^\alpha \quad (2)$$

where $\alpha \in (\frac{1}{2}, 1)$ ² and A_l, A_h denote the level of labour-augmenting technology in sector l and h , respectively. If workers with high-technology education are more productive than workers with low-technology education, we expect A_h to be larger than A_l .³

Total output in the economy is

$$Y = \gamma p_l A_l L^\alpha + (1 - \gamma) p_h A_h H^\alpha \quad (3)$$

---

²Empirical estimates indicate a value for α around $\frac{2}{3}$.

³Notice that, although it is intuitive to present the two sectors as the high and low productivity one, our two sectors do not necessarily reflect the level of technology adopted. There is no specificity in the model related to technology and the analysis holds true if we assume the two sectors to be different along other dimensions (for instance service and manufacture).

where total output price has been normalised to one and p_l and p_h denote (relative) prices in the two sectors.

Labour market is competitive and workers are paid their marginal productivity; thus wages in the two sectors are respectively:⁴

$$w_l = \alpha A_l L^{\alpha-1} p_l \quad (4)$$

and

$$w_h = \alpha A_h H^{\alpha-1} p_h \quad (5)$$

Workers' utility is equal to their consumption, which, in turn, in absence of savings, is equal to wage income.

Firms finance education spending of new workers by paying a lump-sum F in each period.⁵ We assume that the "production function" of new workers is linear and that the unitary cost of producing type L and type H workers is the same and normalized to 1. Thus, $F = N$. The government uses the total amount F to finance two types of education spending: a fraction $\delta \in (0, 1)$ is spent on education of type L workers and a fraction $1 - \delta$ finances education of type H workers. Thus, given available resources, there are δN new workers of type L and $(1 - \delta)N$ new workers of type H .

Letting L_0 and H_0 indicate the initial amount of workers with low-technology education and with high-technology education, respectively, the labour force in the two sector is given by

$$L = L_0 + \delta N \quad (6)$$

and

$$H = H_0 + (1 - \delta)N \quad (7)$$

---

⁴If final output is taken as numeraire, real wage is the same as monetary wage. The relative wage is $\frac{w_h}{w_l} = \frac{A_h}{A_l} \frac{p_h}{p_l} \left(\frac{H}{L}\right)^{\alpha-1}$, where $\frac{H}{L}$ measures the relative scarcity of the two types of workers, $\frac{A_h}{A_l}$ measures the relative productivity and $\frac{p_h}{p_l}$ the relative prices in the two sectors. Notice that, if the price in a sector is relatively high, maybe because the sector is not competitive, then the wage could be higher than the wage in the other sector, even if the latter is more productive.

⁵Having assumed a continuum of firms of measure one, average values and aggregate values coincide; therefore, F indicates the lump-sum paid by each firm as well as the total amount.

Given the cost $F = N$ paid to finance education, and given Eq. 1, 1, 4 and 5, representative firms in the two sectors earn profits given by⁶

$$\pi_l = (1 - \alpha)A_l L^\alpha p_l - N \quad (8)$$

and

$$\pi_h = (1 - \alpha)A_h H^\alpha p_h - N \quad (9)$$

3.1 The social planner

The social planner's objective function is the sum of workers' wage income and firms' profits:⁷

$$SW = W_l + W_h + \Pi_l + \Pi_h \quad (10)$$

where W_s and Π_s indicate wage income and profits in sector s ($s = l, h$).

Total wage income in the two sectors are equal to:

$$W_l = \gamma w_l L \quad (11)$$

and

$$W_h = (1 - \gamma) w_h H \quad (12)$$

which, given Eq.4 and 5 can be rewritten as follows:

$$W_l = \gamma \alpha A_l L^\alpha p_l \quad (13)$$

and

$$W_h = (1 - \gamma) \alpha A_h H^\alpha p_h \quad (14)$$

Firms net monetary profits in the two sectors are given by:

$$\Pi_l = \gamma \pi_l = \gamma [(1 - \alpha) A_l L^\alpha p_l - N] \quad (15)$$

---

⁶Note that relative profits in the two sectors are determined by the same variables as relative wages, except that relative profits increase with H/L.

⁷That is the economy's GDP, net of the amount spent to finance education.

and

$$\Pi_h = (1 - \gamma)\pi_h = (1 - \gamma)[(1 - \alpha)A_h H^\alpha p_h - N] \quad (16)$$

Inserting Eq. 13, 14, 15, 16, the social planner objective function can be rewritten as

$$SW = \gamma p_l A_l L^\alpha + (1 - \gamma)p_h A_h H^\alpha - N \quad (17)$$

The efficient mix of the two types of education coincides with the choice of the social planner, who chooses δ in order to maximize Eq. 17. Solving the first order condition (see the appendix), we obtain the following level of δ :

$$\delta_{PL} = \frac{x(H_0 + N) - L_0}{N(1 + x)} \quad (18)$$

where we have introduced $x \equiv \left(\frac{1}{\lambda}\right)^{\frac{1}{1-\alpha}}$, with $\lambda \equiv \frac{(1-\gamma)p_h A_h}{\gamma p_l A_l}$.

Thus, λ represents the weight of sector h , relative to sector l , in total output. This takes into account not only the economy's sectoral composition ($\frac{(1-\gamma)}{\gamma}$), but also relative productivity ($\frac{A_h}{A_l}$) and the relative price in the two sectors ($\frac{p_h}{p_l}$).

We can easily check that δ_{PL} is decreasing in λ : the higher is sector h weight, relative to sector l , the more it is efficient to allocate resources to type H education than to type L .

In the appendix we also show that if the N is sufficiently high, then $\delta_{PL} \in (0, 1)$.

4 The politics of education and sectoral composition: lobbying

The previous section has shown that the mix of the two types of education that would be chosen by the social planner depends on the "relative importance" of the two sectors in the economy, as measured by λ .

However, firms may get organised and exert their political power to induce the government to deviate from the efficient outcome in the attempt to obtain their preferred value of δ .

We start by assuming that firms in both sectors are active in the lobbying process and, following Grossman and Helpman's seminal paper, we model lobbying as a menu auction

(Bernheim and W 1986) in which interest groups offer contingent payments to the policy-maker in order to influence his action.⁸ Knowing the lobbies' contribution functions, the government sets the policy which maximises his objective function, given by a weighted average of aggregate welfare and lobbies' contributions. We then turn to the equilibrium in which only one sector is politically organised. Finally, in the next section, we characterise the endogenous process of lobby formation, as an equilibrium of the "lobbying game" (Baldwin and Robert-Nicoud, 2007).

There are two organised groups, one representing firms in sector h , the other representing firms in sector l . Workers are politically not organised. Lobbies offer political contributions to the government in order to influence its choice of the education mix. Let $C_s(\delta)$ be the payment offered by each firm in sector s ($s = l, h$) contingent on the government choice of δ . The government's objective function is now a weighted sum of aggregate social welfare and lobby contributions:

$$\Omega = SW + a[\gamma C_l(\delta) + (1 - \gamma)C_h(\delta)] \quad (19)$$

where SW is the utilitarian social welfare function of the previous section and a is the relative weight given by the government to contributions. The higher is a , the higher is government "affinity" for political contributions and the lower is its concern for social welfare.

A subgame perfect Nash equilibrium consists of a value of δ , that maximizes the government's objective function, and a pair of contributions, each of which is optimal given the government's decision and the contribution of the other lobby.⁹

As in Grossman and Helpman's (1994) model, we restrict contributions to be globally "truthful"¹⁰, that is firms offer payments that reflect their true willingness to pay.

---

⁸This is the so-called influence motive for lobbying. Lobbies can be also motivated by electoral motives, i.e. they might try to influence a candidate's chance of winning the election (see Grossman and Helpman, 2001 for a discussion). In this case, lobbies' contributions would be used to "buy" the vote of impressionable citizens (cfr. Grossman and Helpman, 1996). In our model we do not consider elections and restrict the attention to post-electoral lobbying.

⁹Bernheim and Winston (1996 Lemma 2 p. 10) derive necessary and sufficient conditions to characterise the equilibrium.

¹⁰Bernheim and Winston (1996) show that if contribution functions are differentiable, then they are

Formally:

$$\frac{\partial C_h(\delta)}{\partial \delta} = \frac{\partial \pi_h(\delta)}{\partial \delta} \quad (20)$$

and

$$\frac{\partial C_l(\delta)}{\partial \delta} = \frac{\partial \pi_l(\delta)}{\partial \delta} \quad (21)$$

Truthful contribution function offered by each firm in sector s can thus be written as:

$$C_s(\delta) = \pi_s(\delta) - B_s \quad (22)$$

where B_s are scalars that will be determined in the appendix, while proving proposition 3.

The first order condition with respect to δ can thus be written as follows:

$$\frac{\partial \Omega(\delta)}{\partial \delta} = \frac{\partial W_l(\delta)}{\partial \delta} + \frac{\partial W_h(\delta)}{\partial \delta} + \frac{\partial \Pi_l(\delta)}{\partial \delta} + \frac{\partial \Pi_h(\delta)}{\partial \delta} + a \left[\gamma \frac{\partial \pi_l(\delta)}{\partial \delta} + (1 - \gamma) \frac{\partial \pi_h(\delta)}{\partial \delta} \right] \quad (23)$$

$$= \frac{\partial W_l(\delta)}{\partial \delta} + \frac{\partial W_h(\delta)}{\partial \delta} + \sigma \left[\frac{\partial \Pi_l(\delta)}{\partial \delta} + \frac{\partial \Pi_h(\delta)}{\partial \delta} \right] = 0 \quad (24)$$

This implies that the government behaves as if it were maximizing a weighted sum of firms' profits, with weight $\sigma = 1 + a$ and workers wage, with weight equal to 1.

We can now prove the following:

Proposition 1 *When both sectors are active in the lobbying process, the equilibrium mix of education spending is the same as the one chosen by the social planner.*

Intuitively, if the two lobbies have the same weight in the government's objective function, they lobby against each other and their political pressures exactly balance. Thus, proposition 1 suggests that a different weight between wages and profits in the government's objective function (i.e. the value of a) does not alter the composition of human capital as compared with what would be chosen by the social planner.

---

locally truthful. They also show that equilibria based on truthful strategies not only exist but always result in an efficient choice of action. For situations in which non-binding communication is possible, these equilibria have a strong stability property, namely they are coalition-proof Nash. In other words, truthful equilibria are stable even if coalitions of players can communicate to devise a mutually preferable strategy.

We next consider the case where only one sector is politically organised. If only the low-technology sector exerts lobby, the government objective function becomes:

$$\Omega = W_l + W_h + \Pi_l + \Pi_h + a\gamma C_l \quad (25)$$

and the first order condition requires:

$$\frac{\partial \Omega(\delta)}{\partial \delta} = \frac{\partial W_l(\delta)}{\partial \delta} + \frac{\partial W_h(\delta)}{\partial \delta} + \frac{\partial \Pi_h(\delta)}{\partial \delta} + \sigma \frac{\partial \Pi_l(\delta)}{\partial \delta} = 0 \quad (26)$$

Using Eq. 11,12,15 and 16 and solving the first order condition, we obtain the following level of δ :

$$\delta_l = \frac{\eta(H_0 + N) - L_0}{N(1 + \eta)} \quad (27)$$

where $\eta = \left(\frac{\alpha + \sigma(1 - \alpha)}{\lambda} \right)^{\frac{1}{1 - \alpha}}$.

Similarly, if only the high-technology sector lobbies, we obtain the following level of δ :

$$\delta_h = \frac{\mu(H_0 + N) - L_0}{N(1 + \mu)} \quad (28)$$

where $\mu = \left(\frac{1}{\lambda[\alpha + \sigma(1 - \alpha)]} \right)^{\frac{1}{1 - \alpha}}$.

It is easy to check that $\eta > x > \mu$ and thus $\delta_h > \delta_{PL} > \delta_l$. Thus, we have proved the results reported in the next proposition.

Proposition 2 *When only the sector using low (high) technology education exerts lobby, more resources are directed towards the low (high) technology education with respect to the social planner solution.*

The proposition delivers an intuitive result: when only one sector exerts lobby, it manages to attract more resources towards the type of education which is interesting for its production.

4.1 Endogenous lobbying

In this section we endogenize the lobbying activity of the two sectors. Lobbying is costly: if the firm exerts lobby, it pays part of its profits as contributions to the government.

We look at the conditions under which firms in each sector will find it convenient to invest in lobbying. Following Baldwin and Robert-Nicoud (2007) we consider the game in which each lobby must decide whether to offer contribution to the government and the government, simultaneously, must decide whether to accept the contribution offered. Let I be an indicator function which can take only two values: $I_s = 1$ if sector s offers contingent payments and $I_s = 0$ if it does not. Similarly, let G be an indicator function which can take only two values: $G_s = 1$ if the government accepts the contribution offered by sector s and $G_s = 0$ if it does not accept it¹¹. As before, $C_s(\delta)$ is the contribution function offered by sector s . More precisely, each sector proposes a contribution which is a part of its profits, i.e.

$$C_l = \pi_l - B_l \text{ if } I_l = 1; 0 \text{ otherwise} \quad (29)$$

and

$$C_h = \pi_h - B_h \text{ if } I_h = 1; 0 \text{ otherwise} \quad (30)$$

We can thus write the government objective function as follows:

$$\Omega = W_l + W_h + \Pi_l + \Pi_h + a[\gamma G_l I_l C_l + (1 - \gamma) G_h I_h C_h] \quad (31)$$

We are now ready to prove the following result.

Proposition 3 *Active lobbying by both sectors is a Nash equilibrium of the political lobbying game.*

Intuitively, if one sector sets up a lobby to influence the government's choice, then the other sector is better off by doing the same. Notice that with only one lobby the weight given by government to contributions (a) affects the composition of human capital: the higher is a , the more the skill composition is twisted towards the lobby's favourite one.

---

¹¹As in Baldwin and Nicoud (2007), in our model at equilibrium the government always accepts contributions. This is different from Felli and Merlo (2006), where the policymaker chooses the set of lobbies whom to bargain with excluding lobbies whose policy position is too close to his own.

4.1.1 The cost of lobbying

The result in proposition 3 is not the end of the story. Organising a lobby is costly: the administrative structure has to be paid, including “establishing links with politicians, hiring professional lobbyists, building a communications network among members, designing a scheme of punishments for defaulting members, etc” (see Mitra, 1999).

Assume that to get organised a group has to pay a cost (equal for both sectors) $K > 0$. In this case, an interest group may find it convenient to lobby only if its net benefit is larger than this cost. Having this in mind, we can prove the following result.

Proposition 4 *Let $K > 0$ be the cost of organising a lobby and let $\alpha = 2/3$. If the two sectors have the same "relative importance" ($\lambda = 1$) and the same size ($\gamma = 1/2$), they will both exert lobby. If the two sectors have a different size but the same relative importance ($\lambda = 1$, but $\gamma \neq 1/2$), there exists a level of K such that only firms in the more numerous sector will lobby. If the two sectors have the same size, but have a different relative importance ($\gamma = 1/2$ and $\lambda \neq 1$), there exists a level K of the lobbying cost such that only firms in the "relatively more important" sector will find it convenient to exert lobby (i.e. firms in sector l when $\lambda < 1$ and firms in sector h when $\lambda > 1$).*

The above result suggests that the relative importance of the two sectors matters to determine firms' net benefits from lobbying and thus, given the fixed cost, the decision on whether or not to set up a lobby. A sector's relative importance depends on its share in total output, its productivity and price. According to proposition 4, the influence a sector has on the economy's composition of human capital can be attributed to its market structure (price), to technical progress (productivity) and to its share of value added. Thus, a small sector open to competition and less exposed to technical progress might find it difficult to get organized, due to the limited amount of profits that can be used to "bribe" the policymaker. Moreover, size itself is important in determining a sector's decision on whether or not to lobby; in fact, given the fixed cost to be paid to organize a lobby, per-firm cost will be lower the higher the number of firms. This is of course due to our assumption that the cost is fixed and in particular it does not depend on the number

of firms belonging to a lobby¹².

Two natural extensions are worth mentioning at this point. First, one may want to allow for heterogeneity in the fixed cost because groups may differ in their organisational abilities (see Mitra, 1999) or “proximity” to the government (see Faccio, 2006). Second, one may want to allow for heterogeneity in the weight attributed by the government to contributions paid by different groups. In both circumstances, even if the two sectors have the same importance ($\lambda = 1$) and the same size ($\gamma = 1/2$) it may be that only the sector "closer" to the government finds it convenient to get organized.

5 The long run

We have so far considered a one-shot lobbying game. One may wonder what happens if δ is chosen every period from $t = 1$ repeatedly. In this case, we may generalize from the previous section the following expression for δ_{t+1} :

$$\delta_{t+1} = \frac{d(H_t + N) - L_t}{N(1 + d)} \quad (32)$$

where $d = x$ if $\delta = \delta_{PL}$; $d = \eta$ if $\delta = \delta_l$; $d = \mu$ if $\delta = \delta_h$.

Using δ_{t+1} and δ_t it is easy to prove that, if $\frac{\delta_t}{1-\delta_t} < d$, then $\delta_{t+1} > \delta_t$, while if $\frac{\delta_t}{1-\delta_t} > d$, then $\delta_{t+1} < \delta_t$. This implies that in the long run δ_{t+1} converges to δ_t , i.e. δ converges to a constant level, with $\frac{\delta}{1-\delta}$ equal to d .

Moreover, given that $L_{t+1} = L_t + \delta_t N$ and $H_{t+1} = H_t + (1 - \delta_t)N$, if in the long-run δ is constant and $\frac{\delta}{1-\delta}$ equals d , then $\frac{L_{t+1}}{H_{t+1}}$ converges to d . Thus, given the expressions of d , the share of workers employed in the two sectors reflects not only the relative production, the relative price and the relative share in total output, but, in case of lobbying, also the importance of lobbying in the government objective function (σ).

---

¹²The assumption of fixed cost may seem quite restrictive, as some organizational cost are likely to increase with the number of firms. However what matters here is that the cost in per capita terms decreases as the number of firms increases.

6 Concluding remarks

In this paper we have presented a political economy model aiming at explaining the observed differences in education systems and the relation between the composition of education and the structure of production. Our explanation is based on the idea that firms would lobby the policymaker in the attempt to obtain the desired supply of skill. As we know that lobbying activity is diffused in many countries (such as US and Canada) and that firms may lobby for education, the mix of education in a country can be the result of lobbying activity by different types of firms. We have shown that if organising a lobby is costly, an equilibrium might emerge in which firms in the "stronger" sector are able to bribe the policymaker and twist his choice of the education mix towards the type of skill needed in their production. If the "stronger" sector is specialised in the production of traditional goods, then, under the influence of lobbying, a country might be trapped in a low-skill and low-technology specialization. Figure 1 provides evidence that this equilibrium may indeed appear in several countries and may pose serious concerns. This is particularly true in open economies facing global competition: how can a country afford the challenge of globalization if it does not engage its war of talent, if it does not try to be equipped with high-skilled talented labor force and employ them in the production of high-technology sectors? These questions open the space for future analysis more on the normative side.

Our findings complements previous literature by adding a political economy channel to explain the combination of human capital type and productive structure. In terms of policy implications, our analysis suggests that educational policy and the structure of education together with industrial policy should be given top priorities in the government agenda, and the role of lobbying activities by firms should not be neglected. In other words, countries should consider carefully the lobbying activity exerted by traditional sectors with low-technology specialization and its consequences on the industrial structure and the overall economy.

A couple of further extensions are worth mentioning. An interesting application of the model would consider immigration policy. In this setting new workers would be immigrants

and they could be of different education types. The model would suggest that countries specialised in high-tech sectors will favour the in-coming of highly qualified immigrants; on the contrary, countries with a structure of production mainly devoted to traditional sectors will attract low qualified immigrants. Moreover, in our framework, to move from one equilibrium to the other, a shock in the relative importance of the two sectors (λ) is needed. In a truly dynamic settings all the parameters influencing λ should be endogenised. This leaves scope for future research.

7 Appendix

7.1 Optimal mix of education δ and conditions

Substituting Eq. 6 and Eq. 7 into Eq. 17 we obtain the following expression for the social planner's objective function:

$$SW = \gamma p_l A_l (L_0 + \delta N)^\alpha + (1 - \gamma) p_h A_h [H_0 + (1 - \delta)N]^\alpha - N \quad (33)$$

which delivers the following first order condition

$$\gamma p_l A_l \alpha (L_0 + \delta N)^{\alpha-1} N - (1 - \gamma) p_h A_h \alpha [H_0 + (1 - \delta)N]^{\alpha-1} N = 0$$

which can be rewritten as

$$\frac{H_0 + (1 - \delta)N}{L_0 + \delta N} = \left[\frac{\gamma p_l A_l}{(1 - \gamma) p_h A_h} \right]^{\frac{1}{1-\alpha}}$$

Using the definition of λ and x given in the text we have

$$L_0 + \delta N = [H_0 + (1 - \delta)N] x$$

which delivers the expression of δ at Eq.18.

A sufficient condition to guarantee that $\delta > 0$ is that $N > \frac{L_0}{x} - H_0$ and a sufficient condition to guarantee that $\delta < 1$ is that $N > xH_0 - L_0$. Thus, if $N > \max \left\{ \frac{L_0}{x} - H_0; xH_0 - L_0; 0 \right\}$, then $\delta \in (0, 1)$. Notice that, as we will explain in section 5, both $\frac{L_0}{x} - H_0$ and $xH_0 - L_0$ converge to zero in the long run (as $\frac{L_0}{H_0}$ converges to $\frac{\delta}{1-\delta}$) so that in the long run it is sufficient to have a positive N to guarantee that $\delta \in (0, 1)$.

7.2 Proof of proposition 1

The equilibrium level of δ is given by solving the following first order condition:

$$\frac{\partial \Omega}{\partial \delta} = \alpha \gamma p_l A_l \frac{\partial L^\alpha}{\partial \delta} + \alpha (1 - \gamma) p_h A_h \frac{\partial H^\alpha}{\partial \delta} + \sigma (1 - \alpha) [\gamma p_l A_l \frac{\partial L^\alpha}{\partial \delta} + (1 - \gamma) p_h A_h \frac{\partial H^\alpha}{\partial \delta}] = 0 \quad (34)$$

which delivers the same level δ_{PL} chosen by the social planner at Eq. 18.

7.3 Proof of proposition 3

To show that lobbying by both sectors is a Nash equilibrium, we have to check that if one sector lobbies then the other is better off by doing the same. We proceed in two steps: (i) compute the scalars B_h and B_l (ii) show that in each sector firms are better off by paying the contributions and getting δ_{PL} than paying no contribution and getting the level of δ that would be chosen if only the other sector were to lobby.

(i) Computation of B_h and B_l

To compute B_h , consider the case where only firms in the low-technology sector exert lobby. We know that the equilibrium mix of education spending is given by Eq. 27 with $\delta_l > \delta_{PL}$. If firms in sector l pay contributions and the government accepts them the government's objective function is:

$$\Omega(\delta_l) = SW(\delta_l) + a\gamma C_l(\delta_l) = SW(\delta_l) + a[\Pi_l(\delta_l) - \gamma B_l] \quad (35)$$

On the other hand, if both sectors exert lobby, then $\delta = \delta_{PL}$. In this case the government objective function is:

$$\Omega(\delta_{PL}) = SW(\delta_{PL}) + a[\gamma C_l(\delta_{PL}) + (1 - \gamma) C_h(\delta_{PL})] = SW(\delta_{PL}) + a[\Pi_l(\delta_{PL}) - \gamma B_l + \Pi_h(\delta_{PL}) - (1 - \gamma) B_h]$$

Thus, to induce the government to accept its contributions, sectors h should leave the government at least indifferent between $\Omega(\delta_l)$ and $\Omega(\delta_{PL})$ which requires

$$B_h = \frac{SW(\delta_{PL}) - SW(\delta_l) + a[\Pi_l(\delta_{PL}) - \Pi_l(\delta_l)] + a\Pi_h(\delta_{PL})}{a(1 - \gamma)} \quad (36)$$

Each firm in sector h will find convenient to pay the contributions only if $\pi_h(\delta_{PL}) - C_h(\delta_{PL}) = B_h > \pi_h(\delta_l)$ i.e. if

$$SW(\delta_{PL}) - SW(\delta_l) + a[\Pi_l(\delta_{PL}) - \Pi_l(\delta_l)] + a\Pi_h(\delta_{PL}) > a\Pi_h(\delta_l) \quad (37)$$

Similarly, we can compute

$$B_l = \frac{SW(\delta_{PL}) - SW(\delta_h) + a [\Pi_h(\delta_{PL}) - \Pi_h(\delta_h)] + a\Pi_l(\delta_{PL})}{a\gamma}$$

Each firm in sector l will find convenient to pay the contributions only if $\pi_l(\delta_{PL}) - C_l(\delta_{PL}) = B_l > \pi_l(\delta_h)$ i.e. if

$$SW(\delta_{PL}) - SW(\delta_h) + a [\Pi_h(\delta_{PL}) - \Pi_h(\delta_h)] + a\Pi_l(\delta_{PL}) > a\Pi_l(\delta_h)$$

If the above conditions are satisfied, then, if sector $l(h)$ lobbies then sector $h(l)$ is better off by doing the same

(ii) We now show that the above conditions for a Nash equilibrium are satisfied

We start from Eq.17 which can be rewritten as

$$SW = \gamma p_l A_l (L_0 + \delta N)^\alpha + (1 - \gamma) p_h A_h [H_0 + (1 - \delta)N]^\alpha - N$$

Using the following generic expression for δ :

$$\delta = \frac{d(H_0 + N) - L_0}{N(1 + d)} \quad (38)$$

(where $d = x$ if $\delta = \delta_{PL}$; $d = \eta$ if $\delta = \delta_l$; $d = \mu$ if $\delta = \delta_h$)

we can rewrite the government objective function for a generic d as follows:

$$SW(d) = \gamma p_l A_l \left[\frac{d(L_0 + H_0 + N)}{1 + d} \right]^\alpha + (1 - \gamma) p_h A_h \left[\frac{L_0 + H_0 + N}{1 + d} \right]^\alpha - N \quad (39)$$

which can be rewritten as follows:

$$SW(d) = (L_0 + H_0 + N)^\alpha \left(\frac{1}{1 + d} \right)^\alpha [\gamma p_l A_l d^\alpha + (1 - \gamma) p_h A_h] - N \quad (40)$$

Using 38 into 15 and 16 we can also rewrite profits in the two sectors as:

$$\Pi_l(d) = \gamma(1 - \alpha) A_l p_l \left(\frac{d}{1 + d} \right)^\alpha (L_0 + H_0 + N)^\alpha - \gamma N \quad (41)$$

and

$$\Pi_h(d) = (1 - \gamma)(1 - \alpha) A_h p_h \left(\frac{1}{1 + d} \right)^\alpha (L_0 + H_0 + N)^\alpha - (1 - \gamma) N \quad (42)$$

Using 36, 40,41,42, and choosing the appropriate value of d in each case, Eq. 37 becomes:

$$\begin{aligned}
& (L_0 + H_0 + N)^\alpha \left(\frac{1}{1+x} \right)^\alpha [\gamma p_l A_l x^\alpha + (1-\gamma) p_h A_h] - N - \\
& \left((L_0 + H_0 + N)^\alpha \left(\frac{1}{1+\eta} \right)^\alpha [\gamma p_l A_l \eta^\alpha + (1-\gamma) p_h A_h] - N \right) + \\
& a\gamma \left[(1-\alpha) (L_0 + H_0 + N)^\alpha \left(\frac{x}{1+x} \right)^\alpha p_l A_l - N \right] - \\
& a\gamma \left[(1-\alpha) (L_0 + H_0 + N)^\alpha \left(\frac{\eta}{1+\eta} \right)^\alpha p_l A_l - N \right] + \\
& a(1-\gamma) \left[(1-\alpha) (L_0 + H_0 + N)^\alpha \left(\frac{1}{1+x} \right)^\alpha p_h A_h - N \right] - \\
& a(1-\gamma) \left[(1-\alpha) (L_0 + H_0 + N)^\alpha \left(\frac{1}{1+\eta} \right)^\alpha p_h A_h - N \right] \\
& > 0
\end{aligned}$$

Dividing all terms by $\gamma p_l A_l$ and using the definition of $\lambda = \frac{(1-\gamma)p_h A_h}{\gamma p_l A_l}$ after some algebra we can rewrite the above condition as

$$[1 + \sigma(1-\alpha)] (L_0 + H_0 + N)^\alpha \left[\frac{x^\alpha + \lambda}{(1+x)^\alpha} - \frac{\eta^\alpha + \lambda}{(1+\eta)^\alpha} \right] > 0 \quad (43)$$

To check whether the term in parenthesis is positive, we consider the generic function

$$F(f) = \frac{f^\alpha + \lambda}{(1+f)^\alpha} \quad (44)$$

It is easy to check that this function has a unique maximum at $f = \frac{1}{\lambda^{1-\alpha}}$. Since we know that $x = \frac{1}{\lambda^{1-\alpha}}$ and $\eta > x$, we have that $\frac{x^\alpha + \lambda}{(1+x)^\alpha} > \frac{\eta^\alpha + \lambda}{(1+\eta)^\alpha}$. Thus, (43) is satisfied.

Following the same procedure as before, we can easily check that $B_l - \pi_l(\delta_h) = \gamma p_l A_l (L_0 + H_0 + N)^\alpha [1 + a(1-\alpha)] \left[\frac{x^\alpha + \lambda}{(1+x)^\alpha} - \frac{\mu^\alpha + \lambda}{(1+\mu)^\alpha} \right] > 0$ Q.E.D.

7.4 Proof of proposition 4

Remember that at the firm level:

$$B_h - \pi_h(\delta_l) = \gamma p_l A_l (L_0 + H_0 + N)^\alpha [1 + a(1-\alpha)] \left[\frac{x^\alpha + \lambda}{(1+x)^\alpha} - \frac{\eta^\alpha + \lambda}{(1+\eta)^\alpha} \right]$$

$$B_l - \pi_l(\delta_h) = \gamma p_l A_l (L_0 + H_0 + N)^\alpha [1 + a(1 - \alpha)] \left[\frac{x^\alpha + \lambda}{(1 + x)^\alpha} - \frac{\mu^\alpha + \lambda}{(1 + \mu)^\alpha} \right]$$

Firms in sector l will lobby if $\gamma[B_l - \pi_l(\delta_h)] > K$ and firms in sector h if $(1 - \gamma)[B_h - \pi_h(\delta_l)] > K$, where K is (total) cost of setting up a lobby.

It is easy to check that if $\lambda = 1$ then $B_h - \pi_h(\delta_l) = B_l - \pi_l(\delta_h)$. Thus for a given $K > 0$, if $\gamma = 1/2$, i.e. the two sectors have the same share of firms, either both $\gamma[B_l - \pi_l(\delta_h)]$ and $(1 - \gamma)[B_h - \pi_h(\delta_l)]$ are larger than K or none of them is, i.e. either both sectors exert lobby or none of them does. However, even when $\lambda = 1$, if $\gamma > 1/2$ there exists a level of K such that $\gamma[B_l - \pi_l(\delta_h)] > K > (1 - \gamma)[B_h - \pi_h(\delta_l)]$, i.e. only firms in sector l will lobby. Viceversa, if $\gamma < 1/2$ we may have the case where only firms in sector h will lobby.

For $\lambda \neq 1$ and $\gamma = 1/2$ we have that:

$$\begin{aligned} \text{if } \frac{\eta^\alpha + \lambda}{(1 + \eta)^\alpha} &< \frac{\mu^\alpha + \lambda}{(1 + \mu)^\alpha} \implies B_h - \pi_h(\delta_l) > B_l - \pi_l(\delta_h) \\ \text{if } \frac{\eta^\alpha + \lambda}{(1 + \eta)^\alpha} &> \frac{\mu^\alpha + \lambda}{(1 + \mu)^\alpha} \implies B_h - \pi_h(\delta_l) < B_l - \pi_l(\delta_h) \end{aligned}$$

Thus in the first case there exists K such that $(1 - \gamma)[B_h - \pi_h(\delta_l)] > K > \gamma[B_l - \pi_l(\delta_h)]$, which implies that only firms in sector h exert lobby; viceversa in the second case there exists K such that $\gamma[B_l - \pi_l(\delta_h)] > K > (1 - \gamma)[B_h - \pi_h(\delta_l)]$, which implies that only firms in sector l exert lobby. Using Mathematica and setting $\alpha = 2/3$ we can prove that the first case is always satisfied for $\lambda > 1$ and the second case for $\lambda < 1$.

Notice that we are not able to find a solution for every value of $\alpha < 1$. Nevertheless the results hold true also for values different from $\alpha = 2/3$ and specifically they hold for $\alpha = 1/2, \alpha = 3/4, \alpha = 4/5$.

References

- [1] Acemoglu, A. (2002). Technical change, inequality, and the labor market. Journal of Economic Literature, XL:7-72

- [2] Baldwin, R. and F. Robert-Nicoud (2007). Entry and asymmetric lobbying: why governments pick losers. *Journal of the European Economic Association*, 5(5):1064-1093.
- [3] Bernheim, D. and M. Whinston (1986). Menu auction, resource allocation and economic influence. *Quarterly Journal of Economics*, 101:1-31.
- [4] Bertocchi, G. and M. Spagat (2004). The evolution of modern educational systems. Technical vs general education, distributional conflict and growth. *Journal of Development Economics*, 73:559-582
- [5] Bowles, S. (1976). Capitalist development and educational structure. *World Development*, 6:783-796.
- [6] Carlson, C. Executives Lobby for Increased R&D. <http://www.allbusiness.com/government/government-bodies-offices-us-federal-government/13442403-1.html>
- [7] Faccio, M. (2006). Politically connected firms. *American Economic Review*, 96(1):369-386.
- [8] Felli, L. and A. Merlo (2006). Endogenous Lobbying. *Journal of the European Economic Association*, 4(1):180-215.
- [9] Galor, O. and O. Moav (2006). Das human-kapital: a theory of the demise of the class structure. *Review of Economic Studies*, 73:85-117.
- [10] Grossman, G.M. and E. Helpman (1994). Protection for sale. *American Economic Review*, 84:833-850.
- [11] Grossman, G.M. and E. Helpman (1996). Electoral competition and special interest politics. *Review of Economic Studies*, 63: 265-286.
- [12] Grossman, G.M. and E. Helpman (2001). *Special Interest Politics*. MIT Press.
- [13] Janiak, A. (2005) Labor mobility and education policy: the trade-off between specialization and reallocation cost. Mimeo

- [14] Krueger, D. and K.B. Kumar (2004). Skill-specific rather than general education: a reason for US-Europe growth differences? *Journal of Economic Growth*, 9:167-207.
- [15] Mitra, d. (1999). Endogenous lobby formation and endogenous protection: a long-run model of trade policy determination. *American Economic Review*, 89(5): 1116-1134.
- [16] Murphy, K.M. A. Shleifer and R.W. Vishny (1991). The allocation of talent: implications for growth. *Quarterly Journal of Economics*, 106(2): 503-530.
- [17] Nelson, R. and E.Phelps (1966). Investment in humans, technological diffusion and economic growth. *American Economic Review*, 56(2): 69-75.
- [18] Open Secret, Lobbying Database, <http://www.opensecrets.org/lobby/>
- [19] Vandenbussche, J. P. Aghion and C. Meghir (2006). Growth, distance to frontier and composition of human capital. *Journal of Economic Growth*, 11:97-127.

Table 1: Expenditure in education

	Expenditures in education as % of GDP				Total expenditures per student US\$PPP (a)	Graduates in upper secondary general programmes (b)	Graduation rate Tertiary-type A programmes (first degree)
	Primary, secondary and post-secondary non-tertiary education	Tertiary education	Total (public and private) all level of education	Total (public) all level of education			
Australia	3,5	1,5	5,2	3,8	8.786	62,6	59,2
Austria	3,6	1,3	5,4	5,1	10.974	18,6	25,0
Belgium	4,1	1,3	6,1	5,9	9.162	34,4	27,8
Canada	3,5	2,6	6,1	4,6	m	90,7	40,0
Czech Republic	2,8	1,2	4,6	4,1	5.426	24,7	37,3
Denmark	4,3	1,7	7,1	6,6	10.759	53,3	46,5
Finland	3,6	1,6	5,6	5,5	8.440	35,6	82,0
France	3,9	1,4	6,0	5,5	8.932	45,2	35,4
Germany	3,0	1,1	4,7	4,0	8.270	42,7	25,5
Greece	m	m	m	m	m	68,8	23,6
Hungary	3,2	0,9	4,9	4,9	4.811	79,8	34,3
Iceland	5,1	1,2	7,8	7,0	9.015	54,3	57,4
Ireland	3,48	1,2	4,7	4,4	8.628	55,9	46,1
Italy	3,1	0,9	4,5	4,1	7.948	34,6	32,8
Japan	2,8	1,5	4,9	3,3	9.312	75,6	39,4
Korea	4,0	2,4	7,0	4,2	7.325	72,7	43,4
Luxembourg	3,1	m	m	m	m	38,8	5,3
Mexico	3,8	1,2	5,7	4,7	2.598	92,2	18,1
Netherlands	3,7	1,5	5,6	4,7	9.883	34,6	44,7
New Zealand	4,0	1,5	5,9	4,8	6.226	m	50,7
Norway	3,7	1,3	5,5	5,4	11.967	59,6	44,9
Poland	3,4	1,3	5,3	4,8	4.134	62,3	50,0
Portugal	3,5	1,6	5,6	5,1	6.677	67,6	45,3
Slovak Republic	2,5	0,9	4,0	3,4	3.694	25,7	57,1
Spain	2,9	1,1	4,8	4,2	8.618	53,9	29,8
Sweden	4,1	1,6	6,3	6,1	10.262	43,5	39,2
Switzerland	4,0	1,2	5,5	5,1	13.031	30,4	30,4
Turkey	m	m	m	m	m	66,4	19,7
United Kingdom	4,2	1,3	5,8	5,2	9.600	100,0	40,1
United States	4,0	3,1	7,6	5,0	14.269	100,0	37,3

(a) Public institution only for Hungary, Poland, Portugal, Switzerland and Italy (except in tertiary education).

(b) For United Kingdom and United States, year of reference is 2006.

Expenditures on Education as % of GDP (year 2007): Education at Glance, 2010.

Expenditures per student US\$PPP based on full-time equivalents (year 2007): Education at Glance, 2010.

Graduates in upper secondary general programmes (year 2008): Oecd.stat - Education and training

Graduation rate (year 2008): Education at a Glance, 2010

Table 2. Tertiary education

	Tertiary-type A and advanced research programmes (2008)							
	Shares over all fields of study							
	Education	Humanities and Arts	Social sciences business and law	Science	Engineering manufacturing and construction	Agriculture	Health and welfare	Services
Australia	0,11	0,11	0,43	0,12	0,07	0,01	0,15	0,03
Austria	0,11	0,10	0,39	0,13	0,14	0,01	0,10	0,02
Belgium	0,05	0,17	0,36	0,07	0,13	0,03	0,16	0,01
Canada	0,11	0,13	0,37	0,13	0,08	0,01	0,10	0,03
Czech Republic	0,16	0,07	0,32	0,10	0,17	0,04	0,07	0,04
Denmark	0,09	0,15	0,28	0,08	0,12	0,01	0,26	0,01
Finland	0,08	0,17	0,26	0,12	0,15	0,02	0,15	0,05
France	0,02	0,14	0,42	0,14	0,13	0,01	0,10	0,04
Germany	0,09	0,22	0,27	0,16	0,12	0,01	0,09	0,02
Greece	0,12	0,18	0,32	0,14	0,12	0,03	0,08	0,01
Hungary	0,19	0,09	0,39	0,06	0,08	0,02	0,10	0,08
Iceland	0,21	0,10	0,39	0,06	0,07	0,00	0,15	0,02
Ireland	0,09	0,20	0,34	0,13	0,08	0,01	0,14	0,01
Italy	0,06	0,16	0,36	0,07	0,15	0,02	0,15	0,03
Japan	0,06	0,17	0,35	0,05	0,19	0,03	0,08	0,02
Korea	0,10	0,19	0,23	0,10	0,23	0,02	0,09	0,04
Luxembourg	0,00	0,15	0,48	0,29	0,04	0,00	0,00	0,02
Mexico	0,14	0,04	0,42	0,10	0,14	0,02	0,10	0,03
Netherlands	0,15	0,09	0,37	0,06	0,08	0,01	0,18	0,05
New Zealand	0,14	0,16	0,40	0,13	0,07	0,01	0,17	0,01
Norway	0,18	0,09	0,29	0,08	0,08	0,01	0,24	0,05
Poland	0,17	0,08	0,43	0,08	0,09	0,02	0,09	0,05
Portugal	0,09	0,10	0,32	0,15	0,22	0,03	0,21	0,07
Slovak Republic	0,17	0,06	0,31	0,08	0,13	0,02	0,17	0,05
Spain	0,15	0,09	0,29	0,10	0,14	0,02	0,16	0,05
Sweden	0,21	0,06	0,24	0,07	0,17	0,01	0,27	0,01
Switzerland	0,12	0,13	0,37	0,12	0,12	0,01	0,10	0,02
Turkey	0,24	0,06	0,41	0,09	0,09	0,03	0,06	0,02
United Kingdom	0,10	0,18	0,34	0,14	0,09	0,01	0,14	0,01
United States	0,12	0,16	0,40	0,09	0,06	0,01	0,11	0,06

Table 3. Value added by sectors of production

Value added shares relative to total economy.	TOTAL									TOTAL SERVICES	HITECH High- technology manufactures	HMHTECH High and medium-high technology manufactures
	AGRICULTURE HUNTING, FORESTRY AND FISHING	MINING AND QUARRYING	MANUFAC TURING	ELECTRICITY GAS AND WATER SUPPLY	CONSTRUC TION	WHOLESALE AND RETAIL TRADE - RESTAURANT S AND HOTELS	TRANSPORT, STORAGE AND COMMUNIC ATIONS	FINANCE, INSURANCE REAL ESTATE AND BUSINESS SERVICES	COMMUNITY SOCIAL AND PERSONAL SERVICES			
Australia	2,3	7,8	11,2	2,3	7,4	13,1	7,7	29,6	18,6	69,0	0,7	3,1
Austria	1,7	0,5	20,0	2,4	6,9	17,3	6,2	24,3	20,8	68,6	2,2	8,4
Belgio	0,9	0,1	16,7	2,2	5,1	14,5	8,4	28,8	23,4	75,1	2,0	6,9
Czech Republic	2,6	1,3	26,3	4,3	6,3	14,9	10,7	16,4	17,3	59,2	1,8	11,1
Denmark	1,3	4,1	14,2	2,1	5,7	14,1	7,7	24,2	26,6	72,5	2,4	6,2
Finland	2,7	0,4	23,7	2,3	6,0	12,0	10,1	20,8	22,1	64,9	5,2	10,8
France	2,1	0,0	12,8	1,7	6,0	12,6	6,4	33,7	24,9	77,5	1,9	5,3
Germany	0,9	0,2	23,4	2,4	3,9	11,7	5,8	29,2	22,4	69,2	2,8	13,4
Greece	3,9	0,5	10,2	2,6	6,7	24,2	9,4	18,6	23,9	76,1	0,5	1,9
Hungary	4,1	0,2	22,5	2,6	4,8	13,1	7,7	22,3	22,8	65,9	4,2	11,9
Iceland	6,3	0,0	10,9	3,9	11,3	11,5	6,3	26,0	23,7	67,5	1,0	2,0
Ireland	1,6	0,5	22,1	1,2	10,2	13,1	5,3	27,7	18,3	64,4	6,0	12,8
Italy	2,1	0,4	18,7	2,1	6,1	15,3	7,4	26,9	21,0	70,7	1,7	6,9
Japan	1,4	0,1	20,7	3,2	6,1	17,0	6,4	26,7	18,4	68,5	3,3	10,6
Korea	3,3	0,3	28,0	2,3	9,0	9,8	7,1	21,2	19,0	57,1	7,1	16,2
Luxembourg	0,4	0,1	8,7	1,2	5,8	11,0	8,7	48,5	15,6	83,9	..	1,6
Netherlands	2,2	3,3	13,9	1,9	5,5	14,8	7,1	27,7	23,6	73,2	1,1	5,3
New Zealand	5,4	1,3	14,5	2,8	5,5	14,6	7,2	29,9	18,9	70,6	..	..
Norway	1,5	27,8	10,0	2,6	4,5	9,5	7,5	17,0	19,7	53,7	0,8	..
Poland	4,3	2,4	18,8	3,5	6,4	20,1	7,4	18,3	18,9	64,6	1,1	6,0
Portugal	2,8	0,0	14,8	2,9	6,6	17,3	7,0	22,0	26,5	72,9	0,7	3,2
Slovak Republic	3,6	0,4	24,1	6,8	7,7	16,7	7,2	17,6	15,9	57,4	1,6	8,2
Spain	2,8	0,3	15,5	2,0	12,1	18,0	6,9	21,7	20,8	67,4	0,9	5,2
Sweden	1,4	0,6	19,7	2,8	4,7	12,6	7,3	25,4	25,3	70,6	4,1	10,3
Switzerland	1,2	0,2	19,8	2,0	5,6	15,5	6,4	29,4	19,9	71,2	..	11,6
United Kingdom	0,7	2,7	13,0	1,6	6,3	14,4	6,9	31,0	23,4	75,7	2,2	5,5
United States	0,9	2,0	13,0	2,1	4,9	15,2	5,9	32,5	23,6	77,1	2,3	5,6

Source: OECD Stan Indicators 2009

Figure 1: Graduates in science and engineering and value added in high tech

Corr. 0.46; R2=0.21

Figure 2: Graduates in social science, business and law and value added in finance and business services

Corr. 0.63 ; R2=0.40

Pubblicato in proprio
Dipartimento di Economia Pubblica
Facoltà di Economia
Università degli Studi di Roma “La Sapienza”
Via del Castro Laurenziano 9 – 00161 Roma

ISSN 1974-2940

**Working Paper del Dipartimento di Economia Pubblica
Università degli studi di Roma “La Sapienza”
Via del Castro Laurenziano 9 – 00161 Roma**

COMITATO SCIENTIFICO

**Eleonora Cavallaro
Giuseppe Croce
Debora Di Gioacchino
Maurizio Franzini
Luisa Giuriato
Domenico Mario Nuti
Antonio Pedone
Enrico Saltari
Annamaria Simonazzi**

I Working Paper vengono pubblicati per favorire la tempestiva divulgazione, in forma provvisoria o definitiva, dei risultati delle ricerche sulla teoria e la politica economica. La pubblicazione dei lavori è soggetta all’approvazione del Comitato Scientifico, sentito il parere di un referee.

I Working Paper del Dipartimento di Economia Pubblica ottemperano agli obblighi previsti dall’art. 1 del D.L.: 31.8.45 n. 660 e dal Decreto del Presidente della Repubblica 3 maggio 2006 n.252, art.37.