Globalization, Welfare, and the Attitudes toward Higher Education*

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Abstract

Globalization is strongly correlated with the increase of skilled workers in the labor force. However, the changes are unequal between countries with similar economic conditions. Our paper departs from other mainstream studies in that it delves more deeply into the attitudes toward higher education. We analyze how these attitudes give shape to the post-globalization outcomes in the labor market and how they affect total welfare and the welfare of each skill group. We show that an economy more willing to educate itself will gain in terms of welfare even if it displays a higher wage differential and, besides, that a certain degree of flexibility can make up for the welfare loss due to a polarization of the views on higher education.

Keywords: Globalization, Welfare, Skills, Education.

JEL classification: F66, I25, J24, J64.

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1 Introduction

Globalization is reshaping the world economy and, in so doing, is bringing new opportunities for all, but it is also making it harder for some people to rapidly adjust to the changing conditions. In particular, those on the lower end of the skill ladder will find themselves on a tight spot if unable to move up. Education, both formal and otherwise, is thus an enabler for this dynamics that may boost low-skill workers' productivity as to restore their relative losses. Understanding how the attitudes toward higher education in a globalized world can affect welfare becomes then a crucial matter.

The literature on globalization and skills is wide and multifaceted. For example, mainstream studies point out that an increasing wage gap may be observed in highly exposed sectors. In most cases this is the result of the decline in unskilled real wages which, in turn, stems from what the literature identifies both as skill-biased technical change (SBTC) and internationalization processes like offshoring and outsourcing (see, most representatively, Berman et al., 1998, and Feenstra and Hanson, 1996, 1997, 1999, or Moore and Ranjan, 2005).[1] Okazawa (2013) points out that unequal increases in wage inequality among otherwise similar countries are due in part to differences in their educational systems.

Depending on the perspective and the definitions the drop in low-skill real wages can be relative or absolute. At the macro level, however, globalization proves indeed to be a win-win for both the advanced and the emerging economies as it entails a sheer number of exchanges in many fields. For instance, due to internationalization strategies, high-income countries in the west are sending their low-wage jobs overseas but, at the same time, are becoming large recipients of other business functions (Amiti and Wei, 2005).

It follows then that it becomes prominent for workers worldwide to keep up to date with higher productivity requirements. The globalization race makes for a more demanding competitive environment, and workers, especially low skilled, are the first to be shaken up by it. That is why the education decision cannot be taken lightly, as it has to do with potentially higher wages and, thus, a catching-up in terms of welfare with respect to those in the higher productivity range.

We understand globalization as the phenomenon by which productivity levels go up due to the new technological advances made available by higher import penetration. In order to analyze the response of low-skill workers to globalization we build on the matching literature with two types of workers, as in Mortensen and Pissarides (1999), Albrecht and Vroman (2002), and Davidson et al. (2008), among others. For example, Albrecht and Vroman (2002) show the specific role of SBTC in shaping the main labor market variables—this they do with a certain degree of success when compared to the empirical evidence in the US and Europe—but the skill distribution of workers is constant.

[1] See also Forbes (2010); Oladi et al. (2011); and Traca (2011), among many others.

When we look at the data we find a strong positive correlation between globalization, as measured by the openness index, and the high-to-low skill ratio. Figure 1 points to a growing gap in the high-to-low skill ratio for a large group of European countries, as a possible side effect of globalization (e.g. because of SBTC), and as also evidenced by the references in the previous paragraphs.[2] The welfare implications of such a trend are straightforward, namely, a growing high-to-low skill ratio will certainly push for a larger wage gap. Another stylized fact worth mentioning is outlined in Figure 2. There it is shown, for the same group of European countries, a positive relationship between the growth rate of the share of high-skill workers during 1998-2013 and the relative earnings in 2013. This implies that in places where the share of tertiary-educated workers has been increasing more rapidly, the resulting wage inequality is expected to be higher. This is why it becomes necessary to consider the endogenous reaction of skills to explain the post-globalization labor market outcomes. Further, given that such reaction may be dependent on national characteristics we will allow for different educational attitudes.

[insert Figure 1 around here]
[insert Figure 2 around here]

The main goal of the paper is to study how the attitudes toward higher education affect labor market outcomes in the context of globalization. We extend the model in Albrecht and Vroman (2002) to account for the empirical facts disclosed above. We delve into the attitudes toward higher education, usually overlooked in the economic literature, and their role in the aftermath of globalization. We first explore the factors that may lie behind the educational decision and are beyond the typical economic characteristics (e.g. social environment). For instance, as shown above, the change in the students' predisposition to study can be a contributing factor to the resulting wage differential. Then we analyze how the attitudes toward higher education shape the response to globalization, lay the skill distribution among workers, and affect wages, unemployment and welfare, both overall and for each skill group.

We rely on a matching model where employers create both high and low-skill vacancies, and where the distribution of skill requirements across these vacancies is endogenous. Unlike Albrecht and Vroman (2002), however, we endogenize the schooling decision of workers faced with individualized educational costs. Then we calibrate the model for Germany for the period 1998–2013 to assess the effects of globalization and the role of educational attitudes. In the model's terms, we interpret globalization as a widening gap in productivity levels. In

[2]Both globalization and skill data from the OECD were available for a group of 22 European countries, namely: Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, and the United Kingdom.

particular, we allow for an increase in the productivity of high-skill workers as a result of skill-biased technical change.[3] We perform a comparative statics analysis where we compare before and after-globalization equilibria.

Following Albrecht and Vroman (2002) we discuss two possible equilibria: cross-skill matching (CSM) and ex post segmentation (EPS). CSM is reached when high-skill workers and low-skill vacancies are matched, and EPS occurs when such possibilities do not result in matches. We compare the outcomes in environments with different attitudes toward higher education. Our findings suggest that an economy where some part of the population is very unwilling to educate itself will lose in terms of welfare, regardless of the lower wage differential.[4] In such an economy there will be fewer high-skill workers and firms will be opening fewer high-skill vacancies. As a result, high-skill workers will find it more difficult to match, and if they do, it will happen at lower wages, whereas the opposite holds for low-skill workers. Since the wage determines the worker's utility, the resulting sum of all utilities will thus be lower than with more high-skill workers commanding higher wages.[5] We present an example where the welfare loss under polarized attitudes can be offset by reducing the vacancy cost, that is to say, by making it easier on employers to hire new employees. In other words, better social outcomes can be achieved by way of a more homogeneous predisposition toward higher education or else by a more flexible and pro-business atmosphere. All in all, reshaping the society's perception about the importance of education together with policies that make the labor market more flexible are considered welfare-improving strategies.

Our paper is in line with the traditional globalization literature. For instance, Edwards (1998) suggests that more open countries have experienced faster productivity growth rates, with education playing an important role, as countries with a more developed educational system are arguably better at innovating and absorbing new ideas. Other related works touching upon the skill premium effect of globalization emphasize different nuances that, to some extent, also show up in our analysis. For example, Epifani and Gancia (2008) highlight the higher relative demand for skill-intensive goods that, as a result, raises the relative wage of skilled workers—in particular, they find that an increase in the level of openness of countries is highly correlated with an increase in the returns to education but also with the skill premium. Their results suggest that a one percentage point increase in the openness ratio leads to a 0.5% increase in the skill premium. Our results, even when not directly comparable, also point to an increase of the skill premium the size of which depends on the assumptions made about the skill acquisition process. Another example is Helpman et al. (2010), who find that trade enhances wage inequality but it can either raise or reduce

[3]Notice that these productivity improvements are more easily claimed by high-skill workers as they are better equipped to deal with these changes.

[4]In fact, Albrecht and Vroman (2002) can be seen as a special case of our model where the educational attitudes are completely polarized and there is no room for the adjustment of skills to external effects.

[5]Welfare will be measured as the sum of the workers' utilities participating in the labor market.

unemployment. Moreover, they find that wage inequality is higher in a trade equilibrium than in autarky. Our results are consistent with these findings too—we show that wage inequality increases with globalization and unemployment moves up or down depending on the type of equilibrium arrived at.

The remainder of the paper is organized as follows. The general attitudes toward higher education and the educational results in several European countries are analyzed in section 2. The model, its main properties, and the possible types of equilibria are examined in section 3. Details on our calibration are discussed in section 4. The effects of globalization under different educational attitudes along with our counterfactual experiments are studied in section 5. Final remarks are summarized in section 6.

2 Attitudes toward higher education and skills

Lucas (1988) singles out human capital accumulation, that is, the process of acquiring skills both by education and on-the-job training, as an important growth engine. Countries with a larger share of skilled labor force are more productive overall and better prepared to react to different shocks. Immerwahr (2004) reports that in the US, about three quarters of the people believe that getting a college education today is more important than 10 years ago, and this share remains relatively stable over time.[6] In fact, the share of high skilled individuals increases in all developed countries—for instance, a large share of Europeans in 1996 already stated that they wanted to continue learning throughout their lives, from 92% in Denmark, to 60% in Germany and 49% in Austria, according to Eurobarometer (1997). The two most important reasons to go on learning were curiosity (respondent reported the will to improve general knowledge) and enhancement of skills (qualification).

The factors responsible for educational decisions may be of social nature. It is reported that the influence from parents (family expectations), classmates, and teachers, is taken into account when youngsters choose to go on studying and what career to pursue. Following Eurobarometer (2011), the family is the most important source of information when making the educational decision for 20% of Europeans, followed by teachers' and counselors' guidance (14%), and online social networks (10%). Future income, or more enjoyable and stimulating work, are also given as additional relevant factors.[7]

According to Malmström and Öqvist (2016), the students' intention to pursue higher education is significantly correlated to their performance at school. Therefore, their attitudes should have an important impact on such a decision. To see the effect of the performance at school on the education decision, we look at data from the Programme from International

[6] The questionnaire was collected in 1998, 2000 and 2003.

[7] Even though higher education is not a guarantee for a better job, it is a factor that highly improves the chances for it.

Student Assessment (PISA), where 15-year-old students from the Organization for Economic Co-operation and Development (OECD) and other partner countries, are examined in science, mathematics, and reading. PISA classifies the scores in 6 proficiency levels, from 1 being the worst to 6 being the best. We relate the share of high-performing students to the tertiary-educated labor force. If the performance at school is reflecting the intention to go on studying, a higher share of high-performing students would suggest a more qualified workforce—Figure 3 gives support to this hypothesis.

[Insert Figure 3 around here]

We see that as more students achieve a better score on PISA tests in 2003 for reading and mathematics, a higher share of tertiary-educated workers is observed in 2013.[8,9] Taking the level 4 score as the threshold means we are focusing on high-performing students (top performers in mathematics being of level 6). Using level 3 as the threshold results in similar correlations though.

Another characteristic we must consider is the value of the degree. If, for example, people are convinced that an academic degree is more valuable than a vocational one then they will choose accordingly (Furnham and McManus, 2004). In general, vocational training has a more practical orientation toward a particular profession. From Figure 4 we learn that the share of people who perceive vocational training as offering high quality learning is negatively correlated with the growth rate of tertiary-educated. Vocational training can thus be seen as a substitute for higher education.

[Insert Figure 4 around here]

Many countries in our sample start with a high share of low-skill workers in their labor force which diminishes over time at a different pace. All sampled countries start with more than two thirds of low skilled workers in year 1998 (or 1999 in some cases), the average being 78%, just to drop to an average of 66% in 2013. Table 1 shows these changes.

[Insert Table 1 around here]

[8] We allow for a ten-year interval for 15-year-old students in 2003 to obtain a degree.

[9] In 2003 PISA proficiency levels were determined as follows. Mathematics, level 1a below 358 score points, level 1b: 358-420 score points, level 2: 421-482 score points, level 3: 483-544 score points, level 4: 545-606 score points, level 5: 607-668 score points, level 6: above 668 score points. Reading, level 1a below 335 score points, level 1b: 336-407 points, level 2: 408-480 score points, level 3: 481-552 points, level 4: 553-625 score points, level 5: above 626 score points. The results for science are omitted as the breakdown for 2003 was not available.

We assume that the decisions on the acquisition of skills are made according to the individual characteristics, which can be shaped by the social environment and government policies. Taking the attributes of each individual, we hypothesize that the distribution of workers in the market will depend on the above-mentioned characteristics, namely, their background, the social perception of the importance of a higher education, and the individual willingness to overcome obstacles and achieve the desired degree.

In reaction to the changing economic conditions, societies with a different distribution of these characteristics will proceed along different trajectories. In other words, in reaction to the same globalization shock, changes in the education decision will correspond to the country's particular circumstances and characteristics. Thus, if one part of the labor force is strongly convinced about the necessity of higher education and is willing to make the needed effort, but the remaining part is opposed to it, then the share of the population with tertiary education will change, but slowly. On the other hand, if the two views are not strongly polarized, the changing economic conditions will drive more individuals to take up the educational challenge. Empirically, we can proxy such disparities by the differences in the PISA scores between the top 25% (10%) and the bottom 25% (10%) performers. Figure 5 shows the inequality in PISA score points in science in 2003 against the growth rate of the share of tertiary educated workers between 2003 and 2013. We observe that in both cases a less polarized outcome in the initial period (horizontal axis) leads to a larger change in the share of tertiary educated workers (vertical axis).

[insert Figure 5 around here]

The facts presented in this section will help us modeling the educational decision in what follows. Notice that an individual who decides to follow the path of higher education will have to assume a cost. Such a cost, we contend, will be lower if the attitudes toward education are stronger. Furthermore, the distribution of attitudes among the individuals will have different consequences in terms of the labor market outcomes and welfare. Indeed, as globalization is changing the things we do at an unheard pace, labor markets are becoming natural targets and firms and workers are required to adjust accordingly.

3 Model

For our analysis we draw on the model in Albrecht and Vroman (2002). In particular, we endogenize the skill decision of workers while developing additional results for each skill group.

There are two types of infinitely lived workers of measure one and two types of many

infinitely lived firms.[10] Moreover, workers decide to be low or high-skill and firms open low or high-skill vacancies while they face free entry. Time is continuous.

It is understood that all workers have completed their compulsory education. This means that the basic skills, i.e. low-skills, are secured. Each worker is characterized by his attitudes toward higher education. Following the discussion in section 2, a worker that obtains better results in the previous schooling stage is expected to be more willing to undertake higher education. Similarly, a worker whose social and economical environments shape his conviction in benefit of higher education should be more inclined to continue studying. We encompass all such characteristics of the individual worker in the opportunity cost of remaining low-skill and the associated cost of getting new and higher skills. Workers are then ordered according to this opportunity cost and indexed by x. The worker with $x = 0$ has the lowest opportunity cost of remaining low-skill or, what is the same, the highest cost of skill acquisition. Workers who decide to further their education will have, potentially, higher productivity levels than workers who choose to remain low-skill. The cost of acquiring skills is described by a function that accounts for the properties outlined in the previous section. We assume it to be

$$\text{cost}(x) = \lambda (1 - x)^a \tag{1}$$

where $a \geq 1$ and $\lambda > 0$. The individual indexed by $x = 1$ will have an infinite opportunity cost of remaining low-skill and therefore will always become high-skill. Lower values of a imply a more homogeneous distribution of individuals with respect to the cost of skill acquisition, while higher values indicate higher inequality. This is the parameter that reflects the polarization of the attitudes in the labor force. The parameter λ, besides, measures the dispersion between the extremes of the distribution. If an individual indexed by x decides to participate in the market as a high-skill worker, he will experiment a welfare loss associated to the cost of skill acquisition. The skill decision takes place before the agents arrive in the market, so at time zero the labor force will be divided into a share q of low-skill workers, L, and a share $1 - q$ of high-skill workers, H.

Each firm employs one worker when active and jobs that are filled separate at the exogenous rate δ. A vacancy can be opened at an exogenous cost c, which includes the hiring costs but also the firing costs that firms will potentially face in the future. Firms place vacancies of both skill types—a fraction ϕ of vacancies is low-skill, L, and a fraction $1 - \phi$ is high-skill, H, and their distribution is endogenous. Further, if a firm hires a worker to occupy a low-skill vacancy the level of output is y_L, but if a high-skill vacancy is filled then the level of output is y_H. High-skill firms are more productive than their low-skill counterparts, thus $y_H > y_L$. High-skill vacancies, however, will only be filled by high-skill

[10] A description of how the model works for one type of worker can be found in Rogerson et al. (2005) and Williamson (2010).

workers, as low-skill workers are assumed to have zero productivity when operating high-skill technology.[11] If a worker of any type is employed he gets a wage corresponding to the type of vacancy and the type of skills he has. A worker of type L (H) working in a job of type L (H) will get a wage w_L (w_H), and a worker of type H working in an L type job will get $w_{L(H)}$. Wages earned by high-skill mismatched workers will be usually higher than wages of low-skill workers matched correctly with a low-skill job, hence $w_H > w_{L(H)} > w_L$.[12] If a worker is unemployed he is entitled to an exogenously set unemployment benefit b, and any worker can refuse the job if his reservation wage is not met.

Vacant firms and unemployed workers meet according to a matching technology $M(u, v)$ where u represents unemployed workers (unemployment rate) and v vacancies. The meeting function is characterized by constant returns to scale,

$$\frac{1}{u}M(u,v) = M(1, \frac{v}{u}) = m\left(\theta\right)$$

where $\theta = \frac{v}{u}$. We assume that $m(\cdot)$ is increasing in θ, i.e. $m\left(\theta\right)' > 0$, and $\lim_{\theta \to 0} m\left(\theta\right) = 0$. In this process an endogenously determined fraction γ of unemployed workers will be low skilled. In addition, arrival of jobs to workers happens at a rate $\frac{M(u,v)}{u}$ and arrival of workers to employers at a rate $\frac{M(u,v)}{v}$. If we define θ as market tightness, we can rewrite the job arrival rate to workers as $M(1, \frac{v}{u}) = m(\theta)$ and the workers' arrival rate to firms as $\frac{\frac{M(u,v)}{u}}{\frac{v}{u}} = \frac{m(\theta)}{\theta} = z(\theta)$.

If the match succeeds, the employed worker's expected utility is W_i and the active firm's expected profits are J_i, $i = L$, H or $L(H)$; where $i = L$ stands for a match between a low-skill worker and a low-technology firm, $i = H$ is a match between a high-skill worker and a high-technology firm, and $i = L(H)$ is the case where a high-skill worker matches with a low-skill firm. The utility of a worker comes from earning the wage w_L when low-skill, and the wage w_H or $w_{L(H)}$ when high-skill. The firm's profits π_i stem from the difference between production and incurred costs, that is

$$\pi_i = y_i - w_i - c. \tag{2}$$

If the match does not succeed, the utility comes from earning the unemployment benefits b and becomes U_L or U_H, respectively. The expected profits of a vacant firm are V_j, $j = L$ or H and its negative profits come from financing a vacancy, $-c$ (hiring and firing costs mainly).

[11] This in practice will mean that a high-skill worker can take both types of jobs, whereas a low-skill worker can only fill a vacancy that corresponds to his type.

[12] Notice that even if the workers are indexed by x, the wage does not depend on x, as it is assumed that the productivity of all workers depends on their educational attainment, not the educational attitudes or cost.

At each moment of time there will be E_L employed low-skill workers,

$$E_L = q - \gamma u, \tag{3}$$

and E_H employed high-skill workers

$$E_H = 1 - q - (1 - \gamma)\, u. \tag{4}$$

Workers may experience spells of employment and unemployment.

Problem of the worker A worker of type L or H maximizes his expected lifetime discounted utility function. Given that the workers are assumed to be risk neutral the utility maximization is as follows

$$E \int_0^\infty e^{-rt} \sigma_j(t) dt$$

where r is the discount rate, common to both types of workers, and $\sigma_j(t)$ is the consumption of worker j, $j = L$ or H, at time t.[13] Income comes in the form of wages or unemployment benefits. Hence, consumption is equal to the income in each period and saving is not possible.

Problem of the firm Firms maximize their expected lifetime discounted profits as follows

$$E \int_0^\infty e^{-rt} \pi_i(t) dt$$

where $\pi_i(t)$ are profits of firm i, $i = L$, H or $L(H)$, at time t. Profits are equal to the employed worker's productivity minus the corresponding wage and vacancy cost, as seen in equation (2).

Wage setting Recall that W_i stands for the value of working and U_j for the value of unemployment, while J_i stands for the value of the job and V_j for the value of the vacancy of the corresponding type. There is something to bargain over if the value of working is higher than the value of unemployment, $W_H > U_H$, $W_{L(H)} > U_H$ and $W_L > U_L$, and when

[13] The discrete time equivalent of the maximization problem would be

$$E \sum_{t=0}^{\infty} \left(\frac{1}{1+r} \right)^t \sigma_{jt}.$$

We should take into account that for small r, $e^{-rt} \approx (1+r)^{-t}$.

the value of the job is higher than the value of the vacancy, $J_H > V_H$, $J_{L(H)} > V_L$ and $J_L > V_L$. Wages are set to maximize the weighted surplus of workers and firms in a Nash bargaining process

$$\max_{\{w_i\}} \left[W_i(w_i) - U_j\right]^{\beta} \left[J_i(w_i) - V_j\right]^{1-\beta} \tag{5}$$

where the weighting parameter β represents the bargaining power of workers.

Educational choice As in Okazawa (2013), the skill choice of workers depends on the comparison between its cost and the wage differential between low and high-skill workers. The worker whose cost of skill acquisition is cost(x) chooses to be high skilled if the steady state wage gap is higher than the cost, i.e.

$$w_H - w_L > \text{cost}(x), \tag{6}$$

the worker on the threshold will be indifferent to remain low skilled or to become high skilled

$$w_H - w_L = \lambda \left(1 - x^*\right)^a. \tag{7}$$

Therefore, all workers with $0 \leq x < x^*$ will be low skilled and the ones with $x^* \leq x \leq 1$ will become high skilled. This implies that the share of the labor force that remains low skilled, q, will be determined by the threshold value x^*, i.e. [14]

$$q = x^* = 1 - \left(\frac{w_H - w_L}{\lambda}\right)^{\frac{1}{a}}. \tag{8}$$

We can observe from (8) that an increase in the wage gap decreases the fraction of low-skill workers in the labor force, $\frac{dq}{d(w_H - w_L)} < 0$, i.e. when facing a possible higher payoff the workers may willingly incur in higher costs, and more individuals will eventually get further education. Also, higher polarization means that under the otherwise same conditions it will be more expensive for some individuals to go on with higher education, $\frac{dq}{da} > 0$.

As discussed in Albrecht and Vroman (2002) two types of equilibria may be realized: the equilibrium with cross skill matching (CSM) and the equilibrium with ex post segmentation (EPS). CSM occurs when high-skill workers and low-skill vacancies match, while EPS takes place when potential matches do not prosper, i.e. high-skill workers only work in high-skill jobs. In fact, for some parameter values both equilibria can coexist, whereas for other cases

[14] We assume that the skill distribution of the labor force does not vary across periods due to the particularity of the education decision: it is a once-in-a-lifetime process, usually taken before the labor market is joined, and depends on long term expectations. To assume a labor force that varies in each period, an alternative setup should be considered. In such an environment the skill differences would have to be interpreted as on-the-job-training or learning-by-doing, and it would thus not correspond to the process of high education we focus on in this paper.

the equilibrium is unique. The type of equilibria achieved thus depends on the parameter values and on the labor market expectations of high-skill workers and their willingness to accept a low-skill job, as discussed in Davidson et al. (2008). If high-skill workers expect an easy search for a high-skill job then it will be easier for high-skill firms to fill their vacancies and thus more firms will choose a high-skill technology. This in turn reinforces the expectations of high-skill workers and the EPS equilibrium is realized.[15] Figure 6 shows the model's possible matches and payoffs.

[insert Figure 6 around here]

3.1 Steady State Equilibrium

Like Albrecht and Vroman (2002) or Davidson et al. (2008) we focus on the steady state equilibrium. In the steady state equilibrium

$$\delta E_L = \phi m(\theta)\left(q - E_L\right), \tag{9}$$

and

$$\delta E_H = \begin{cases} m(\theta)\left(1 - q - E_H\right) \text{ in CSM equilibrium, and} \\ (1-\phi)\, m(\theta)\left(1 - q - E_H\right) \text{ in EPS equilibrium,} \end{cases} \tag{10}$$

meaning that previously employed workers of each type who lose their job—left hand side of the equations (9) and (10)—coincide with the unemployed workers that find a job—right hand side of the same equations.

Let us examine the equilibrium equations of Albrecht and Vroman (2002). When the match between a worker and a firm is successful, the worker gets the utility that corresponds to the skill level of the firm employing him. The following Bellman equations state that the discounted value of working (left-hand side) must be equal to the flow of income (first item on the right-hand side) and the expected loss from changing the employment status (second item on the right-hand side) [16]

$$rW_L = w_L - \delta(W_L - U_L), \tag{11}$$

$$rW_H = w_H - \delta\left(W_H - U_H\right), \tag{12}$$

$$rW_{L(H)} = w_{L(H)} - \delta\left[W_{L(H)} - U_H\right]. \tag{13}$$

Subscripts L and H characterize low and high-skill workers, respectively, matched in the corresponding firms, and $L(H)$ stands for high-skill workers mismatched in low-skill jobs.

[15] In the CSM equilibrium high-skill workers take low-skill jobs because they expect to have a hard time finding high-skill jobs. This prompts firms to open low-skill jobs and the expectations become self-fulfilling.

[16] The discount rate can be interpreted as the interest rate.

The Bellman equations for the active firms take the following form

$$rJ_L = (y_L - w_L - c) - \delta (J_L - V_L), \tag{14}$$

$$rJ_H = (y_H - w_H - c) - \delta (J_H - V_H), \tag{15}$$

$$rJ_{L(H)} = \left[y_L - w_{L(H)} - c\right] - \delta[J_{L(H)} - V_L] \tag{16}$$

where the discounted value of the job must be equal to the flow of profits earned by the active firm and the expected loss from changing the labor market status (becoming inactive). Clearly, the equations (13) and (16) can only apply in case of the CSM equilibrium.

The analogous equations for the unsuccessful match hold: the discounted value of being unemployed must be equal to the flow of income (unemployment benefits) and the expected gain from finding a job

$$rU_L = b + \phi m(\theta) (W_L - U_L), \tag{17}$$

$$rU_H = \begin{cases} b + m(\theta)[\phi \left(W_{L(H)} - U_H\right) + (1-\phi) (W_H - U_H)] & \text{for CSM equilibrium, and} \\ b + (1-\phi) m(\theta) (W_H - U_H) & \text{for EPS equilibrium.} \end{cases} \tag{18}$$

The Bellman equations for the inactive firms are

$$rV_L = \begin{cases} -c + z(\theta) \left[(1-\gamma) \left(J_{L(H)} - V_L\right) + \gamma (J_L - V_L)\right] & \text{for CSM equilibrium,} \\ -c + z(\theta)\gamma (J_L - V_L) & \text{for EPS equilibrium, and} \end{cases} \tag{19}$$

$$rV_H = -c + z(\theta)(1-\gamma) (J_H - V_H) \tag{20}$$

where the discounted value of the vacancy must be equal to the flow of income lost by maintaining the vacancy open and the expected gain from switching to the active status. There is free entry into the market and new firms enter while the value of the vacancy is positive. No more firms enter when the value of the vacancy decreases to zero; the free entry condition can be then expressed as

$$V_L = 0 \text{ and } V_H = 0. \tag{21}$$

The resulting wages for each type of match are [17]

$$w_L = \beta(y_L - c) + (1-\beta)\, rU_L, \tag{22}$$

$$w_H = \beta(y_H - c) + (1-\beta)\, rU_H, \tag{23}$$

$$w_{L(H)} = \beta(y_L - c) + (1-\beta)\, rU_H. \tag{24}$$

The condition for the CSM equilibrium to exist is that matches between high-skill workers and low-skill jobs do take place. This happens when [18]

$$y_L - c > rU_H. \tag{25}$$

The opposite must hold in the EPS equilibrium

$$y_L - c \leq rU_H.$$

Details on how to obtain the unemployment rate, u, the fraction of firms that open low-skill vacancies, ϕ, the fraction of low-skill workers that are unemployed, γ, market tightness, θ, and aggregate output, Y, are discussed in the Appendix.

Globalization may affect each type of worker in a very different way. We want to look into the post-globalization situation of each group of workers separately. To see this we derive the unemployment rates of both types of workers. The low-skill unemployment rate is

$$u_L = \frac{\gamma u}{q} \tag{26}$$

and the high-skill unemployment rate is

$$u_H = \frac{(1-\gamma)\, u}{1-q}. \tag{27}$$

Then we evaluate the welfare of each skill group, as well as the total welfare. We measure it by the expected utility of the average low-skill worker (which are all alike), Ω_L, and that of the average high-skill worker (which will differ as a result of the incurred skill cost), $\overline{\Omega_H}$,

[17] Maximizing (5), one gets the following first order condition

$$\beta\, W_i'(w_i)\,[J_i(w_i) - V_j] + (1-\beta)\, J_i'(w_i)\,[W_i(w_i) - U_j] = 0,$$
$$i = L,\ L(H),\ H,\ j = L, H.$$

Using (11)-(13), (14)-(16) and their derivatives, together with the free entry condition (21), we get the expressions for the corresponding wages.

[18] Conditions $J_{L(H)} > V_L$ and $W_{L(H)} > U_H$ must hold. As $V_L = 0$, the value of the job $J_{L(H)}$ must be positive. Whether the value of working when mismatched is greater than the value of being unemployed can be checked by processing the corresponding Bellman equations.

as follows

$$\Omega_L = \frac{E_L W_L + (q - E_L) U_L}{q}, \tag{28}$$

$$\overline{\Omega_H} = \begin{cases} \frac{\phi E_H\left[W_{L(H)} - \overline{\text{cost}(x)}\right] + (1-\phi) E_H\left[W_H - \overline{\text{cost}(x)}\right] + (1-q-E_H)\left[U_H - \overline{\text{cost}(x)}\right]}{1-q} & \text{in CSM equilibrium, and} \\ \frac{E_H\left[W_H - \overline{\text{cost}(x)}\right] + (1-q-E_H)\left[U_H - \overline{\text{cost}(x)}\right]}{1-q} & \text{in EPS equilibrium} \end{cases} \tag{29}$$

where the average education cost is

$$\overline{\text{cost}(x)} = \frac{1}{1-x^*} \int_{x^*}^{1} \text{cost}(x) dx = \frac{\lambda (1-q)^a}{a+1}. \tag{30}$$

The overall welfare Ω is the weighted sum of the two,

$$\Omega = q\Omega_L + (1-q)\,\overline{\Omega_H}. \tag{31}$$

When analyzing the effect of globalization we allow for an increase in the productivity of high-skill workers as a result of SBTC, as mentioned in the introduction. To predict the effect of an increase in the productivity gap on the wage gap we need to inspect wage equations (22) and (23). We can see that

$$w_H - w_L = \beta (y_H - y_L) + (1-\beta)(rU_H - rU_L) \tag{32}$$

where the expression for rU_H together with the one for rU_L is provided in the Appendix. Both depend positively on the respective productivity levels. We can conclude that a higher productivity gap implies a higher wage gap. Especially, the effect of the wage gap on the skill distribution will depend on the educational attitudes, as implied by equation (8). The skill distribution will in turn affect vacancies (see Appendix for the expression for ϕ), and this will successively alter the wage gap. The skill distribution will also affect the unemployment rate of each type of worker, as seen in equations (26) and (27). If more individuals acquire high skills the unemployment rate of low-skill workers will increase, and the one of high-skill workers, on the contrary, will decrease. All in all, the analytical results imply that globalization will worsen the condition of low-skill workers and increase wage inequality, but the size of the effects will depend on the differences in the predisposition to study.

The behavior of all variables will be determined numerically, given that the analytical solution for the set of equilibrium equations is not available. Below we compare two steady states: a pre-globalization and then a post-globalization scenario.

4 Calibration

We calibrate the model to fit the German economy in the period 1998-2003 using yearly data. Table 1 shows that several countries have around 24% of tertiary educated workers in 1998 (or 1999). We choose Germany because, apart from having a skill distribution of the labor force which is close to the average (and median) in the initial year, it is also an important player in the international scene.

Baseline parameters are chosen in line with the characteristics found in the data.[19] Jobs between 1998 and 2013 last on average 10.6 years, implying that the rate at which the employment relationship is broken is $\delta = 0.095$. Low real interest rates during the period are reflected in a low discount rate, which is set to $r = 0.005$. We follow the search literature and assume that the bargaining power of the workers is the same as that of the firms, $\beta = 0.5$, and consider the Cobb-Douglas matching function $M(u, v) = 2\sqrt{uv}$, which implies that the job arrival rate to workers is

$$m(\theta) = 2\sqrt{\theta}. \tag{33}$$

We assume CSM as the baseline (pre-globalization) equilibrium and set the productivity gap that enables such equilibrium: the output produced by high-skill workers in a high-skill firm is $y_H = 1.1$, and the output produced in a low-skill firm is $y_L = 1$. The unemployment benefits are equal to about 60% of the wages in the data; a value we get by setting $b = 0.48$. Unemployment rates, similar to those found in the data (around 6%), are generated when the cost of opening a vacancy is around 20% of the total output, or $c = 0.2$.

Finally, the form of the educational cost function characterizes the attitudes toward higher education—that is, those which can be shaped by the social but also economic environments. We set the parameters in the cost function in order to generate an initial $q = 0.76$ (in the CSM pre-globalization equilibrium). Note that depending on the grade of the polynomial the steepness of the cost function varies as plotted in Figure 7. The steeper the cost function, or the bigger a, the more polarized the attitudes of the workers—this means bigger differences between the ones willing to go on with tertiary education and the ones who do not mind staying low skilled.[20] The parameter λ, in turn, is used to scale the function so the skill distribution is the same under different costs in the baseline case. For our calibration, and given the degree of the polynomial in the cost function, the scaling parameter that generates the endogenous value of $q = 0.76$ in the baseline equilibrium can be obtained as

$$\lambda = (1 - 0.76)^{2-a}. \tag{34}$$

[19] To calibrate the parameters we use data on the average job tenure and the unemployment rate from OECD.Stat, and data on the average net replacement rate from the European Commission.

[20] If we allowed for $a \to \infty$, the educational attitudes of the working population would be completely polarized, the cost function would be vertical, and the model would collapse into Albrecht and Vroman (2002).

The values of the exogenous parameters are summarized in Table 2.

[insert Figure 7 around here]
[insert Table 2 around here]

5 Results

Globalization unleashes increased competition worldwide while making for serious productivity imbalances as resources are poured into certain sectors at the expense of other alternative uses. This creates an increasing productivity gap in terms of the skills involved, or skill-biased technical change (see Berman et al., 1994, for instance). By assuming the SBTC hypothesis we are accepting that high-skill workers are better suited to the new technological aspects offered by globalization. In this regard, our analysis will consider an increase in the productivity level of high-skill workers as the globalization-driven SBTC effect.[21]

5.1 Determination of the skill distribution of workers

In section 3 we have derived the reaction of the skill distribution to the wage gap from equation (8), now we present the decision about the skill choice graphically. The family of slightly slanted horizontal lines in Figure 8 shows the effects of an increasing productivity gap on the wage differential (vertical axis) for different skill compositions of the labor force (horizontal axis).[22]

We compare these steady-state equilibria to the cost of skill acquisition function (the steep continuous line), with anything to the left being low skilled and anything to the right high skilled.[23] A higher payoff—or a higher wage gap in our context—will induce more workers to acquire education (see Burdett and Smith, 2002). If both equilibria coexist the expectations about the matching prospects can influence the number of workers that decide to further their education. It is understood that poor matching prospects for potential high-skill workers under the CSM equilibrium reduce the rate of return on skill acquisition.[24] Intuitively, as the productivity gap expands, it will make more sense for firms and workers alike to go after the highly coveted high-skill high-pay jobs, triggering an equilibrium switch from CSM to EPS.

[21] Our contribution does not distinguish between globalization and internationalization business practices such as offshoring or outsourcing.

[22] Notice that from (22)-(24) we have that higher productivity leads to higher wages.

[23] The cost function pictured in Figure 8 is a fourth degree polynomial because that is the one we will be using later on as a best fit for Germany in the post-globalization equilibrium.

[24] Note that the CSM curves in Figure 8 are low and the EPS curves are high, as the latter offers better matching prospects for those getting better skills. Also, the CSM equilibrium only exists for a narrow interval of productivity gaps and skill compositions, and both equilibria can coexist for some values of the parameters.

[insert Figure 8 around here]

5.2 The effects of globalization and the role of educational attitudes

This section offers the main results of our paper, namely, that an economy more willing to educate itself will gain in terms of welfare in a post-globalization context, in spite of a higher wage differential. In the model's terms, globalization is understood as the widening of the productivity gap between high and low-skill workers. In particular, we allow for an increase of high-skill workers' productivity levels as a result of skill-biased technical change.

In what follows we discuss the consequences of globalization under different attitudes on labor market outcomes for both equilibria, CSM and EPS. Notice that the pre-globalization results (in the CSM baseline equilibrium) are common for economies with different educational attitudes. Our analysis is outlined in Figures 9, 10 and 11.

[insert Figure 9 around here]

The top-left section of Figure 9 shows that a more polarized distribution of attitudes toward higher education, higher a, makes for a lower effect of globalization on q, i.e. facing the same wage gap, fewer workers decide to adjust and bear the cost of higher education. The skill decision adjustment to globalization will trigger changes to other variables. The balance between increased productivity of high-skill workers and wages (i.e. profits), will determine how many vacancies of each type will be opened.[25] According to (22)-(24), wages depend on the productivity and the number of corresponding vacancies, and vacancies react to the skill choice (see Table A.1. in the Appendix for each particular case).[26] If there are many low-skill workers, firms will open many low-skill vacancies and vice versa. When the fraction of high-skill workers increases, their chances of matching improve and the skill mismatch eventually disappears.[27]

When assessing the effect of educational attitudes we must think jointly about vacancies and wages. We observe that the smaller the reaction of the skill share to globalization (high a), the higher the resulting share of low-skill workers as well as low-skill vacancies, and hence the better the matching prospects of low-skill workers. This will have a positive effect on their wages, as depicted in the middle-left section of Figure 9. The opposite holds for high-skill workers. When the reaction of q is small, i.e. when a is high, their wages are

[25] Profits depend on the worker's productivity minus wages and vacancy costs, see section 3.

[26] Table A.1 displays the values of all the variables used to create Figures 9, 10 and 11.

[27] We can observe in the top-right section of Figure 9 that in the CSM equilibrium there are generally fewer low-skill workers than low-skill vacancies, $q < \phi$. It is thus easier for low-skill workers to find a match. In the EPS equilibrium, on the other hand, the situation is reversed, $1 - q < 1 - \phi$.

lower because of worse matching conditions. This leads to a lower wage gap for higher a (higher polarization), as seen at the bottom-left section of Figure 9. Notice that even if all high-skill wages grow faster than productivity in percentage terms, some combinations of total increases in productivity and wages result in higher profits for the firms (see Figure 9, middle-right section for the wages and bottom-right section for the profits).[28] For a given change in the productivity gap, high skill wages change less for a higher a. The prospect of having to pay lower wages and obtain higher profits makes firms more prone to open high-skill vacancies. This is why the number of high skill vacancies is much higher than that of high-skill workers, $1-\phi > 1-q$, for higher a (see the top-right section of Figure 9).

Concerning the unemployment rate, it may increase significantly for low-skill workers, and it does so very quickly for more flexible adjustments (see left section of Figure 10). This is caused by the already mentioned reaction of vacancies to the skill adjustment. Low-skill vacancies disappear much faster when the fraction of high-skill workers increases more quickly, i.e. for lower a. On the other hand, the difficult conditions suffered by low-skill workers are somewhat hidden in the global unemployment picture (see the right section of Figure 10). This is due to the fact that the unemployment rate of high-skill workers is reduced by a considerable margin once many workers change their skill status and more high-skill vacancies are opened (see Table A.1 of the Appendix for more details).

We finally turn to the welfare effects. Wages and the resulting skill distribution play an important role in the determination of total welfare, as seen in equations (28), (29) and (31). Total welfare is higher when more workers adjust to globalization (lower a) because a higher fraction of the population commands higher wages. The welfare results are shown in Figure 11. Notice that higher wages of a higher number of high-skill workers compensate for lower wages of a smaller number of low-skill workers. On the other hand, more polarized attitudes toward higher education result in better relative wages (e.g. smaller gap), but they are more costly in terms of welfare, as lower wages of fewer high-skill workers are not compensated by higher wages of more low-skill individuals. When distinguishing between low and high-skill welfare we can see that high-skill workers gain considerably by globalization, with larger gains when the adjustment of skills is more flexible (right section of Figure 11). This is consistent with the fact that high-skill workers are better endowed to deal with the technological changes implied by globalization (e.g. SBTC).

[insert Figure 10 around here]
[insert Figure 11 around here]

Overall, for this particular calibration we see that globalization is welfare-improving for the economy as a whole, yet low-skill workers are generally worse off. This is consistent with the idea that economies tend to adjust to the globalization process in the end, and what

[28] Note the change in the y-axis in the middle-right section of Figure 9.

is more, that societies with a more flexible predisposition to education can achieve better welfare results. In what follows we analyze those aspects in more detail.

5.3 Counterfactual: the effect of changes in educational attitudes

We propose the first counterfactual exercise that aims to illustrate the effect of different educational attitudes on labor market outcomes (relative wages, unemployment rate, and welfare). In particular, by plugging the parameters of other selected economies in the calibration for Germany, we can observe what these outcomes would have been under different circumstances.

In this exercise we compare the equilibrium with skill distribution at the beginning of our time period in Germany (when $q = 0.76$), and the equilibrium where, as a result of globalization, the skill distribution is the one at the end of the studied period (when $q = 0.71$), as seen in Table 1. In order to determine the productivity gap that initiates the transition into this post-globalization steady state, we target the change in the wage gap observed in the data. We use three interdecile ratios of gross earnings as a proxy for relative wages, P50/P10, P90/P10, and P90/P50 (OECD.Stat). These ratios increased on average 8% between 1998 and 2013. Using this information as a reference, we look for the cost function that delivers the following after-globalization result: an increase in the relative wage with respect to the baseline case of about 8%, with a 71% share of low-skill workers in the labor force.[29] We find that this holds true when the cost of skill acquisition in Germany is a fourth degree polynomial, thus $a = 4$. The corresponding productivity gap is 14%, i.e. $y_H = 1.14$, $y_L = 1$ (in EPS equilibrium).[30] The post-globalization results for Germany are reported in Table 3 as case 0.

Several countries in Table 1 above exhibit a very similar share of low-skill workers to that of Germany in 1998 (the initial year of our analysis), but then their 2013 values (the final year of our analysis) are suggestive of very different patterns. These countries are the Netherlands, France, Norway, Switzerland, and Ireland. Let us focus on France and Ireland for instance—the former being a relatively equal-sized country in terms of population and GDP per capita, the latter being the country where skill upgrading took off more than in any other country of the sample with the exception of Luxembourg. We learn from Table 1 that the share of below-tertiary education in 2013 was 64% in France and 55% in Ireland (compared to 71% in Germany).

We examine the labor market outcomes for the German economy subject to globalization (14% productivity gap), while employing different cost functions that result in the above

[29] The relative wage is $\frac{w_H}{w_L} = 1.073$ in the baseline case; see Table A.1 for the individual wages. We increase the productivity gap to obtain the post-globalization relative wage of $\frac{w_H}{w_L} = 1.159$.

[30] In our baseline case we start in the CSM equilibrium. Opening the productivity gap (globalization) induces a switch toward the EPS equilibrium and, for that reason, all the results that follow refer to this particular equilibrium.

mentioned skill distributions. We learn from Table 3 that if the German economy had shown the educational attitudes which are intrinsically consistent with a larger share of high-skill workers (lower q), say the ones observed in France ($q = 0.64$), then relative wages would have been 0.5% higher and welfare would have been 1% higher (case 1, Table 3, compared to case 0). Moreover, if during those 15 years the German economy had reduced the share of low-skill workers to the Irish value ($q = 0.55$), relative wages and welfare would have been 1.2% and 2.5% higher, respectively (see case 2, Table 3, compared to case 0).

Certainly, had the degree of polarization of educational attitudes been lower (a lower a in Table 3, cases 1 and 2), then the overall welfare would have been higher. This however would have implied harsher conditions for low-skill workers, namely: their unemployment rate would have been higher and their welfare reduced, and not only in relative terms. This seems to be consistent with the usual economic intuition that more flexible and open economies will experience a certain degree of wage inequality which is more than compensated by a greater overall welfare (see Helpman et al., 2010).

As a final methodological note let us analyze how our results compare to those in Albrecht and Vroman (2002), where the share of low-skill workers is exogenously given and the education costs are not made explicit. They are reported as case A&V in Table 3 (first row). Notice that they are an extreme case of our cost function—extreme in that there is a perfect dichotomy between improving one's skills or not, instead of a continuum of workers with different education-related opportunity costs. Our results indicate that, when allowing for a more generic interpretation, the effects of globalization tend to expand the low-to-high-skill welfare differences (cases 0 to 2 in Table 3). However, it must also be noted that the adjustment in skills, or the drop in q (with respect to A&V), implies additional education costs, which are more than compensated by higher welfare for the high skilled but also higher overall welfare.

[insert Table 3 around here]

5.4 Counterfactual: the effect of changes in labor market conditions

Our second counterfactual is policy-oriented. Here we propose an experiment that accounts for the effects of different labor market conditions on overall welfare. In particular, we change the parameter descriptive of the vacancy costs as it partly reflects the degree of market flexibility in our model in terms of hiring and firing.

According to the literature, labor market flexibility can improve welfare results (see, for example Jung and Mercenier, 2014, or Agnese and Hromcová, 2016). Our policy experiment shows how to offset the effect of a higher polarization in Germany by reducing the vacancy cost and thus making it easier on employers to hire new employees. The results of this

exercise are shown in Table 3 as cases 3 and 4, where we aim at the total welfare level of cases 1 and 2, respectively, while keeping the polarized view on educational attitudes ($a = 4$).

To obtain the same level of welfare as in cases 1 and 2, the vacancy cost should be reduced from the baseline $c = 0.2$ to $c = 0.192$ and $c = 0.181$, respectively (that is 3% and 9%). Notice that, not only can such changes bring the welfare levels to the one of a less polarized economy (cases 1 and 2), but they can also reduce the existing wage inequality. Lowering the cost of the vacancy means that it becomes relatively less expensive for firms to open one—this promotes hiring, as seen by lower unemployment rates across the board, and drives up wages for both types of workers. This mechanism proves to be an effective way to make low-skill workers relatively better-off when faced with the globalization phenomenon.

6 Final remarks

We have used a matching model to analyze the effects of different attitudes toward higher education on labor market outcomes. Within our framework, and as expected, we observe that globalization raises wage inequality. In addition to this, we see that a more polarized population concerning the willingness to study will not experiment such a big change in relative wages as compared to the one which is less polarized. On the other hand, where the views on higher education are not dissimilar, the adjustment to globalization is much more flexible.

Therefore, as the fraction of tertiary-educated population increases faster the economy performs efficiently with many high productive workers. This results in higher welfare, even if the inequality in wages is larger. We show that allowing for certain labor flexibility by reducing the vacancy cost, remains an effective policy to encourage hiring and improve the economy's welfare. It can offset the negative effect of polarization in the attitudes toward higher education on total welfare, and also enhance the relative welfare of low-skill workers.

Policy makers ought to keep in mind all these facts when designing the educational policies that will shape the labor force in the next few years. In particular, by acknowledging that a positive attitude toward higher education can effectively pave the way for a rapid transition to a better welfare outcome in the light of the new challenges emerging from the globalization phenomenon.

References

[1] Agnese, Pablo and Hromcová, Jana, 2016. Low-skill Offshoring and Welfare Compensation Policies, *Economic Modelling* 52, 408–426.

[2] Amiti, Mary and Wei, Shang-Jin, 2005. Fear of service outsourcing: Is it justified?, *Economic Policy* 20, 308–347.

[3] Albrecht, James and Vroman, Susan, 2002. A Matching Model with Endogenous Skill Requirements, *International Economic Review* 43, 283–305.

[4] Berman, Eli, Bound, John, and Griliches, Zvi, 1994. Changes in the Demand for Skilled Labor within U.S. Manufacturing: Evidence from the Annual Survey of Manufacturers, *The Quarterly Journal of Economics* 109, 367–397.

[5] Berman, Eli, Bound, John, and Machin, Stephen, 1998. Implications of Skill-Biased Technological Change: International Evidence, *The Quarterly Journal of Economics* 113, 1245–1279.

[6] Burdett, Ken, and Smith, Eric, 2002. The Low Skill Trap, *European Economic Review* 46, 1439–1451.

[7] Davidson, Carl, Matusz, J. Steven, and Shevchenko, Andrei, 2008. Outsourcing Peter to pay Paul: High-skill Expectations and Low-skill Wages with Imperfect Labor Markets, *Macroeconomic Dynamics* 12, 463–479.

[8] Edwards, Sebastian, 1998. Openness, Productivity and Growth: What Do We Really Know?, *The Economic Journal* 108, 383–398.

[9] Epifani, Paolo, and Gancia, Gino, 2008. The Skill Bias of World Trade, *The Economic Journal* 118, 927–960.

[10] Eurobarometer 112, 1997. Europeans and their Attitude to Education and Training, European Commission, Public Opinion.

[11] Eurobarometer 369, 2011. Attitudes towards Vocational Education and Training, European Commission, Public Opinion.

[12] Feenstra, Robert C. and Hanson, Gordon H., 1996. Globalization, Outsourcing, and Wage Inequality, *American Economic Review* 86, 240–245.

[13] Feenstra, Robert C. and Hanson, Gordon H., 1997. Foreign Direct Investment and Wage Inequality: Evidence from Mexico's Maquiladoras, *Journal of International Economics* 42, 371–393.

[14] Feenstra, Robert C. and Hanson, Gordon H., 1999. The Impact of Outsourcing and High-Technology Capital on Wages: Estimates for the US, *Quarterly Journal of Economics* 114, 907–940.

[15] Forbes, Kristin, 2010. Skill Classification Does Matter: Estimating the Relationship Between Trade Flows and Wage Inequality, *The Journal of International Trade and Economic Development* 10, 175–209.

[16] Furnham, Adrian and McManus, Ian C., 2004, Student Attitudes to University Education, *Higher Education Review* 36, 29-38.

[17] Helpman, Elhanan, Itskhoki, Oleg, and Redding, Stephen, 2010. Inequality and Unemployment in a Global Economy, *Econometrica* 78, 1239–1283.

[18] Immerwahr, John, 2004. Public Attitudes on Higher Education A Trend Analysis, 1993 to 2003, *Public Agenda*, The National Center for Public Policy and Higher Education.

[19] Jung, Jaewon, and Mercenier, Jean, 2014. On modeling task, skill and technology upgrading effects of globalization with heterogeneous labor, *Economic Modelling* 39, 49–62.

[20] Lucas, Robert E., Jr., 1988. On the Mechanics of Economic Development, *Journal of Monetary Economics* 22, 3–42.

[21] Malmström, Malin and Öqvist, Anna, 2016. Students' Attitudes and Intentions Toward Higher Education as Determinants for Grade Performance, *International Journal of School and Educational Psychology*, http://dx.doi.org/10.1080/21683603.2016.1254132

[22] Moore, Mark P. and Ranjan, Priya, 2005. Globalisation vs Skill-Biased Technological Change: Implications for Unemployment and Wage Inequality, *The Economic Journal* 115, 391–422.

[23] Mortensen, Dale T. and Pissarides Christopher A., 1999. Unemployment Responses to 'Skill-Biased' Technology Shocks: The Role of Labour Market Policy, *The Economic Journal* 109, 242–265

[24] OECD Employment Outlook 2011

[25] OECD.Stat

[26] Okazawa, Ryosuke, 2013. Skill-biased Technical Change, Educational Choice, and Labor Market Polarization: the U.S. versus Europe, *Journal of Economic Inequality* 11, 321–342.

[27] Oladi, Reza, Gilbert, John, and Beladi, Hamid, 2011. Foreign Direct Investment, Non-Traded Goods and Real Wages, *Pacific Economic Review* 16, 36–41.

[28] PISA, 2013.

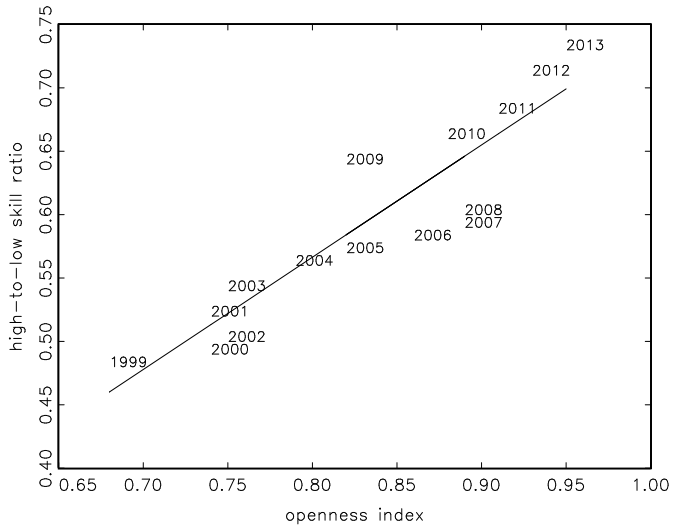
[29] PISA, 2015.

[30] Rogerson, Richard, Shimer, Robert and Wright, Randall, 2005. Search-Theoretic Models of the Labor Market: A Survey, *Journal of Economic Literature* 43, 959–988.

[31] Traca, Daniel, 2011. Trade Liberalization, Labour Mobility and Wages, *The Journal of International Trade & Economic Development* 13, 111–136.

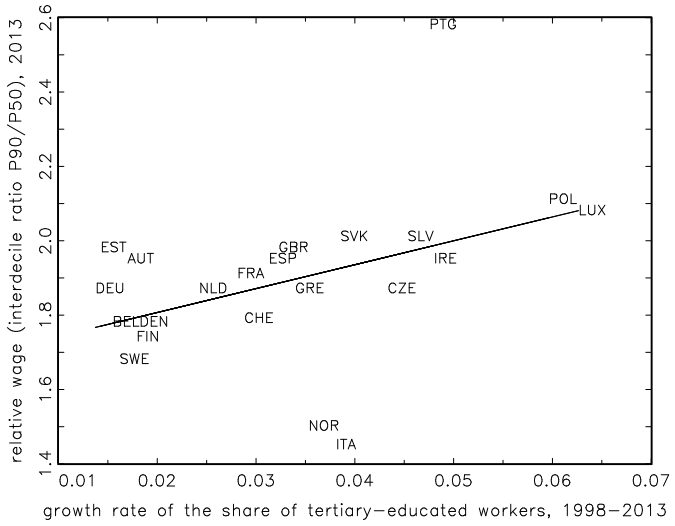
[32] Williamson, Stephen D., 2010. Notes on Search. Washington University in St. Louis, 1–38.

Figure 1: Globalization and the high-to-low skill ratio, EU22 (weighted average)



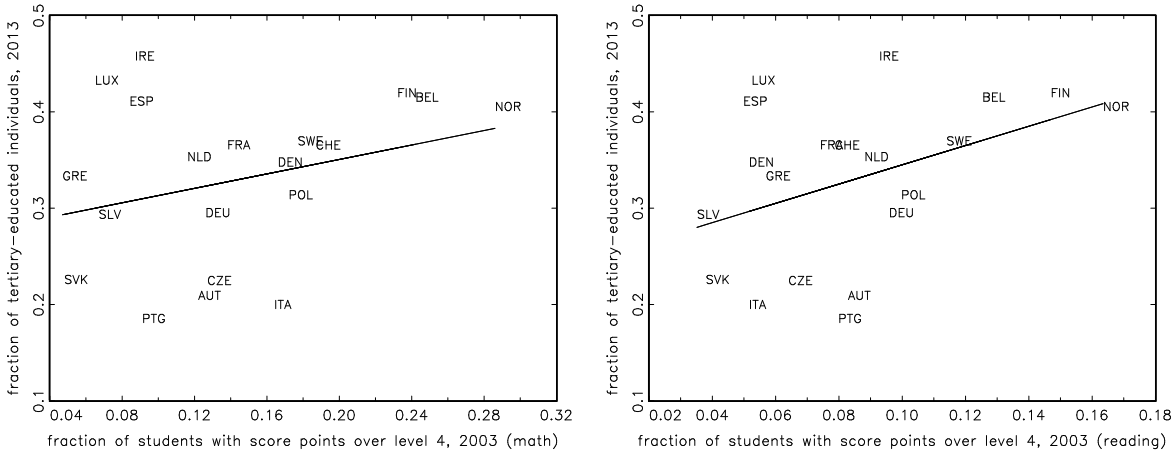
Source: openness index, own calculations, OECD Economic Outlook Database (2017); skill ratio, own calculations, OECD World Indicators of Skills for Employment Dataset (2017). Notes: openness is defined as imports plus exports in real GDP (volume, market prices); low skilled is upper secondary (ISCED 3) and high skilled is tertiary first stage (ISCED 5).

Figure 2: Changes in higher education attainment vs. relative wage



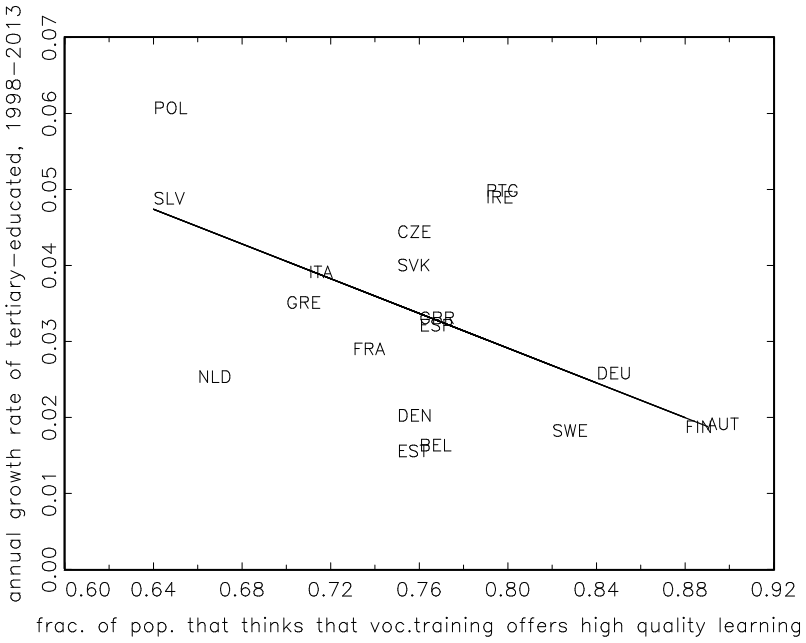
Source: Tertiary-educated are tertiary first stage (ISCED 5), OECD World Indicators of Skills for Employment Dataset (2017); relative wage is relative earnings (interdecile ratio P90/P50), OECD.stat

Figure 3: Excellence in performance in mathematics and reading vs. higher education attainment



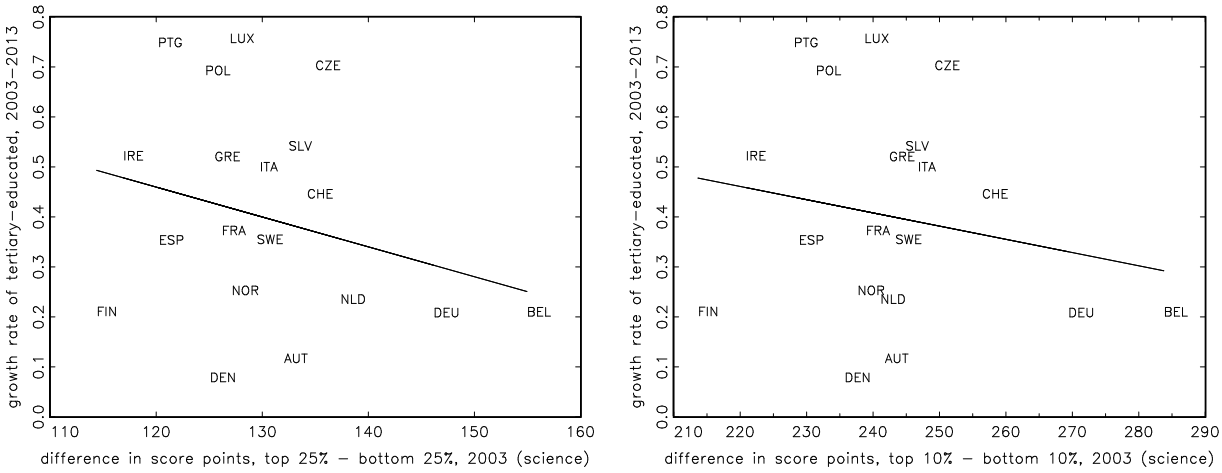
Note: PISA data is not available for Estonia and UK. Level 4 is considered excellent performance. Source: Tertiary-educated are tertiary first stage (ISCED 5), OECD World Indicators of Skills for Employment Dataset (2017); student performance is from PISA (2003).

Figure 4: Perceptions of vocational education training vs. changes in higher education attainment



Note: Data on vocational training is not available for Norway and Switzerland. Skill data for Austria, Germany and Luxembourg for 1999-2013. Source: Tertiary-educated are tertiary first stage (ISCED 5), OECD World Indicators of Skills for Employment Dataset (2017); opinions of Europeans about vocational education training, Eurobarometer (2011).

Figure 5: Inequality in PISA score points vs. changes in higher education attainment



Note: Differences in score are not available for Estonia, Slovakia and the UK. Source: Differences in score points are from PISA (2015), tertiary-educated are tertiary first stage (ISCED 5), OECD World Indicators of Skills for Employment Dataset (2017).

Figure 6: Possible matches, equilibria, and payoffs

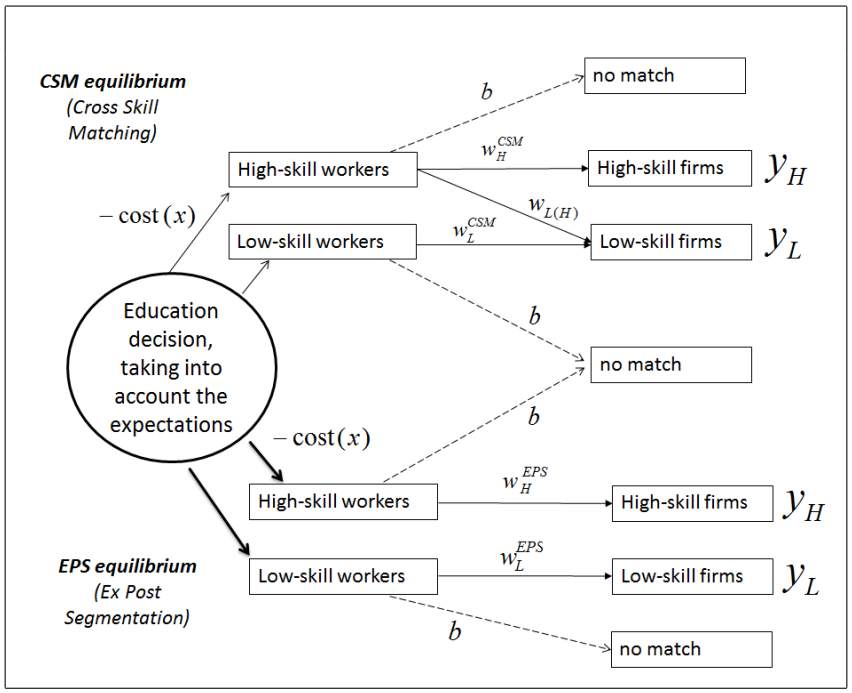
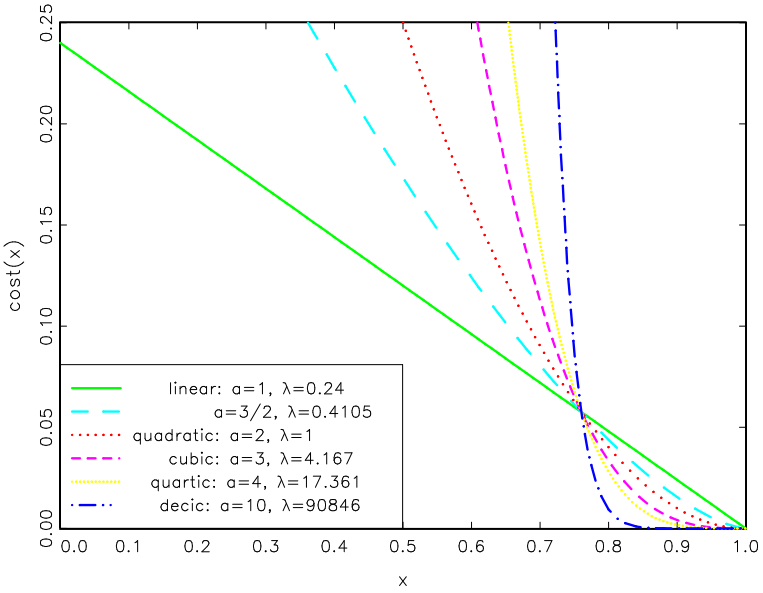
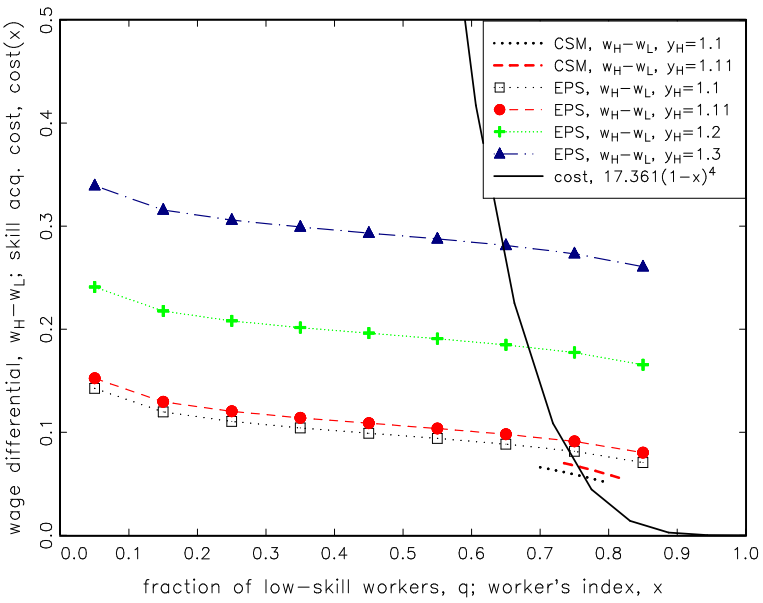


Figure 7: Shape of the cost function for different parameter values



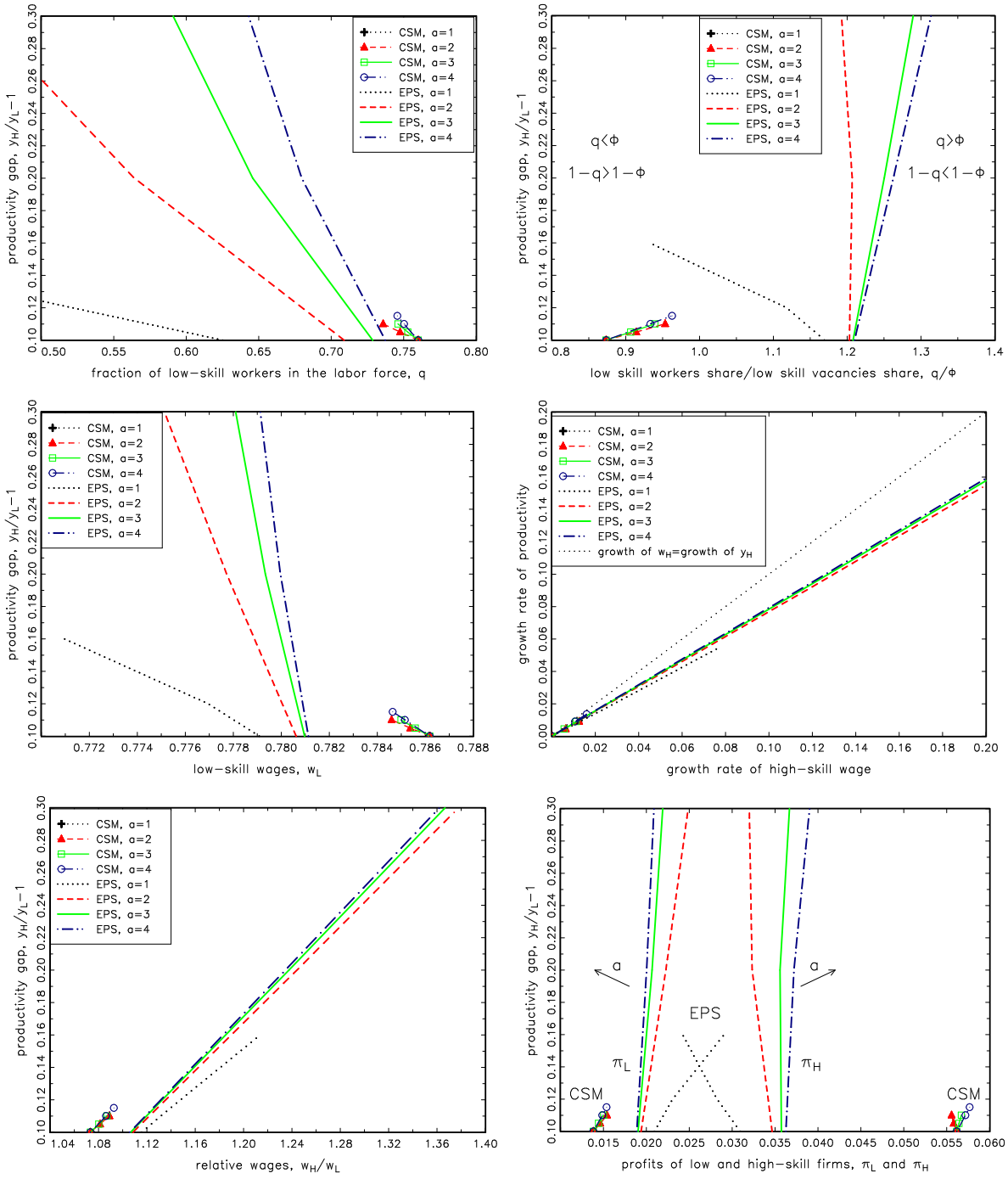
Note: Parameter a is the grade of the polynomial in the cost function, λ is the scaling parameter to obtain endogenously $q = 0.76$ in the baseline case for different shapes of the cost function.

Figure 8: Wage differential and skill composition under CSM and EPS



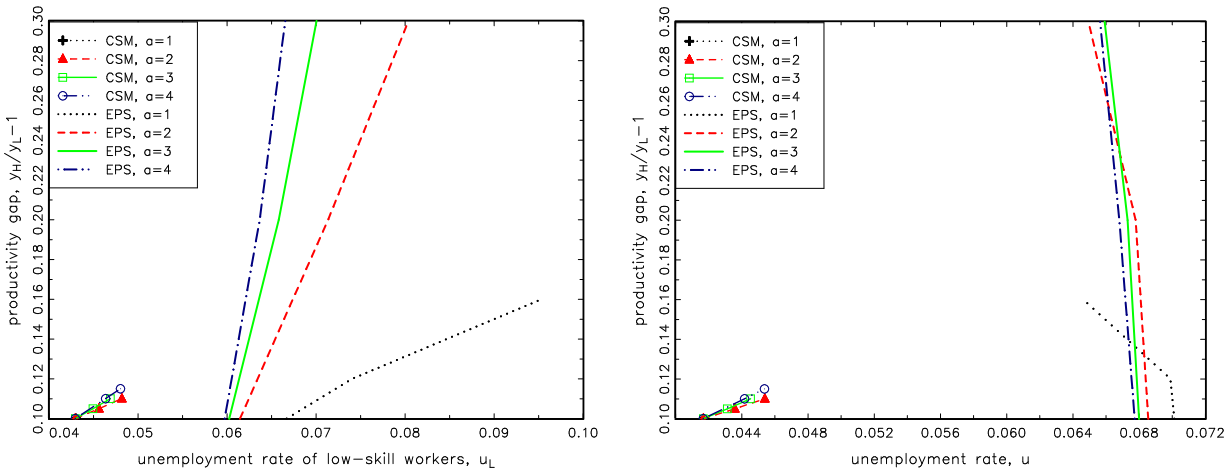
Note: Relationship between the productivity gap ($y_L = 1$, y_H: in the legend) and the wage differential for different skill combinations (q) and under different equilibria, CSM and EPS, contrasted with the 4th polynomial cost of acquiring skills.

Figure 9: Outcomes under different educational attitudes: skills, vacancies, wages and profits



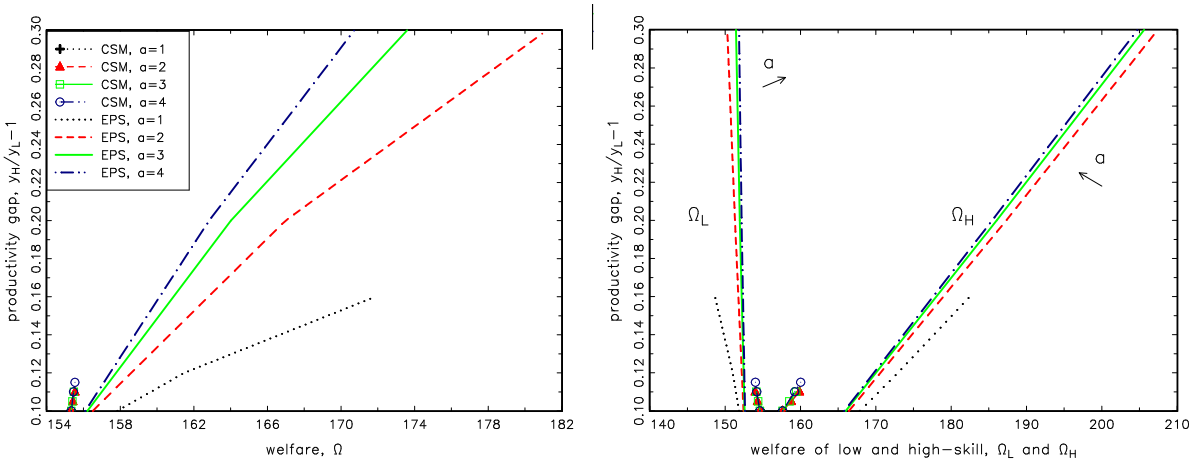
Note: Relationship between the productivity gap (globalization) and various variables of interest for different educational attitudes under CSM and EPS equilibria.

Figure 10: Outcomes under different educational attitudes: unemployment



Note: Relationship between the productivity gap (globalization) and various variables of interest for different educational attitudes under CSM and EPS equilibria.

Figure 11: Outcomes under different educational attitudes: welfare



Note: Relationship between the productivity gap (globalization) and various variables of interest for different educational attitudes under CSM and EPS equilibria.

Table 1: Share of low-skill workers in the analyzed sample of EU countries

Country	1998	2013	annualized % change between 1998 and 2013
Belgium	0.673	0.589	-0.009
Estonia	0.674	0.596	-0.008
Finland	0.682	0.585	-0.010
Sweden	0.713	0.634	-0.008
Denmark	0.738	0.656	-0.008
United Kingdom*	0.740	0.594	-0.016
Spain	0.744	0.593	-0.015
Netherlands	0.756	0.651	-0.010
Germany*	0.760	0.709	-0.005
France	0.762	0.639	-0.012
Norway	0.762	0.599	-0.016
Switzerland	0.764	0.639	-0.012
Ireland*	0.765	0.546	-0.024
average	0.785	0.666	-0.011
Greece	0.801	0.671	-0.012
Luxembourg*	0.817	0.571	-0.025
Austria*	0.838	0.795	-0.004
Slovenia	0.851	0.711	-0.012
Poland	0.870	0.690	-0.015
Slovak Republic	0.874	0.778	-0.008
Czech Republic	0.883	0.779	-0.008
Italy	0.888	0.804	-0.007
Portugal	0.910	0.819	-0.007

Note: * value in 1999 instead of 1998. Source: Low-skill workers are the ones below tertiary level (ISCED 5), OECD World Indicators of Skills for Employment Dataset (2017).

Table 2: Summary of the baseline parameter values

y_H	y_L	b	β	c	δ	r	b	r
1.1	1	0.48	0.5	0.2	0.095	0.005	0.48	0.005

Table 3: Behavior of the model for various changes of key parameters (counterfactuals for educational attitudes and vacancy costs), EPS equilibrium

case	y_H	a	c	q	ϕ	u	u_L	u_H	w_L	w_H	$\frac{w_H}{w_L}$	Y	Ω	Ω_H	Ω_L
A&V	1.14	+inf	0.2	0.76	0.613	0.066	0.058	0.090	0.782	0.901	1.152	0.965	157.520	172.520	152.772
0	1.14	4	0.2	0.710	0.577	0.067	0.062	0.082	0.781	0.904	1.159	0.970	158.609	173.750	152.420
1	1.14	1.95	0.2	0.639	0.530	0.069	0.066	0.074	0.779	0.907	1.164	0.978	160.262	175.051	151.911
2	1.14	1.31	0.2	0.546	0.474	0.069	0.072	0.066	0.777	0.910	1.171	0.990	162.619	176.355	151.185
3	1.14	4	0.192	0.710	0.577	0.065	0.060	0.080	0.789	0.912	1.156	0.972	160.263	175.470	154.044
4	1.14	4	0.181	0.710	0.578	0.063	0.057	0.076	0.800	0.924	1.155	0.975	162.618	177.921	156.353

Note: A&V is a case with $a \to \infty$ that corresponds to Albrecht and Vroman (2002); case 0 is our baseline calibration for Germany (targeting $q = 0.71$, with $a = 4$); case 1 is targeting $q = 0.639$ (as in France in 2013) with $a = 1.95$; case 2 is targeting $q = 0.546$ (as in Ireland in 2013) with $a = 1.31$; case 3 is targeting $\Omega = 160.26$ (as in case 1) by modifying the flexibility/vacancy cost ($c = 0.192$); case 4 is targeting $\Omega = 162.62$ (as in case 2) by modifying the flexibility/vacancy cost ($c = 0.181$). Variable y_H is the productivity of high-skill workers, a is the degree of the polynomial in the cost function, q is the share of low-skill workers, ϕ is the share of low-skill vacancies, u is total unemployment rate, u_i, $i = L, H$ is the unemployment rate of low an high-skill workers, respectively, w_i, $i = L, H$ are the wages of low an high-skill workers, respectively, Y is total output, Ω is total welfare, Ω_i, $i = L, H$ is the welfare of low an high-skill workers, respectively.

Appendix.

Solving for Equilibrium

Rewriting (9) and (10), using (3) and (4), we obtain the following for the unemployment rate

$$u = \begin{cases} \frac{\delta(1-q)}{m(\theta)(1-\gamma)+\delta(1-\gamma)} \text{ in CSM equilibrium, and} \\ \\ \frac{\delta(\gamma+q-2\gamma q)}{\gamma(1-\gamma)[m(\theta)+2\delta]} \qquad \text{in EPS equilibrium} \end{cases} \tag{35}$$

and for the share of low-skill vacancies

$$\phi = \begin{cases} \frac{(1-\gamma)qm(\theta)+\delta(q-\gamma)}{m(\theta)\gamma(1-q)} \text{ in CSM equilibrium, and} \\ \\ \frac{(1-\gamma)qm(\theta)+\delta(q-\gamma)}{m(\theta)(\gamma+q-2\gamma q)} \qquad \text{in EPS equilibrium.} \end{cases} \tag{36}$$

Using the Bellman equations for the expected utility of a vacant firm, (19) and (20), and the free entry condition (21), we can write

$$\text{when } V_L = 0,\ c = z(\theta)\left[\gamma J_L + (1-\gamma)J_{L(H)}\right], \tag{37}$$

$$\text{when } V_H = 0,\ c = z(\theta)(1-\gamma)J_H \tag{38}$$

for the CSM equilibrium, and

$$\text{when } V_L = 0,\ c = z(\theta)\gamma J_L, \tag{39}$$

$$\text{when } V_H = 0,\ c = z(\theta)(1-\gamma)J_H \tag{40}$$

for the EPS equilibrium. Combining all the corresponding equilibrium equations we obtain the combinations of γ and θ, or $\gamma = f_{V_L=0}(\theta)$, for which (37) or (39) hold, and the combinations of γ and θ, or $\gamma = f_{V_H=0}(\theta)$, for which (38) or (40) hold too. In general, for $\gamma \in (0,1)$, $\gamma = f_{V_L=0}(\theta)$ is increasing and $\gamma = f_{V_H=0}(\theta)$ is decreasing. The intersection of the two loci determines the share of low-skill unemployed γ and the market tightness θ.

Free entry conditions (37) and (38), and (39) and (40) can be rewritten using(14)-(16) and (11)-(13) as

$$\text{when } V_L = 0,\ c = z(\theta)\left\{\gamma\frac{(1-\beta)(y_L - c - rU_L)}{r+\delta} + (1-\gamma)\frac{(1-\beta)(y_L - c - rU_H)}{r+\delta}\right\}, \tag{41}$$

$$\text{when } V_H = 0,\ c = z(\theta)(1-\gamma)\frac{(1-\beta)(y_H - c - rU_H)}{r+\delta} \tag{42}$$

for CSM equilibrium, and as

$$\text{when } V_L = 0,\ c = z(\theta)\gamma\frac{(1-\beta)\,(y_L - c - rU_L)}{r+\delta}, \tag{43}$$

$$\text{when } V_H = 0,\ c = z(\theta)(1-\gamma)\frac{(1-\beta)\,(y_H - c - rU_H)}{r+\delta} \tag{44}$$

for EPS equilibrium, where

$$rU_L = \frac{b\,(r+\delta) + \beta\phi m(\theta)\,(y_L - c)}{r+\delta+\beta\phi m(\theta)},$$

$$rU_H = \left\{ \begin{array}{ll} \frac{b(r+\delta)+\beta m(\theta)[\phi(y_L-c)+(1-\phi)(y_H-c)]}{r+\delta+\beta m(\theta)} & \text{for CSM equilibrium, and} \\ \\ \frac{b(r+\delta)+\beta(1-\phi)m(\theta)(y_H-c)}{r+\delta+(1-\phi)\beta m(\theta)} & \text{for EPS equilibrium.} \end{array} \right\}$$

These last expressions can be obtained by rewriting (17) and (18) using (14)-(16), (11)-(13) and (22)-(24). Recall that the expression for ϕ is given by (36) and the one for $m(\theta)$ by (33). We can see that we have the system of two equations, (41) and (42) for CSM, and (43) and (44) for EPS, with two unknowns, which is nonlinear, and can deliver multiple solutions for general parameter values. However, given that parameters γ and ϕ are restricted, $0 < \gamma < 1$, $0 < \phi < 1$, multiple solutions are not found in our exercise.

The expected aggregate output is [31]

$$Y = \left\{ \begin{array}{ll} E_L y_L + \phi E_H y_L + (1-\phi)\,E_H y_H & \text{in CSM equilibrium, and} \\ E_L y_L + E_H y_H & \text{in EPS equilibrium.} \end{array} \right.$$

[31] Each worker employed in a low-skill firm produces y_L and each worker employed in a high-skill firm produces y_H. As we do not know how many high-skill workers actually end up in a low-skill job, we consider that the number is proportional to the number of low-skill vacancies.

Equilibrium results obtained for the CSM and EPS equilibria

Table A.1. Summary of the results for the CSM and EPS equilibria

CSM

y_H	a	q	ϕ	u	u_L	u_H	w_L	$w_{L(H)}$	w_H	π_L	$\pi_{L(H)}$	π_H	Y	Ω	Ω_H	Ω_L
1.1	1	0.760	0.870	0.042	0.043	0.038	0.786	0.794	0.844	0.014	0.006	0.056	0.961	155.325	157.610	154.603
1.1	2	0.760	0.870	0.042	0.043	0.038	0.786	0.794	0.844	0.014	0.006	0.056	0.961	155.329	157.618	154.607
1.105	2	0.747	0.818	0.044	0.046	0.038	0.785	0.797	0.849	0.015	0.003	0.056	0.961	155.419	158.758	154.291
1.11	2	0.736	0.772	0.045	0.048	0.038	0.785	0.799	0.854	0.015	0.001	0.056	0.961	155.535	159.857	153.984
1.1	3	0.760	0.870	0.042	0.043	0.038	0.786	0.794	0.844	0.014	0.006	0.056	0.961	155.331	157.626	154.607
1.105	3	0.753	0.830	0.043	0.045	0.038	0.786	0.796	0.849	0.014	0.004	0.056	0.961	155.396	158.522	154.370
1.11	3	0.746	0.794	0.045	0.047	0.038	0.785	0.798	0.853	0.015	0.002	0.057	0.961	155.477	159.412	154.138
1.1	4	0.760	0.870	0.042	0.043	0.038	0.786	0.794	0.844	0.014	0.006	0.056	0.961	155.333	157.634	154.606
1.11	4	0.750	0.804	0.044	0.046	0.038	0.785	0.798	0.853	0.015	0.002	0.057	0.961	155.456	159.225	154.201
1.115	4	0.746	0.774	0.045	0.048	0.038	0.785	0.800	0.857	0.015	0.000	0.058	0.961	155.535	160.028	154.002

EPS

y_H	a	q	ϕ	u	u_L	u_H	w_L	w_H	π_L	π_H	Y	Ω	Ω_H	Ω_L
1.1	1	0.625	0.535	0.070	0.067	0.076	0.779	0.869	0.021	0.031	0.965	157.840	167.865	151.828
1.12	1	0.521	0.467	0.070	0.074	0.065	0.777	0.892	0.023	0.028	0.984	161.485	172.914	150.992
1.16	1	0.313	0.336	0.065	0.095	0.051	0.771	0.936	0.029	0.024	1.040	171.870	182.462	148.645
1.1	2	0.709	0.589	0.069	0.061	0.086	0.781	0.865	0.019	0.035	0.958	156.504	166.426	152.430
1.2	2	0.564	0.468	0.068	0.071	0.063	0.778	0.968	0.022	0.032	1.014	166.991	187.309	151.297
1.3	2	0.459	0.385	0.065	0.080	0.052	0.775	1.068	0.025	0.032	1.089	181.196	207.407	150.283
1.1	3	0.729	0.603	0.068	0.060	0.089	0.781	0.864	0.019	0.036	0.957	156.216	166.008	152.568
1.2	3	0.646	0.517	0.067	0.066	0.070	0.779	0.964	0.021	0.036	0.999	164.012	186.056	151.927
1.3	3	0.591	0.458	0.066	0.070	0.060	0.778	1.063	0.022	0.037	1.049	173.596	205.603	151.443
1.1	4	0.737	0.609	0.068	0.060	0.090	0.781	0.864	0.019	0.036	0.956	156.092	165.812	152.629
1.2	4	0.680	0.538	0.067	0.064	0.073	0.780	0.963	0.020	0.037	0.993	162.826	185.430	152.174
1.3	4	0.643	0.490	0.066	0.067	0.064	0.779	1.061	0.021	0.039	1.035	170.711	204.704	151.844

Note: Variable y_H is the productivity of high-skill workers, a is the degree of the polynomial in the cost function, q is the share of low-skill workers, ϕ is the share of low-skill vacancies, u is the total unemployment rate, u_i, $i = L, H$ is the unemployment rate of low an high-skill workers, respectively, w_i, $i = L, H$ are the wages of low an high-skill workers, respectively, $w_{L(H)}$ are the wages of mismatched workers, π_i, $i = L, H$ are profits of low and high-skill firms, respectively, $\pi_{L(H)}$ are the profits of low-skill firms employing high-skill workers, Y is the total output, Ω is the total welfare, Ω_i, $i = L, H$ is the welfare of low an high-skill workers, respectively. Low-skill worker's productivity is $y_L = 1$.