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Anurag Banerjee, Parantap Basu & Elisa Keller

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Department Economics and Finance
Durham University Business School
Mill Hill Lane
Durham DH1 3LB, UK
Tel: +44 (0)191 3345200
https://www.dur.ac.uk/business/research/economics/

Cross-country Disparities in Skill Premium and Skill Acquisition

Anurag Banerjee*, Parantap Basu† & Elisa Keller ‡

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Abstract

Skilled individuals are rewarded more in poor countries than in rich countries. Why aren't more individuals acquiring skills in poor countries? We study the role of unemployment risk. In a sample of 33 countries, we document that the unemployment rate of the skilled net of that of the unskilled decreases with a country's level of development. Using a matching model of endogenous occupational choice and skill acquisition, we argue that the cost of doing business is a first order determinant of these unemployment rates and, therefore, of the skill acquisition decision. We then quantify the model and find that decreasing each country's gap in the cost of doing business to the US by 10% decreases the gap in skill acquisition between rich and poor countries of between 48% and 63%.

JEL: O11, J31, J24, E24.

Key words: Skill acquisition. Unemployment. Business cost.

*Durham University Business School. Email: a.n.banerjee@durham.ac.uk.

†Durham University Business School. Email: parantap.basu@durham.ac.uk.

‡University of Exeter, Department of Economics. Email: e.keller@exeter.ac.uk.

1 Introduction

Cross-country data on wages and schooling indicate that although poor countries have higher skill premium than rich countries, the fraction of skilled individuals is substantially lower in poor countries. A 1% increase in income per worker is associated with a 0.44 percentage-point *decrease* in the ratio of tertiary- and secondary-educated lifetime earnings relative to primary-educated lifetime earnings ("skill premium") and with an *increase* of 0.07 percentage points in the fraction of men with secondary and tertiary schooling ("skilled" individuals).[1] If skilled individuals are rewarded more in poor countries, why aren't more individuals acquiring skills in these countries?

In this paper, we argue that disparities in unemployment rates by skill level are quantitatively important for generating the cross-country pattern of skill acquisition given the observed skill premium. Consider a simple back-of-the-envelope calculation in which individuals choose whether or not to acquire skill in order to maximize expected earnings. Expected earnings (E^j) of individuals of skill level $j \in \{\text{un-skilled}, \text{skilled}\}$ are: $E^j = e^j \times (1 - u^j) + 0 \times (u^j)$. In this identity, u is the probability of unemployment and e is full-time earnings. Thus, skill is acquired if $\left(\frac{e^{\text{skilled}}}{e^{\text{un-skilled}}}\right)\left(\frac{1-u^{\text{skilled}}}{1-u^{\text{un-skilled}}}\right) \geq 1$. A measure of the first term of this inequality, $\left(\frac{e^{\text{skilled}}}{e^{\text{un-skilled}}}\right)$, is the skill premium. As this increases with a country's income per worker, the above inequality counter-factually implies more people acquiring skill in poor countries compared to rich countries, for fixed unemployment rates.

Using the World Development Indicator dataset provided by the World Bank, we measure the second term of the inequality above, $\left(\frac{1-u^{\text{skilled}}}{1-u^{\text{un-skilled}}}\right)$, by constructing unemployment rates for skilled and unskilled men in a sample of 52 countries over the period 2000-2010. Figure 1 plots the unemployment rate of skilled workers net of that of unskilled workers ("unemployment differential") and shows a negative association with income per worker.[2] Skilled individuals

[1]Details are in Figures 5a and 5b in the Appendix. Many in the literature report cross-country patterns in skill composition and skill premia similar to ours (see, among others, Caselli, 2005, and Fernández, Guner, and Knowles, 2005). Moreover, in our sample, comparable cross-country trends in skill composition emerge for different definitions of skill. Figure 7 in the Appendix shows skill composition across countries when skilled individuals are defined as male individuals with tertiary schooling and unskilled individuals are their complement.

[2]Figure 6 in the Appendix plots skilled and unskilled unemployment against the logarithm of income per capita while Table 6 summarizes the cross-country correlations of unemployment rates by skill level, fraction of skilled individuals and skill premium. Similar cross-country patterns of unemployment of skilled and unskilled individuals emerge for the alternative definition of skilled individuals as tertiary-educated men and of unskilled individuals as the complement (see Figure 8 and Table 7 in the Appendix). Recently, Feng,

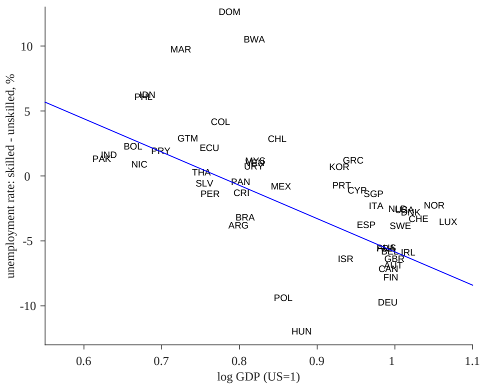


Figure 1: Unemployment differential. For each country, unemployment rates are measured between year 2000 and year 2010 for male individuals and calculated as averages during these years. Source: the World Bank.

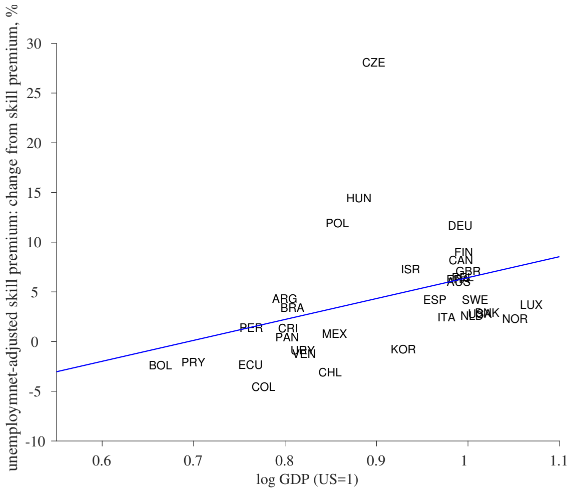


Figure 2: Skill premium and unemployment risk. For each country, the figure shows the unemployment-adjusted skill premium, which is the product of the skill premium and the ratio of employment rates of skilled to unskilled workers. Source: the World Bank and Fernández, Guner, and Knowles (2005).

consistently face a higher risk of unemployment than unskilled individuals in poor countries compared to rich countries. Taking into account this unemployment risk, Figure 2 plots the unemployment-adjusted skill premium (that is, the left-hand-side of the inequality above) as a deviation from the skill premium. The size of this deviation substantially *increases* with a country's level of development, therefore closing the disparities in measured rewards to skill acquisition between rich and poor countries.

In light of this evidence, we investigate the quantitative role of unemployment by skill level in reconciling a lower skill acquisition despite a higher skill premium in poor compared to rich countries. Unemployment certainly affects the rewards to skill acquisition but it also determines the riskiness of such investment. We consider a simple matching model of occupational choice and skill acquisition that encompasses both effects. Exogenous business cost, schooling cost and skill-productivity profile endogenously determine the fraction of skilled individuals, skill premium and unemployment rates by skill level in a country. We include the business cost as it can easily be considered a first-order determinant of unemployment rates. For example, Fonseca, Lopez-Garcia, and Pissarides (2001) report a negative correlation between start-up business costs and employment levels across major OECD economies

Lagakos, and Rauch (2018) also reported similar patterns of unemployment by skill levels using household level data.

and show that, in a standard equilibrium search framework with endogenous occupational choice, start-up business costs and employment are monotonically related. On the other hand, schooling cost and individuals' lifetime productivities have been identified as important drivers of skill acquisition across countries (see, among others, Bils and Klenow, 2000). Through the lenses of our model we infer a higher business cost in poor countries and find that disparities in such cost accounts for 56% of the cross-country negative correlation between skill premium and skill acquisition.

Our quantitative exercise relies on a matching model of endogenous occupational choice and skill acquisition. In our model, ex-ante identical individuals can improve their skill and/or become an entrepreneur by incurring, respectively, a schooling and a business cost. Workers and entrepreneurs randomly and anonymously match in the labour market to produce output (a match productivity) in relation to both their skills. Given match productivities, schooling and business costs determine the relative supplies of skilled and unskilled workers and entrepreneurs. We show that the business cost influences the unemployment rate differential (i.e. the difference in the unemployment rates of skilled and unskilled workers) and ultimately the fraction of skilled individuals in relation to the shape of the skill-match productivity profile and the extent of risk aversion. Under risk neutrality and a structure of match productivities that is log supermodular in worker's skill, a higher business cost increases the unemployment rate differential. The fraction of skilled workers decreases and that of skilled entrepreneurs increases and, overall, the fraction of skilled individuals decreases.

We use our model to assess the role of the business cost for skill acquisition across countries. To do so, we first calibrate our model. We allow countries to differ by their schooling cost, business cost, and match productivities. We calibrate these country-specific parameters so that the model implied fraction of skilled individuals, unemployment rates of skilled and unskilled workers, fraction of skilled entrepreneurs, and skill premium are as close as possible to replicating these same moments observed in each country in our sample. We calibrate a higher business cost for poor countries compared to rich countries, consistently with anecdotal evidence provided by the World Bank and the study of Djankov, Porta, de Silanes, and Shleifer (2002) on regulatory costs of entry to business. The cross-country correlation between the calibrated business cost and the observed logarithm of GDP per worker is –0.405. At the same time, poor countries calibrate lower productivities of matches where at least one party between the worker and the entrepreneur is skilled ("skilled matches"). In our framework, cross-country disparities in match productivities can be linked to disparities in the bias toward skill of the production technology as well as in individuals' productivities. The positive correlation between productivities of skilled matches and a country's level of development that we calibrate is therefore consistent with Caselli and Coleman (2006) who, for a cross-section of 52 countries in the late 1980s, find that the bias toward skill of the production technology increases with a country's GDP per worker and with the development literature measuring a higher quality of the educational system in rich countries (see, among others, Caselli, 2005). Lastly, we calibrate no consistent variation in the cost of schooling along the development spectrum. We interpret this findings by considering that the schooling cost in our model maps to both direct schooling costs, such as tuitions, which tend to decrease as a fraction of income with development, and foregone earnings, which instead increase with development (see, among others, Lee and Barro, 2001).

Our calibrated model is in line with the cross-country covariation between skill acquisition and premium as well as with the cross-country variation in the unemployment rate differential. We then use our model to run an accounting exercise to study the role of the business cost for skill acquisition. We find decreasing each country's gap in the business cost to the US by 10% decreases the gap in skill acquisition between rich and poor countries by between 48% and 63%. The channel through which the business cost affects skill acquisition is via the unemployment differential: a decreased business cost decreases the unemployment rate of skilled workers relative to that of unskilled workers and so boosts the returns to acquiring skill. In the same alternative experiment where we decrease the gap in business cost to the US by 10%, the gap in the unemployment differential decreases of 3p.p., or by 56%.[3]

The importance of the business cost for skill acquisition makes the business cost a key driver of the cross-country correlation between skill acquisition and premium, accounting for 56% of it. That is, when the cross-country gap in the business cost to the US is reduced by 10%, this correlation reduces from a significant -0.400 to a non-significant -0.174. A second important driver of the skill acquisition-premium correlation is the productivity of skilled matches, as it shapes the evolution of the skill premium across the development spectrum. We find that a 10% closure in this match productivity gap to the US level, decreases the gap in the skill premium between rich and poor countries by between 23% and 45%.

[3]The business cost, as a determinant of the economic environment in which firms operate, has been found relevant in explaining various cross-country economic outcomes. The seminal paper of Hall and Jones (1999) shows that countries with good social infrastructures have high human capital and output per worker. Studies on cross-country market regulations include, among others, Bertrand and Kramarz (2002), Botero, Djankov, Porta, de Silanes, and Shleifer (2004) and Fang and Rogerson (2011).

Literature review. Our paper relates to the literature in macroeconomics and development addressing disparities in skill acquisition and skill premium across countries. It complements this literature by analyzing the role of business cost in a model that is consistent with cross-country patters of unemployment rates by skill level along with skill premium and skill acquisition. Prominent papers in the skill acquisition literature, such as Restuccia and Vandenbroucke (2014), focus on the role of productivity and life expectancy for skill acquisition but do not consider the effect of unemployment and its determinants. By simultaneously considering cross-country patterns of skill acquisition and skill premium, we show that this additional dimension is indeed relevant.

Studies on the skill premium mainly focus on time series trends and identify the key role of skill-biased technical change for the rise of the skill premium in both rich (see, among others, Acemoglu, 2002, Goldin and Katz, 2008, and Krusell, Ohanian, Rios-Rull, and Violante, 2000) and in poor countries (Burstein, Cravino, and Vogel, 2013). Consistent with this literature, our paper accommodates the possibility of different biases of technology toward skill across countries via country- and skill-specific match productivities. Differently, we focus on cross-sectional data and aim at measuring the importance of match productivities for cross-country patterns of the skill premium, in comparison to that of schooling and business cost.

Within the equilibrium search literature, our model is close to that in Fonseca, Lopez-Garcia, and Pissarides (2001), which endogenizes sorting between entrepreneurs and workers through heterogeneity in entrepreneurial ability that does affect the output of a match. Differently, we endogenize a facet of heterogeneity via a skill acquisition decision that induces heterogeneity on both workers and entrepreneurs.[4] This allows us to describe the equilibrium effects of costs related to the acquisition of skills.

The rest of the paper is organized as follows. Section 2 outlines the model. Section 3 calibrates the model and details the results of the quantitative experiment. Section 4 concludes.

[4] Up to the skill acquisition decision, our model is a static version of Fonseca, Lopez-Garcia, and Pissarides (2001)'s framework under a degenerate distribution of entrepreneurial ability.

2 Model

We consider a matching model of occupational choice and skill acquisition. There are continuum of individuals of measure one. Individuals are ex ante identical and live for one period. They are endowed with y_0 units of goods and one unit of time. Individuals take two decisions simultaneously: (i) skill acquisition decision as to whether to incur a schooling cost sc to acquire additional skill, and (ii) occupational decision as to whether to incur a business cost c to run a business. If the schooling cost is incurred, the individual gains the status of "skilled", (s), otherwise he remains "unskilled". If the business cost is incurred, the individual acquires the status of "entrepreneur", (f), – that is, a firm's owner/manager, otherwise he remains a "worker". Entrepreneurs manage firms and create jobs (one per firm); workers occupy jobs to make them productive. Individuals take their skill acquisition and occupational decisions on the basis of their expected payoffs. These two decisions give rise to a set of four individual types, $T = \{t : sf, sw, uf, uw\ \}$: (i) skilled entrepreneur (sf), incurring costs c and sc, (ii) skilled worker (sw), incurring cost sc, (iii) unskilled entrepreneur (uf), incurring cost c, and (iv) unskilled worker (uw), incurring no costs.

After the skill acquisition and occupational decisions are made, all individuals enter the labor market. Entrepreneurs and workers meet randomly and anonymously. That is, given market tightness Θ, defined as the ratio of workers to entrepreneurs in the labour market, the number of matches in the labour market equals $p_f \times \frac{1}{1+\Theta}$, where p_f is the fraction of entrepreneurs. This matching function respects the constant returns to scale assumption typical of the search literature (see Mortensen and Pissarides, 1999).

A non-negative output $y_{ij} \in \{y_{uu}, y_{su}, y_{us}, y_{ss}\}$ is produced when an entrepreneur with skill status ($i \in \{sf, uf\}$) meets a worker with a skill status $j \in \{sw, uw\}$. For notational simplicity we drop the f and w from the subscript of output and denote the skill level of the entrepreneur (worker) in the first (second) subscript. A firm's output is split between the worker and the entrepreneur: the latter pays the former a wage, w_{ij}, determined via Nash bargaining. Workers with non-productive matches are deemed unemployed since their labour is unused. Entrepreneur are always engaged since their labor is used up to open and manage the firm.

Let p_{jw} be the mass of individuals who choose to be workers with skill j and p_{if} the mass of individuals who choose to be entrepreneurs with skill i, for j, $i \in \{s, u\}$. They describe the skill and occupational distribution of individuals, which is determined in equilibrium and will be discussed later. An entrepreneur matches with a skilled worker with probability p_{sw} and with an unskilled worker with probability p_{uw}. With the complementarity probability $1 - p_{sw} - p_{uw}$ the firm remains vacant. Analogously, a worker matches with a skilled entrepreneur with probability p_{sf} and with an unskilled entrepreneur with probability p_{uf}. With probability $1 - p_{sf} - p_{uf}$ the worker remains unemployed. After matching, production takes place.

We now turn to the expected payoff of the individuals of all four types from various matches. Let $\Phi(\cdot)$ be a strictly concave utility function with the standard regularity conditions. An entrepreneur's value of the match is represented by the following utility matrix:

	Entrepreneur	
Matched with	unskilled (uf)	skilled (sf)
unskilled worker (uw)	$J_{uu} = \Phi\left(y_{uu} - w_{uu} - y_0 - c\right)$	$J_{su} = \Phi\left(y_{su} - w_{su} + y_0 - c - sc\right)$
skilled worker (sw)	$J_{us} = \Phi\left(y_{us} - w_{us} + y_0 - c\right)$	$J_{ss} = \Phi\left(y_{ss} - w_{ss} + y_0 - c - sc\right)$
unmatched (vacant)	$V_u = \Phi\left(y_0 - c\right)$	$V_s = \Phi\left(y_0 - c - sc\right)$

The term $w_{ij} \in \mathbf{w} \equiv \{w_{uu}, w_{su}, w_{us}, w_{uu}\}$ indicates the wage of a worker of skill j employed in a firm with an entrepreneur of skill i. Notice that as we assumed that y_{uu} equals zero, the maximum wage an unskilled entrepreneur is willing to pay an unskilled worker is zero. The expected utility of an entrepreneur given his skill is:

$$J_u = p_{sw} J_{us} + p_{uw} J_{uu} + \left(1 - p_{sw} - p_{uw}\right) V_u, \tag{1}$$

$$J_s = p_{sw} J_{ss} + p_{uw} J_{su} + \left(1 - p_{sw} - p_{uw}\right) V_s. \tag{2}$$

Similarly, a worker's value of matching with an entrepreneur is represented by the following utility matrix:

	Worker	
Matched with	unskilled (uw)	skilled (sw)
unskilled entrepreneur (uf)	$E_{uu} = \Phi\left(w_{uu} + y_0\right)$	$E_{us} = \Phi\left(w_{us} - sc + y_0\right)$
skilled entrepreneur (sf)	$E_{su} = \Phi\left(w_{su} + y_0\right)$	$E_{ss} = \Phi\left(w_{ss} - sc + y_0\right)$
unmatched (unemployed)	$U_u = \Phi\left(y_0\right)$	$U_s = \Phi\left(y_0 - sc\right)$

The expected utility of a worker given his skill is:

$$W_u = p_{sf} E_{su} + p_{uf} E_{uu} + (1 - p_{sf} - p_{uf})\, U_u, \tag{3}$$
$$W_s = p_{sf} E_{ss} + p_{uf} E_{us} + (1 - p_{sf} - p_{uf})\, U_s, \tag{4}$$

such that $p_{sw} + p_{uw} + p_{sf} + p_{uf} = 1$, as agents in a unit interval must be distributed over the sample space of types $\{sw, uw, sf, uf\}$.

The total surplus of a match, $J_{ij} + E_{ij} - V_i - U_j$, is divided between the worker and the entrepreneur. We assume the wage is determined via Nash bargaining between the worker and the entrepreneur (Mortensen and Pissarides, 1999):

$$\begin{aligned}
w_{ss} &= \arg\max \left[(J_{ss} - V_s)^{\theta} (E_{ss} - U_s)^{1-\theta} \right], \\
w_{us} &= \arg\max \left[(J_{us} - V_u)^{\theta} (E_{us} - U_u)^{1-\theta} \right], \\
w_{su} &= \arg\max \left[(J_{su} - V_s)^{\theta} (E_{su} - U_u)^{1-\theta} \right], \\
w_{uu} &= \arg\max \left[(J_{uu} - V_u)^{\theta} (E_{uu} - U_u)^{1-\theta} \right],
\end{aligned} \tag{5}$$

where $\theta \in [0, 1]$ is a parameter that measures the entrepreneur's bargaining power.

Equilibrium. In equilibrium, each individual optimally chooses its skill acquisition and occupation to maximize his expected utility of a match given the distribution of choices of other individuals. We only focus on an interior equilibrium where a non-degenerate probability distribution of other individual types, $\mathbf{p} \equiv \{p_{uf}, p_{sf}, p_{sw}, p_{uw}\}$, exists within the set of probability distributions $\mathcal{P}$ such that no agent has any incentive to deviate from his chosen option.

Formally, such an equilibrium is a vector $\{\mathbf{p}, \mathbf{w}\}$ that satisfies the following restrictions.

1. Given $\{\mathbf{p}, w_{uu}, w_{su}, w_{us}, w_{uu}\}$, each individual chooses the best response option as follows:

   (a) choose sf if $J_s \geq max(J_u, W_s, W_u)$,

   (b) choose sw if $W_s \geq max(J_u, J_s, W_u)$,

   (c) choose uf if $J_u \geq max(W_s, J_s, W_u)$,

   (d) choose uw if $W_u \geq max(W_s, J_s, J_u)$.

Therefore individuals have no incentives to deviate from their chosen option if the following value matching condition holds:

$$J_s = J_u = W_s = W_u.$$

2. Wages, w_{ij}, are determined by Nash bargaining as shown in eq. 5.

The equilibrium distribution of skill acquisition and occupational choices $\mathbf{p}$ is a fixed point within the set of probability distributions $\mathcal{P}$. Since individuals are non-atomistic, only individuals with zero measure can deviate in equilibrium. Note that the game is symmetric and therefore by Mas-Colell (1984) (Theorem 2) the equilibrium exists. Such an interior equilibrium is unique. We characterize the exact solution when individuals are risk neutral in Appendix A.1.

Discussion. The focus of our paper is on the determinants of skill acquisition, skill premium and unemployment rates by skill level. In the following, we consider the response of these three variables to changes in the business cost.

We start by defining skill acquisition, skill premium and unemployment rates by skill level in the contest of our model. Skill acquisition is given by the fraction of skilled individuals. As the population has total measure of one, the proportion of skilled individuals, p_s, is the sum of skilled workers and skilled entrepreneurs:

$$p_s = p_{sw} + p_{sf}. \tag{6}$$

We compute the skill premium as the average earnings of employed skilled individuals relative to that of employed unskilled individuals:

$$skp = \frac{E_s}{E_u}, \tag{7}$$

where

$$\begin{aligned} E_s &= \frac{(y_{ss} - w_{ss})\, p_{sf} p_{sw} + (y_{su} - w_{su})\, p_{sf} p_{uw} + w_{us} p_{sw} p_{uf} + w_{ss} p_{sf} p_{sw}}{p_{sw}(p_{sf} + p_{uf}) + p_{sf}}, \\ E_u &= \frac{(y_{us} - w_{us}) p_{uf} p_{sw} + (y_{uu} - w_{uu}) p_{uf} p_{uw} + w_{uu} p_{uw} p_{uf} + w_{su} p_{uw} p_{sf}}{p_{uw}(p_{sf} + p_{uf}) + p_{uf}}. \end{aligned}$$

The numerator of the first (second) equation is the weighted sum of the earnings of (un-)

skilled individuals, where the weights are the relevant match probabilities. The denominator of the same equation is the proportion of employed (un-) skilled individuals. The earnings of a worker are his wage while the earnings of an entrepreneur are the firm's profit flow, $y - w$. Last, the unemployment rate of (un) skilled individual, u_s (u_u), is the proportion of skilled workers that are not matched with a firm out of all (un) skilled individuals:

$$u_s = \frac{p_{sw}(1 - p_{uf} - p_{sf})}{p_s}, \tag{8}$$

$$u_u = \frac{p_{uw}(1 - p_{uf} - p_{sf})}{p_u}. \tag{9}$$

Recall that entrepreneurs are always employed in our model as they spend their time managing and opening the firm independently of whether a worker is hired or not.

Next, for illustration, we study response of the endogenous moments of interest in equations 6 to 9 with respect to the business cost. To do so, we solve for the interior equilibrium of our model under risk neutrality (a linear utility function) and an entrepreneur's share in bargaining equal to $\theta = 50\%$ (as in the quantitative exercise). The assumption of risk neutrality allows us to solve for the equilibrium in closed form solution. Equilibrium wages are linear in output: $w_{ij} = (1-\theta)y_{ij}$. We report the equilibrium probabilities, p, in Appendix A.1 to simplify the technical details of the derivation.

Proposition 1 *Assume risk neutrality and a share bargaining parameter equal to* $\theta = 0.5$. *(i) Assume the skill productivities are log supermodular in worker's skill, such that* $\log(y_{ss}) - \log(y_{su}) > \log(y_{su}) - \log(y_{us}) > \log(y_{us}) - \log(y_{uu}) > 0$.[5] *Then,*

$$\frac{\partial p_s}{\partial c} < 0,$$

and, in the in the neighborhood of $c = 0$ *and* $sc = 0$,

$$\left.\frac{\partial skp}{\partial c}\right|_{c=0,sc=0} > 0.$$

(ii) Further assume that y_{ss} *is high enough, such that* $y_{ss} > \frac{(y_{su}+y_{us})^2-4y_{su}y_{uu}}{y_{us}-y_{uu}}$. *Then, in the*

[5]The assumption of log supermodularity implies that the skill acquisition decisions of workers and entrepreneurs reinforce one another. We further impose that $y_{su} > y_{us}$ and characterize the log supermodularity to be in worker's skill.

in the neighborhood of $c = 0$ *and* $sc = 0$,

$$\left.\frac{\partial u_s - u_u}{\partial c}\right|_{c=0,sc=0} > 0.$$

Proof: see Appendix A.1.

The response of the proportion of skilled individuals to a change in the business cost, c, is:

$$\begin{aligned}\frac{\partial p_s}{\partial c} &= \underbrace{\frac{y_{uu} - y_{su}}{y_{ss}y_{uu} - y_{su}y_{us}}}_{\frac{\partial p_{sw}}{\partial c}} + \underbrace{\frac{y_{us} - y_{uu}}{y_{ss}y_{uu} - y_{su}y_{us}}}_{\frac{\partial p_{sf}}{\partial c}}, \\ &= \frac{y_{us} - y_{su}}{y_{ss}y_{uu} - y_{su}y_{us}}.\end{aligned}$$

The first term in the above equation shows the response of workers, $\frac{\partial p_{sw}}{\partial c}$, whereas the second term shows the response of entrepreneurs, $\frac{\partial p_{sf}}{\partial c}$. Two things are important to notice. First, the log supermodularity assumption, a form of strategic complementarity, implies that the denominator of the above equation is positive and so the fraction of skilled workers decreases with the business costs while that of entrepreneurs increases. This assumption also implies that the fraction of the skilled among entrepreneurs increases with an increasing business cost, while the overall fraction of entrepreneurs decreases (see Appendix A.1). Second, the overall change in the fraction of skilled individuals with the business cost depends on the relative sizes of the responses of workers and entrepreneurs as determined by the productivities of their intermediate matches (su and us). These productivities shape the returns to skill acquisition under risk neutrality as the productivity of a match is proportionally split between the entrepreneur and the worker. The match productivity pair for a worker goes from (y_{uu}, y_{su}) to (y_{us}, y_{ss}) when he becomes skilled, whereas that of an entrepreneur goes from (y_{uu}, y_{us}) to (y_{su}, y_{ss}). When y_{su} is greater than y_{us}, workers respond more strongly than entrepreneurs to a change in the business cost. Therefore, the overall fraction fo skilled individuals decreases.

Proposition 1 implies that our model can generate a negative correlation between the fraction of skilled individuals and both the unemployment rate differential and the skill premium, in a world where countries only differ by their business cost. Indeed, in the neighborhood of $c = 0$ and $sc = 0$:

$$\frac{\partial p_s}{\partial c} / \frac{\partial u_s - u_u}{\partial c} < 0, \quad \frac{\partial p_s}{\partial c} / \frac{\partial skp}{\partial c} < 0.$$

This result holds under the further assumption of a high enough value for the match productivity of skilled workers and entrepreneurs, y_{ss}. A high enough value for y_{ss} also assures that as the business cost rises, the unemployment rates of both skilled and unskilled workers rise (see Appendix A.1). This is consistent with the findings of the standard equilibrium search framework under endogenous occupational choice (see, for example, Fonseca, Lopez-Garcia, and Pissarides, 2001).

3 The role of business cost for skill acquisition

We run a quantitative experiment with the objective of understanding the main forces that account for the negative cross-country correlation between skill acquisition and premium. Our quantitative strategy consists of three steps. First, we calibrate cross-country disparities in schooling cost, business cost and match productivities to cross-country disparities in skill acquisition, skill premia and unemployment. Then, we measure the importance of the business cost along with the schooling cost and the match productivities, for skill acquisition and expected returns to such investment via multiple accounting exercises in which we counterfactually decrease cross-country disparities in each of these three exogenous factors.

Data. We construct a dataset of skill acquisition by entrepreneurial status, unemployment rate by skill, and skill premium. We focus on male individuals and define an individual as skilled if he holds either secondary or tertiary-education. We collect data on skill acquisition and the unemployment rate by skill from the World Bank World Development Indicators dataset. We compute the relevant statistics as country averages over the years 2000-2010, based on data availability. We use data on the lifetime income ratio of individuals with more than a high-school education relative to those with less than a high-school education from Fernández, Guner, and Knowles (2005), measured between year 1992 and year 1998. We collect data on the skill distribution of entrepreurs from the Global Entrepreneurish Monitor dataset (GEM). We consider established business only.

Our sample includes 33 countries at different stages of development: Argentina, Australia, Belgium, Bolivia, Brazil, Great Britain, Canada, Chile, Colombia, Costa Rica, Check Republic, Denmark, Ecuador, Finland, France, Germany, Hungary, Israel, Italy, Luxembourg, Mexico, Netherlands, Norway, Panama, Paraguay, Peru, Poland, Spain, Croatia, Sweden, Uruguay, United States, Venezuela. These are the countries for which we observe skill ac-

Parameter	Symbol	Value
Workers' share in bargaining	θ	0.5
Curvature of the utility function	γ	1
Initial endowment	y_0	1
Unskill-unskill match productivity	y_{uu}	1

Table 1: Calibration: parameters chosen without solving the model.

quisition, skill premium, and unemployment rates by skill. For some of the countries in our sample, we don't observe the distribution of entrepreneurs by skill. We impute these data using GDP per worker as a predictor.

3.1 Parameterization

We assume countries differ from one another on three dimensions:

- cost of doing business, c,
- schooling cost, sc,
- productivity of worker-firm match by skill, y_{ss}, y_{su}, and y_{us}.

We calibrate these sources of cross-country heterogeneity within the model, given a set of parameters that we set without solving the model. This set of parameters is reported in Table 1, together with the assigned values. In particular, we set the entrepreneur's share in bargaining, θ, to 50%. We assume individual preferences are represented by a logarithmic utility function, $\gamma = 1$. The curvature of the utility function measures the willingness of an individual to endure variability in his consumption stream: the higher the γ, the less variability the individual wants in his consumption stream. The microeconomics literature suggests that γ must be approximately equal to 1 (see, among others, the early works of Arrow, 1971, Kydland and Prescott, 1982, and Kehoe, 1983). Last, we normalize y_0 and y_{uu} to 1.

We calibrate cross-country heterogeneity by targeting the following statistics, for each country:

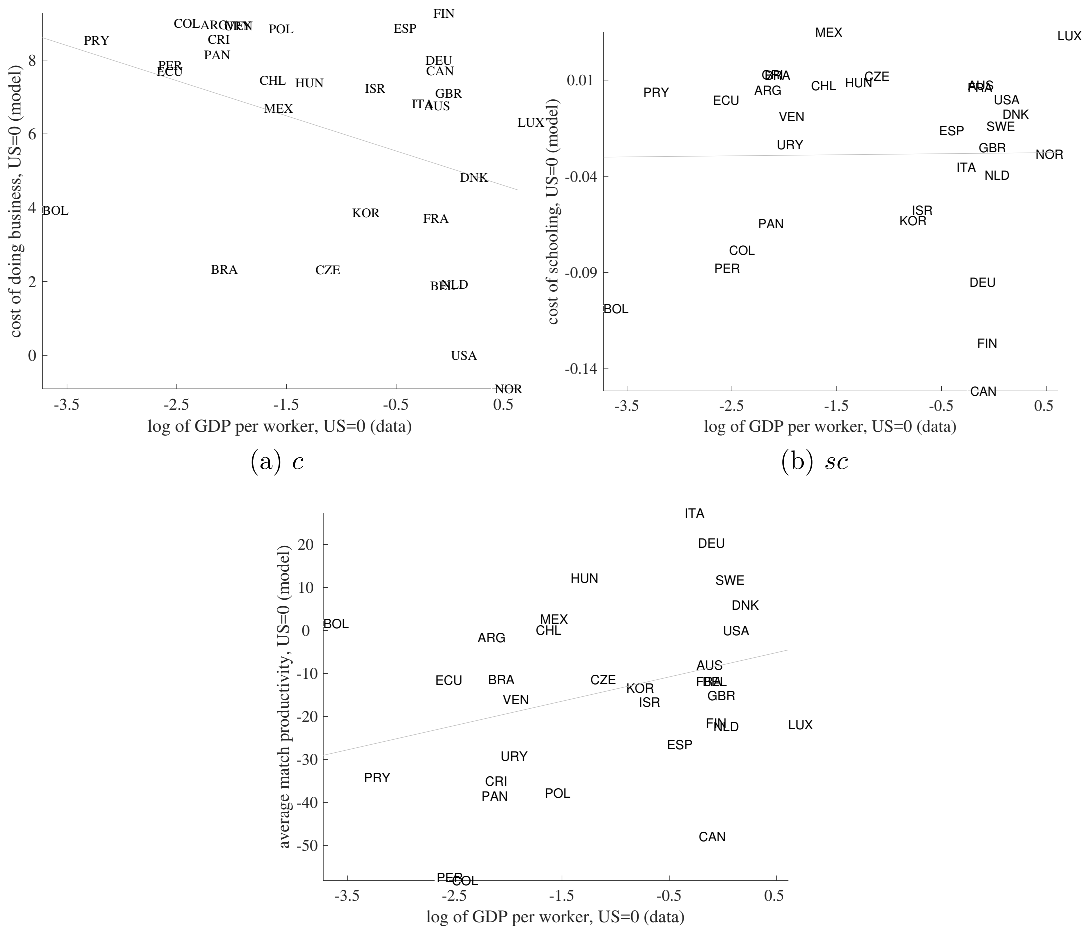
1. fraction of skilled individuals: number of secondary- and tertiary-educated males divided by number of primary educated males,
2. skill premium: ratio of tertiary- and secondary-educated lifetime earnings relative to primary-educated lifetime earnings,
3. unemployment rate of unskilled workers: number of secondary- and tertiary-educated unemployed male workers divided by number of secondary- and tertiary-educated males,
4. unemployment rate of skilled workers: number of primary-educated unemployed male workers divided by number of primary-educated males,
5. fraction of skilled entrepreneurs: fraction of individuals with at least a high-school education among male individuals owning an established business in the labor force.

Figures 5a, 5b and 6 in the Appendix show targets 1 to 4 across countries. In our sample of 33 countries, the fraction of skilled individuals is positively correlated with the logarithm of GDP per worker, at 0.508, while the skill premium is negatively correlated, at -0.701. The unemployment rate of skilled workers is negatively correlated with the logarithm of GDP per worker, at -0.428, while the unemployment rate of unskilled workers does not significantly vary along the development spectrum. We compute the fraction of skilled entrepreneurs across countries using GEM dataset, see Figure 9 in the Appendix. The slope of a regression that considers this fraction and the logarithm of GDP per worker is a statistically different from zero at 6.14. In our sample of 33 countries, the fraction of skilled entrepreneurs is positively correlated with the logarithm of GDP per worker, at 0.306.

Formally, the calibration strategy consists of minimizing the following equation:

$$\min_{\Lambda_j} \sum_{u=1}^{3} \left(\frac{x_{u,j}(\Lambda_j) - \tilde{x}_{u,j}}{\tilde{x}_{u,j}} \right)^2,$$

for $\Lambda_j = \{c_j, sc_j, y_{ss,j}, y_{us,j}, y_{su,j}\}$. For a given Λ_j, we compute the model moments, $x_{u,j}(\Lambda)$, that correspond to the targets described above, $\tilde{x}_{u,j}$. The model is solved numerically. Even though the parameter values are chosen simultaneously to match the data targets, each parameter has a first-order effect on some targets. The cost of doing business in a country, c, is important for matching the unemployment rate by skill in that country. The comparative statics of our model under the risk neutrality assumption reported in the preceding section



(a) c (b) sc

(c) average y

Figure 3: Calibration: implied cost of doing business, schooling cost, and average match productivities. For clarity, figures disregard outliers: Sweden for the cost of doing business, Belgium and Poland for the cost of schooling and Norway for the average match productivity.

show that the unemployment rate differential responds to changes in the cost of doing business (see Section 2). The average of the match productivities for which at least one party is skilled, y, is key to match the data on the skill premium. Then, given a value for y and c, the schooling cost in a country, sc, and the dispersion of match productivities, $\{y_{ss}, y_{su}, y_{us}\}$, are parameterized so that the model implied skill distribution and average unemployment rate is as close as possible to replicating the these statistics in the data for that country.

Outcome. The values of the calibrated parameters are shown in Figure 3 and summarized in Table 2. Table 2 reports the cross-country correlations of the values of the calibrated parameters with observed GDP per worker. The calibrated business cost is lower in richer

Correlations of and:	Observed log(GDP per worker)
c	-0.405
	(0.019)
sc	0.000
	(1.000)
y_{ss}	0.234
	(0.191)
y_{su}	0.284
	(0.109)
y_{us}	0.458
	(0.007)
average y	0.313
	(0.076)

Table 2: Calibration: statistics on calibrated parameters. P-values are in parenthesis. Source: the World Bank for cross-country data on GDP per worker and own computations.

countries: the correlation between the calibrated c and the observed logarithm of GDP per worker is -0.405 (Table 2, first row). This finding is supported by anecdotal evidence on measured cost of doing business. The World Bank publishes a ranking of 189 countries based on how conducive to business operations their regulatory environments are, with first place being the best. Figure 10 in Appendix A.2 shows a significant negative correlation of a country's ranking and the logarithm of GDP per worker.

We calibrate a cost of schooling that does not systematically vary with development (Table 2, second row). On the one hand, direct schooling costs (such as fees and tuitions) represents a higher fraction of family income for individuals in poorer countries, on average, and so much so to make schooling unaffordable more frequently (see, for example, Lee and Barro, 2001). On the other hand, indirect costs (such as foregone earnings) are a sizeable component of the schooling cost of higher education, and these costs tend to increase with development. For example, for individuals born between 1920 and 1980 in the US, foregone earnings while attending college are, on average, at least twice as high as college fees and tuitions (see panel (a) of Figure 11 in Appendix A.2). Panel (b) of Figure 11 reports a positive correlation of 0.875 between the wages of low-skill individuals and the GDP per worker in a 191 sample of countries.

Lastly, on average, richer countries calibrate higher productivities of matches where at least one of the two parties is skilled (the correlation with the logarithm of observed GDP per worker is 0.313, see Table 3, row 6). In particular, the stronger association of the match productivity with the logarithm of observed GDP per worker is for matches where the entrepreneur is not skilled and the worker is skilled (correlation of 0.458, see Table 3, row 5). In Appendix A.1 we show that, in our framework, cross-country disparities in match productivities originate from cross-country disparities in the bias toward skill of the production technology as well as in individuals' productivities. In particular, higher bias toward skill of the production technology and higher productivity of skilled individuals relative to that of unskilled individuals, due for example to higher schooling quality, feeds into the model via higher mach productivities for matches where at least one of the two parties between the worker and the firm is skilled. The calibrated cross-country pattern of our match productivities are therefore consistent with Caselli and Coleman (2006) who, for a cross-section of 52 countries in the late 1980s, find that the bias toward skill of the production technology increases with a country's income level and with the development literature claiming a higher quality of the educational system in rich countries than poor countries (see, among others, Caselli, 2005).

The model's performance on targets is shown in Table 3, which reports the correlations between the logarithm of observed GDP per worker and targeted moments for both the observed data and the simulated model. The model-generated fraction of skilled individuals and the skill premium show a correlation with the logarithm of observed GDP per worker of 0.393 and -0.675, respectively. These correlations are close to those observed in the data which are of 0.508 and -0.701, respectively. The model, consistently with the data, generates a negative correlation between the logarithm of observed GDP per worker and the unemployment rate of skilled workers and a positive, non-significant correlation between the unemployment rate of unskilled workers and the logarithm of observed GDP per worker. Last, the correlation between the fraction of entreprenous that are skilled and the logarithm of observed GDP per worker is 0.306 in the data and 0.496 in the model.

After calibration, the model-generated skill premium is negatively correlated with the fraction of skilled individuals, as in the data (Table 3, row 6). The straight difference in the unemployment rates of skilled and unskilled workers in the model correlate at -0.440 with the logarithm of observed GDP per worker, which is close to the correlation measured in the data (Table 3, row 7). These two moments are not direct targets of the calibration and, therefore, the alignment of the model with data testifies of the merits of the model.

Correlations	Data	Model
Targets:		
log GDP and skilled workers	0.508	0.393
	(0.003)	(0.024)
log GDP and skill premium	-0.701	-0.675
	(0.000)	(0.000)
log GDP and skilled unemployment	-0.428	-0.270
	(0.013)	(0.129)
log GDP and unskilled unemployment	0.196	0.181
	(0.273)	(0.313)
log GDP and skilled entrepreneurs	0.306	0.496
	(0.084)	(0.003)
Non Targets:		
skilled workers and skill premium	-0.592	-0.400
	(0.000)	(0.021)
log GDP and unemployment differential	-0.422	-0.440
	(0.014)	(0.010)

Table 3: Calibration: model fit. In parenthesis are p-values. The correlations for the logarithm of observed GDP per worker and data moments differ from those reported in Table 6 as in the quantitative exercise we focus on a sub-sample of the dataset presented in the introduction and used in Table 6. Source: the World Bank and Fernández, Guner, and Knowles (2005) and own computations.

To summarize, Figure 4 plots the model fit on skill acquisition along with the two moments that summarize the channels this paper see as drivers of skill acquisition – that is, the skill premium and the unemployment differential. In poor countries, individuals face low match productivities for skilled matches and higher business cost, both of which decrease the returns to skill acquisition. Countries in the bottom-quarter of the income distribution have an average business cost which is twice as high as that of countries in the top-quarter of the income distribution. The average match productivity for countries in the bottom-quarter of the income distribution is about 1/10 that of countries in the top-quarter of the income distribution, mostly driven by differences in the match between by the match of unskilled entrepreneurs and skilled workers.

3.2 Accounting Exercises

How much of the cross-country variation in skill acquisition and observed returns to such investment is explained by business cost, schooling cost and match productivities? Countries

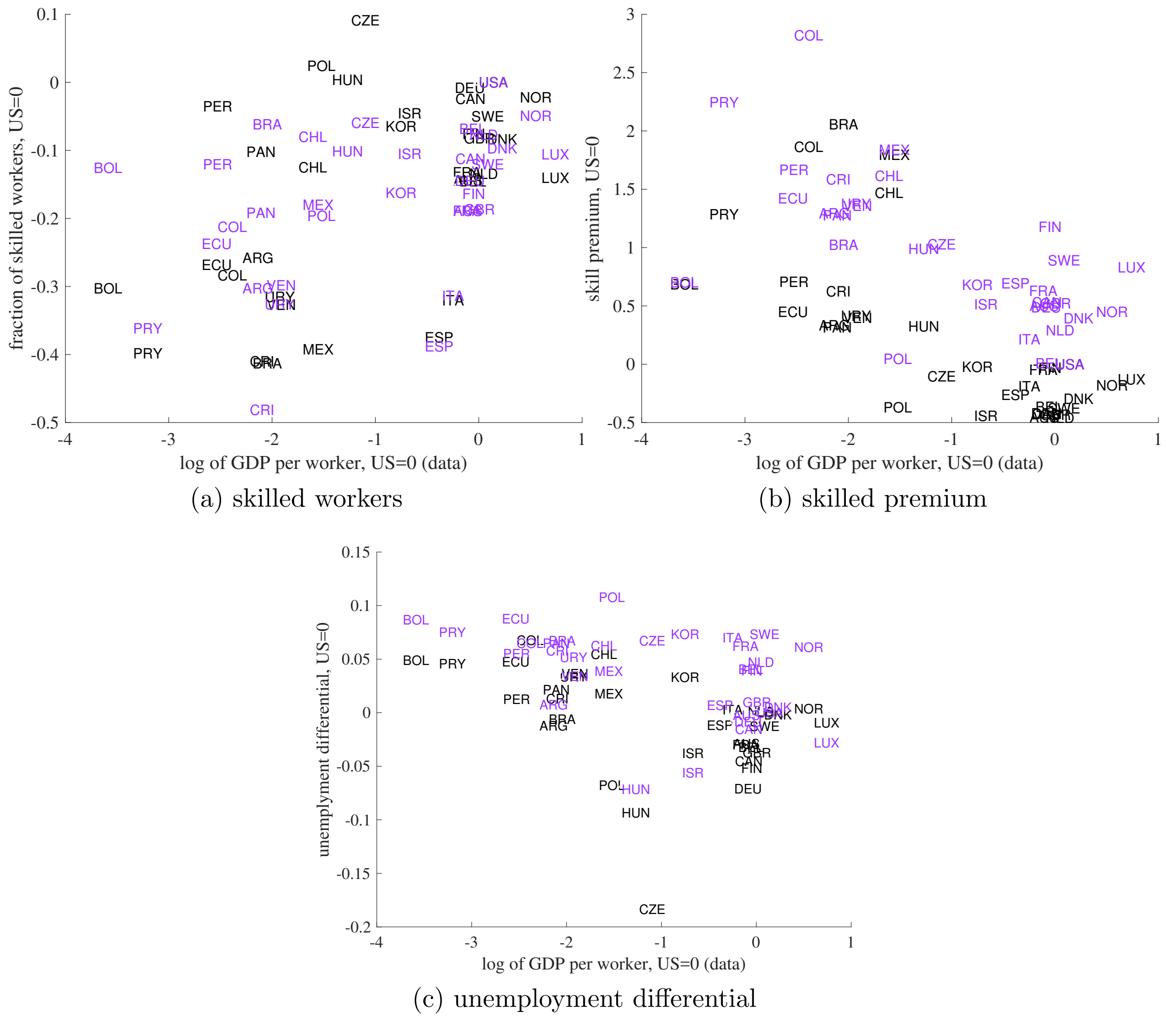


Figure 4: Calibration: overall performance. Differential wrt the US. US=0 all the times.

in the bottom third of the income distribution have a fraction of skill individuals 12p.p. (percentage points) lower than that observed in the top third of the income distribution despite they record a skill premium which is 1.04p.p. higher. Why?

To answer these two questions we conduct an accounting exercise consisting of five experiments in which we attenuate cross-country heterogeneity in business cost, schooling cost and match productivities. In particular, in each alternative experiment we assign to decrease of 10% the country's gap to the US values of, respectively, the cost of doing business ("Decreased c variation"), the schooling cost ("Decreased sc variation") and each of the match productivities for which at least one of the two parties is skilled ("Decreased $y_{ss}/y_{su}/y_{us}$

variation"). In addition, we run an experiment in which we decrease the gap to the US for all match productivities at once ("Decreased y variation"). A 10% variation in the gap is chosen to assure the model solves in all the exercises for all countries. Appendix A.2 reports the results of experiments in which the gap to the US is decreased by 25%, 33% and 50%. Our main conclusions carry over to these alternative variations of the gap.[6]

We present our results in relation to the two questions posed above under "Cross-country correlations", where we analyze the determinants of the cross-country correlations of interests, and "Gap between poor and rich countries", where we study the gap between rich and poor countries in the variables of interest, respectively.

Cross-country correlations. We study the role of the business cost for the cross-country correlation between skill acquisition and skill premium. For each alternative experiment mentioned above, Table 4 reports the cross-country correlation with the observed logarithm of GDP per worker of three moments: (i) the fraction of skilled individuals, (ii) the skill premium, and (iii) the unemployment differential. In addition, the same table also reports the correlation between skill acquisition and premium.

The business cost is the main driver of the cross-country correlation between skill acquisition and premium, accounting for 56% of it. When the cross-country gap in the business cost is reduced by 10%, this correlation reduces from a significant -0.400 to a non-significant -0.174 (Table 4, row 4). When the cross-country gap is further reduced, this correlation turns positive: it is at 0.092 for a 25% reduction, at 0.162 for a 33% reduction and at 0.241 for a 50% reduction (see Table 9 in the Appendix). This results reflects the fact that the business cost influences the skill acquisition decision. When the gap in the business cost is decreased, the correlation between the logarithm of GDP per worker and the fraction fo skilled workers decreases and turns non-significant (Table 4, row 1). From a significant 0.393 in the baseline, this correlation decreases to a non-significant 0.216, 0.122, -0.080, -0.080 when, the gap is reduced by 10%, 25%, 33% and 50%, respectively.

The channel via which the business cost influences the skill acquisition decision is the unemployment differential. This differential is one of the determinants of the returns to skill acquisition for workers. Table 4, row 3, shows that cross-country differences in the business cost shape the evolution of the unemployment differential along the development spectrum.

[6] In the experiments where the gap to the US is decreased by 25%, 33% and 50%, the model solves across all six experiments for, respectively, 30, 27, and 24 countries out of 33 countries.

	Data	Model	Without 10% variation in					
			c	sc	y_{ss}	y_{su}	y_{us}	y
GDP & skilled workers	0.508	0.393	0.216	0.409	0.410	0.456	0.434	0.380
	0.003	0.024	0.228	0.018	0.018	0.008	0.012	0.029
GDP & skill premium	-0.701	-0.675	-0.662	-0.694	-0.583	-0.656	-0.628	-0.673
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
GDP & unemp. diff.	-0.422	-0.440	-0.255	-0.348	-0.503	-0.458	-0.260	-0.428
	0.014	0.010	0.152	0.047	0.003	0.007	0.144	0.013
skilled workers & premium	-0.592	-0.400	-0.174	-0.400	-0.300	-0.552	-0.490	-0.536
	0.000	0.021	0.331	0.021	0.089	0.001	0.004	0.001

Table 4: Accounting exercise: cross-country correlations. The table reports the correlation between the logarithm of observed GDP per worker and moments in the data, in the calibrated model, and in each alternative experiments. The experiments are explained in the text. Source: the World Bank, Fernández, Guner, and Knowles (2005) and own computations.

With a 10% reduction in the cross-country gap in the business cost, the correlation between the logarithm of GDP per worker and the unemployment differential, decreases of 42% – that is, it goes from -0.440 in the baseline to a -0.255 in the alternative experiment. Along with the business cost, the match productivity when employers are skilled and workers are unskilled is also an important driver of the unemployment differential: a closure of the gap in the business cost attenuates this correlation by 49% (from -0.440 to -0.260).

The business cost in its determination of the unemployment differential is only one facet of the return to acquiring skill. The match productivities also influence this return by determining the skill premium. We find that the skill premium is most responsive to a 10%-decrease in the gap of the match productivity to the US when both parties are skilled, out of all alternative experiments. The correlation between the logarithm of output per worker and the skill premium decreases from -0.675 in the baseline to -0.583 in this alternative experiment. As a consequence, the match productivity for which both parties are skilled is also an important driver of cross-country correlation between skill premium and acquisition. The correlation between the fraction of skilled individuals and the skill premium drops of 45% when the gap in this match productivity decreases of 10% – that is, the correlation increases from -0.400 to -0.300.

Lastly, the schooling cost exerts the smallest role in explaining cross-country differences in skill acquisition and premium. This is because the calibrated schooling cost shows lower

	Data	Model	Without 10% variation in					
			c	sc	y_{ss}	y_{su}	y_{us}	y
Less than 1/10 vs more than 9/10 of the US GDP per worker. Gaps in:								
skilled workers	0.186	0.137	0.051	0.182	0.136	0.190	0.164	0.124
skill premium	-1.240	-1.295	-0.911	-1.108	-2.411	-1.137	-0.754	-1.011
uemp. diff.	-0.048	-0.048	-0.021	-0.041	-0.083	-0.041	-0.012	-0.036
Less than 1/4 vs more than 3/4 of the US GDP per worker. Gaps in:								
skilled workers	0.160	0.103	0.054	0.104	0.108	0.122	0.111	0.103
skill premium	-1.103	-0.900	-0.740	-0.852	-1.275	-0.833	-0.689	-0.755
uemp. diff.	-0.039	-0.031	-0.021	-0.025	-0.049	-0.029	-0.018	-0.029
Less than 1/3 vs more than 2/3 of the US GDP per worker. Gaps in:								
skilled workers	0.122	0.079	0.034	0.079	0.084	0.097	0.086	0.080
skill premium	-1.039	-0.898	-0.743	-0.853	-1.252	-0.835	-0.689	-0.753
uemp. diff.	-0.025	-0.028	-0.019	-0.023	-0.045	-0.026	-0.016	-0.026

Table 5: Decomposition exercise: gap between poor and rich countries. The table reports the gap between rich and poor countries for the fraction of skilled workers, the skill premium and the unemployment differentials. The gap are reported in the data, in the model and in various experiments. The experiments within the main decomposition exercise are explained in the main text. Countries are defined to be *poor* or *rich* based on three criteria. Source: the World Bank, Fernández, Guner, and Knowles (2005) and own computations.

cross-country variation than the calibrated match productivities and business cost. As mention in the Section 3.1, this reflects the opposite effects of direct schooling costs and foregone earnings. Studies that focus solely on one of these effects demonstrate the beneficial effect of the abolition of school fees on the schooling attainment of poor countries (Alderman, Orazem, and Paterno, 2001, Deininger, 2003, Al-Samarrai and Zaman, 2007 and Schultz, 2004). In addition, we show in Appendix A.1 that disparities in match productivities are linked to disparities in the determinants of individual's productivity, among which are schooling quantity and quality. Hence, through the lens of our framework, some of the effects of schooling costs reflect in the calibrated match productivities.

Gap between poor and rich countries. We study the implications of business cost for the gap between poor and rich countries in skill acquisition and skill premium. Table 5 reports the gap between rich and poor countries in the model, the data, and each experiment for three statistics: (i) the fraction of skilled workers, (ii) the skill premium, (iii) the unemployment differential. Countries are defined as being rich or poor based on three rules. A country is defined as poor if it records a GDP per worker of less than a 1/10th that of the US, or less than a 1/4th or less than a 1/3rd. A country is defined as rich if it records a GDP per worker of more than 9/10th that of the US, or more than 3/4th or more than 2/3rd. The gap between rich and poor countries for each moment is computed as the difference in the average of the moment between the two groups of countries.

The business cost is a key driver of the gap in skill acquisition between poor and rich countries. Decreasing the gap in business cost to the US by 10% decreases the gap in skill acquisition between rich and poor countries of between 3p.p. and 7p.p.. In this alternative experiment, countries in the bottom tenth of the income distribution have a fraction of skilled workers that is 7p.p. lower than that of countries in the top tenth, compared to 14p.p. lower in the baseline model and 19p.p. lower in the data. When comparing countries in the bottom and top third of the income distribution, the skill-acquisition gap decreases from 8p.p. in the baseline model to 3p.p.in the alternative experiment, in front of a 12p.p. gap in the data. Overall, we conclude that decreasing each country's gap in the business cost to the US by 10% decreases the gap in skill acquisition between rich and poor countries of between 48% and 63%.

As in the cross-country exercise, the channel through which the business cost affects skill acquisition is the unemployment differential. The business costs is the second most important driver of the gap in the unemployment differential between rich and poor countries. The difference between the unemployment rate of skilled and unskilled workers is of 2p.p. (p.p. in the baseline model) in countries in the bottom tenth of the income distribution and of -3p.p. (-5p.p. in the baseline model) in countries in the top tenth, with a gap of -5p.p.. Decreasing the gap in business cost to the US by 10% decreases the gap in the unemployment differential of 3p.p., or by 56%. An effect almost equal in magnitude would happen if countries in the top and bottom 1/4 or in the top and bottom 1/3 of the income distribution experience the same 10% decline in the gap. Across the exercises, it emerges that the business cost is the most important driver of the gap in the unemployment rate of skilled workers: a 10% closure in the business cost gap decreases the skilled unemployment gap by 1/3. The unemployment rate of unskilled workers is less responsive to changes in the business costs, with the exception of when comparing countries in the bottom and top tenth of the income distribution.

Countries in the bottom tenth of the income distribution have a skill premium of 2.75 (2.57 in the baseline model) compared to the 1.51 (1.27 in the baseline model) skill premium of countries in the top tenth, with a gap of -1.24 (-1.30 in the baseline model). The gap in the match productivity where entrepreneurs are unskilled and workers are skilled is the main driver of the gap in the skill premium – a 10% closure in this match productivity gap decreases the gap in the skill premium by between 23%, looking at countries in the top and bottom third, and 45%, looking at countries in the top and bottom tenth. The productivity of those matches where at least one party is skilled influences the decision of investing in skills directly by increasing its return, but also indirectly by determining the unemployment differential. Note that the gap in this match productivity is also important in generating the unemployment differential, given the strong response of the unemployment rate of unskilled workers. Overall, the direct effect is stronger, and the gap in skill acquisition between rich and poor countries increases, even though only between 1p.p. and 3p.p., when the gap in match productivity closes.

Overall, the business cost is a key determinant of both gaps in the fraction of skilled individuals and the skill premium. Match productivities have a similar quantitative importance as that of the business cost for determining the gap in the fraction of skill workers. We take these results to indicate the potential role of trends and policies affecting the business cost for a country's skill acquisition and skill premium.

4 Conclusion

In this paper, we study the role of business cost for the cross-country patterns of skill premium and fraction of skilled workers. In a cross section of countries, a 1% increase in income per worker is associated with an increase of 0.07p.p. in the fraction of skilled individuals and with a 0.44p.p. decrease in the skill premium. In light of cross-country evidence of a positive correlation between the unemployment differential and income per worker, we argue that the business cost, as a first order determinant of the unemployment rate, can reconcile a higher skill premium and a lower skill acquisition in poor countries compared to rich countries.

We develop a simple search model of occupational choice and skill acquisition and use it to assess the quantitative significance of differences in business cost along with schooling cost and skill-productivity profile in explaining skill acquisition and skill premium across countries. We calibrate a higher business cost for poor than rich countries and find that disparities in the business cost accounts for about one third of the cross-country correlation between skill premium and acquisition. Decreasing the gap in business cost to the US by 10% in each country decreases the gap in skill acquisition between rich and poor countries of between 48% and 63%. The significant response of skill investment to changes in the business cost is informative about the potential role of policies and other trends affecting the business cost.

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A Appendix

A.1 Model Derivations

Risk neutrality case. Under the risk neutrality assumption and $\theta = 0.5$, the equilibrium distribution of individuals by skill and occupation is described by the following four probabilities:

$$
\begin{aligned}
p_{sw} =& \frac{c y_{ss} y_{su} y_{us} - c y_{ss}^2 y_{su} + c y_{ss} y_{su}^2 - c y_{su}^2 y_{us} + s c y_{ss} y_{su} y_{us} - s c y_{ss} y_{su}^2}{y_{ss}\left(y_{ss} - y_{su}\right)\left(y_{ss} y_{uu} - y_{su} y_{us}\right)} + \frac{2c + y_{ss}}{2 y_{ss}} \\
&+ \frac{4 s c y_{ss} - 2 s c y_{su} - 2 s c y_{us} + y_{ss} y_{su} + y_{ss} y_{us} - y_{ss}^2 - y_{su} y_{us}}{2\left(y_{ss} - y_{su}\right)\left(y_{ss} - y_{su} - y_{us} + y_{uu}\right)}, \\
p_{uw} =& \frac{-c y_{ss} y_{su} - c y_{ss} y_{us} + c y_{ss}^2 + c y_{su} y_{us} + s c y_{ss} y_{su} - s c y_{ss} y_{us}}{\left(y_{ss} - y_{su}\right)\left(y_{ss} y_{uu} - y_{su} y_{us}\right)} \\
&+ \frac{-4 s c y_{ss} + 2 s c y_{su} + 2 s c y_{us} - y_{ss} y_{su} - y_{ss} y_{us} + y_{ss}^2 + y_{su} y_{us}}{2\left(y_{ss} - y_{su}\right)\left(y_{ss} - y_{su} - y_{us} + y_{uu}\right)}, \\
p_{sf} =& \frac{-c y_{ss} y_{su} y_{us} + c y_{ss}^2 y_{us} - c y_{ss} y_{us}^2 + c y_{su} y_{us}^2 + s c y_{ss} y_{su} y_{us} - s c y_{ss} y_{us}^2}{y_{ss}\left(y_{ss} - y_{us}\right)\left(y_{ss} y_{uu} - y_{su} y_{us}\right)} - \frac{2c - y_{ss}}{2 y_{ss}} \\
&+ \frac{4 s c y_{ss} - 2 s c y_{su} - 2 s c y_{us} + y_{ss} y_{su} + y_{ss} y_{us} - y_{ss}^2 - y_{su} y_{us}}{2\left(y_{ss} - y_{us}\right)\left(y_{ss} - y_{su} - y_{us} + y_{uu}\right)}, \\
p_{uf} =& \frac{c y_{ss} y_{su} + c y_{ss} y_{us} - c y_{ss}^2 - c y_{su} y_{us} - s c y_{ss} y_{su} + s c y_{ss} y_{us}}{\left(y_{ss} - y_{us}\right)\left(y_{ss} y_{uu} - y_{su} y_{us}\right)} \\
&+ \frac{-4 s c y_{ss} + 2 s c y_{su} + 2 s c y_{us} - y_{ss} y_{su} - y_{ss} y_{us} + y_{ss}^2 + y_{su} y_{us}}{2\left(y_{ss} - y_{us}\right)\left(y_{ss} - y_{su} - y_{us} + y_{uu}\right)}.
\end{aligned}
$$

The comparative static of the fraction of the skilled among the entrepreneurs is:

$$
\frac{\partial\left(p_{sf}/p_f\right)}{\partial c} = -\frac{8\mathrm{sc}\left(y_{\mathrm{su}} y_{\mathrm{us}} - y_{\mathrm{ss}} y_{\mathrm{uu}}\right)}{\left(y_{\mathrm{su}}\left(-2c + 2\mathrm{sc} + y_{\mathrm{us}}\right) - 2(c + \mathrm{sc}) y_{\mathrm{us}} + y_{\mathrm{ss}}\left(2c - y_{\mathrm{uu}}\right) + 2c y_{\mathrm{uu}}\right)^{2}}.
$$

The local comparative statics of the unemployment rates of skilled and unskilled workers with respect to the business cost, in the neighborhood of $c = 0$ and $sc = 0$, read:

$$\begin{aligned}
\left.\frac{du_s}{dc}\right|_{c=0,sc=0} &= \frac{(y_{\text{su}} - y_{\text{uu}})\,(y_{\text{su}} + 3y_{\text{us}} - 4y_{\text{uu}})\,(-y_{\text{ss}} + y_{\text{su}} + y_{\text{us}} - y_{\text{uu}})}{(y_{\text{su}} + y_{\text{us}} - 2y_{\text{uu}})^{\,2}\,(y_{\text{su}}y_{\text{us}} - y_{\text{ss}}y_{\text{uu}})}, \\
\left.\frac{du_u}{dc}\right|_{c=0,sc=0} &= \frac{(y_{\text{ss}} - y_{\text{us}})\,(4y_{\text{ss}} - 3y_{\text{su}} - y_{\text{us}})\,(y_{\text{ss}} - y_{\text{su}} - y_{\text{us}} + y_{\text{uu}})}{(-2y_{\text{ss}} + y_{\text{su}} + y_{\text{us}})^{\,2}\,(y_{\text{ss}}y_{\text{uu}} - y_{\text{su}}y_{\text{us}})}, \\
\left.\frac{d(u_s - u_u)}{dc}\right|_{c=0,sc=0} &= \frac{(y_{\text{ss}} - y_{\text{su}} - y_{\text{us}} + y_{\text{uu}})^{\,2}\,(4y_{\text{ss}}\,(y_{\text{uu}} - y_{\text{us}}) + (y_{\text{su}} + y_{\text{us}})^{\,2} - 4y_{\text{su}}y_{\text{uu}})}{(-2y_{\text{ss}} + y_{\text{su}} + y_{\text{us}})^{\,2}\,(y_{\text{su}} + y_{\text{us}} - 2y_{\text{uu}})^{\,2}}\frac{dp_s}{dc}.
\end{aligned}$$

The local comparative static of the skill premium with respect to the business cost, in the neighborhood of $c = 0$ and $sc = 0$, reads:

$$\left.\frac{dE_s/E_u}{dc}\right|_{c=0,sc=0} = \frac{4\,(y_{\text{su}} + y_{\text{us}} - 2y_{\text{uu}})\,(y_{\text{ss}} - y_{\text{su}} - y_{\text{us}} + y_{\text{uu}})^{\,2}}{(-2y_{\text{ss}} + y_{\text{su}} + y_{\text{us}})\,(y_{\text{su}} + 2y_{\text{us}} - 3y_{\text{uu}})^{2}}\frac{dp_s}{dc}.$$

The local comparative static of the fraction of entrepreneurs with respect to the business cost, in the neighborhood of $c = 0$ and $sc = 0$, reads:

$$\left.\frac{\partial p_f}{\partial c}\right|_{c=0,sc=0} = \frac{y_{\text{ss}} - y_{\text{su}} - y_{\text{us}} + y_{uu}}{y_{\text{su}}y_{\text{us}} - y_{\text{ss}}y_{\text{uu}}}.$$

Proof of Proposition 1. The assumption of log supermodularity in worker's skill implies that:

$$\begin{aligned}
&\log(y_{ss}) - \log(y_{su}) > \log(y_{us}) - \log(y_{uu}), \\
&\Rightarrow \frac{y_{ss}}{y_{su}} > \frac{y_{us}}{y_{uu}}, \\
&\Rightarrow y_{ss}y_{uu} - y_{us}y_{su} > 0,
\end{aligned}$$

This assumption further implies:

$$y_{ss} > y_{su} > y_{us} > y_{uu}.$$

Therefore,

$$\frac{dp_s}{dc} < 0, \quad \text{and} \quad \left.\frac{\partial skp}{\partial c}\right|_{c=0,sc=0} > 0.$$

The local comparative statics of the unemployment rate differential with respect to the business cost, in the neighborhood of $c = 0$ and $sc = 0$, imply that:

$$\left.\frac{d(u_s - u_u)}{dc}\right|_{c=0,sc=0} > 0, \quad \text{if} \quad 4y_{\text{ss}}\,(y_{\text{uu}} - y_{\text{us}}) + (y_{\text{su}} + y_{\text{us}})^{\,2} - 4y_{\text{su}}y_{\text{uu}} < 0.$$

The above condition imposes a lower bound on $y_{ss} > \underline{y}_{ss}$, for $\underline{y}_{ss} = \frac{(y_{su}+y_{us})^2 - 4y_{su}y_{uu}}{y_{us}-y_{uu}}$. The log supermodularity assumption implies that $\underline{y}_{ss}$ is well define, $\underline{y}_{ss} < \infty$

Origins of match productivities. We show that, in our framework, disparities in match productivities are linked to disparities in the bias toward skill of the production technology and to disparities in the determinants of individuals' productivities.

Assume a firm production technology, y, can be described as:

$$y(N_{sw}, N_{sf}, N_{uw}, N_{uf}) = [(\alpha_{sw}h_{sw}N_{sw} + \alpha_{sf}h_{sf}N_{sf})^\rho + (\alpha_{uw}h_{uw}N_{uw} + \alpha_{uf}h_{uf}N_{uf})^\rho]^{\frac{1}{\rho}},$$

where se (uf) indicates a (un)skilled entrepreneur, and sw (uw) indicates a (un)skilled worker, N is the number of individuals of a given type and h their average productivity (or human capital). We can re-formulated this production function as in the skill-biased technical change literature (see, among others, Heckman, Lochner, and Taber, 1998 and Restuccia and Vandenbroucke, 2013) and group labour by skill level:

$$y(N_{sw}, N_{sf}, N_{uw}, N_{uf}) = \left[\left(\bar{\alpha}_s\bar{h}_s\bar{N}_s\right)^\rho + \left(\bar{\alpha}_u\bar{h}_u\bar{N}_u\right)^\rho\right]^{\frac{1}{\rho}},$$

where $\bar{\alpha}_x$ and $\bar{h}_x$ are the averages of, respectively, the shares and productivities between workers and entrepreneurs of a given skill x, i.e. $\bar{\alpha}_x = \frac{\alpha_{xw}+\alpha_{xf}}{2}$ and $\bar{h}_x = \frac{h_{xw}+h_{xf}}{2}$. $\bar{N}_x$ is a human capital aggregator of individuals of a given skill, (see Jones, 2014): $\bar{N}_x(N_{xw}, N_{xe}) = \frac{1}{\bar{\alpha}_x\bar{h}_x}\left(\alpha_{xw}h_{xw}N_{xw} + \alpha_{xf}h_{xf}N_{xf}\right)$. The bias of the technology toward skill is given by:

$$\left(\frac{\bar{\alpha}_s}{\bar{\alpha}_u}\right)^\rho.$$

When this ratio is greater (lower) than one then the technology has a positive (negative) bias toward skill.

In our framework a firm employes one worker and one entrepreneur and match productivities are firms' output. We can therefore write:

$$\begin{aligned}
y_{ss} &= y(1,1,0,0) = \left[\left(\bar{\alpha}_s\bar{h}_s\bar{N}_s(1,1)\right)^\rho\right]^{\frac{1}{\rho}}, \\
y_{su} &= y(1,0,0,1) = \left[\left(\bar{\alpha}_s\bar{h}_s\bar{N}_s(1,0)\right)^\rho + \left(\bar{\alpha}_u\bar{h}_u\bar{N}_u(0,1)\right)^\rho\right]^{\frac{1}{\rho}}, \\
y_{us} &= y(0,1,1,0) = \left[\left(\bar{\alpha}_s\bar{h}_s\bar{N}_s(0,1)\right)^\rho + \left(\bar{\alpha}_u\bar{h}_u\bar{N}_u(1,0)\right)^\rho\right]^{\frac{1}{\rho}}, \\
y_{uu} &= y(0,0,0,0) == \left[\left(\bar{\alpha}_u\bar{h}_u\bar{N}_u(1,1)\right)^\rho\right]^{\frac{1}{\rho}}.
\end{aligned}$$

For a set of $\bar{\alpha}_{xx}\bar{h}_{xx}$ products, and therefore a set of $\bar{\alpha}_x\bar{h}_x$, we have a set of match productivities. It is easy to see that, for example, a higher skill bias of the technology would increase the ratio of y_{ss} to y_{uu}. Similarly, a higher productivity of skilled individuals, due for example to a better quality of schooling, would also increase y_{ss} to y_{uu}.

A.2 Tables and Figures

Correlations between log(GDP per worker) and:	value	p-value
% of skilled workers	0.511	0.000
skill premium	-0.701	0.000
unemployment rate of skilled workers	-0.359	0.008
unemployment rate of unskilled workers	0.164	0.240
unemployment rate of skilled workers net of that of unskilled workers	-0.410	0.002

Table 6: Correlations. Skilled individuals are defined to be those with secondary and tertiary education while unskilled individuals are their complement. For each country, all data except the skill premium are measured between year 2000 and year 2010 and calculated as average during these years. The skill premium is measured between year 1992 and year 1998. Source: the World Bank and Fernández, Guner, and Knowles (2005).

Correlations between log(GDP per worker) and:	value	p-value
% of skilled workers	0.482	0.000
skill premium	-0.701	0.000
unemployment rate of skilled workers	-0.519	0.000
unemployment rate of unskilled workers	-0.073	0.604
unemployment rate of skilled workers net of that of unskilled workers	-0.525	0.000

Table 7: Correlations. Skilled individuals are defined to be those with tertiary education while unskilled individuals are their complement. For each country, all data except the skill premium are measured between year 2000 and year 2010 and calculated as average during these years. The skill premium is measured between year 1992 and year 1998. Source: the World Bank and Fernández, Guner, and Knowles (2005).

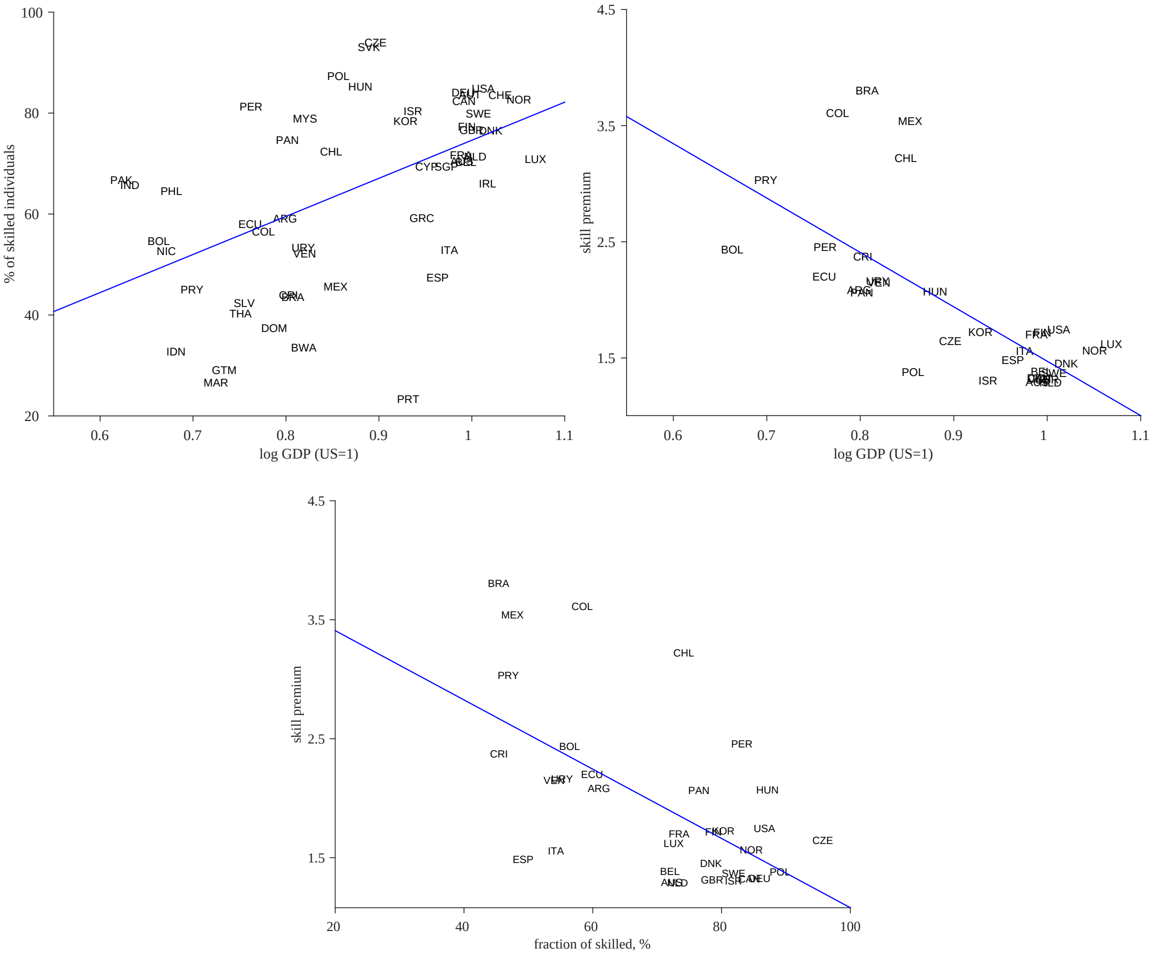


Figure 5: Fraction of skilled individuals and skill premium across countries. For each country, the fraction of skilled individuals is computed as the ratio of tertiary-educated to primary- and secondary-educated males. Data are measured between year 2000 and year 2010 and calculated as average during these years. Source: the World Bank. For each country, the skill premium is computed as the ratio of secondary and tertiary-educated lifetime earnings relative to primary-educated lifetime earnings. Data are measured between year 1992 and year 1998. Source: Fernández, Guner, and Knowles (2005).

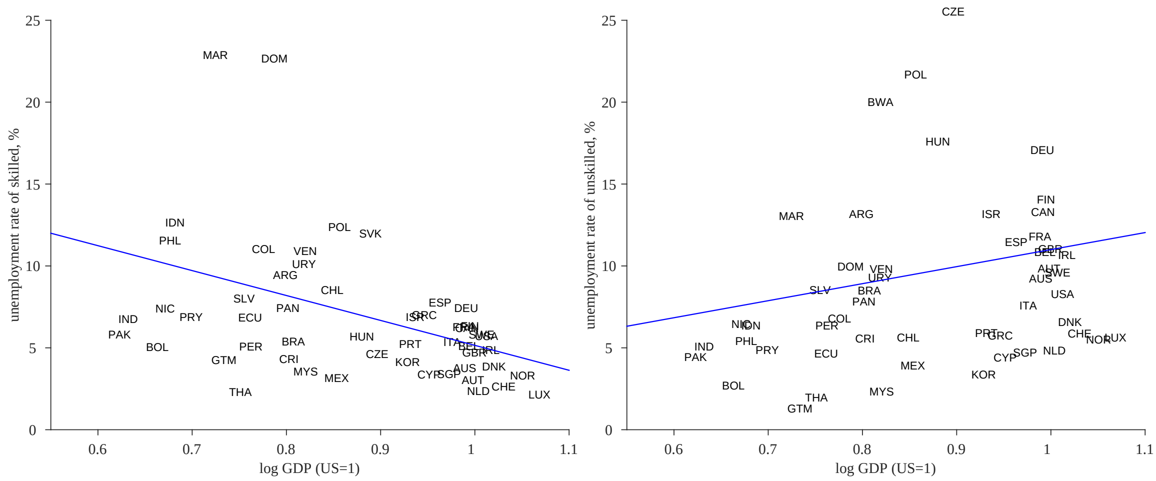


Figure 6: Unemployment rates for skilled and unskilled individuals across countries. Skilled individuals are defined to be those with tertiary and secondary education while unskilled males are their complement. For each country, unemployment rate is measured between year 2000 and year 2010 and calculated as average during these years. Source: the World Bank.

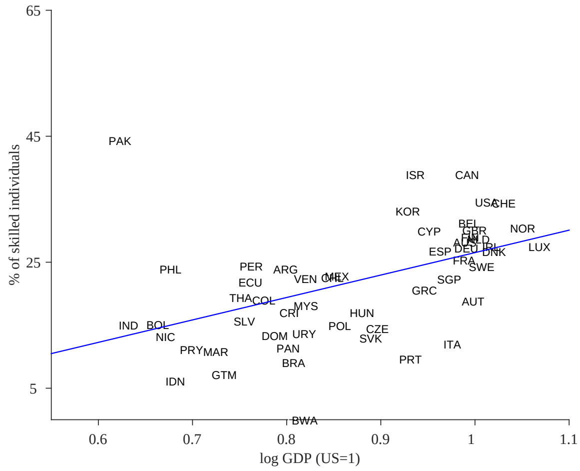


Figure 7: Fraction of skilled individuals across countries. Skilled individuals are defined to be those with tertiary education while unskilled individuals are their complement. For each country, the fraction of skilled individuals is computed as the ratio of secondary- and tertiary-educated to primary-educated males. Data are measured between year 2000 and year 2010 and calculated as average during these years. Source: the World Bank.

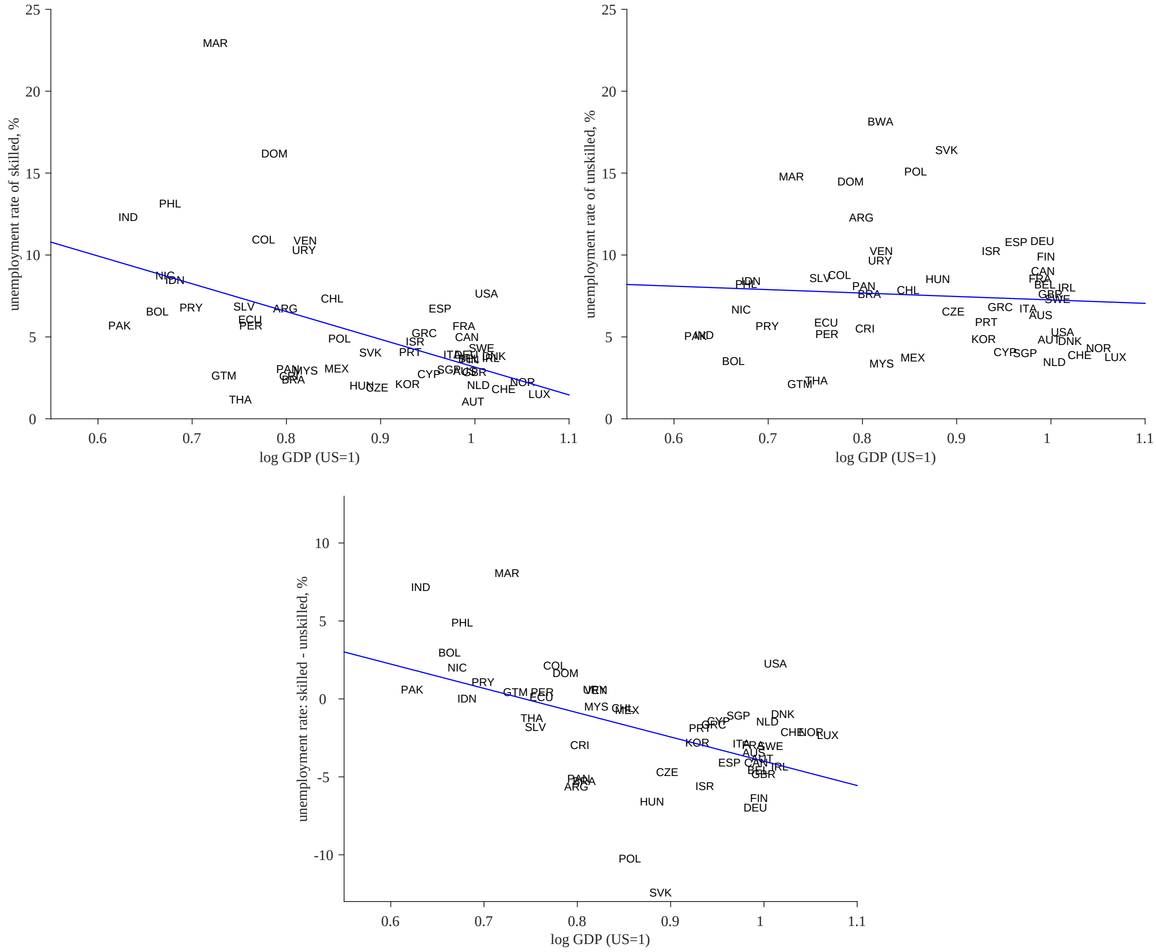


Figure 8: Unemployment rates for skilled and unskilled individuals across countries. Skilled individuals are defined to be those with secondary and tertiary education while unskilled males are their complement. For each country, unemployment rate is measured between year 2000 and year 2010 and calculated as average during these years. Source: the World Bank.

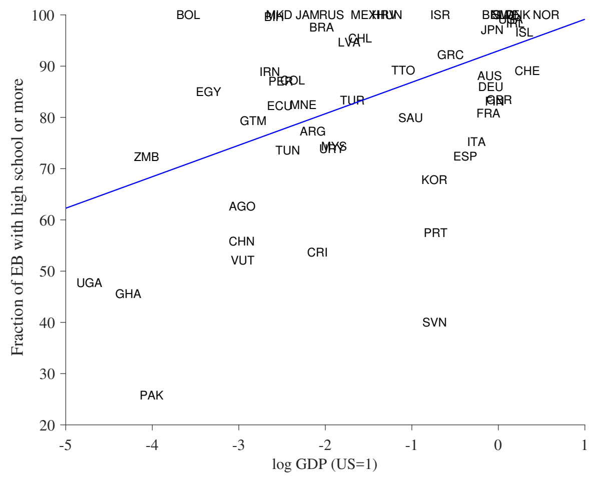


Figure 9: Fraction of skilled entrepreneurs. For each country, the fraction of skilled entrepreneurs is computed as the fraction of individuals with at least a high-school education among those owning an established business among male individuals in the labor force in 2010. Source: GEM data, 2010.

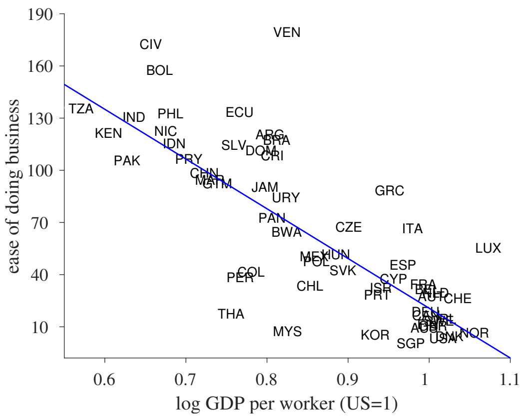
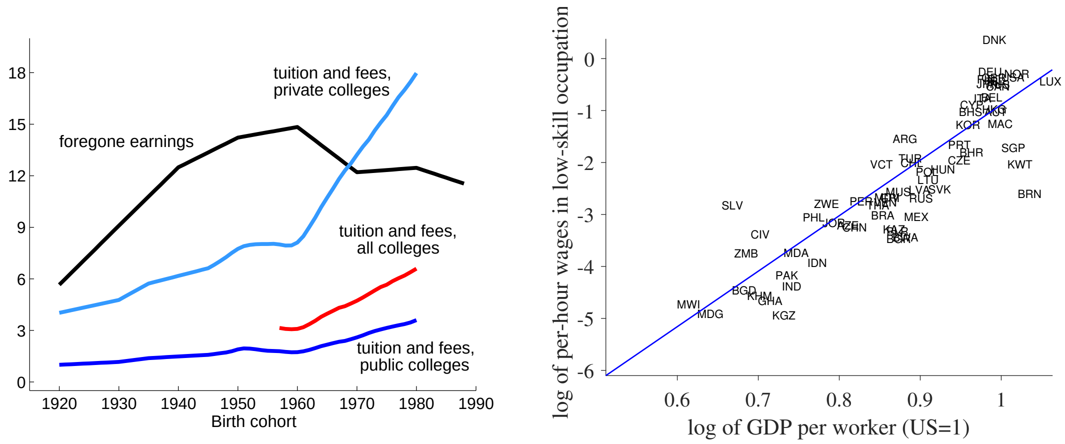


Figure 10: Anecdotal evidence on cost of doing business across countries. The figure plots the ease of doing business as published by the World Bank. This ranks economies from 1 to 189, with first place being the best. A high ranking (a low numerical rank) means that the regulatory environment is conducive to business operation. The index averages the country's percentile rankings on 10 topics covered in the World Bank's Doing Business. The ranking on each topic is the simple average of the percentile rankings on its component indicators. Source: the World Bank.



(a) (b)

Figure 11: Anecdotal evidence on cost of schooling across countries. Panel (a) plots the composition of the cost of college in the US. Foregone earnings are the sum of high-school graduates mean earnings between ages 19 and 22. Tuition and fees for public college reflect in-state charges. Data are normalized to tuition and fees in public colleges for the 1920 cohort. Source: IPUMS-USA, Snyder and Dillow (2011) table 345, and Conrad and Hollis (1955) Panel (b) plots average hourly wages in low-skill occupations. Low-skill occupations are: service workers and shop and market sales (code 5 for 1-digit ISCO88 coding), plant and machine operators and assembler (code 8 for 1-digit ISCO88 coding) and elementary occupations (code 9 for 1-digit ISCO88 coding). Source: Occupations around the World dataset and Penn-World Table dataset.

Table 8: Add caption

	10% VARIATION IN								25% VARIATION IN *							
	DATA	MODEL	c	sc	y_{ss}	y_{su}	y_{us}	y	DATA	MODEL	c	sc	y_{ss}	y_{su}	y_{us}	y
GDP & skilled workers	0.508	0.393	0.216	0.409	0.410	0.456	0.434	0.380	0.601	0.422	0.122	0.397	0.339	0.478	0.461	0.435
	0.003	0.024	0.228	0.018	0.018	0.008	0.012	0.029	0.000	0.020	0.522	0.030	0.067	0.008	0.010	0.016
GDP & skill premium	-0.701	-0.675	-0.662	-0.694	-0.583	-0.656	-0.628	-0.673	-0.704	-0.679	-0.537	-0.657	-0.656	-0.673	-0.600	-0.701
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000
GDP & unemp. diff.	-0.422	-0.440	-0.255	-0.348	-0.503	-0.458	-0.260	-0.428	-0.468	-0.467	-0.417	-0.144	-0.107	-0.590	-0.178	-0.487
	0.014	0.010	0.152	0.047	0.003	0.007	0.144	0.013	0.009	0.009	0.022	0.449	0.573	0.001	0.347	0.006
skilled workers & premium	-0.592	-0.400	-0.174	-0.400	-0.300	-0.552	-0.490	-0.536	-0.641	-0.434	0.092	-0.275	-0.409	-0.603	-0.463	-0.695
	0.000	0.021	0.331	0.021	0.089	0.001	0.004	0.001	0.000	0.016	0.629	0.141	0.025	0.000	0.010	0.000

	33% VARIATION IN **								50% VARIATION IN ***							
	DATA	MODEL	c	sc	y_{ss}	y_{su}	y_{us}	y	DATA	MODEL	c	sc	y_{ss}	y_{su}	y_{us}	y
GDP & skilled workers	0.631	0.406	-0.080	0.391	0.356	0.484	0.459	0.451	0.618	0.363	-0.080	0.388	0.359	0.407	0.349	0.410
	0.000	0.035	0.692	0.044	0.069	0.010	0.016	0.018	0.001	0.082	0.709	0.061	0.085	0.048	0.095	0.047
GDP & skill premium	-0.720	-0.717	-0.523	-0.697	-0.729	-0.711	-0.591	-0.723	-0.720	-0.729	-0.406	-0.716	-0.645	-0.676	-0.445	-0.743
	0.000	0.000	0.005	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.049	0.000	0.001	0.000	0.029	0.000
GDP & unemp. diff.	-0.485	-0.493	-0.324	-0.074	-0.128	-0.663	-0.018	-0.493	-0.471	-0.569	-0.252	-0.086	-0.109	-0.620	0.087	-0.634
	0.010	0.009	0.100	0.714	0.524	0.000	0.930	0.009	0.020	0.004	0.234	0.691	0.613	0.001	0.686	0.001
skilled workers & premium	-0.604	-0.436	0.162	-0.322	-0.438	-0.628	-0.449	-0.733	-0.602	-0.399	0.241	-0.302	-0.324	-0.505	-0.400	-0.780
	0.001	0.023	0.420	0.101	0.022	0.000	0.019	0.000	0.002	0.053	0.256	0.151	0.122	0.012	0.053	0.000

Table 9: Accounting exercise: cross-country correlations. The table reports the correlation between the logarithm of observed GDP per worker and other variables in the data and in the model, under the calibration and various alternative experiments. The experiments within the main accounting exercise are explained in the main text. % SKILLEDis the fraction of skilled individuals; SKP is the skill premium; U SKILLED is the unemployment rate of skilled workers, U SKILLED is the unemployment rate of unskilled workers, U SKILLED - UNSKILLED is the unemployment rate of skilled workers net of that of unskilled workers. "*": sample of 30 countries; "**": sample of 27 countries; "***": sample of 24 countries. Source: the World Bank, Fernández, Guner, and Knowles (2005) and own computations.