Unemployment benefits, job protection, and the nature of educational investment∗

Bruno Decreuse†and Pierre Granier‡

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Abstract: This paper examines the impact of labor market institutions covering the risk of unemployment on the nature of educational investment. We offer a matching model of unemployment in which individuals of a given education determine the scope (or adaptability) and intensity (or productivity) of their human capital before entering the labor market. Our model features an increasing relationship between match surplus and the return to adaptability skills. This relationship explains why matching frictions promote adaptability skills instead of productivity skills, and why unemployment benefits and job protection create the incentive for productivity skill acquisition.

Keywords: Matching frictions; Education; Adaptability skills; Labor market institutions

J.E.L. classification: I21; J24

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†Aix-Marseilles University, GREQAM, and IDEP. GREQAM - 2, rue de la charité, 13236 Marseille cedex 02, France. E-mail: bruno.decreuse@univmed.fr

‡Aix-Marseilles University, GREQAM, and IDEP. GREQAM - 2, rue de la charité, 13236 Marseille cedex 02, France. E-mail: pierre.granier@univmed.fr
1 Introduction

Labor market institutions (LMIs) and the magnitude of educational investment in specialized human capital have been put forward to explain the relatively low performance of a number of European labor markets since the end of the 1970s. On the one hand, the generosity of unemployment insurance and the strictness of employment protection legislation tend to favor the persistence of high unemployment rates while slowing down the job reallocation process necessary to sustain high productivity growth (see Nickell, 1997, Ljungqvist and Sargent, 1998, Mortensen and Pissarides, 1999). On the other hand, vocationally-oriented European schooling systems tend to alter workers’ between-sector mobility (see Krueger and Kumar, 2004). These two lines of argument are separately advanced. The purpose of this paper is to examine how unemployment benefits and job protection affect the extent of specialization of schooling choices.

Unfortunately, it is hard to measure how specialized educational programs or the workforce human capital are. One possibility is to exploit the divide between vocational and general education. Krueger and Kumar (2004) use cross-section data. They point to the fact that student enrolment in vocational programs is much higher in Continental Europe than in the US. Mukoyama and Sahin (2006) show that there is a positive correlation between the generosity of unemployment compensation and the percentage of students enrolled in vocational programmes. In the same vein, unemployment benefits and job protection are (weakly) positively correlated with the proportion of upper-secondary graduates with a vocational education. The 2000 correlation coefficient between the latter variable and the OECD unemployment benefit index or the OECD strictness of employment protection legislation are slightly below 30%.

A possible interpretation is that unemployment benefits and job protection are detrimental to general education. In turn, this may affect worker productivity and worker mobility across sectors during their entire working life.

The relationship between LMIs and the nature of human capital investment has already been examined in the context of on-the-job training. Wasmer (2006) focuses on the decision to invest in general versus specific human capital. Following Becker (1964), general human capital can be used everywhere in the economic system, whereas specific human capital can only be used within the firm. Wasmer shows that layoff taxes favor the acquisition of specific human capital.

The primary purpose of our paper is to complement Wasmer’s contribution but instead focusing on human capital investments before labor market entry, rather than once in the job. The abrupt distinction between general and specific human capital cannot be directly used in the study of educational investment. At the time of educational choice, individuals are not well informed as to the identity of the firms they will meet. Human capital cannot be purely specific in the traditional sense: workers would have no chance of using such a kind of human capital, and, consequently, the whole investment would be spent in general human capital. We need a formal approach where human capital transferability between

\[^1\text{The variables are detailed in the Appendix.}\]
jobs and sectors varies in a more continuous way.

Our paper builds on Charlot et al (2005). In this model, education jointly determines the scope and intensity of human capital. Such human capital is composed of two skills. Adaptability skills govern the fraction of jobs the worker can occupy, while productivity skills refers to worker’s ability once in these jobs. Adaptability skills define the degree of human capital transferability across jobs. When adaptability skills expand, human capital becomes more general as it can be used in more firms. Conversely, when adaptability skills decline, human capital becomes more specialized.

In Charlot et al, the divide between investment in adaptability and in productivity is fixed. In this paper, we endogenize the mix of adaptability and productivity skills. Students allocate a fixed amount of investment between the two types of skills. The scope of one’s human capital and its intensity evolve in opposite directions. Figure 1 explains how this works. The different jobs are ranked on the horizontal axis according to a worker’s perspective, from the most to the least preferred. The vertical axis indicates the worker’s ability in such jobs. Human capital has two components: adaptability skills determine the x value, whereas productivity skills set the y value. The trade-off here means that increasing the x value (and so making human capital more transferrable) is detrimental to the y value (the worker is less productive in each job that s/he can actually occupy).

![Diagram](https://via.placeholder.com/150)

Figure 1: When human capital becomes more general. The different jobs lie on the x axis, whereas the y axis displays the worker’s output in each possible job.

Our model highlights a key relationship between *match surplus* and the *return to
adaptability skills. Match surplus is the wealth associated with a job net of the worker’s and the employer’s outside options. This relationship drives all the results obtained subsequently. Adaptability skills improve the rate at which workers find jobs. Such skills, therefore, are set to capture match surplus. All the parameters that reduce match surplus also modify the optimal allocation of investment in favor of productivity skills.

In this perspective, Section 2 insists on the Rosen and rent-capture effects. The Rosen effect is named after Rosen (1983), who argues that the incentives to specialization are closely related to skill use: “the return to investment in a particular skill is increasing in its subsequent rate of utilization”. In our framework, matching frictions increase match surplus and, therefore, the need to invest in skills that facilitate the capture of such a surplus. In the competitive environment – the limit case where frictions disappear – adaptability skills are useless because it is extremely easy to contact any type of job. Individuals, therefore, devote the main part of their investment to productivity skills and so human capital is highly specialized. Conversely, specialized skills become less attractive when contacting an adequate job takes a lot of time.\(^2\)

The rent-capture effect denotes the effect of workers’ bargaining power. This parameter reduces match surplus and, therefore, promotes productivity skills rather than adaptability skills. Adaptability skills can increase outside options and this increases the bargained wage. Such skills become less advantageous when worker’s bargaining power is very high.

Section 2 also examines macroeconomic implications. It introduces the main ingredients of a search equilibrium model: there is a matching function, vacant jobs need to be advertised at some cost, and the supply of jobs is determined through entry. The vacancy-to-unemployed equilibrium ratio increases with the contact surplus, e.g. the product of matching probability by match surplus. Workers’ bargaining power has an ambiguous impact on the skill divide. The rent-capture effect lowers the returns to adaptability skills. However, employers post fewer jobs, which increases the severity of market frictions and so raises the returns to adaptability skills through the Rosen effect. Overall, the model predicts a non-monotonic relationship. The minimum of the curve is reached when the Hosios condition is satisfied.

We also show that individuals invest more in adaptability skills than they would do in the efficient allocation. The two allocations coincide in the case where the Hosios condition holds. Unlike standard models of human capital investment, the skill divide does not convey any externality. The reason is that individuals set the skill divide to maximize the contact surplus, e.g. the product of matching probability by match surplus, whereas firms make entry decisions on the basis of the same variable. When the Hosios condition is satisfied, increasing the share of investment spent in productivity skills above the individual choice deteriorates the contact surplus, and, therefore, reduces job creation.

\(^2\)In a different setting, Gould, Moav and Weinberg (2001) argue that unemployment creates educational incentives, because it originates a demand for precautionary education from risk averse individuals. Unlike Gould et al, individuals are risk neutral in our paper, and education can offer both general and specific skills.
In Section 3, we focus on each institution separately. We examine unemployment benefits (UB) and job protection. We show that both reduce expected match surplus and so distort the trade-off between adaptability and productivity skills towards productivity skills. In the case of UB, the result is not obvious because individuals set the skill divide before labor market entry. The replacement rate reduces match surplus for two reasons: it improves the well-being of the unemployed at given taxation; it also reduces the well-being of employees because payroll taxes must increase to finance the benefits. However, entrants cannot claim unemployment benefits. Investing in adaptability skills has a new type of return, because finding a job also means having access to UB once the job is lost. Increasing the replacement ratio appreciates this return.

In the case of job protection, we extend the basic model to account for endogenous job destruction. Job protection is a dismissal cost paid out of the employment relationship. We follow others and assume that job protection is not immediately available: firms pay the cost only if the worker is dismissed after a first productivity shock has occurred. Dismissal costs unambiguously reduce the match surplus as such costs leave the firm–worker pair. This encourages students to invest in more specialized skills even though reducing the scope of their skills further impairs their chances of finding a job.

Section 4 discusses the robustness of the increasing relationship between match surplus and the return to adaptability skills. We examine two extensions: firstly, the case where individuals choose both the skill divide and the magnitude of investment. We here study how the skill divide changes with educational level. Secondly, we propose a directed search version of the model where the search market is segmented by sector and workers only apply for jobs they can actually perform. The only difference with the random search version is that the Hosios condition no longer ensures constrained efficiency. Individuals always invest too much in adaptability skills.

There is a substantial theoretical literature on the relations between matching frictions and the magnitude of educational investment (see e.g. Laing et al, 1995, Acemoglu, 1996, Moen, 1999, Burdett and Smith, 2002, Charlot and Decreuse, 2005). We complement this literature by focusing on the type of skills rather than on the skill level. Mukoyama and Sahin (2006) examine the impact of unemployment compensation on the incentives to specialization. However, contact rates are exogenous and there is no trade-off between general and specialized skills: a worker who invests more can perform more tasks with unchanged productivity.

This paper is also related to the literature emphasizing the role of industry-specific skills in labor markets where workers are imperfectly mobile between sectors. Stevens (1994) introduces the notion of transferable skills. These skills can only be used in proportion to the different available jobs. Stevens argues that there is an underprovision of transferable skills by employers. Smits (2007) distinguishes industry-specific skills from generic skills (that have a higher value elsewhere in the economy). Workers want more generic skills than is socially optimal, while firms prefer industry-specific skills. There is also a growing literature that analyses the role of LMIs on the incentives for firms to fund general training investment. Unions may encourage training because they reduce labor
turnover (Booth and Chatterji, 1998). Wage compression induced by a minimum wage increase may have a positive effect on the incentives to train the less skilled workers to improve their productivity (Acemoglu and Pischke, 1999, 2003). Fella (2004) predicts a positive correlation between investment in general training and the strictness of employment protection rules. Our paper complements both strands of literature by focusing on educational investments rather than on-the-job training.

The trade-off between adaptability and productivity borrows from the notions of marketability and specialization highlighted in the literature on money and search (see e.g. Kiyotaki and Wright, 1993, and Shi, 1997). The main idea in these papers is that each producer faces a trade-off between specialization and marketability. Specializing in the production of a given commodity allows better productivity, but at the expense of reducing the proportion of consumers interested in purchasing the good.

All proofs are in the Appendix.

2 The skill divide with market frictions

We propose a model of educational investment that features a trade-off between adaptability and productivity skills, and a frictional labor market. The model abstracts from unemployment benefits and job protection, which we introduce in Section 3. We first examine the skill divide in partial equilibrium. Job creation is then endogenized. We finally examine the efficiency of job-posting and human capital investment decisions.

2.1 The Rosen effect and the rent-capture effect

We are interested in the schooling investment of individuals living in a stationary environment. They face a constant risk of dying $n$. They are also risk-neutral and $\rho$ is the pure rate of time preference; $r \equiv \rho + n$ is thus the global discount rate. The total human capital investment $I$ is given. It can be viewed either as the exogenous schooling duration, or total spending in education. Individuals must divide this investment between adaptability and productivity skills. Let $g$ denote the level of adaptability skills, while $s = I - g$ denotes the level of productivity skills.

The notions of adaptability and productivity skills rely on the technological side of the economy. There are a continuum of sectors, each producing a final good entering preferences symmetrically. Sectors are of mass one. Each sector is associated with a particular technology. While dividing human capital, workers choose the scope and intensity of their skills. Adaptability skills increase the share of technologies the worker can operate, while productivity skills raise the productivity in each known technology. Formally, the proportion of technologies the worker knows is $H(g)$, with $H(0) = 0$, $H(I) < 1$, $H'(g) > 0$, $H''(g) < 0$. The intensity of her skills is $f(s)$, with $f(0) = 0$, $f'(s) > 0$, $f''(s) < 0$.

The labor market is frictional. Matching frictions capture two notions. First, the per-period probability of contacting a job is lower than one. Second, the contacted job may not fit the worker’s skills and mismatch may result. Let $\mu$ denote the flow probability...
of receiving a job offer. Thus $\mu^{-1}$ measures the severity of frictions. Each job offer is a random draw from the set of potential jobs. Given that $H(g)$ is the proportion of jobs the worker can occupy, $\mu H(g)$ is the rate of acceptable job offers. It is increasing in $g$, and decreasing in the severity of frictions.

Each match is associated with a match surplus that the employer and the worker must share. We follow the literature and assume that there is wage bargaining over match surplus.

Let $U = U(s,g)$ denote the utility of an unemployed person, and $W = W(s,g)$ the utility of an employed worker. We have

$$rU = \mu H(g) [W - U],$$
$$rW = w + q [U - W],$$

where $q$ is the (exogenous) rate of job destruction and $w$ is the wage. Symmetrically, $J = J(s,g)$ is the value of a filled job. We have

$$rJ = f(I - g) - w + q [V - J],$$

where $V$ the value of a vacancy is given. The wage splits the match surplus $S = W - U + J - V$ according to

$$W - U = \beta S = \frac{\beta}{1 - \beta} (J - V),$$

where $\beta \in (0,1)$ is workers’ bargaining power.

It follows that the match surplus is

$$S(s,g) = \frac{f(s) - rV}{r + q + \beta \mu H(g)}.$$  

(5)

Match surplus increases with the flow output $f(s)$, and decreases with the discount rate $r$, the job destruction rate $q$, and the product $\beta \mu H(g)$ of bargaining power by job-finding rate.

At the time of investment, the individual does not know which firm will hire them. As a consequence, they maximize the value of their future search. From the different equations, we have

$$rU(s,g) = \beta \mu H(g) S(s,g).$$

(6)

The value of search is the product of $\beta \mu$ by the contact surplus $H(g) S(s,g)$, e.g. fraction of the technologies the worker can operate times match surplus.

The optimal allocation of educational investment between adaptability and productivity skills maximizes the contact surplus:

$$\hat{g} \in \arg \max_{g} rU(s,g).$$

(\*)

The skill divide results from the first-order condition to the maximization problem (\*). This gives

$$\frac{H'(g)}{H(g)} + \frac{\partial S(I - g,g)}{\partial g} / S(I - g,g) = \frac{\partial S(I - g,g)}{\partial s} / S(I - g,g),$$

(7)
where
\[
\frac{\partial S(s, g)}{\partial g} = \frac{H'(g)}{H(g)} \frac{\beta \mu H(g)}{r + q + \beta \mu H(g)},
\]
(8)
\[
\frac{\partial S(s, g)}{\partial s} = \frac{f'(I) - rV}{f(s) - rV}.
\]
(9)

The skill divide balances the marginal returns to adaptability and productivity skills. Adaptability skills have two opposite effects on the contact surplus. On the one hand, they increase it by reducing the mismatch risk. On the other hand, they improve the odds of contacting an adequate employer, thereby making the economic position of the unemployed closer to that of an employed worker and so reducing match surplus. The size of the latter effect increases with the product $\beta \mu$, that is with the chance of contacting a vacancy times the share of contact surplus obtained in such a case. Productivity skills unambiguously increase the contact surplus. They do not alter the matching probability, but they raise workers’ output, thereby increasing the match surplus.

It follows that
\[
\frac{H'(g)}{H(g)} S(I - g, g) = \frac{H'(g)}{H(g)} \frac{f(I) - rV}{r + q + \beta \mu H(g)} = \frac{f'(I) - rV}{r + q}.
\]
(10)

This equation shows that the divide between adaptability and productivity skills depends on the match surplus $S(I - g, g)$.

**Proposition 1 Matching frictions, bargaining power, and the skill divide**

Let $V$ be sufficiently small. Then,

(i) Rosen effect: $d\hat{g}/d\mu > 0$, that is adaptability skill investment increases with matching frictions;

(ii) Rent-capture effect: $d\hat{g}/d\beta < 0$, that is adaptability skill investment decreases with workers’ bargaining power

Parameters $\beta$ and $\mu$ deteriorate the match surplus. This explains the results displayed by Proposition 1.

The *Rosen effect* characterizes the impact of matching frictions on investment in adaptability skills. The primary purpose of adaptability skills is to improve the ability of receiving job offers, thereby raising workers’ share of match surplus. Hence, matching frictions motivate the acquisition of more general skills because frictions increase the size of match surplus. Adaptability skills are useless in the Walrasian environment where $\mu$ tends to infinity. Unemployment spells are arbitrarily short, and contacting any type of alternative employer is immediate. Match surplus is nil as a result, and there is no need to speed up job search. The whole investment is then devoted to the acquisition of productivity skills, i.e. $\hat{g} = 0$. Conversely, market frictions reduce the interest of very specialized human capital, which becomes much more difficult to trade.
The Rent-capture effect describes the impact of workers’ bargaining power. This parameter reduces match surplus because workers can capture a larger part of alternative match surpluses. Having more general skills allows the worker to enhance the value of outside options. The worker benefits from such outside options through a better wage. This effect is all the higher as workers’ bargaining power is low. As the bargaining power increases, the need to raise outside options decreases, and so the investment in adaptability skills declines.

### 2.2 Equilibrium unemployment and the composition of human capital

We incorporate the framework of the previous sub-section into an equilibrium matching model of the labor market. The main result is that there is a non-monotonic relationship between the bargaining power and the share of schooling investment spent in adaptability skills.

To close the model, we need an explicit matching market with a matching technology. There is a unique search place for all workers and vacant jobs. Let \( \theta \) be the labor market tightness, that is the ratio of vacancies to unemployed. The rate of contacting a vacancy is thus \( \mu = \mu(\theta) \), while the rate of contacting a worker is \( \mu(\theta)/\theta \). The function \( \mu \) is such that \( \mu'(\theta) > 0, \mu''(\theta) < 0 \), and \( \mu(0) = \mu(\infty)^{-1} = 0 \). The elasticity of the contact rate with respect to market tightness is \( \alpha(\theta) = \theta \mu'(\theta)/\mu(\theta) \).

We also need agents who make schooling decisions at each instant. We assume that new cohorts enter the economy at rate \( n > 0 \); this parameter is also the risk of dying and so the population is constant and normalized at unity.

Equilibrium tightness is derived from a zero-profit condition. Assume that all workers have the same amount of general and specific skills. Let \( c \) be the flow cost of posting a vacancy. The value of a vacancy is recursively defined as follows:

\[
\Delta V = -c + \frac{\mu(\theta)}{\theta} H(g) [J(s,g) - V].
\]  
(11)

In equilibrium, \( V = 0 \) and

\[
c \frac{\theta}{\mu(\theta)} = (1 - \beta) H(g) S(\theta, s, g, \beta).
\]  
(12)

This equation defines tightness as an increasing function of contact surplus \( H(g) S(\theta, s, g, \beta) \), where the dependence of match surplus vis-à-vis \( \theta \) and \( \beta \) has been highlighted. As discussed in the previous section, adaptability skills improve the probability of matching with an adequate worker, but they deteriorate match surplus. Productivity skills raise output, thereby increasing match surplus. It follows that tightness is increasing in \( s \). Finally, tightness is decreasing in workers’ bargaining power \( \beta \), which lowers firms’ profitability.
Equilibrium tightness $\theta^*$ and adaptability skill investment $g^*$ jointly solve

$$\frac{H'(g)}{H(g)} S(\theta, I - g, g, \beta) = \frac{f'(I - g)}{r + q}.$$

(SD)

$$(1 - \beta) H(g) S(\theta, I - g, g, \beta) = \frac{c}{\mu(\theta)}.$$  

(MT)

**Proposition 2** Bargaining power and the skill divide

(i) There exists a unique equilibrium;

(ii) $d\theta^*/d\beta < 0$, that is tightness strictly decreases with workers’ bargaining power;

(iii) $dg^*/d\beta > 0$ if and only if $\beta > 1 - \alpha(\theta^*)$;

(iv) if $\alpha'(\theta) \leq 0$ for all $\theta \geq 0$, then the function $g^*(\beta)$ is $\cup$-shaped.

Figure 2: Existence and uniqueness of equilibrium. The loci (MT) and (SD) intersect once in the maximum of (MT).

Figure 2 depicts the equilibrium. The skill divide equation defines the curve (SD). Along the lines of Proposition 1, it features a decreasing relationship between adaptability skill investment and labor market tightness. The market tightness equation defines the curve (MT). This curve is bell-shaped. Indeed, market tightness increases with the contact surplus $H(g) S(\theta, g, I - g)$. This contact surplus first increases and then decreases with adaptability skill investment.
The two curves intersect once at the maximum of (MT). The max of this curve results when the contact surplus is the highest. However, at given tightness, workers set the skill divide to maximize such a contact surplus. It must follow that, in equilibrium tightness $\theta^*$, the contact surplus is also maximized and so this must correspond to the max of the (MT) curve. This property implies that there is a unique equilibrium.

Unsurprisingly, Proposition 2 shows that equilibrium tightness is strictly decreasing in bargaining power. It follows that bargaining power affects the skill divide in two different ways. Following the rent-capture effect, it directly decreases match surplus, which reduces the return to adaptability skills. Owing to the Rosen effect, it reduces tightness, thereby increasing match surplus and raising the return to adaptability skills.

Overall, we have

$$\frac{dg^*}{d\beta} \equiv \beta - (1 - \alpha (\theta^*)) . \quad (13)$$

The proportion of investment spent in adaptability skills follows a non-monotonic curve as $\beta$ goes from 0 to 1. When the elasticity of the matching technology is particularly volatile, the equation $\beta - (1 - \alpha (\theta^*))$ may have several roots in $\beta$. Imposing $\alpha' (\theta) \leq 0$ implies that there is a unique root, and the curve is $\cup$-shaped. The minimum of the curve obtains when the Hosios condition is met (Hosios, 1990), that is when $\beta = 1 - \alpha$.

As explained below Proposition 1, investment in adaptability skills increases with match surplus. In turn, match surplus is minimized when the Hosios condition holds. The upper bound $g_0$ on adaptability skill investment is reached for $\beta = 0$ and $\beta = 1$. Using (SD), this gives $g_0 < I$ such that $H'(g_0) / H(g_0) = f'(I - g_0) / f(I - g_0)$.

The equilibrium unemployment rate $u$ balances unemployment inflows and outflows, e.g. $\mu u = (q + n)(1 - u)$. At given tightness, this gives the Beveridge curve:

$$u = \frac{q + n}{q + n + \mu(\theta)H(g)} . \quad (14)$$

In equilibrium, $\theta = \theta^*$ and $g = g^*$.

### 2.3 Efficiency of schooling and job creation decisions

We consider the case where $\rho \to 0$. The social planner aims to maximize steady-state consumption, i.e. total output net of search costs:

$$(\theta^*, g^*) \in \max_{\theta, g} (1 - u)f(I - g) - c\theta u \quad (***)$$

subject to the Beveridge curve (14).

The first-order conditions to the maximization problem give

$$\frac{H'(g)}{H(g)}S(\theta, I - g, g, 1 - \alpha(\theta)) = \frac{f'(I - g)}{r + q} , \quad (SD^*)$$

$$\alpha(\theta)H(g) S(\theta, I - g, g, 1 - \alpha(\theta)) = c \frac{\theta}{\mu(\theta)} . \quad (MT^*)$$

11
Proposition 3  Efficient allocation vs equilibrium allocation

Let $\alpha'(\theta) \leq 0$ for all $\theta \geq 0$. Then,

(i) $\theta^* \geq \theta^s$ if and only if $\beta \leq 1 - \alpha(\theta^s)$;

(ii) $g^* > g^s$ if and only if $\beta \neq 1 - \alpha(\theta^s)$.

The restriction $\alpha'(\theta) \leq 0$ ensures that the equation $\beta = 1 - \alpha(\theta^*(\beta))$ has a unique root. Proposition 3 displays two main results. First, the Hosios condition $\beta = 1 - \alpha(\theta^s)$ ensures constrained efficiency. This result differs from other models of human capital investment with labor market frictions. In such models, the contact surplus and the match surplus coincide. Workers choose the human capital level to maximize their share of match surplus minus the full cost of education. Firms make entry decisions on the basis of the remaining share of match surplus. The hold-up phenomenon results: investment does not maximize match surplus. This gives birth to a pecuniary externality: increasing the magnitude of investment for a small mass of agents also increases expected match surplus; firms post more jobs per unemployed, which increases the return to education and provides incentive to investment for all.\(^3\)

In our model, the contact surplus differs from the match surplus because there is a mismatch probability. As in traditional models, workers maximize their share of the contact surplus; however, the only cost of productivity skills is an opportunity cost in terms of adaptability skills. This opportunity cost bears on the contact surplus; thus maximizing worker’s share of the contact surplus means maximizing the contact surplus. In other words, the pecuniary externality usually at work in search models does not arise in our framework where workers choose how to allocate their investment between two types of skills.

Second, workers invest more in adaptability skills than in the efficient allocation. There are two main implications. First, the scope of skills is larger than in the efficient allocation and so mismatch is reduced. The second implication is a simple corollary: agents invest less in productivity skills. Output per worker is lower in the equilibrium allocation than in the efficient allocation.

3 Labor market institutions and the composition of educational investment

In this section, we study the impacts of unemployment benefits and job protection on the divide of educational investment between adaptability and productivity skills.

\(^3\)This property crucially depends on the fact that the search market is not segmented by education level. See Section 4.2.
3.1 Unemployment compensation

It has been argued that unemployment insurance allows the workers to invest in specific skills (see e.g. Grossman and Shapiro, 1982, Estevez et al, 2001). We revisit this prediction. Using our model, we show that unemployment compensation and wage taxation are detrimental to adaptability skills.

Let $b$ denote unemployment benefits (UB). For simplicity, there is no time limit to UB, and eligibility to unemployment insurance is obtained with the first job. UB are financed by a payroll tax on wages. Employers’ tax rate is $t_e$, while workers’ tax rate is $t_w$.

We must distinguish $U_0$ the intertemporal utility of a newcomer on the labor market from $U$ the intertemporal utility of an unemployed person who is eligible to unemployment insurance. We have

\[ rU_0 = \mu H(g)[W - U_0], \]
\[ rU = b + \mu H(g)[W - U]. \]  

Other value functions write

\[ rW = w(1 - t_w) + q(U - W), \]
\[ rJ = f - w(1 + t_e) + q(V - J). \]

Wages are continuously bargained. Nash bargaining over match surplus $S$ yields

\[ W - U = \gamma S, \]
\[ J - V = (1 - \gamma) S, \]

where $\gamma = \beta (1 - t_w) / [\beta (1 - t_w) + (1 - \beta)(1 + t_e)]$. Equations (16) to (20) jointly define the match surplus:

\[ S = \frac{\beta (1 - t_w) + (1 - \beta)(1 + t_e)f - b\frac{1 + t_e}{1 + t_w} - rV}{r + q + \beta \mu H}. \]

Match surplus strictly decreases with UB and payroll taxes.

The skill divide results from the maximization of the return to search:

\[ rU_0(s, g) = \gamma \mu(\theta) H(g) S(s, g) + \frac{\mu H(g)}{r + \mu H(g)} b. \]

The return to search is equal to the contact rate times the proportion $\gamma$ of contact surplus $HS$, plus a term that corresponds to the permanent gain achieved once the first job is obtained. This gain increases with adaptability skills.

The f.o.c. writes

\[ \frac{H'(g) f(I - g) - b\frac{1 + t_e}{1 + t_w}}{H(g) r + q + \beta \mu(\theta) H(g)} + \beta^{-1} \frac{H'(g) b\frac{1 + t_e}{1 + t_w} r}{r + q + \beta \mu(\theta) H(g)} = \frac{f'(I - g)}{r + q}. \]
Equation (23) features an additional return to adaptability skills on its left-hand side. To benefit from the permanent increase in human wealth due to the first job, individuals set adaptability skills above the point that maximizes the contact surplus \( HS \).

Job creation results from

\[
\frac{c_\theta}{\mu (\theta)} = (1 - \gamma) H (g) S (\theta, I - g, g). \tag{24}
\]

An equilibrium is a pair \((\theta^*, g^*)\) that solves equations (23) and (24). The following result summarizes the impacts of UB and wage taxation on the skill divide.

**Proposition 4** UNEMPLOYMENT COMPENSATION AND THE SKILL DIVIDE

Assume that \( f (I) > b \). Provided that the discount rate \( r \) is sufficiently low,

(i) an increase in UB lowers market tightness and adaptability skill investment, i.e. \( d\theta^*/db < 0 \) and \( dg^*/db < 0 \);

(ii) an increase in employer’s or in employee’s tax rate lowers market tightness and adaptability skill investment, i.e. \( d\theta^*/dt_w < 0 \), \( d\theta^*/dt_e < 0 \), \( dg^*/dt_w < 0 \), and \( dg^*/dt_e < 0 \).

UB have three different effects. First, there is a rent-capture effect as UB decrease match surplus. This effect tends to raise investment in productivity skills. Second, there is a Rosen effect. As the match surplus decreases, firms post fewer jobs, which reduces the contact rate. This effect motivates the acquisition of adaptability skills. Third, there is an entitlement effect that further raises the incentive to invest in more general human capital. As UB tend to increase search effort/ decrease search choosiness among non-entitled workers, UB also tend to favor adaptability skills, which speed-up job-finding.

For a sufficiently low discount rate, the entitlement effect can be neglected. Formally, the second term in the left-hand side of equation (23) vanishes. Thus the Rosen effect is dominated by the rent-capture effect. According to equation (23), adaptability skills increase with match surplus. If the Rosen effect were dominating the rent-capture effect, match surplus would increase with UB. In turn, equation (24) would imply that market tightness goes up, which is contradictory. The reason why small discounting plays against the entitlement effect can be understood from the extreme situation where individuals do not discount time. In such a case, they are only interested in their long-run situation. As non-entitlement is only temporary, they neglect this first period of working life.

Qualitatively, wage taxation has similar effects to UB. Wage taxation lowers equilibrium match surplus, which reduces the incentives to acquire adaptability skills. Meanwhile, wage taxation decreases the returns to finding a job, thereby increasing the relative return due to benefit entitlement. This second effect favors adaptability skills. It also vanishes when the discount rate is sufficiently small.

How small must the discount rate be? To answer this question, we turn to numerical simulations. The matching technology is Cobb-Douglas, with \( \mu (\theta) = M_0 \theta^\alpha \). Output is \( f (s) = 1 - \exp (-\nu s) \). The proportion of jobs that the worker can operate is \( H (g) = \)
\[ 1 - \exp(-\kappa g). \] The parameter \( I \) is set to one. Consequently, \( g^* \) is directly the proportion of educational investment spent in adaptability skills. Parameters \( \alpha \) and \( \beta \) have been set equal to 1/2. Bargaining is thus efficient in the absence of UB/wage taxation.

Let \( b = \rho (1 - t_w) w \), where \( \rho \) denotes the replacement rate over net wage. Let \( u^o \) denote the number of unemployed who already had a job in the past. Balanced budget requires that \( (1 - u) (t_w + t_e) w = u^o b \). In steady state, \( u^o \) is equal to overall unemployment \( u = (n + q) / (n + q + \mu H) \) minus the number \( u^y \) of young workers seeking their first job, with \( u^y = n / (n + \mu H) \). It follows that \( t_w + t_e = \rho q / (n + \mu H) \).

The other parameters have been chosen to (i) broadly replicate the upper-secondary segment of the French labor market in 2000, and (ii) to target a proxy for the proportion of educational investment spent in adaptability skills. (i) The mean OECD replacement rate was 40%, and the unemployment rate of upper-secondary graduates was about 9%. As the proportion of upper-secondary graduates goes down among younger cohorts, the mean unemployment rate slightly undervalues the stationary rate. The mean job destruction rate \( q \) was about 10%. As \( u = (n + q) / (n + q + \mu (g^*) H (g^*)) \) and \( n \) is at most 0.5%, the job-finding rate is about one. This corresponds to a mean unemployment duration of about one year. (ii) Meanwhile, the proportion of upper-secondary graduates with a general education was 25% in 2003. We choose to consider, somewhat arbitrarily, that this indicates that 25% of the schooling investment was directed towards adaptability skills.

Table 1 presents the parameters of the baseline simulation. The discount rate has been set to 5%.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>( \alpha )</th>
<th>( \beta )</th>
<th>( n )</th>
<th>( q )</th>
<th>( M_0 )</th>
<th>( c )</th>
<th>( I )</th>
<th>( \nu )</th>
<th>( \kappa )</th>
<th>( r )</th>
<th>( \rho )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Values</td>
<td>0.5</td>
<td>0.5</td>
<td>0.005</td>
<td>0.1</td>
<td>1.0</td>
<td>0.15</td>
<td>1.0</td>
<td>2.0</td>
<td>2.0</td>
<td>0.05</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Table 1: Parameters

The corresponding stationary values are about \( g^* = 22.8\% \) and \( u = 9.9\% \). As \( H(g^*) = 0.36 \), an unemployed worker needs to contact three vacancies on average before being hired. To illustrate the results of Proposition 3, we examine the sensitivity of \( g^* \) vis-à-vis changes in \( \rho \) and \( r \). Figure 3 depicts five curves in the \((\rho, g^*)\) plane. Each curve is associated with a particular value of the discount rate \( r \), from 0 to 20%. When the discount rate is 0, the entitlement effect is nil, and the curve is strictly decreasing. In the other cases, the curve is U-shaped. As the magnitude of the entitlement effect increases with the discount rate, the minimum of the curve decreases with the discount rate. The main message of Figure 3 is that the entitlement effect is dominated for reasonable values of the replacement rate and discount rate.

3.2 Employment protection

Wasmer (2006) argues that employment protection distorts on-the-job skill investments towards specific rather than general skills. In this sub-section, we show that Wasmer’s
main message also holds at the time of education. Dismissal costs make individuals allocate a larger proportion of their educational investment to productivity skills. Specialized human capital becomes more attractive because match surplus goes down with employment protection, and this is so whether the model accounts for job creation decisions or not.

The modeling aspects of EPL and job destruction closely follow Mortensen and Pissarides (1994) and Wasmer (2006). The productivity of a job depends on productivity skills \( s \) and on a firm-specific component \( \varepsilon \) as follows: \( y = f(s) + \varepsilon \). The firm component is random. It evolves according to a Poisson process with intensity \( \lambda \) and is drawn from a density function \( g(\varepsilon) \) with c.d.f. \( G(\varepsilon) \). The density has support \([\varepsilon^- , \varepsilon_0]\) and \( \varepsilon_0 \) is also the initial value of \( \varepsilon \) at the time of match formation. Before a new shock arrives, separation takes place at no cost. After the shock, the firm must pay the administrative dismissal cost \( T \) in case of separation. We assume that \( \varepsilon_0 > \lambda T \).

Match surplus is \( S^0(s,g) \) when the job had never experienced a productivity shock, whereas it is \( S(s,g,\varepsilon) \) when the firm component is \( \varepsilon \). We define value functions accordingly, i.e. workers’ and firms’ value functions are denoted by \( W^0(s,g) \), \( W(s,g,\varepsilon) \), \( J^0(s,g) \) and \( J(s,g,\varepsilon) \). Match surpluses are defined as follows:

\[
S^0(s,g) = W^0(s,g) - U(s,g) + J^0(s,g) - V, \quad (25)
\]
\[
S(s,g,\varepsilon) = W(s,g,\varepsilon) - U(s,g) + J(s,g,\varepsilon) - V + T. \quad (26)
\]

Match surplus is still split between the firm and the worker so that \( W^0(s,g) = \beta S^0(s,g) \) and \( W(s,g,\varepsilon) = \beta S(s,g,\varepsilon) \). This rule has two well-known implications. First, it leads to

\[ \begin{align*}
\rho & = 20\% \\
\rho & = 15\% \\
\rho & = 10\% \\
\rho & = 5\% \\
\rho & = 0
\end{align*} \]
efficient job separation: job destruction occurs whenever match surplus becomes negative. Let \( \varepsilon^d \equiv \varepsilon^d(s,g) \) denote the reservation productivity such that match surplus is equal to zero, i.e. \( S(s,g,\varepsilon^d) = 0 \). Second, \( S^0(s,g) = S(s,g,\varepsilon_0) - T \).

After usual computations, and setting \( V \) to zero, we obtain
\[
S^0(s,g) = \frac{\varepsilon_0 - \varepsilon^d(s,g) - (r + \lambda)T}{r + \lambda},
\]
\[
\varepsilon^d(s,g) = \beta \mu H(g) S^0(s,g) - f(s) - rT - \frac{\lambda}{r + \lambda} \int_{\varepsilon^d(s,g)}^{\varepsilon_0} [1 - G(\varepsilon)] d\varepsilon.
\]
Changes in educational mix \((s,g)\), tightness \( \theta \) or bargaining power \( \beta \) only transit through changes in \( \varepsilon^d \). Importantly, initial match surplus decreases with dismissal costs \( T \).

The optimal divide of schooling investment between adaptability and productivity skills results from
\[
\max_g \left\{ rU(I - g, g) = \beta \mu H(g) S^0(I - g, g) \right\}.
\]
The f.o.c. is expressed
\[
\frac{H'(g)}{H(g)} S^0(I - g, g) = \frac{f'(I - g)}{r + \lambda G(\varepsilon(I - g, g))}.
\]
The left-hand side is the marginal return to adaptability skills, while the right-hand side is the marginal return to productivity skills. An increase in dismissal costs distorts investments towards more specialized skills. On the one hand, initial match surplus \( S^0 \) goes down, which deteriorates the returns to adaptability skills. On the other hand, \( \varepsilon^d \) decreases and jobs last longer, which raises the returns to productivity skills.

To close the model, consider tightness determination
\[
c \frac{\theta}{\mu(\theta)} = (1 - \beta) H(g) S^0(\theta, I - g, g),
\]
where the dependence vis-à-vis \( \theta \) has been highlighted.

Equilibrium tightness \( \theta^* \) and adaptability skills \( g^* \) solve equations (27), (28), (30), and (31). The following result summarizes the impact of job protection on the skill divide.

**Proposition 5** Employment Protection and the Skill Divide

Firing costs lower the labor market tightness, i.e. \( d\theta^*/dT < 0 \), and distort the skill divide towards productivity skills, i.e. \( dg^*/dT < 0 \).

Dismissal costs have two different effects. At given tightness, they lower initial match surplus \( S^0 \) and favor productivity skills. However, the decrease in initial match surplus deteriorates job creation and tightness \( \theta^* \) falls as a result – the usual Rosen effect. The fall in tightness lowers the decline in initial match surplus, thereby reducing the direct effect of job protection on schooling investment allocation. The latter effect being a second-order effect (the fall in tightness must occur because initial match surplus goes down), job protection promotes more specialized human capital. Accounting for endogenous tightness does not alter the reasoning made at given contact rate: dismissal costs lower the relative returns to adaptability skills at the time of educational investment.
4 Discussions

We argue that matching frictions increase the incentive to invest in adaptability skills, whereas unemployment benefits and job protection motivate productivity skill acquisition. In both cases, the reason is due to the fact that the return on adaptability skills increases with match surplus. We now study the robustness of this relationship vis-à-vis two departures of the basic model: investment in skill level on top of the skill divide, and directed search instead of random search.

4.1 Investment in skill level

We extend our model to the case where individuals choose both the magnitude of investment and the way they allocate this investment between adaptability and productivity skills.

The cost of acquiring education is $K(I) = \kappa I$, whereas individuals differ in marginal cost $\kappa$. A higher education level allows agents to have access to better jobs characterized by a more sophisticated technology. The search place is segmented by education level as a result. There is a segment-specific tightness $\theta(I)$ and a segment-specific skill divide summarized by $g(I)$. Segment-specific tightness results from a free-entry condition, whereas the skill divide is set by individuals who reach educational level $I$. In the remaining, we write $S(\theta, g, I-g)$ to make explicit the dependence with respect to $\theta$.

For a given education level $I$, tightness and skill divide jointly result from equations (SD) and (MT), which we reproduce for convenience:

\[
\frac{H'(g(I))}{H(g(I))} S(\theta(I), I-g(I), g(I), \beta) = \frac{f'(I-g)}{r+q}, \quad \text{(SD)}
\]
\[
(1-\beta) \frac{H(g(I))}{H(g(I))} S(\theta(I), I-g(I), g(I), \beta) = \frac{c \theta(I)}{\mu(\theta(I))}. \quad \text{(MT)}
\]

The optimization problem of an individual with marginal cost $\kappa$ is

\[
(I(\kappa), g(\kappa)) \in \arg \max \{\beta \mu(\theta(I)) S(\theta(I), I-g, g) - \kappa I\}. \quad \text{(***)}
\]

whereas $I$-specific tightness is determined by equation (MT).

Proposition 6 Skill level and skill divide

(i) Investment level $I \equiv I(\kappa)$ and skill divide $g \equiv g(\kappa)$ solve

\[
\frac{H'(g)}{H(g)} S(\theta(I), I-g, g) = \frac{f'(I-g)}{r+q}, \quad \text{(32)}
\]
\[
\beta \mu(\theta(I)) H(g) f'(I-g) \left(1 - \alpha(\theta(I))(r+q) + \beta \mu(\theta(I)) H(g)\right) = \kappa. \quad \text{(33)}
\]

(ii) $I$ and $g$ decrease with $\kappa$. 

The model predicts the allocation of agents across education levels and associated market segments. Optimal investment decreases with the marginal cost of investment $\kappa$. As agents differ in $\kappa$, they also differ in $I$. However, all persons of the same $I$ also choose the same $g$, here $g(I)$, which solves (SD)–(MT).

Adaptability skills increase with education level. More educated workers have not only a higher amount of human capital; it is also more general: their skills are more transferable across the different available jobs. This implies that the unemployment rate decreases with education. More educated workers benefit from a higher vacancy-to-unemployed ratio; they are also more mobile across jobs. The job-finding rate $\mu(\theta(I))H(g)$, therefore, increases with $I$.

This prediction hinges on a crucial assumption: that the mismatch probability $1 - H(g)$ only depends on adaptability skill investment, and not on education level. As education gives access to better jobs, we may alternatively consider that this probability increases with education. Two opposite effects would be involved: on the one hand, the more educated would have more adaptability skills and this would reduce the mismatch probability. On the other hand, they would prospect more complex jobs and this would increase the latter probability.

Proposition 6 allows the main predictions of the model to be revisited. It confirms that the return to adaptability skills increases with match surplus at given education (equation (32)). Thus, conditional on education, the parameters that affect match surplus affect skill transferability across jobs in a similar way. However, such parameters may also affect the return on education investment (equation (33)). Given that the level of adaptability skills increases with education, this may modify the unconditional composition of skills.

Education does not vehicle any externality. If a mass of agents increase their education investment, they will have access to another market segment. Firms in the initial segment are no longer confronted by such individuals, whereas these workers join a group of job-seekers who made similar choices.

4.2 Directed search vs random search

In the basic model, workers may apply for all jobs, including jobs they are not qualified to occupy. This behavior corresponds to situations where job-specific abilities are partly unobserved. We now consider another extreme case where workers only apply for jobs they are qualified to perform. To this purpose, we use a description of the search market that can also be found in Charlot et al. (2005).

The technology space is $K = [0, 1]$. All workers know a subset of this space. The subset varies across workers; however, its measure $H(g)$ is the same for all. The search market is segmented by technology: there is a separate search sub-market for each technology. Each of these sub-markets has no mass. However, by summing matching odds across sub-markets, workers end up with a realistic chance of finding a suitable job. Under random search, workers prospect jobs in all possible sectors. A fraction of job offers must be turned down. Under directed search, job advertisements convey full information on
the skill requirement and so workers only seek jobs in sub-markets where they have the required skills.

We focus on the symmetric situation where all individuals set the same skill divide, and where the number of vacancies is the same in each sector. Under random matching, the number of job-seekers is \( u \) in each sector, tightness is \( \theta = v/u \), the chance of receiving a job offer is \( \int K \mu(\theta) dj = \mu(\theta) \), and the chance that this job can be occupied by the worker is \( H(g) \). Under directed search, the number of job-seekers is \( H(g)u \) in each sector, tightness is \( \theta = v/(uH(g)) \), the chance of receiving a job offer is \( H(g)\mu(\theta) \), and the chance that this job can be occupied by the worker is equal to one. In both cases, the job-finding rate is the same. However, directed search is more efficient than random search. The number of job-seekers is higher under random search than under directed search. Thus, at a given tightness, the number of vacancies must also be higher under random search.

On the workers' side, whether search is random or directed does not affect our results. In particular, the return to adaptability skills increases with match surplus. This also means that matching frictions are detrimental to productivity skills, whereas labor market institutions favor them.

On the firms' side, directed search means that firms only meet workers who can occupy the job. There is no mismatch as a result. This property slightly modifies equilibrium determination. Namely, an equilibrium is a vector \((g^*, \theta^*)\) such that

\[
\frac{H'(g)}{H(g)} S(\theta, I - g, g, \beta) = \frac{f'(I - g)}{r + q}, \tag{SD'}
\]

\[
(1 - \beta) S(\theta, I - g, g, \beta) = c \frac{\theta}{\mu(\theta)}. \tag{MT'}
\]

**Proposition 7** Equilibrium with directed search

(i) There exists a unique equilibrium, with \( d\theta^*/d\beta < 0 \), and \( dg^*/d\beta > 0 \) if and only if \( \beta > 1 - \alpha'(\theta^*) \);

(ii) Let \( \rho \to 0 \) and \((\theta^*, g^*)\) be the efficient allocation; let also \( \alpha'(\theta) \leq 0 \) for all \( \theta \geq 0 \). Then \( g^* < g^* \).

Equations (SD') and (MT') look very much like equations (SD) and (MT). A closer inspection reveals that the left-hand side of (MT') differs from (MT). Firms are now interested in match surplus and not in contact surplus. This particularity does not affect the comparative statics of equilibrium; however, it does imply that the skill divide now vehicle a negative externality. Individuals invest too much in adaptability skills.

This kind of externality is common to matching models with ex-ante human capital investment (see, e.g., Laing et al, 1995, Coles and Smith, 2002). Nash bargaining over match surplus combined with the free-entry condition imply that increasing workers’ productivity boosts job creation. Thus distorting the skill divide towards productivity skills for a small mass of agents would benefit all the others through higher sector-specific job-finding rates.

This result confirms the random search model where workers invest more in adaptability skills than in the efficient allocation unless the Hosios condition holds.
5 Conclusion

Do labor market institutions direct schooling investments towards more specialized skills? We provide a theoretical analysis based on the idea whereby students face a trade-off between adaptability and productivity skills. Adaptability skills expand the scope of skills, thereby increasing the degree of skill transferability across jobs. Productivity skills increase workers’ expected output once in a job that s/he can actually occupy. Our model features an increasing relationship between match surplus and the return to adaptability skills. This relationship explains why matching frictions promote adaptability skills rather than productivity skills, and why unemployment benefits and job protection create the incentive for productivity skill acquisition. In two extensions, we examine the robustness of this relationship: the consideration of investment in education level, and the consideration of directed search.

Our paper together with others (e.g. Krueger and Kumar, 2004, Mukoyama and Sahin, 2006, Wasmer, 2006) makes a strong claim: institutions covering the risk of unemployment make human capital more specialized. This comes at the expense of worker occupational mobility, thereby increasing the magnitude of risk to be covered. This statement goes beyond unemployment insurance and job protection: any policy that creates a tax wedge between unemployment and employment (like government spending financed by taxes on employed workers) will reduce the match surplus, and hence distort the investment decision away from adaptability skills and towards productivity skills.

Workers are heterogenous in our framework. However, our model abstracts from additional types of worker heterogeneity. Different workers may adopt different combinations of adaptability and productivity skills at given education. In turn, this type of heterogeneity may affect firms’ incentive to create jobs. Our model also leaves aside job-to-job transitions. Productivity skills may increase the expected duration of a job, whereas adaptability skills may facilitate the job-shopping process. Finally, we do not discuss technological change. All these extensions are on our research agenda.

6 References


7 Appendix

7.1 Data description

We use ISCED data, which organize a horizontal differentiation of educational attainments. These data rank educational attainments into six levels (1 to 6), that go from pre-primary schooling to research. At each schooling level, there are three different types of education: from A (general) to C (vocational). Both vocational and general schooling afford adaptability and productivity skills. Our presumption is that general schooling (type A) is turned more towards the acquisition of adaptability skills than vocational schooling (types B and C).

Krueger and Kumar (2004) and Mukoyama and Sahin (2006) compute the enrolment rate in general education among the students at upper-secondary level. Table 2 also provides figures showing the proportion of individuals with a general education among the graduates with an upper-secondary education. Unfortunately, the variable is not very well documented. In several cases, the proportion is one, while the enrolment rate in the corresponding program is lower than one. We choose to impute the value taken by the enrolment rate in such a case. The variable is computed for the year 2003 (only a few consecutive years are available).

Of course, these data have shortcomings. Our paper focuses on the individual tradeoff between adaptability and productivity skills at the time of educational investment. Namely, we want to understand how LMIs alter the skill divide at the margin. However, the aggregate data we use concern people who either completed a vocational education, or a general education. Our assumption is that changes in the proportion of people who choose a vocational education are correlated with changes in the individual proportion of educational investment that is devoted to specialized skill acquisition.

Unemployment insurance is proxied by the OECD measure of benefit entitlements averaged over the period 1999-2001. The measure is defined as the average of the gross unemployment benefit replacement rates for two earning levels, three family situations and three durations of unemployment. Job protection is proxied by the weighted mean of two OECD indices, the strictness of employment protection legislation on regular jobs and the strictness of EPL for collective dismissals. The weights correspond to the weights used for the computation of the overall OECD index (that also captures the availability of temporary contracts): 5/7 for regular jobs and 2/7 for collective dismissals. The index is computed for the end of the 1990s.

The correlation coefficient between the percentage of upper-secondary graduates with a general education and the OECD UB index is -28.6%. The correlation coefficient with the OECD EPL index is -27.4%.
7.2 Proof of Proposition 1

The assumption that $V$ is sufficiently small guarantees that $f(I - \tilde{g}) > rV$. The result follows from the implicit function theorem. Indeed, $d\tilde{g}/d\mu$ has the sign of $\partial S/\partial \mu > 0$, and $d\tilde{g}/d\beta$ has the sign of $\partial S/\partial \beta < 0$.

7.3 Proof of Proposition 2

Part (i). Equation (SD) defines an implicit function $g = g(\theta, \beta)$ that is strictly decreasing in both arguments. In addition, $\lim_{\theta \to 0} g(\theta, \beta) = g_0 < I$ such that $H'(g_0)/H(g_0) = f'(I - g_0)/f(I - g_0)$, and $\lim_{\beta \to -\infty} g(\theta, \beta) = 0$. Equation (MT) defines an implicit function $\theta = \theta(g, \beta)$. It is strictly decreasing in $\beta$, while it is non-monotonic in $g$, increasing at first, reaching a maximum and then decreasing. In addition, $\lim_{g \to 0} \theta(g, \beta) = 0$. These properties imply that there exists an equilibrium with $g_\theta(\theta^*, \beta) < 0$. Moreover, $\theta_g(g^*, \beta)$ has the sign of $(\partial/\partial g)[H(g^*) S(\theta^*, I - g^*, g^*, \beta)]$. As $g(\theta, \beta)$ results from $(\partial/\partial g)[H(g) S(\theta, I - g, g, \beta)] = 0$, we have $\theta_g(g^*, \beta) = 0$. It follows that (SD) and (MT) intersect once and only once.

Parts (ii) and (iii). As $\partial \theta(g^*, \beta)/\partial g = 0$, we have

$$\frac{d\theta^*}{d\beta} = \frac{d\theta(g^*, \beta)}{d\beta} < 0 \quad (34)$$

$$\frac{dg^*}{d\beta} = \frac{dg(\theta^*, \beta)}{d\beta} + \frac{d\theta(g^*, \beta)}{d\beta} \frac{d\theta^*}{d\beta} \quad (35)$$

Therefore,

$$\frac{dg^*}{d\beta} \frac{\text{sign}}{d\beta} = \frac{\partial S(\theta^*, I - g^*, g^*, \beta)}{\partial \beta} + \frac{\partial S(\theta^*, I - g^*, g^*, \beta)}{\partial \theta} \frac{d\theta^*}{d\beta} \quad (36)$$

The result follows.

We have

$$S_\beta = -\frac{\mu H}{r + q + \alpha \beta \mu H} S, \quad (37)$$

$$S_\theta = -\frac{\beta \mu H}{\theta r + q + \beta \mu H} S, \quad (38)$$

$$\theta_\beta(g^*, \beta) = -\frac{\theta}{(1 - \alpha)(r + q) + \beta \mu H \theta} \quad (39)$$

It follows that $dg^*/d\beta$ has the sign of $\alpha(\theta^*) + \beta - 1$.

Part (iv). We have $\alpha'(\theta^*)(d\theta^*/d\beta) + 1 > 0$. Thus the equation $\alpha(\theta^*) + \beta = 1$ has a unique solution in $\beta$ and the result follows.

7.4 Proof of Proposition 3

Comparing (SD)–(MT) with (SD*)–(MT*) reveals that $\theta^* = \theta^*$ and $g^* = g^*$ when $\beta = 1 - \alpha(\theta^*)$. Proposition 2 combined with restriction $\alpha'(\theta) \leq 0$ then ensures that $g^* > g^*$ when $\beta \neq 1 - \alpha(\theta^*)$, whereas $\theta^* \leq \theta^*$ when $\beta \geq 1 - \alpha(\theta^*)$. 

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7.5 Proof of Proposition 4

As $r$ tends to 0, the solving reduces to finding $(g^*, \theta^*)$ such that

\[
\frac{H'(g)}{H(g)} S(\theta, I - g, g) = \frac{\beta (1 - t_w) + (1 - \beta) (1 + t_e) f'(I - g)}{1 + t_e} \frac{f'(I - g)}{r + q}
\]

Following the proof of Proposition 2, equations (40) and (41) define two loci in the plane $(g, \theta)$. The (SD) locus is strictly decreasing, while the (MT) locus is \cap-shaped. The two loci intersect in the maximum of (MT). This property implies that $d\theta^*/db$ has the sign of $\partial S/\partial b < 0$. Using (40) and (41), one obtains

\[
\frac{H'(g)}{H(g)} \frac{c\theta}{\mu(\theta)} = (1 - \gamma) H(g) S(\theta, I - g, g)
\]

In turn, equation (42) implies that $dg^*/db$ has the sign of $d\theta^*/db < 0$.

Similarly, $d\theta^*/dt_i$, $i = e, w$, has the sign of $-\gamma'(t_i) H S + (1 - \gamma) H \partial S/\partial t_i$. Overall, this term is negative. Then, equation (42) implies that $dg^*/dt_i < 0$ since $\theta^*$ diminishes with $t_i$.

7.6 Proof of Proposition 5

The equilibrium is a duple $(\theta^*, g^*)$ satisfying the following conditions:

(i) Initial match surplus and threshold productivity value

\[
S^0(\theta, I - g, g, T) = \frac{\varepsilon_0 - \varepsilon^d(\theta, I - g, g, T) - (r + \lambda)T}{r + \lambda}
\]

\[
\varepsilon^d(\theta, I - g, g, T) = \beta \mu(\theta) H(g) S^0(\theta, I - g, g, T)
\]

\[
- f(I - g) - rT - \frac{\lambda}{r + \lambda} \int_{\varepsilon^0}^{\varepsilon_0} [1 - G(\bar{\varepsilon})] d\bar{\varepsilon}
\]

(ii) Optimal skill divide

\[
\frac{H'(g)}{H(g)} S^0(\theta, I - g, g, T) = \frac{f'(I - g)}{r + \lambda G(\varepsilon^d(\theta, I - g, g, T))}
\]

(iii) Equilibrium tightness

\[
c\frac{\theta}{\mu(\theta)} = (1 - \beta) H(g) S^0(\theta, I - g, g, T)
\]

Equations (43) and (44) define initial match surplus and threshold productivity as functions of tightness, general skills, and dismissal costs. After computation, the following
are obtained
\[
\frac{\partial S^0(\theta, I - g, g, T)}{\partial \theta} = -\frac{\alpha(\theta)}{\theta} \left( r + \beta \mu(\theta) H(g) + \lambda G(\varepsilon_d(I - g, g)) \right) < 0 \tag{47}
\]
\[
\frac{\partial \varepsilon_d(\theta, I - g, g, T)}{\partial \theta} = -\frac{\lambda G(\varepsilon_d(I - g, g))}{r + \beta \mu(\theta) H(g) + \lambda G(\varepsilon_d(I - g, g))} < 0 \tag{48}
\]
\[
\frac{\partial S^0(\theta, I - g, g, T)}{\partial T} = -\frac{\lambda G(\varepsilon_d(I - g, g))}{r + \beta \mu(\theta) H(g) + \lambda G(\varepsilon_d(I - g, g))} < 0 \tag{49}
\]
\[
\frac{\partial \varepsilon_d(\theta, I - g, g, T)}{\partial T} = -\frac{r + \beta \mu(\theta) H(g)}{r + \beta \mu(\theta) H(g) + \lambda G(\varepsilon_d(I - g, g))} < 0 \tag{50}
\]

Equations (45) and (46) jointly determine the equilibrium pair \((g^*, \theta^*)\). As in the proof of Proposition 2, uniqueness derives from the fact that \(g\) maximizes the contact surplus \(H_S\). Consider the following functions
\[
\phi_1(g, \theta, T) = \frac{H'(g)}{H(g)} S^0(\theta, I - g, g, T) - \frac{f'(I - g)}{r + \lambda G(\varepsilon_d(\theta, I - g, g, T))} \tag{51}
\]
\[
\phi_2(g, \theta, T) = \frac{c \theta}{\mu(\theta)} - (1 - \beta) \frac{H}{H} S^0(\theta, I - g, g, T) \tag{52}
\]

Let \(J\) denote the Jacobian matrix of function \(\Phi \equiv (\phi_1, \phi_2)\) evaluated in equilibrium.
\[
J = \begin{bmatrix}
\frac{\partial \phi_1}{\partial g} & \frac{\partial \phi_1}{\partial \theta} \\
\frac{\partial \phi_2}{\partial g} & \frac{\partial \phi_2}{\partial \theta}
\end{bmatrix} \tag{53}
\]

where partial derivatives are computed by use of equations (47) and (48). It can be shown that
\[
\frac{\partial \phi_1}{\partial g} < 0 \tag{54}
\]
\[
\frac{\partial \phi_1}{\partial \theta} < 0 \tag{55}
\]
\[
\frac{\partial \phi_2}{\partial g} \equiv 0 \tag{56}
\]
\[
\frac{\partial \phi_2}{\partial \theta} \equiv (1 - \beta) \frac{H S^0(1 - \alpha)(r + \lambda G + \beta \mu H)}{r + \beta \mu H + \lambda G} > 0 \tag{57}
\]

By the implicit function theorem,
\[
\begin{bmatrix}
dg^*/dT \\
d\theta^*/dT
\end{bmatrix} = -J^{-1} \begin{bmatrix}
\frac{\partial \phi_1}{\partial T} \\
\frac{\partial \phi_2}{\partial T}
\end{bmatrix} \tag{58}
\]

where
\[
\frac{\partial \phi_1}{\partial T} < \frac{H'}{H} \frac{\partial S^0}{\partial T} < 0 \tag{59}
\]
\[
\frac{\partial \phi_2}{\partial T} \equiv - (1 - \beta) H \frac{\partial S^0}{\partial T} > 0 \tag{60}
\]

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and
\[ J^{-1} = \frac{1}{\det J} \begin{bmatrix} \partial \phi_2 / \partial \theta & -\partial \phi_1 / \partial \theta \\ -\partial \phi_2 / \partial g & \partial \phi_1 / \partial g \end{bmatrix} \] (61)

with \( \det J = (\partial \phi_1 / \partial g)(\partial \phi_2 / \partial \theta) < 0 \). Therefore,
\[ \frac{d\theta^*}{d\beta} \text{sign} = (\partial \phi_1 / \partial g)(\partial \phi_2 / \partial T) < 0 \] (62)

Similarly,
\[ \frac{dg^*}{d\beta} \text{sign} = (\partial \phi_2 / \partial g)(\partial \phi_1 / \partial T) - (\partial \phi_1 / \partial \theta)(\partial \phi_2 / \partial T) < 0 \] (63)

7.7 Proof of Proposition 6

(i) Equations (32)–(33) follow from the first-order conditions to the maximization problem. Equation (33) is rather long to derive because we must take into account the implicit function \( \theta(I) \) derived from the free-entry condition (MT).

(ii) The result follows from the fact that the objective is strictly concave at the minimum point.

7.8 Proof of Proposition 7

The proof is similar to Propositions 2, 3, and 5.

(i) Let \( J \) denote the Jacobian matrix of equations (SD')–(MT') evaluated in equilibrium. We obtain:
\[ J = \begin{bmatrix} \frac{(1-\alpha)(1-\beta)S}{\theta} - (1-\beta)S_g & -(1-\beta)S_g \\ \lambda_H S_g & \lambda_H S + \lambda S_g + f''/ (r + q) \end{bmatrix} \] (64)

with \( \lambda_H = H'(g)/H(g) \). We have \( \det J < 0 \) and so the equilibrium is unique. Then, \( d\theta^*/d\beta < 0 \), whereas \( dg^*/d\beta \) has the sign of \( \beta - (1-\alpha(\theta^*)) \).

(ii) The efficient allocation results from
\[ (g^*, \theta^*) \in \arg\max_{g, \theta} (1-u)f(I-g) - c\theta H(g)u, \] (65)

subject to the Beveridge curve (14).

The f.o.c. imply that
\[ (1-\alpha(\theta)) \frac{H'(g)}{H(g)} S(\theta, I-g, g, 1-\alpha(\theta)) = \frac{f'(I-g)}{n+q}, \] (66)
\[ \alpha(\theta) S(\theta, I-g, g, 1-\alpha(\theta)) = \frac{c}{\mu(\theta)}. \] (67)
Let $\tilde{\beta} \in \arg\max_{\beta} \beta \mu(\tilde{\theta}(g, \beta))$. The condition $\alpha'(\theta) \leq 0$ implies that $\tilde{\beta}$ is unique and solves $\tilde{\beta} = 1 - \alpha(\tilde{\theta}(g, \tilde{\beta}))$. By construction, $\tilde{\beta} = 1 - \alpha(\theta^*)$ when $g = g^*$. We also denote $\beta^* = 1 - \alpha(\tilde{\theta}(g^*, \beta^*))$.

Part (i) together with $\alpha'(\theta) \leq 0$ imply that $g^*(\beta^*) \leq g^*(\beta)$ for all $\beta \in (0, 1)$. Thus we simply have to prove that $g^* < g^*(\beta^*)$.

Let $\tilde{\theta}(g, \beta)$ be the implicit solution in $\theta$ of equation (SD). Let also

$$\psi_1(g) = A(g) - S(\tilde{\theta}(g, \beta^*), g, \beta^*) \quad (68)$$
$$\psi_2(g) = A(g) - (1 - \alpha^*)S(\tilde{\theta}(g, 1 - \alpha^*), g, 1 - \alpha^*) \quad (69)$$

with $\alpha^* = \alpha(\theta^*)$ and $A(g) = f'(I - g)(\lambda_H(g))^{-1}/(n + q)$. We have $\psi_1(g^*) = 0$ and $\psi_2(g^*) = 0$.

Both $\psi_1$ and $\psi_2$ are increasing in $g$ (because $A$ increases with $g$, whereas $S$ decreases with $g$). By construction, $\beta^* \mu(\tilde{\theta}(g^*, \beta^*)) \leq (1 - \alpha^*)\mu(\tilde{\theta}(g^*, 1 - \alpha^*))$. It follows that $S(\tilde{\theta}(g^*, 1 - \alpha^*), g^*, 1 - \alpha^*) \leq S(\tilde{\theta}(g^*, \beta^*), g^*, \beta^*)$. Thus $\psi_1(g^*) < 0$ and so $g^* > g^*$. 

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8 Side calculations – Not for publication

In this technical Appendix, we provide further details to the discussions in Section 4.

8.1 Unemployment benefits

We proceed in two steps. (i) We derive the equation for the match surplus given in the text. (ii) We provide further details about the numerical simulations.

(i) The wage results from Nash bargaining

\[
\max_w \{ \beta \ln (W - U) + (1 - \beta) \ln (J - V) \} \tag{70}
\]

The f.o.c yields

\[
\frac{\beta (1 - t_w)}{W - U} = \frac{(1 - \beta) (1 + t_e)}{J - V} \tag{71}
\]

Using equations (16) to (18), we obtain equations (19) and (20) in the text, which we reproduce here for convenience:

\[
W - U = \gamma S \tag{72}
\]
\[
J - V = (1 - \gamma) S \tag{73}
\]

where \( \gamma = \beta (1 - t_w) / [\beta (1 - t_w) + (1 - \beta) (1 + t_e)] \). Then, we use the fact that \( rS = r (W - U) + r (J - V) \). Together with (16) to (18), we obtain

\[
(r + q + \gamma \mu H) S = f - (t_w + t_e) w - b - rV \tag{74}
\]

This gives a first equation linking match surplus \( S \) to wage \( w \). The second equation derives from \( r (W - U) = \gamma r S \). Using (16) and (17), we obtain

\[
(r + q + \mu H) \gamma S = w (1 - t_w) - b \tag{75}
\]

Solving in \( S \), we get equation (21) in the text, which we reproduce here:

\[
S = \frac{\beta (1 - t_w) + (1 - \beta) (1 + t_e) f - b \frac{1 + t_e}{1 - t_w} - rV}{r + q + \beta \mu H} \tag{76}
\]

(ii) The equilibrium pair \((\theta^*, g^*)\) solves

\[
\frac{H'(g)}{H(g)} \frac{f (I - g) - b \frac{1 + t_e}{1 - t_w}}{r + q + \beta \mu (\theta) H(g)} + \beta^{-1} \frac{H'(g) b \frac{1 + t_e}{1 - t_w} r [r + q + \beta \mu (\theta) H(g)]}{H(g) [r + \mu (\theta) H(g)]^2} = \frac{f'(I - g)}{r + q} \tag{77}
\]

\[
\frac{c \theta}{\mu (\theta)} = (1 - \gamma) H(g) S(\theta, I - g, g) \tag{78}
\]

\[
= (1 - \beta) H(g) \frac{f (I - g) - b \frac{1 + t_e}{1 - t_w}}{r + q + \beta \mu (\theta) H(g)} \tag{79}
\]
UB respond to $b = \rho w (1 - t_w)$. Using the wage equation (75) and the match surplus equation (76), we obtain

$$w (1 - t_w) = \frac{\beta (r + q + \mu H)}{(r + q) (1 - (1 - \beta) \rho) + \beta \mu H \frac{1 - t_w}{t_c}}.$$

Replacing $b$ by $\rho w (1 - t_w)$ in equations (77) and (79), we obtain

$$H' (g) \frac{(1 - \rho) f (I - g)}{H (g) (r + q) B + \beta \mu H} + \frac{H' (g)}{H (g)} \frac{r + q + \mu H}{r + q} \frac{\rho f}{\rho} \frac{r [r + q + \beta \mu H (g)]}{[r + \mu (\theta) H (g)]^2}$$

$$= 0 \quad \frac{c \theta}{\mu (\theta)} = (1 - \beta) H (g) \frac{(1 - \rho) f (I - g)}{(r + q) B + \beta \mu H}$$

with $B = 1 - (1 - \beta) \rho$. 

With $\mu (\theta) = M_0 \theta^{1/2}$, equation (79) is equivalent to

$$\beta H c \theta + \frac{c}{M_0} (r + q) B \theta^{1/2} - (1 - \beta) H (1 - \rho) f = 0$$

This equation can be solved in $\theta$. This gives

$$\mu (\theta (g)) = \frac{-(r + q) B + [(r + q)^2 B^2 + 4 \beta (1 - \beta) (1 - \rho) M_0^2 H f / c]^{1/2}}{2 \beta H}$$

The resolution can be simplified to finding $g^*$ such that

$$\phi (g) = \lambda_H (g) (1 - \rho) \frac{r + q}{(r + q + \mu \theta (g)) (r + q + \beta \mu \theta (g))}$$

$$+ \frac{r + q}{[r + \mu \theta (g)] H (g)]^2} \rho$$

$$- \frac{(r + q) B + \beta \mu \theta (g) H (g)}{r + q} \lambda_f (I - g)$$

$$= 0$$

with $\lambda_H (g) = H' (g) / H (g)$ and $\lambda_f (s) = f' (s) / f (s)$. The functions indicated in the text are such that $H (g) = 1 - \exp (-\kappa g)$ and $f (s) = 1 - \exp (-\nu s)$. This implies that

$$\lambda_H (g) = \frac{\kappa \exp (-\kappa g)}{1 - \exp (-\kappa g)}$$

$$\lambda_f (I - g) = \frac{\nu \exp (-\nu (I - g))}{1 - \exp (-\nu (I - g))}$$

We use Matlab to find the numerical solution of (85) as a function of $\rho$ for various values of $r$. 30
8.2 Employment protection

We derive the various equations given in the text. Workers’ value functions are

\[
rW(s, g, \varepsilon) = w(s, g, \varepsilon) + \lambda \int_{\varepsilon^0}^{\varepsilon} W(s, g, \bar{\varepsilon})dG(\bar{\varepsilon}) + G(\varepsilon^d(s, g))U(s) - W(s, g, \varepsilon)
\]

(89)

\[
rW^0(s, g) = w^0(s, g) + \lambda \int_{\varepsilon^0}^{\varepsilon} W(s, g, \bar{\varepsilon})dG(\bar{\varepsilon}) + G(\varepsilon^d(s, g))U(s) - W^0(s, g, \varepsilon)
\]

(90)

\[
rU(s, g) = \mu H(g) [W^0(s, g) - U(s, g)]
\]

(91)

Firms’ value functions are

\[
rJ(s, g, \varepsilon) = f(s) + \varepsilon - w(s, g, \varepsilon)
\]

(92)

\[
rJ^0(s, g) = f(s) + \varepsilon - w^0(s, g, \varepsilon)
\]

(93)

Match surpluses are given in the text. We reproduce them here:

\[
S^0(s, g) = W^0(s, g) - U(s, g) + J^0(s, g) - V
\]

(94)

\[
S(s, g, \varepsilon) = W(s, g, \varepsilon) - U(s, g) + J(s, g, \varepsilon) - V + T
\]

(95)

Nash bargaining implies that

\[
W^0(s, g) = \beta S^0(s, g)
\]

(96)

\[
W(s, g, \varepsilon) = \beta S(s, g, \varepsilon)
\]

(97)

Finally, the productivity threshold derives from

\[
S(s, g, \varepsilon^d) = 0
\]

(98)

Mixing the different conditions leads to the following equation for match surplus

\[
(r + \lambda) S(s, g, \varepsilon) = f(s) + \varepsilon - r[U(s, g) - T] + \frac{\lambda}{r + \lambda} \int_{\varepsilon^d(s, g)}^{\varepsilon^0} [1 - G(\bar{\varepsilon})] d\bar{\varepsilon}
\]

(99)

Using (i) \( S^0(s, g) = S(s, g, \varepsilon_0) - T \), (ii) equations (91), (96) and (97), we finally obtain the equations given in the text, that is

\[
S^0(s, g) = \frac{\varepsilon_0 - \varepsilon^d(s, g) - (r + \lambda)T}{r + \lambda}
\]

(100)

\[
\varepsilon^d(s, g) = \beta \mu H(g) S^0(s, g) - f(s) - rT - \frac{\lambda}{r + \lambda} \int_{\varepsilon^d(s, g)}^{\varepsilon^0} [1 - G(\bar{\varepsilon})] d\bar{\varepsilon}
\]

(101)
The equation defining initial match surplus is standard (see for instance the analogous equation in Wasmer, 2006). The second equation is also standard, even though we have expressed it somewhat differently for greater concision. These equations can also be expressed less elegantly:

$$S^0(s,g) = \frac{f(s) + \varepsilon_0 - \lambda T + \frac{1}{r + \lambda} \int_{\varepsilon^d(s,g)}^{\varepsilon_0} [1 - G(\varepsilon)] \, d\varepsilon}{r + \lambda + \beta \mu H(g)}$$

$$\varepsilon^d(s,g) \left[ r + \lambda + \beta \mu (\theta) H(g) \right] + \lambda \int_{\varepsilon^d(s,g)}^{\varepsilon_0} [1 - G(\varepsilon)] \, d\varepsilon = \beta \mu H(g) \varepsilon_0$$

Both initial match surplus and threshold productivity level diminish with dismissal costs $T$.

The f.o.c. to the maximization program can be expressed:

$$H'(g) \, S^0(I - g, g) = H(g) \left[ \frac{\partial S^0(I - g, g)}{\partial s} + \frac{\partial S^0(I - g, g)}{\partial g} \right]$$

Using the fact that

$$\frac{\partial S^0(s,g)}{\partial s} = \frac{f'(s)}{r + \beta \mu H(g) + \lambda G(\varepsilon^d(s,g))}$$

$$\frac{\partial S^0(s,g)}{\partial g} / S^0(s,g) = \frac{H'(g)}{H(g)} \frac{\beta \mu H(g)}{r + \beta \mu H(g) + \lambda G(\varepsilon^d(s,g))}$$

We finally obtain the equation given in the text:

$$\frac{H'(g)}{H(g)} S^0(I - g, g) = \frac{f'(I - g)}{r + \lambda G(\varepsilon^d(I - g, g))}$$
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<th>rep. rate</th>
<th>epl index</th>
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*The value of the enrolment rate has been imputed. The variable grad. prop. is the proportion of upper-secondary graduates with a general education. The variable enrol. rate is the proportion of students in a general programme among the students in upper-secondary education. The rep. rate variable is the OECD index for unemployment benefit entitlements, and epl is an EPL index based on OECD indices.

Table 2: General education at upper-secondary level, UB replacement rate, and EPL index for 2000