Business Cost and Skill Acquisition

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──────────── Abstract ────────────

Although the ratio of higher-educated to primary-educated lifetime earnings (skill premium) is higher in poor than rich countries, poor countries have a substantially lower fraction of individuals with higher education (skilled individuals). Why? In a sample of 52 countries, we document that the unemployment rate of the skilled net of that of the unskilled decreases with a country's level of development. We argue that the cost of business is a first order determinant of these unemployment rates and quantify that disparities in such cost account for about 1/3 of the cross-country correlation between skill premium and fraction of skilled individuals.

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1   Introduction

Cross-country data on wages and schooling indicate that although poor countries have higher skill premia than rich countries, the fraction of skilled individuals is substantially lower in poor countries. For example, between 2000 and 2010, a 1% increase in income per worker is associated with an *increase* of 0.07 percentage points in the fraction of men with secondary and tertiary schooling ("skilled" individuals) and 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").[1] This negative cross-country correlation is surprising as one would expect the higher incentives associated with a higher skill premium to boost the fraction of skilled individuals in poor countries. By now, the literature has put forward various explanations based on supply side factors (fewer high education institutions in poor counties), credit constraints, and factors relating to wage determination. In this paper, we study the role of the cost of opening and running a business ("business cost").

Our focus on the business cost for rationalizing the negative cross-country correlation between skill premium and acquisition is motivated by two observations we report on the cross-country patterns of unemployment rates. Using the World Development Indicator dataset provided by the World Bank, we construct conditional unemployment rates for skilled and unskilled men in a sample of 52 countries over the period 2000-2010. We find that, first, skilled individuals face a higher risk of unemployment in poor countries compared to rich countries. The cross-country correlation between the conditional unemployment rate of skilled workers and the logarithm of income per worker is -0.36. Second, the unemployment rate of unskilled workers shows no consistent cross-country correlation with the logarithm of income per worker.[2] Combining these two observations, Figure 1 shows the conditional unemployment rate of skilled workers net of that of unskilled workers ("unemployment differential"). A 1% increase in income per capita *decreases* the unemployment differential by

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[1]Details are in Figures 6a and 6b 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 8 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 7 in the Appendix plots skilled and unskilled unemployment against the logarithm of income per capita while Table 7 summarizes the cross-country correlations of unemployment rates by skill level, fraction of skill 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 9 and Table 8 in the Appendix).
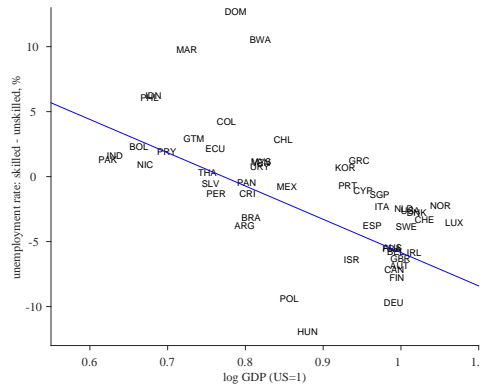
Figure 1: Unemployment differential. For each country, conditional unemployment rates are measured between year 2000 and year 2010 for male individuals and calculated as averages during these years. Source: the World Bank.

0.02 percentage points. Ceteris paribus, the higher unemployment differential in poor countries can potentially reconcile the lower fraction of skilled workers despite the higher skill premia as it decreases the incentives to acquire skills in poor countries by both decreasing the expected returns and increasing the riskiness of such investment. In light of this evidence, we study cross-country skill acquisition within a framework that encompasses what we consider being a first-order determinant of the unemployment rate: the business cost.[34]

A substantial body of literature in macroeconomics and development attempts to understand cross-country disparities in skill acquisition, based at least in part on the tight link of a country's skill composition with its human capital and aggregate productivity. Schooling cost and individuals' lifetime productivities have been identified as important drivers (see, among others, Bils and Klenow, 2000). We develop a simple matching model of occupational choice and skill acquisition in which business cost, along with 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 use our model to quantify the significance of disparities in business cost along with schooling cost and skill-productivity profile in ex-

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[3]Fonseca, Lopez-Garcia, and Pissarides (2001) report a negative correlation between start-up business costs and employment levels across major OECD economies. They are also the first to show that, in a standard equilibrium search framework with endogenous occupational choice, business start-up costs discourage entrepreneurs and increase the number of workers, giving rise to a monotonic relation between start-up business costs and employment.

[4]We acknowledge that other potential explanations, such as country-specific networks related to economic inequality and country-specific idiosyncratic business risk (Michelacci and Schivardi, 2013), can be important for employment levels and deserve a quantitative assessment. However, we abstract from these potential alternative explanations in this article.

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plaining skill acquisition and skill premium across countries. We infer a higher business cost in poor countries and find that disparities in such cost accounts for about one third 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. The business cost influences 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, a higher business cost decreases the fraction of skilled entrepreneurs and increases the fraction of skilled workers asymmetrically so that the overall fraction of skilled individuals decreases when the slope of skill-match productivity profile is higher for workers than it is for entrepreneurs. Our model has independent interest as it describes, simultaneously, occupational choice, skill acquisition and unemployment outcomes. Fonseca, Lopez-Garcia, and Pissarides (2001), within the equilibrium search literature, come closest by endogenizing 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.[5] This allows us to describe the equilibrium effects of costs related to the acquisition of skills.

We use our model to implement a quantitative experiment to assess the role of business cost for skill acquisition and skill premium across countries. First, we calibrate our model. We allow countries to differ by their schooling cost, business cost and match productivities. These country-specific parameters are calibrated so that the model implied fraction of skilled individuals, unemployment differential and skill premium are as close as possible to replicating these same moments observed in each country in our sample. The calibrated model fits the targets well and is also in line with the cross-country variations in the conditional unemployment rate of skilled and unskilled workers, which were not targets of the calibration exercise.

We calibrate a higher business cost for poor countries compared to rich countries, consis-

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[5]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.

tently 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 -0.48. At the same time, poor countries calibrate lower schooling costs and 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).

Second, we use our calibrated model to run a decomposition exercise where we shut down, one at the time, cross-country disparities in schooling cost, business cost and match productivities. We find that disparities in the business cost and match productivities explain, for the most, the negative cross-country correlation between skill premium and skill acquisitions, whereas the model still produces a negative cross-country correlation between skill premium and fraction of skilled individuals with no cross-country differences in the cost of schooling. Disparities in the business cost account for about one third of the cross-country correlation between skill premium and fraction of skilled individuals. Decreasing the business cost to US-levels would decrease the gap in the skill premium between countries in the top-half and bottom-half of the income distribution in our sample of 78% and entirely eliminate the gap in skill acquisition. A lower business cost increases the expected returns to acquiring skill as it depresses the conditional unemployment rate of skilled workers in poor countries of about 2 percentage points and turns the unemployment differential from positive to negative.[6]

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

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[6]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).

papers, 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 rends 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, Ros-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. However, we focus on cross-sectional data and take match productivities as exogenous with the aim of measuring their importance for cross-country patterns of the skill premium in comparison to that of schooling and business cost.

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.

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, $T = \{t : sf, sw, uf, uw\}$: (a) skilled entrepreneur (sf), incurring costs c and sc, (b) skilled worker (sw), incurring cost sc, (c) unskilled entrepreneur (uf), incurring cost c, and (d) (uw) unskilled worker.

After the skill acquisition and occupational decisions are made, all individuals enter the labour market. Entrepreneurs and workers meet randomly and anonymously.[7] 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. We assume that the matching of an unskilled entrepreneur (uf) with an unskilled worker (uw) produces zero output i.e. $y_{uu} = 0$.[8] 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. 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)	$J_{uu} = \Phi(y_0 - c)$	$J_{su} = \Phi(y_{su} - w_{su} + y_0 - c - sc)$
skilled worker (sw)	$J_{us} = \Phi(y_{us} - w_{us} + y_0 - c)$	$J_{ss} = \Phi(y_{ss} - w_{ss} + y_0 - c - sc)$
unmatched (vacant)	$V_u = \Phi(y_0 - c)$	$V_s = \Phi(y_0 - c - sc)$

[7] The assumption of anonymous and random matching implicitly defines a matching function. 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 $\Omega \times \frac{1}{1+\theta}$, where Ω is the number of entrepreneurs in the labour market. This matching function respects the constant returns to scale assumption typical of the search literature (see Mortensen and Pissarides, 1999).

[8] Setting y_{uu} to zero implies that we implicitly assume the output of an unskill-unskill match equals the wage of an unemployed worker and the profits of a vacant firm.

The terms $w_{ij} \in \mathbf{w} \equiv \{w_{uu}, w_{su}, w_{us}, w_{uu}\}$ in the matrix indicates the wage of a worker of skill j employed in a firm with an entrepreneur of skill i, for $i, j \in \{s, u\}$. 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. As the worker is willing to accept only positive wages, the value of a match with an unskilled worker for an unskilled entrepreneur is identical to that of a vacant firm, i.e. $J_{uu} = V_u$. The expected utility of an entrepreneur given his skill is:

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

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

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

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

The expected utility of a worker given his skill is:

$$W_u = p_{sf} E_{su} + (1 - p_{sf}) U_u, \tag{3}$$

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

such that $p_{sw} + p_{uw} + p_{sf} + p_{uf} = 1$.

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):

$$w_{ss} = \arg\max \left[(J_{ss} - V_s)^\theta (E_{ss} - U_s)^{1-\theta} \right], \tag{5}$$

$$w_{us} = \arg\max \left[(J_{us} - V_u)^\theta (E_{us} - U_u)^{1-\theta} \right], \tag{6}$$

$$w_{su} = \arg\max \left[(J_{su} - V_s)^\theta (E_{su} - U_u)^{1-\theta} \right], \tag{7}$$

where $\theta \in [0, 1]$ is a parameters 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 cost of business.[9]

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[9]We report the comparative statics of the schooling cost with respect to skill acquisition, skill premium and unemployment rates by skill level in Appendix A.1.

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:

$$p_s = p_{sw} + p_{sf}. \tag{8}$$

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

$$skp = \frac{E_s}{E_u}, \tag{9}$$

where

$$E_s = \frac{(y_{ss} - w_{ss})\, p_{sf} p_{sw} + (y_{su} - w_{su})\, p_{sf} p_{uw} + w_{us} p_{sw} p_{uf} + w_{ss} p_{sf} p_{sw}}{p_{sw}(p_{sf} + p_{uf}) + p_{sf}},$$

$$E_u = \frac{p_{uf} p_{sw}(y_{us} - w_{us}) + p_{uw} p_{sf} w_{su}}{p_{uw}(p_{sf} + p_{uf}) + p_{uf}}.$$

The numerator of the first (second) equation is the sum of the earnings of (un-) skilled individuals weighted by the relevant match probabilities, while the denominator 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:

$$u_s = \frac{p_{sw}(1 - p_{uf} - p_{sf})}{p_{sw} + p_{sf}}, \tag{10}$$

$$u_u = \frac{p_{uw}(1 - p_{uf} - p_{sf})}{p_{uw} + p_{uf}}. \tag{11}$$

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, we solve for the interior equilibrium of our model under risk neutrality (a linear utility function) and study the comparative statics of the endogenous moments of interest in eqs. 8, 9, 10 and 11 with respect to the business cost. 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. A higher business increases the proportion of skilled

workers and decreases the proportion of skilled entrepreneurs:

$$\frac{\partial p_s}{\partial c} = \underbrace{\frac{1}{y_{us}}}_{\frac{\partial p_{sw}}{\partial c}} - \underbrace{\frac{1}{y_{su}}}_{\frac{\partial p_{sf}}{\partial c}}.$$

Whether the fraction of skilled individuals increases or decreases with the cost of business depends on the relative slopes of the skill-match productivity profiles faced by workers and entrepreneurs. 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}). These changes in the match productivity pair are a component of the returns to skill acquisition as the productivity of a match is proportionally split between the entrepreneur and the worker. When y_{us} is greater than y_{su}, the slope of the skill-match productivity profile of workers is steeper than that of entrepreneurs and the latter have lower returns to skill acquisition than the former. In this case then, an increase in the cost of business decreases the fraction of skilled entrepreneurs more than it rises the fraction of skilled workers, therefore decreasing the fraction of skilled individuals altogether – that is, when $y_{us} > y_{su}$ then $\frac{\partial p_s}{\partial c} < 0$.

Turning to the skill premium and the unemployment rates, we calculate the local comparative statics in the neighborhood of $c = 0$ and $sc = 0$ assuming $\theta = 0.5$ to simplify the derivations. The local derivative of the skill premium with respect to the business cost reads:

$$\frac{\partial skp}{\partial c}\Big|_{c=0, sc=0} = \frac{4(-y_{ss} + y_{su} + y_{us})^2(y_{us}^2 - y_{su}^2)}{y_{su}y_{us}(y_{su} + y_{us} - 2y_{ss})(y_{su} + 2y_{us})^2}.$$

Two things are important to point out. First, when the productivities of the intermediate matches (su and us) are equal, the business cost does not have an effect on both the skill premium and the fraction of skilled individuals under risk neutrality. Second, if countries only differ in their business cost, the model produces a negative cross-country correlation between skill premium and fraction of skilled individuals when the output of the skilled-skilled match (y_{ss}) is lower than the average outputs of the intermediate matches (su and us):

$$\frac{\partial p_s}{\partial c} \Big/ \frac{\partial skp}{\partial c} < 0, \quad \text{for:} \quad \frac{y_{us} + y_{su}}{2} > y_{ss}.$$

The restriction of $\frac{y_{us} + y_{su}}{2} > y_{ss}$ tells of a degree of complementarity between skilled and unskilled individuals in production. Under this restriction, and turning to the unemployment

rates, we can show that the unemployment rates of skilled and unskilled workers increase with the business cost.[10] When p_s decreases with the cost of business – that is, when $y_{us} > y_{su}$, the model generates a negative correlation between the unemployment rates and the fraction of skilled individuals in a world where countries only differ in their business cost:

$$\frac{\partial p_s}{\partial c} \Big/ \frac{\partial u_u}{\partial c} < 0, \quad \frac{\partial p_s}{\partial c} \Big/ \frac{\partial u_s}{\partial c} < 0, \quad \text{for: } y_{us} > y_{su}.$$

Most importantly, the model can generate a negative correlation between the unemployment differential and the fraction of skilled individuals in a world where countries only differ by their business cost:

$$\frac{\partial p_s}{\partial c} \Big/ \frac{\partial u_s - u_u}{\partial c} < 0, \quad \text{for: } \frac{y_{us} + y_{su}}{2} < \sqrt{y_{ss}}\sqrt{y_{us}}.$$

It can be shown that if $y_{us} > y_{ss}$ and y_{su} is "small enough", the set of (y_{ss}, y_{us}, y_{su}) that satisfies conditions $\frac{y_{us}+y_{su}}{2} < \sqrt{y_{ss}}\sqrt{y_{us}}$ and $\frac{y_{us}+y_{su}}{2} > y_{ss}$ is not empty.[11] That is, there exist combinations of match productivities for which the model generates a negative correlation between the fraction of skilled individuals and the unemployment differential as well as a negative correlation between the fraction of skilled individuals and the skill premium in a world where countries only differ by their business cost.

3   Quantitative Experiment

We run a quantitative experiment with the objective of understanding the main drivers of the negative cross-country correlation between skill acquisition and skill premium. Our quantitative strategy consists of three steps. First, we calibrate cross-country disparities

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[10]This result holds under the lighter restriction of $y_{us} + y_{su} > y_{ss}$. This same restriction also guarantees a negative response of the fraction of skilled individuals to increases in the schooling cost, i.e. $\frac{\partial p_s}{\partial sc} < 0$ (see Appendix A.1). For completeness, we report the derivatives of the unemployment rates by skill level:

$$\frac{\partial u_u}{\partial c}\Big|_{c=0,sc=0} = -\frac{(y_{ss} - y_{su} - y_{us})(y_{su} + 3y_{us})}{y_{us}(y_{su} + y_{us})^2},$$

$$\frac{\partial u_s}{\partial c}\Big|_{c=0,sc=0} = -\frac{(y_{ss} - y_{us})(y_{su} + y_{us} - y_{ss})(-4y_{ss} + 3y_{su} + y_{us})}{y_{su}y_{us}(-2y_{ss} + y_{su} + y_{us})^2},$$

$$\frac{\partial(u_s - u_u)}{\partial c}\Big|_{c=0,sc=0} = \frac{(y_{su} - y_{us})(-y_{ss} + y_{su} + y_{us})^2((y_{su} + y_{us})^2 - 4y_{ss}y_{us})}{y_{su}y_{us}(y_{su} + y_{us})^2(y_{su} + y_{us} - 2y_{ss})^2}.$$

[11]The restriction of a "small enough" y_{su} requires: $y_{su} \in \left(0, \max\left\{0, y_{us}\left(2(\frac{y_{ss}}{y_{us}})^{\frac{1}{2}} - 1\right)\right\}\right)$.

in schooling cost, cost of business and match productivities to cross-country disparities in: 1) fraction of skilled individuals, 2) skill premium, and 3) unemployment rate differential between skilled and unskilled workers. Second and to check the merit of the model, we explore the model implications for cross-country disparities in the unemployment rates of skilled and unskilled workers. Third, we measure the importance of business cost, schooling cost and match productivities for skill acquisition and expected returns to such investment via multiple decomposition exercises in which we counterfactually shut down cross-country disparities in each of these three exogenous factors.

Based on data availability, we consider a sample of 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, Slovakia, Spain, Sweden, Uruguay, United States, Venezuela. For each country, we observe: 1) fraction of skilled individuals, 2) skill premium, and 3) unemployment rate by worker's skill. All data except for the skill premium are measured between year 2000 and year 2010 and calculated as average during these years (Source: WDI dataset provided by the World Bank). The skill premium is measured between year 1992 and year 1998 (Source: Fernández, Guner, and Knowles, 2005).

3.1 Simulation set-up

Strategy. We let the 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 set a number of parameters a-priori and calibrate the remaining within the model. The parameters that we calibrate without solving the model are reported in Table 1 together with the assigned values. We set the entrepreneur's share in bargaining, θ, to 40%.[12] We assume

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[12]The performance of our calibration exercise changes only slightly when we set the share parameter to 50%: the average percentage explained of the data targets by our model decreases from 99% to 95%.

Parameter	Symbol	Value
Workers' share in bargaining	θ	0.4
Curvature of the utility function	γ	1.035
Initial endowment	y_0	1

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

individual preferences are represented by a CRRA utility function and set its curvature, γ, to 1.035. The curvature 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 (the logarithmic utility case; see, among others, the early works of Arrow, 1971, Kydland and Prescott, 1982, and Kehoe, 1983). Last, we normalize y_0 to 1.

The list of remaining parameters that are calibrated within the model is:

$$\Lambda = \{c_j, sc_j, y_{ss,j}, y_{us,j}, y_{su,j}\}$$

where the index j indicates a country. Given that we have 33 countries in our sample, we calibrate a total of 5x33=165 parameters. The calibration targets are the following statistics for each country:

- fraction of skilled individuals: number of secondary- and tertiary-educated males divided by number of primary educated males,

- skill premium: ratio of tertiary- and secondary-educated lifetime earnings relative to primary-educated lifetime earnings,

- unemployment rate differential: logarithm of the unemployment odds for skilled workers net of that for unskilled workers.

There are a total of 3x33=99 targets.

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

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

CORRELATIONS OF AND:	OBSERVED LOG(GDP PER WORKER)
c	-0.480 (0.047)
sc	0.348 (0.047)
y_{ss}	0.321 (0.068)
y_{su}	-0.111 (0.538)
y_{us}	0.300 (0.089)
average y	0.334 (0.058)

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.

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. We simulate the model separately for each of the 33 countries in our calibration exercise. Even though the parameter values are chosen simultaneously to match the data targets, each parameter has a first-order effect on some targets. Match productivities for which at least one party is skilled, $\{y_{ss}, y_{su}, y_{us}\}$, are key to match the data on the skill premium . The cost of doing business in a country, c, is important for matching the unemployment rate differential in that country. Comparative statics on our model under the risk neutrality assumption show that the unemployment rate differential responds to changes in the cost of doing business (see Section 2). Given a value for y and c, the schooling cost in a country, sc, is parameterized so that the model implied fraction of skilled individuals is as close as possible to replicating the fraction of skilled individuals observed in that country.

The values of calibrated parameters are shown in Figures 2 and 3. Table 3 reports the cross-country correlations of the values of calibrated parameters with observed GDP per worker. The calibrated cost of business is lower in richer countries: the correlation between the calibrated c and the observed logarithm of GDP per worker is -0.48 (Table 3, 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. Panel (a) of Figure 4 shows a significant negative correlation of a country's ranking and the logarithm of GDP per worker.
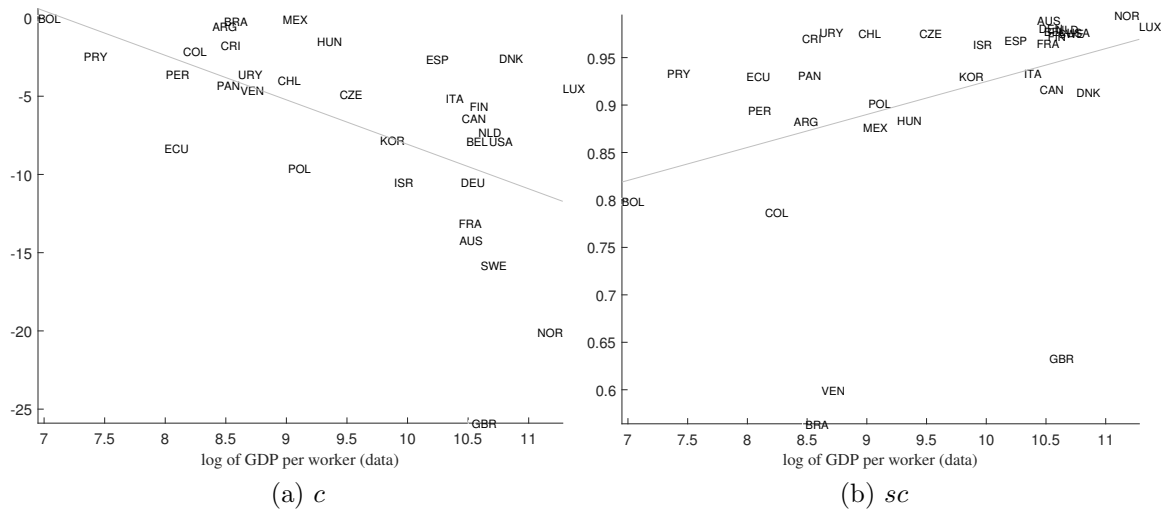
Figure 2: Calibration: implied cost of doing business and schooling cost.

We calibrate a cost of schooling that is higher for richer countries: the correlation between the calibrated sc and the observed logarithm of GDP per worker is 0.35 (Table 3, second row). Foregone earnings are a sizable component of the schooling cost of higher education. 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 Figure 10 in the Appendix). Panel (b) of Figure 4 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 mach productivities for matches where the worker is skilled and the average productivity of matches where at least one of the two parties is skilled tends to increase with the logarithm of observed GDP per worker (correlation of 0.33, see Table 3, rows 3 to 6). 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
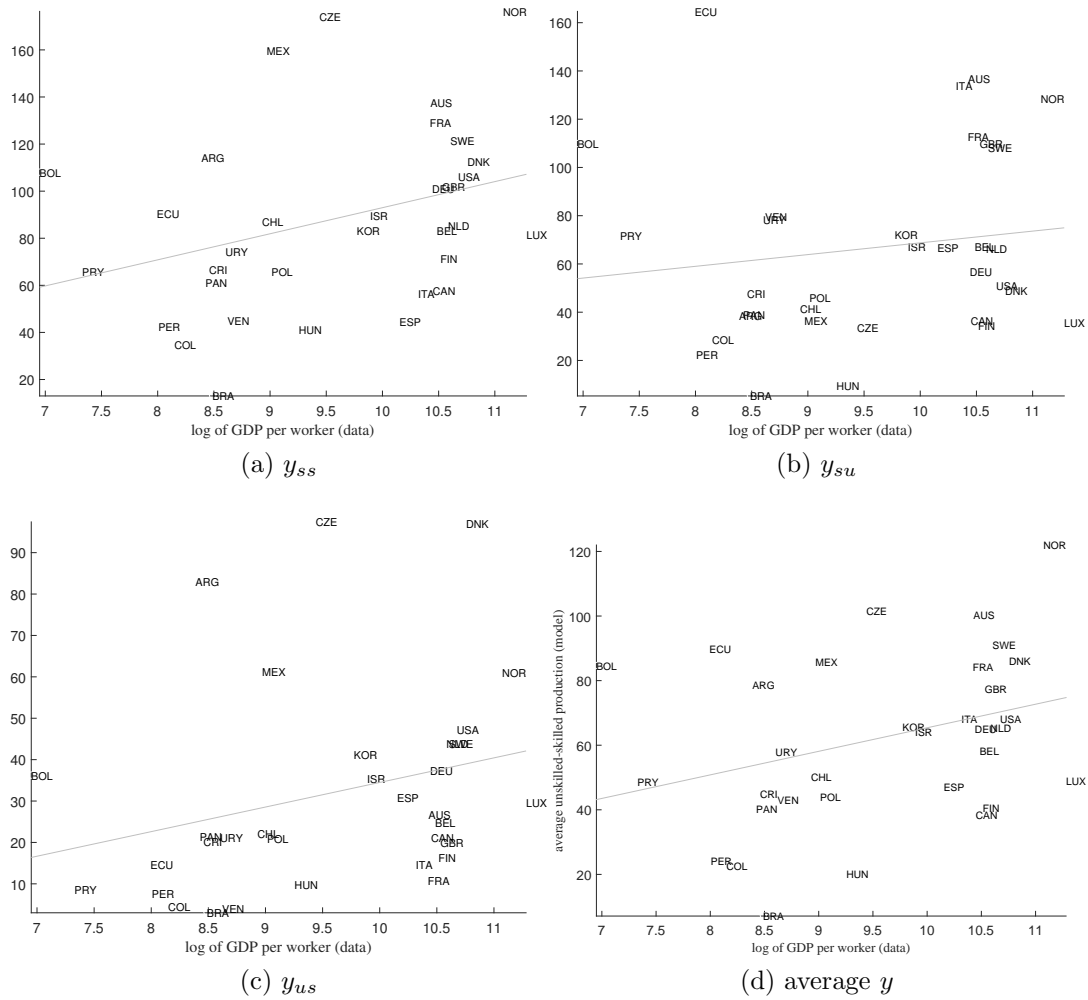
Figure 3: Calibration: implied match productivities.

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 Figure 5. On average, the model explains 99% and 98% of, respectively, the skill premium and the fraction of skilled individuals in a country. Moreover, the squared correlation between model and data moments is 99.8% for the skill premium and 95.4% for the fraction of skilled individuals. The model fit on the unemployment rate differential by skill sees a squared correlation between model and data moments of 99.8% and the model matching on average 98.9% of the unemployment rate differential by skill in each country. To further check the fit of the model, the first two rows of Table 3 report the correlations between the logarithm of observed GDP per
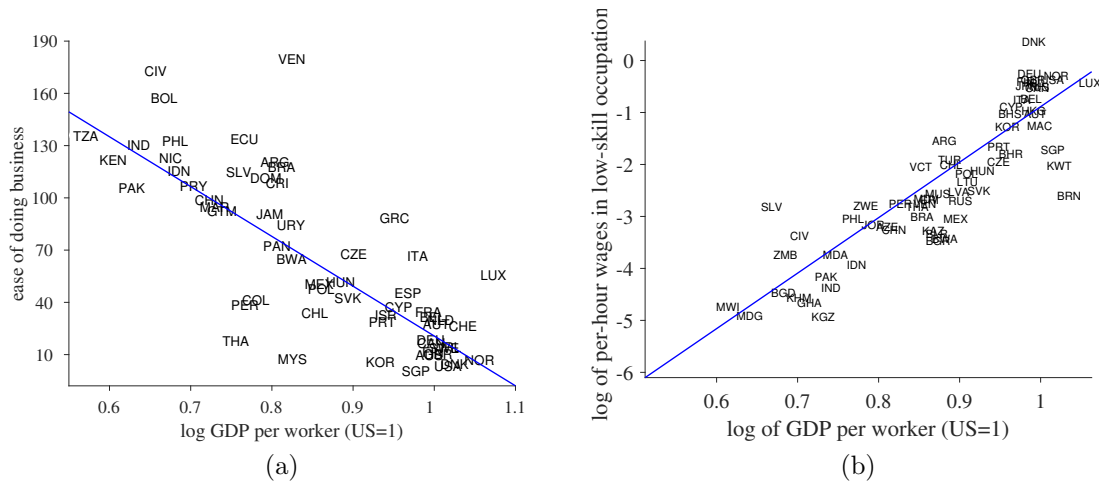
Figure 4: Anecdotal evidence on cost of doing business and cost of schooling across countries. Panel A plots the ease of doing business as published by the World Bank. This ranks economies from 1 to 189, with first place being the best. A high ranking (a low numerical rank) means that the regulatory 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. Panel B plots average per-hour 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.

worker and targeted moments for both the observed data and the simulated model. After calibration, the model-generated fraction of skilled individuals and skill premium show a correlation with the logarithm of observed GDP per worker equal to, respectively, 0.515 and -0.704. The straight difference in the unemployment rates of skilled and unskilled workers is negatively correlated with the logarithm of observed GDP per worker in the model as it is in the data. However, the model correlation is not significant. Overall and consistently with the data, the model produces a negative correlation between the fraction of skilled individuals and the skill premium. This correlation is -0.642 in the model and -0.599 in the data, both statistically different from zero. In poor countries, despite the lower cost of schooling, individuals face low match productivities for skilled matches and higher cost of business, both of which decrease the returns to skill acquisition. Countries in the bottom-half of the income distribution have an average business cost of -4.3, compared to the average business cost of countries in the top-half of the income distribution of -8.8 and to that of the US of -7.8. The average match productivity for countries in the bottom-half of the income distribution is about 3/4 that for the US and for countries in the top-half of the income

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CORRELATIONS	DATA	MODEL
BETWEEN OBSERVED LOG(GDP) PER WORKER AND:		
% skilled	0.508 (0.002)	0.515 (0.002)
skill premium	-0.701 (0.000)	-0.704 (0.000)
unemployment skilled minus unemployment unskilled	-0.422 (0.014)	-0.169 (0.346)
unemployment skilled	-0.428 (0.013)	-0.489 (0.004)
unemployment unskilled	0.196 (0.273)	-0.298 (0.092)
BETWEEN % OF SKILLED INDIVIDUALS AND:		
skill premium	-0.599 (0.001)	-0.642 (0.000)

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 7 as in the quantitative exercise we focus on a sub-sample of the dataset presented in the introduction and used in Table 7. Source: the World Bank and Fernández, Guner, and Knowles (2005) and own computations.

distribution.

We assess the merit of the model based on moments that are not targets of the calibration exercise: cross-country variations in the unemployment rate of skilled and unskilled workers. Table 3, rows 5 and 6, reports the cross-country correlations of these unemployment rates with the logarithm of observed GDP per worker. The negative correlation between the logarithm of observed GDP per worker and the unemployment rate of skilled workers generated by the model is very closed to the corresponding correlation in the data: this correlation is -0.428 in the data and -0.489 in the model. The cross-country correlation of the unemployment rate of unskilled workers and the logarithm of observed GDP per worker is 0.196 in the data. The same correlation computed on the model-implied unemployment rate of unskilled workers is -0.298. However, both correlations are not statistically different from zero at 95% confidence level.

3.2 Decomposition Analysis

How much of the cross-country variation in skill acquisition and observed returns to such investment are explained by business cost, schooling cost and match productivities? Countries in the bottom half of the income distribution have a fraction of skill individuals 21 percentage points lower than that observed in the US and, at the same time, they record a

(a) % skilled individuals

(b) skill premium

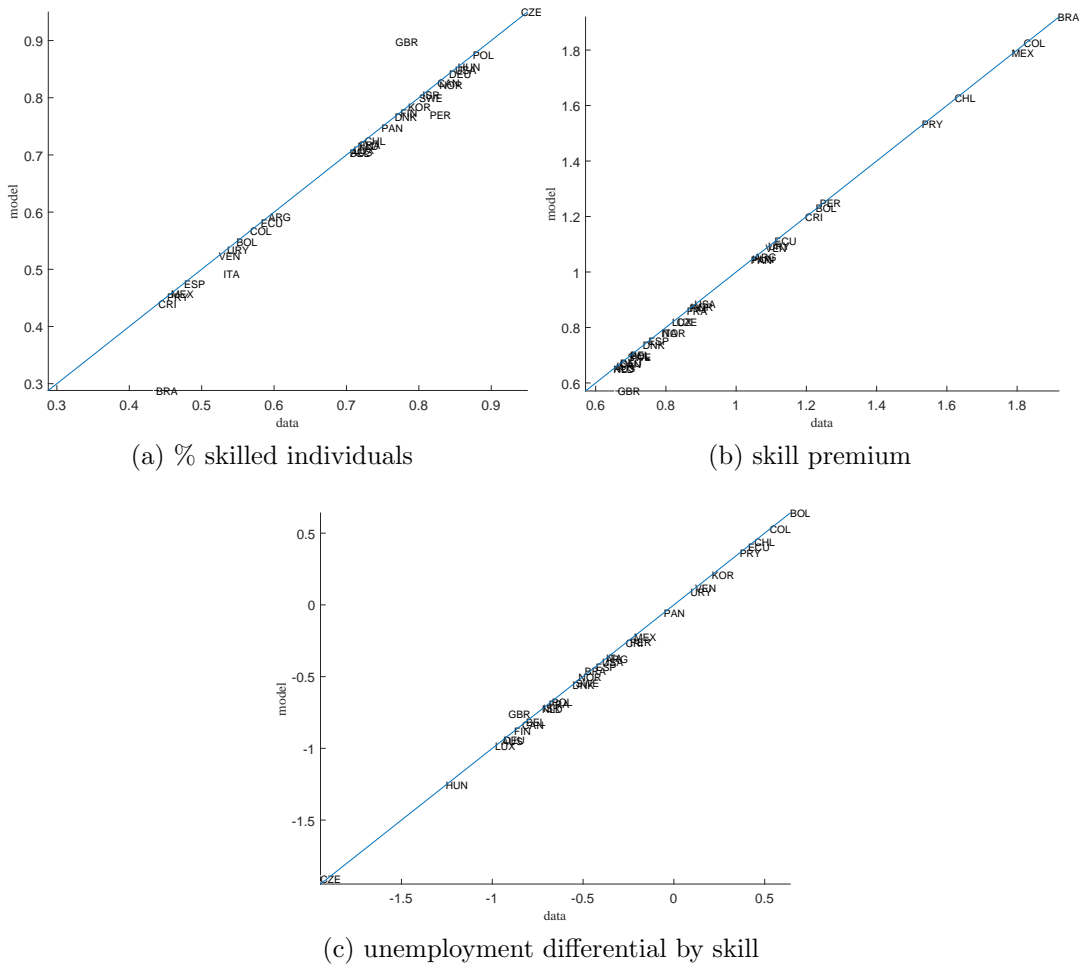(c) unemployment differential by skill

Figure 5: Calibration: model fit.

skill premium which is 1.4 times that in the US. How? To answer these two questions we run two decomposition exercises, each of them is described, respectively, under "Cross-country analysis" and "Poor vs rich countries analysis".

Cross-country analysis. How much correlation between skill acquisition and skill premium would we observe if all countries had the same a) schooling cost, b) business cost, c) match productivities? To address this question we conduct a decomposition exercise consisting of three counterfactual experiments. In each counterfactual experiment we assign to each country the sample averages of, respectively, the cost of doing business ("No c variation"), the schooling cost ("No sc variation") and the match productivities for which at least one of the two parties is skilled ("No y variation"). For each counterfactual experiment, we measure the

	% SKILLED	SKP	U SKILLED	U UNSKILLED	U SKILLED - UNSKILLED
AVERAGE PERCENTAGE EXPLAINED OF THE CALIBRATED MODEL					
no c variation	90.0%	64.9%	40.6%	67.2%	54.3%
no sc variation	89.9%	72.8%	60.2%	66.4%	47.2%
no y variation	89.9%	64.7%	59.3%	39.6%	41.4%
SQUARED CORRELATION WITH THE CALIBRATED MODEL					
no c variation	62.1%	7.4%	14.2%	88.1%	76.8%
no sc variation	70.9%	14.3%	60.5%	88.3%	30.5%
no y variation	54.4%	6.7%	67.7%	12.9%	18.2%

Table 4: Decomposition exercise: cross-country analysis. The experiments within the main decomposition exercise are explained in the main text. % SKILLED is 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 countries: Canada, Costa Rica, Denmark, Ecuador, Israel, Italy, Netherlands, Panama, Peru, Poland, Spain, Korea and Uruguay. USA. Source: the World Bank, Fernández, Guner, and Knowles (2005) and own computations.

deviations from the calibrated model of five moments: (i) the fraction of skilled individuals, (ii) the skill premium, (iii) the unemployment rate of skilled workers, (iv) the unemployment rate of unskilled workers and (v) the unemployment rate of skilled workers net of that of unskilled workers. These deviations, for a given moment and counterfactual experiment, are summarized as the cross-country average of the percentage of that model-generated moment in the calibration exercise explained by the given counterfactual experiment and as the squared correlation between that simulated moment in the calibrated model and in the given counterfactual experiment.[13] The results of the first decomposition exercise are reported in Table 4.[14]

Match productivities for which at least one of the two parties is skilled are the main driver of

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[13]The cross-country average of the percentage of a model-generated moment u in the calibrated model explained by a counterfactual experiment is computed as follows:

$\frac{1}{J} \sum_{j=1}^{J} \left\{ \begin{array}{ll} |x_{u,j}(\tilde{\Lambda}_j)/x_{u,j}(\hat{\Lambda}_j)| & \text{if } x_{u,j}(\tilde{\Lambda}_j) < x_{u,j}(\hat{\Lambda}_j) \\ |x_{u,j}(\tilde{\Lambda}_j)/x_{u,j}(\hat{\Lambda}_j)| & \text{otherwise} \end{array} \right\}$, where $\hat{\Lambda}_j$ is the vector of calibrated parameters for country j, $\tilde{\Lambda}_j$ is the vector of counterfactual parameters for country j and J is the total number of countries in the sample.

[14]The results in Table 4 only consider those countries for which the model consistently solves across *all* the counterfactual experiments: there are a total of 13 countries. This sample covers countries with a substantial variation in output per worker: the poorest country has a per-worker GDP which is 7% the one of the US.

cross-country differences in skill acquisition, accounting for about half of it. With no cross-country differences in match productivities, the model explains only 54% of cross-country patterns in the percentage of skilled individuals and, on average, 90% of the fraction of skilled individuals in a country (Table 4, row 3). Moreover, the correlation between the fraction of skilled individuals and the logarithm of observed GDP per worker drops from 0.154 in the calibrated model (0.146 in the data) to 0.047 when we keep productivities for which at least one of the two parties is skilled equal across countries (see Table 5). Higher productivities for matches where at least a party is skilled increase the returns to acquiring skill in higher income countries by boosting both wages and firm profits of such matches. Each match productivity exert a similar role on skill acquisition, with the productivity of a skill-skill match having a slightly higher effect.[15]

Match productivities are only one facet of the return to acquiring in skill as business cost determines the probability of skilled workers to acquire this premium by shaping the unemployment rate of skilled workers. Business costs explain about 1/3 of the cross-country differences in skill acquisition. With no cross-country differences in the business cost, the model can account only 62% of cross-country patterns in the fraction of skilled individuals (Table 4, row 4). This is due to the effect that c has on the unemployment rate of skill workers. Table 4, row 1 shows that cost of business alone accounts, on average, for 59% of the unemployment rate of skilled workers in a country and for 63% of the difference in the unemployment rate between skilled and unskilled workers. Moreover, with no cross-country differences in the business cost, the model can explain only 14% of cross-country patterns in the unemployment rate of skilled workers compared to 88% of the unemployment rate of unskilled workers (Table 4, row 4).

Lastly, the direct cost of acquiring skill, the schooling cost sc, exerts the smallest role in explaining cross-country differences in skill acquisition. With no cross-country differences in schooling cost, the model accounts for 71% of cross-country patterns in the percentage of skilled individuals (Table 4, row 5). This is not to say that schooling cost has no impact on the decision of acquiring skill. Notice that the calibrated schooling cost shows lower cross-country variation than calibrated match productivities and business cost. A series of studies indeed demonstrate the beneficial effect of abolition of school fees on the schooling attainment of poor countries (Alderman, Orazem, and Paterno, 2001, Deininger, 2003, Al-

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[15]The disaggregated results for specific match productivities are not reported in Table 4: details are available upon request.

Correlation with GDP per worker	% skilled	skp	u skilled	u unskilled	u skilled - unskilled
Data	0.146	-0.772	-0.484	-0.042	-0.329
Model	0.154	-0.772	0.284	0.472	-0.675
with no c variation	-0.065	-0.574	0.216	0.455	-0.448
with no sc variation	0.252	-0.437	0.086	0.257	-0.210
with no y variation	0.047	-0.276	-0.117	0.012	-0.130

Table 5: Decomposition exercise: cross-country analysis. 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 counterfactual experiments. The experiments within the main decomposition exercise are explained in the main text. % skilled is 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 countries: Canada, Costa Rica, Denmark, Ecuador, Israel, Italy, Netherlands, Panama, Peru, Poland, Spain, Korea and Uruguay. USA. Source: the World Bank, Fernández, Guner, and Knowles (2005) and own computations.

Samarrai and Zaman, 2007 and Schultz, 2004).[16]

Cross-country patters of the skill premium are mainly driven by match productivities for which at least one party is skilled and by the business cost, each of them accounting for about 1/3 of them. Match productivities and business cost account on average, for 35% of a country's skill premium. When we don't allow for cross-country differences in either of these two parameters, the model explains about 7% of the cross-country pattern in the skill premium (Table 4, rows 4 and 6). The correlation between the skill premium and the logarithm of observed GDP per worker increases from -0.772 in the calibrated model (same in the data) to -0.574 when we keep the business cost equal across countries and to -0.276 when we keep match productivities for which at least one party is skilled equal across countries (see Table 5). Notice that, in this case, y_{ss} and y_{us} play a significantly more sizable role compared to y_{us}, and particularly so y_{ss}. Cross-country differences in skill-skill productivities alone account, on average, for 25% of the skill premium in a country.

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[16]We recognize that the set-up of our exercise may lead to an underestimation of the role of schooling cost for skill acquisition. Indeed, one could argue that the schooling cost influences match productivities when it affects schooling quality. 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 the quality. A non-zero effect of the schooling cost on schooling quality implies that schooling has an additional indirect effect on skill acquisition via changing match productivities. This additional effect is not captured in our quantitative exercises as we hold productivities fixed while changing the schooling quality.

	% SKILLED	SKP	U SKILLED	U UNSKILLED	U SKILLED - UNSKILLED
COUNTRIES IN THE BOTTOM-HALF OF THE INCOME DISTRIBUTION:					
Data	65%	2.32	6.96%	6.39%	0.57%
Model	65%	2.32	2.78%	2.73%	0.05%
with c_{USA}	77%	1.67	0.85%	1.70%	-0.85%
with sc_{USA}	60%	2.02	1.97%	2.86%	-0.89%
with $y_{.,USA}$	76%	2.42	4.71%	3.28%	1.42%
COUNTRIES IN THE TOP-HALF OF THE INCOME DISTRIBUTION:					
Data	76%	1.42	4.91%	10.17%	-5.26%
Model	76%	1.42	1.55%	3.02%	-1.47%
with c_{USA}	77%	1.99	1.24%	3.10%	-1.87%
with sc_{USA}	75%	1.99	1.33%	2.56%	-1.23%
with $y_{.,USA}$	85%	1.46	2.21%	3.32%	-1.11%

Table 6: Decomposition exercise: poor vs rich countries analysis. The experiments within the main decomposition exercise are explained in the main text. % SKILLED is 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 countries: 1) Bottom half: Chile, Costa Rica, Panama, South Korea and Uruguay; 2) Top half: Australia, Belgium, Denmark, Finland, Germany, Israel, Luxembourg, Netherlands and Sweden. Source: the World Bank, Fernández, Guner, and Knowles (2005) and own computations.

Overall, match productivities and business cost are the major drivers of the negative cross-country correlation between skill premium and the fraction of skill workers. This correlation increases from -0.387 in the calibrated model (-0.367 in the data) to 0.187 with no cross-country differences in the cost of business and to 0.472 with no cross-country differences in the match productivities for which at least one party is skilled. On the other hand, the model still produces a negative cross-country correlation between skill premium and fraction of skill workers with no cross-country differences in the cost of schooling (-0.133).

Poor vs rich countries analysis. How much gap between poor and rich countries would be observe with respect to skill acquisition and skill premium if all countries had the same a) schooling cost, b) business cost, c) match productivities? Similarly to above, to address this question we run a decomposition exercise, consisting of three counterfactual experiments. In each experiment, we assign to each country the US-values of, respectively, the cost of doing business ("with c_{USA}"), the schooling cost ("with sc_{USA}") and the match productivities

for which at least one of the parties is skilled ("with $y_{.,USA}$").[17] Table 6 reports for the data, calibrated model and and each of the three counterfactual experiments the implied averages of: i) the fraction of skilled workers, (ii) the skill premium, (iii) the unemployment rate of skilled workers, (iv) the unemployment rate of unskilled individuals and (v) the unemployment rate of skilled workers net of that of unskilled workers for countries in the top- and bottom-half of the income distribution. Statistics are reported separately for countries with income in the upper-half of the cross-country distribution of GDP per worker and for those in the lower-half.[18]

Business cost and productivities of those matches for which at least one party is skilled are the main drivers of the gap in skill acquisition between poor and rich countries. Decreasing the business cost of countries in the bottom-half of the income distribution to US levels would increase their fraction of skilled individuals of 12 percentage points, closing the gap in skill acquisition between rich and poor counties entirely (Table 6 row 3). An effect almost equal in magnitude would happen if countries in the bottom-half of the income distribution were to obtain match productivities similar to those of the US (Table 6, row 5). Productivity of those matches where at least one party is skilled influence the decision of investing in skills directly by increasing its return. Differently, the business cost depresses the unemployment rate of skilled workers in poor countries of about 2% and the unemployment differential between skilled and unskilled workers of 1%, turning the latter from positive to negative.

The business cost is also the main driver of the skill-premium gap between rich and poor countries. Decreasing the business cost of countries in the bottom-half of the income distribution to US levels would decrease their skill premium from 2.32 to 1.67, closing the gap in skill premium with rich countries by 72% (Table 6, row 3).

Overall, the cost of business is a prime driver of both gaps in the fraction of skilled individuals and the skill premium. Match productivities have a similar quantitative importance as that of the cost of business for 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.

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[17]We pick the US as reference country for this decomposition exercise as this is the richest country in our sample.

[18]Table only reports statistics for those countries for which the model consistently solves across all the alternative experiments within each decomposition exercise.

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 0.07 percentage points in the fraction of skilled individuals and with a 0.44 percentage-point 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 cost of business, 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 cost of business 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 business cost to US-levels, while holding constant other country-specific parameters, would entirely eliminate the gap in the fraction of skilled individuals between countries in the top-half and bottom-half of the income distribution in our sample and reduce of 72% the gap in the skill premium.

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, the equilibrium distribution of individuals by skill and occupation is described by the following four probabilities:

$$
\begin{aligned}
p_{sw} &= \frac{cy_{ss} - cy_{su} + scy_{su}}{y_{us}(y_{ss} - y_{su})} - \frac{2scy_{ss} - y_{ss}y_{su} + y_{su}^2}{2(y_{ss} - y_{su})(-y_{ss} + y_{su} + y_{us})}, \\
p_{uw} &= \frac{-cy_{ss}y_{su} + cy_{ss}^2 + scy_{ss}y_{su}}{y_{su}y_{us}(y_{su} - y_{ss})} + \frac{2c + 2sc + y_{su}}{2y_{su}} + \frac{2scy_{ss} - y_{ss}y_{su} + y_{su}^2}{2(y_{ss} - y_{su})(-y_{ss} + y_{su} + y_{us})}, \\
p_{sf} &= \frac{-2c - 2sc + y_{su}}{2y_{su}} + \frac{-2scy_{ss} + y_{ss}y_{su} - y_{su}^2}{2y_{su}(-y_{ss} + y_{su} + y_{us})}, \\
p_{uf} &= \frac{cy_{ss} - cy_{su} + scy_{su}}{y_{su}y_{us}} + \frac{2scy_{ss} - y_{ss}y_{su} + y_{su}^2}{2y_{su}(-y_{ss} + y_{su} + y_{us})}.
\end{aligned}
$$

We report the comparative statics with respect to the cost of schooling:

$$
\begin{aligned}
\frac{\partial p_s}{\partial sc} &= \frac{(y_{su} + y_{us})^2}{y_{su}y_{us}(y_{ss} - y_{su} - y_{us})}, \\
\frac{\partial sk}{\partial sc}\Big|_{c=0,sc=0} &= \frac{\begin{array}{c}4(y_{su} + y_{us})(-y_{ss} + y_{su} + y_{us})(6(y_{su} + 2y_{us})y_{ss}^2, \\ -6(y_{su}^2 + 4y_{us}y_{su} + y_{us}^2)y_{ss} + (y_{su} + y_{us})(y_{su}^2 + 7y_{us}y_{su} + y_{us}^2))\end{array}}{y_{su}y_{us}(-2y_{ss} + y_{su} + y_{us})^2(y_{su} + 2y_{us})^2}, \\
\frac{\partial(u_s - u_u)}{\partial sc}\Big|_{c=0,sc=0} &= -\frac{(y_{su} - y_{us})(-y_{ss} + y_{su} + y_{us})(y_{su}^2 + (4y_{ss} - y_{us})y_{us})}{y_{su}y_{us}(y_{su} + y_{us})(y_{su} + y_{us} - 2y_{ss})^2}, \\
\frac{\partial u_u}{\partial sc}\Big|_{c=0,sc=0} &= \frac{2}{y_{su} + y_{us}} - \frac{1}{y_{us}}, \\
\frac{\partial u_s}{\partial sc}\Big|_{c=0,sc=0} &= -\frac{(y_{su} - y_{us})\left(4y_{ss}^2 - (3y_{su} + 5y_{us})y_{ss} + y_{us}(y_{su} + y_{us})\right)}{y_{su}y_{us}(-2y_{ss} + y_{su} + y_{us})^2}.
\end{aligned}
$$

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 employs 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 7: 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 8: 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).
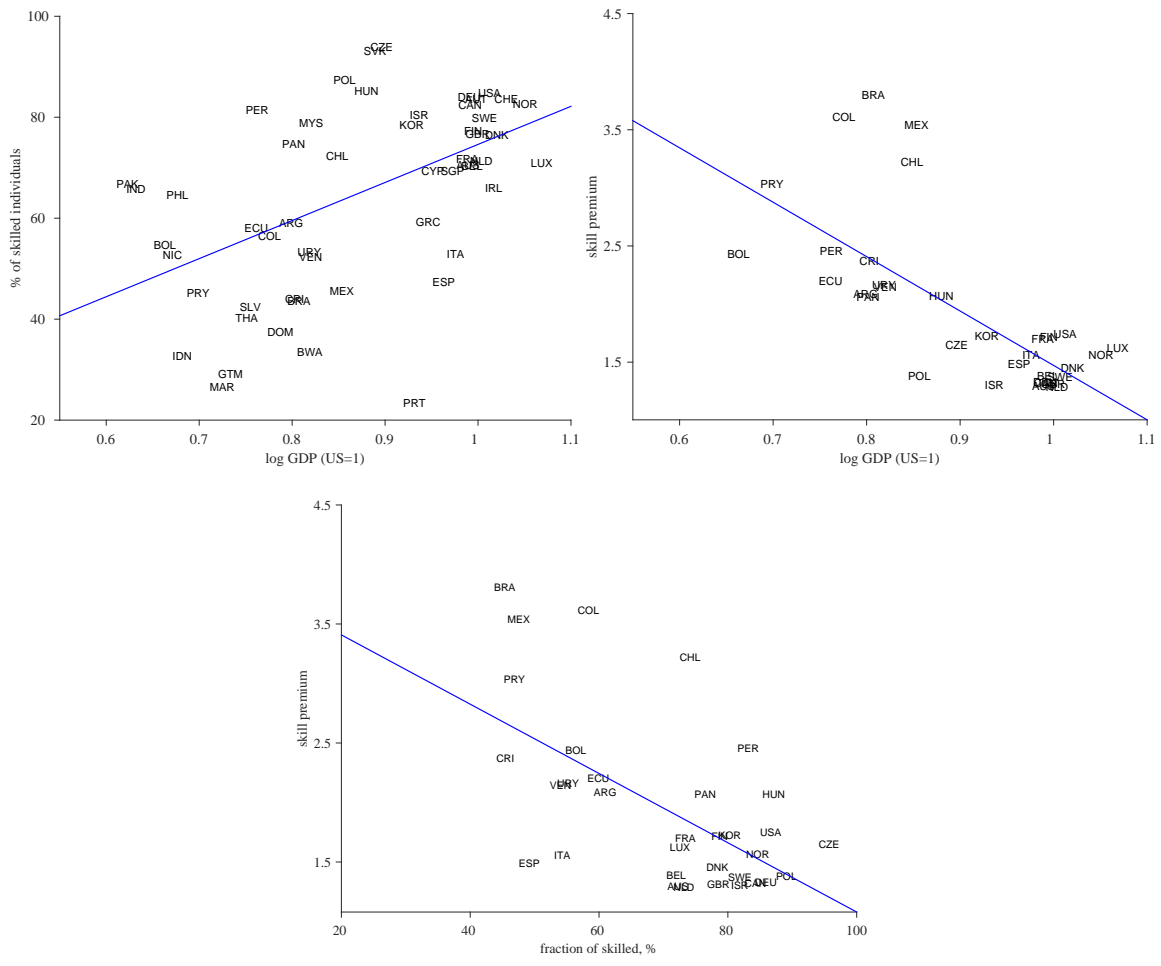
Figure 6: Fraction of skilled individuals and skill premium across countries. For each country, the fraction of skilled individuals is computed as the ratio of tertiary-educated to primary- and secondary-educated males. Data are measured between year 2000 and year 2010 and calculated as average during 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).
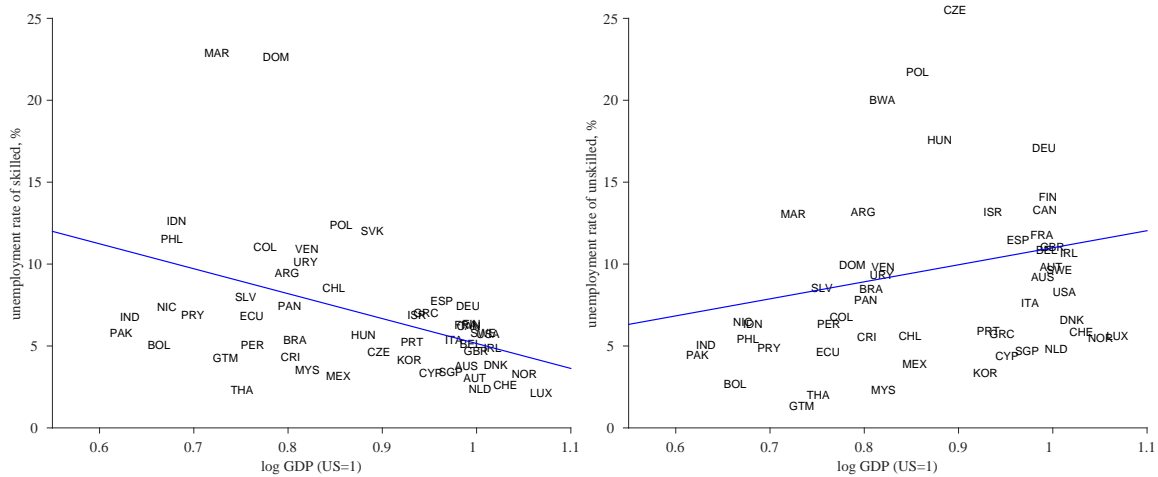
Figure 7: Unemployment rates for skilled and unskilled individuals across countries. Skilled individuals are defined to be those with tertiary and secondary education while unskilled males are their complement. For each country, unemployment rate is measured between year 2000 and year 2010 and calculated as average during these years. Source: the World Bank.
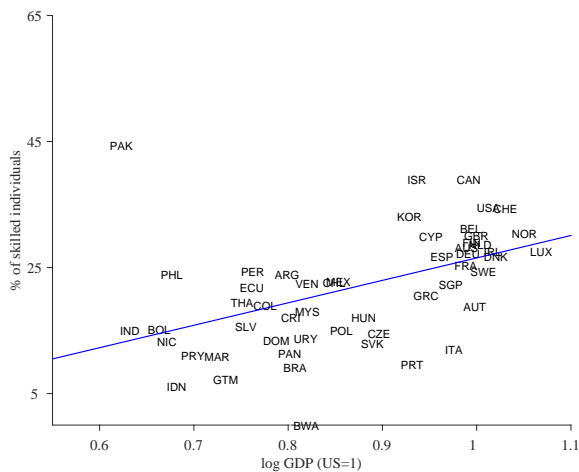

Figure 8: Fraction of skilled individuals across countries. Skilled individuals are defined to be those with tertiary education while unskilled individuals are their complement. For each country, the fraction of skilled individuals is computed as the ratio of secondary- and tertiary-educated to primary-educated males. Data are measured between year 2000 and year 2010 and calculated as average during these years. Source: the World Bank.
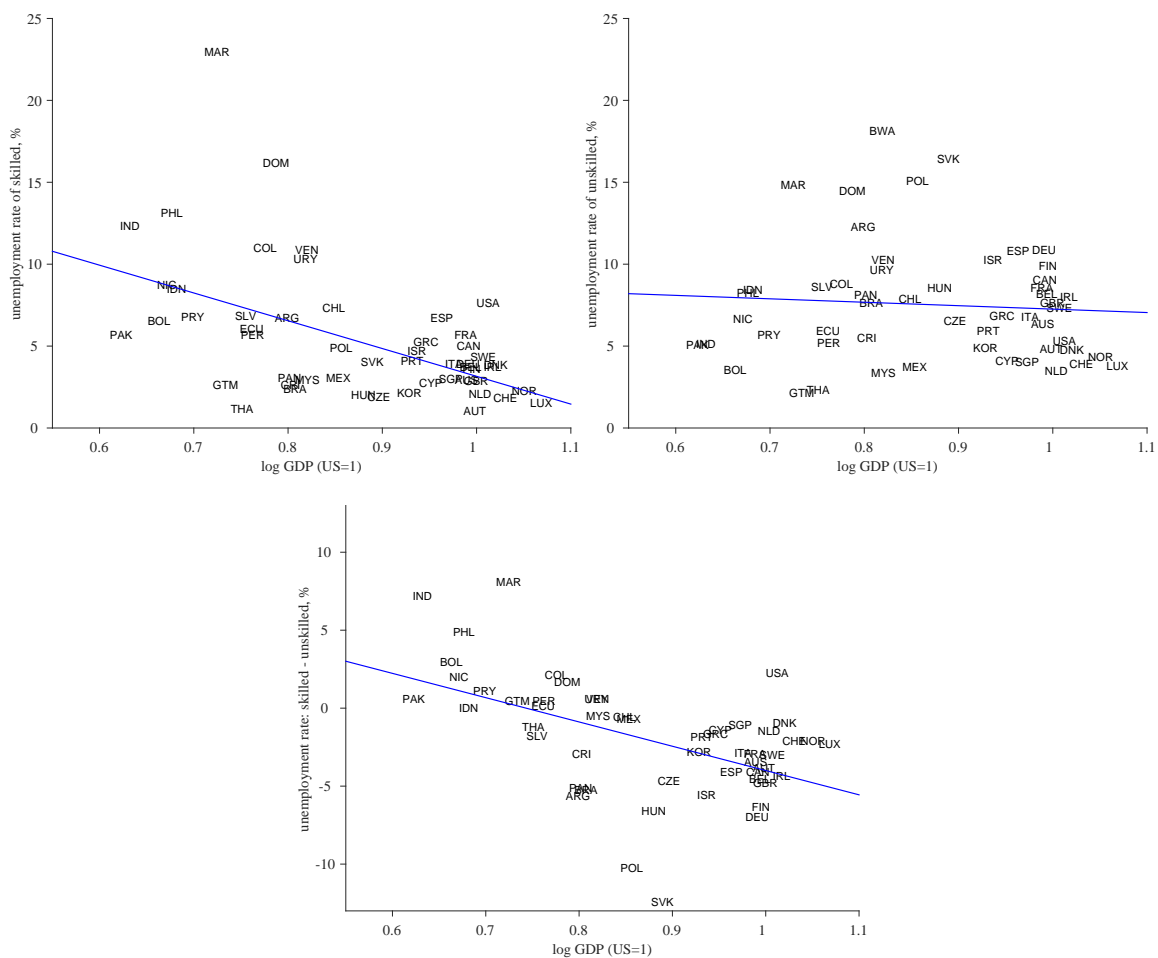
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Figure 9: Unemployment rates for skilled and unskilled individuals across countries. Skilled individuals are defined to be those with secondary and tertiary education while unskilled males are their complement. For each country, unemployment rate is measured between year 2000 and year 2010 and calculated as average during these years. Source: the World Bank.
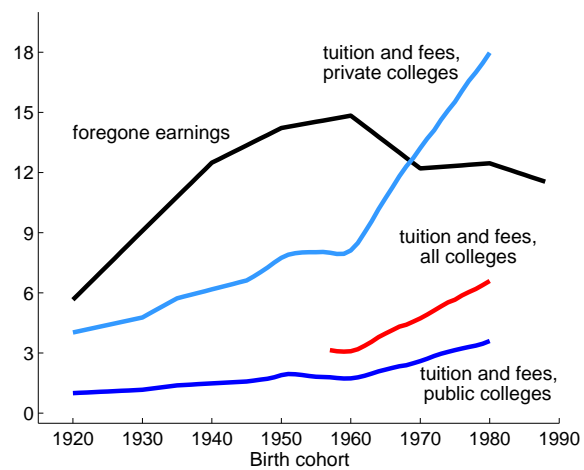
Figure 10: Cost of schooling in the US. Foregone earnings: sum of high school graduates mean earnings between ages 19 and 22. Tuition and fees for public college reflect in-state charges. Data are normalized to tuition and fees in public colleges for the 1920 cohort. Source: IPUMS-USA, Snyder and Dillow (2011) table 345, and Conrad and Hollis (1955).