

The Allocation of Talent and Skill Premia Across
Countries
(Work in Progress)

Germán Cubas
B. Ravikumar
Gustavo Ventura

1 Introduction

Three central observations motivate this paper. First, there is little variation in the fraction of unskilled workers between rich and middle income countries. This occurs despite well-known, large differences in output per worker. Figure 1 illustrates this fact. Among a set of rich countries, unskilled workers 25 and older, defined as those with at most high school education, averaged 82.0%. If Canada and U.S. are included, this fraction drops to about 78.1%. Meanwhile, for a set of middle income countries, the average fraction is about 87.0%. Second, skill premia does vary across the same set of countries, as Figure 2 illustrates. Skill premium in the poorer countries is about 62.5% higher than in the rich group: it averaged 1.5 in across rich countries whereas it averaged 2.4 for the middle income group.¹ Finally, per-pupil expenditures in tertiary education as a fraction of GDP per worker are remarkably constant across poorer and richer countries in the sample. Figure 3 illustrates this fact.

What accounts for these observations? We develop a parsimonious, unified framework of the division of the labor force between skilled and unskilled workers, and map this division into observables such as output, capital and skill premia, as well as unobservables such as 'quality' of workers across countries. We discipline this framework with a host of aggregate and cross sectional observations, and then use it to investigate the extent to which the three observations mentioned above can be accounted for by exogenous differences across countries – Total Factor Productivity (TFP), the relative price of capital and distortions.

In our model, individuals are heterogeneous in terms of their innate abilities. All individuals are born as unskilled workers, but their raw abilities can be converted into 'skilled' efficiency units. Converting ability to skill is *costly*, both in terms of time and goods, and irreversible. Holding ability fixed, it is more costly to become a higher quality skilled worker. Investing goods in the conversion of skills implies that a skilled worker has access to the wage rate for skilled labor, and to the earnings that are proportional to his innate ability and quality of skills. There is a single good in the economy, which is produced using skilled labor, unskilled labor and capital services. Skills are imperfect substitutes, and potentially substitutes or complements to the different types of capital. Given factor prices, there is unique division of individuals into skilled and unskilled workers: those with relatively high innate ability become part of the skilled labor pool, whereas the rest form the pool of unskilled workers.

¹Section 2 describes this data in detail. Countries considered in the rich group are Australia, Belgium, Canada, Denmark, Finland, France, Germany, Israel, Italy, Netherlands, Norway, Spain, Sweden, United Kingdom and United States. Countries in the middle-income group are Argentina, Bolivia, Brazil, Chile, Czech Republic, Ecuador, Hungary, Mexico, Panama, Peru, Poland, Slovakia, Uruguay and Venezuela.

In the model, an exogenous reduction in TFP, and/or changes in the relative price of capital, lead to a reduction in investments in the quality of skilled labor. In turn, this reduction leads to a lower fraction of skilled workers in steady state and to an increase in skill premia, measured by the ratio of earnings per skilled worker to the earnings per unskilled worker. We show that the resulting changes in skill premia are the result of three forces: changes in relative wages, changes in the ratio of skilled to unskilled labor (in efficiency units) as well as changes in the relative fractions of skilled to unskilled workers.

We use the U.S. facts on earnings inequality, skill premia and the division of the labor force by skill to discipline the choice of model parameters. Specifically, we set parameter values to reproduce in steady state the fraction of skilled workers, skill premia measured by the ratio of earnings per worker across skill groups, the variance of log-earnings, and expenditures per-pupil as a fraction of output per worker. Our preliminary findings indicate that when TFP varies across countries, the implied movements in the fraction of skilled workers and tertiary expenditure are broadly in line with data. In particular, the required reductions in TFP (relative to the U.S.) to reproduce the data on output per worker lead to little variation in the fraction of skilled workers across countries, essentially constant tertiary expenditures, and are accompanied by moderate increases in skill premia.

Relevance and Related Literature Our paper has important implications for the ongoing research on the wealth of nations and its determinants. It closely connects with the debate on the role of human capital differences in determining the magnitude of measured productivity differences across countries. Manuelli and Seshadri (2005) argue that true, intrinsic productivity differences are rather small. Hence, measured differences in TFP largely reflect differences in unmeasured labor quality. Our framework yields estimates of the differences in labor quality under imperfect substitution of skill types, when model parameters are restricted by data on the division of the labor force by skill and skill premia.

Our framework has implications also for the earnings of immigrants relative to natives of rich countries. Labor earnings in our model depend on wage rates, idiosyncratic productivity levels and endogenous investments in the quality of labor. Exogenous differences in TFP, say, across countries lead to (i) changes in the composition of each skill group and (ii) changes in the investments in quality of skills. In these circumstances, a skilled immigrant from a low TFP country who received fewer investments in the quality of his labor might, on average, have higher innate ability than natives and might earn more than the natives in the high TFP country.

Caselli and Coleman (2006), Hendricks (2008) and others observe that disparities in

labor ratios across countries (constructed using average years of schooling) are too large to be consistent with differences in skill premia (approximated by wage ratios). Our framework permits a decomposition of observed differences in skill premia. We measure this variable within the model and in the data as *earnings per-worker* ratios across skilled groups. We then decompose skill premia differences in three components: wage ratio differences, differences in labor quality, and differences in the size of each skill group. Our preliminary findings suggest that modest variation in skill premia are natural, despite relatively large movements in wage ratios driven by changes in labor ratios.

2 Skills and Skill Premia Across Countries

We define skilled workers as the ones included in the category called “Some Post-Secondary Education” in Barro and Lee (2001). That means our measure of skilled workers is the fraction of the population over 25 years, that has completed secondary school and has at least one year of post-secondary education. Figure 1 plots this data from the Barro and Lee (2001) data for the year 1995. Data on output per worker is from the Penn World Tables v. 6.2 for 1996.

We take measures of skill premia from Fernandez, Guner, and Knowles (2005). The data used by the authors are calculated directly from national surveys of 30 countries from 1990 to 1997. The countries included are Argentina, Australia, Belgium, Bolivia, Brazil, Canada, Chile, Colombia, Costa Rica, Czech Republic, Denmark, Ecuador, Finland, France, Germany, Hungary, Israel, Italy, Luxembourg, Mexico, Netherlands, Norway, Panama, Paraguay, Peru, Poland, Slovakia, Spain, Sweden, Taiwan, United Kingdom, Uruguay, United States and Venezuela. The skill skill premium is defined as the ratio of *earnings (labor income) per worker*, for skilled male workers to unskilled ones.² A skilled worker is an individual who has more years of education than those required to complete secondary school. Therefore, this definition is consistent with the data we use on educational attainment reported in Barro and Lee (2001). For comparison purposes, we divide this sample of countries in two groups, *rich* and *middle income* countries. Countries the rich group are Australia, Belgium, Canada, Denmark, Finland, France, Germany, Israel, Italy, Netherlands, Norway, Spain, Sweden, United Kingdom and United States. Countries in the middle-income group are Argentina, Bolivia, Brazil, Chile, Czech Republic, Ecuador, Hungary, Mexico, Panama, Peru, Poland, Slovakia, Uruguay and Venezuela.

In terms of expenditures on skilled workers, we use data from the World Education Indi-

²In their sample, workers are husbands of age between 36 and 45 years old.

cators (UIS-OECD). Specifically, we obtain data on the annual expenditure on educational institutions in 1999, from public and private sources, per full-time-equivalent student enrolled in tertiary institutions, in international dollars converted using PPPs. By using this data and the GDP per worker figures from Penn World Tables, we can calculate the share of tertiary educational expenditures on GDP per worker.³ As Figure 3 shows, with the exception of Brazil, expenditure ratios as a fraction of GDP per worker are remarkably constant across poor and rich countries in the sample.

3 Theoretical Framework

We now describe a one-sector growth model with an endogenous division of individuals between two groups, skilled and unskilled.

There is a single representative household in the economy. The household comprises at time t a continuum of members of total size L_t , who value only consumption. The size of the household (population) grows at the constant rate (g_L). The household is infinitely lived and maximizes

$$\sum_{t=0}^{\infty} \beta^t L_t \log(C_t/L_t), \quad (1)$$

where $\beta \in (0, 1)$ and C_t denotes total household consumption at date t .

Endowments Each household member is born with z units of efficiency units (talent). These efficiency units are distributed with support in $Z = [0, \bar{z}]$, with cdf $G(z)$ and density $g(z)$, which are invariant with respect to population growth. Each household member has one unit of time which he/she supplies inelastically. Depending upon his type, each household member can be a *skilled* or *unskilled* worker. We describe below this decision and the associated incomes in detail. The household is also endowed with initial capital stock $K_{i,0}$ for $i = e, s$ where e represents capital equipment and s structures.

Technology There is a representative firm that operates a constant returns to scale technology. This technology requires four inputs: two types of capital goods, equipment K_e and structures K_s , skilled labor S and unskilled labor U . As in Krusell, Ohanian, Ríos-Rull, and Violante (2000), output (Y) is given by

³These data is not yet available for Bolivia, Ecuador, Israel, Panama and Venezuela. For this reason, we assign the value of 0.20 for the share of expenditures on GDP per worker (the median of the sample) to these countries.

$$Y = F(K_e, K_s, S, U; A) = A K_s^\alpha \left\{ \mu U^\sigma + (1 - \mu) [\lambda K_e^\rho + (1 - \lambda) S^\rho]^{\sigma/\rho} \right\}^{(1-\alpha)/\sigma} \quad (2)$$

where A stands for a Total Factor Productivity parameter. This technology displays *capital-skill complementarity* if $\rho < \sigma$.

For $\lambda \rightarrow 0$, this production function becomes a standard CES production function, and structure capital is interpreted the single capital input. In this case, the elasticity of substitution between skilled and unskilled labor is $1/1 - \sigma$.

The representative firm behaves competitively and faces rental prices R_e , R_s , W_S , W_U for the use of equipment, structures, skilled and unskilled labor, respectively. Both types of capital depreciate at the rate δ_e and δ_s .

The Household Problem We assume that the segregation of individuals by skill is costly. This segregation only applies to newborns, and cannot be changed once a household member has been assigned to either pool. Converting one newborn into a skilled worker requires (i) goods, and (ii) implies foregone earnings for a period. If a newborn household member is selected for the unskilled labor pool at t , her efficiency units are contemporaneously transformed into efficiency units of unskilled labor, and her income is then given by $W_{U,t}z$.

If instead she becomes part of the skilled pool, it takes one period to contribute to skilled labor. The household invests x_t consumption goods in the 'quality' of her efficiency units, an amount common to all household members. Investing x_t implies that her innate efficiency units are adjusted at $t+1$ by the factor h_{t+1} , where $h_{t+1} = Bx_t^\phi$, $\phi \in (0, 1)$. Her contribution to household's income is then given at $t+1$ by $W_{S,t+1}zh_{t+1}$. It follows that only individuals with sufficiently high levels of innate efficiency units become skilled. Given rental prices, there exists a unique threshold $\hat{z}_t$ such that newborn household members with efficiency units below this threshold become unskilled workers at t , and those with efficiency units above it are skilled workers, from $t+1$ on.

If there are $N_t \equiv g_L L_{t-1}$ newborns in each period, and $N_t(1 - G(\hat{z}_t))$ newborns become skilled, the household pays a total of $N_t x_t(1 - G(\hat{z}_t))$ at t for adding the efficiency units of these individuals into the total quantity of skilled labor at $t+1$, with quality h_{t+1} . It transpires that the aggregate quantities of unskilled and skilled labor evolve according to

$$U_t = U_{t-1} + \underbrace{N_t \int_0^{\hat{z}_t} z g(z) dz}_{\text{Additions to unskilled labor}} \quad (3)$$

$$S_t = S_{t-1} + \underbrace{N_{t-1} h_t \int_{\hat{z}_{t-1}}^{\bar{z}} z g(z) dz}_{\text{Additions to skilled labor}} \quad (4)$$

We also assume that the cost for the household of transforming one unit of consumption into investment in equipment ($I_{e,t}$) or structures ($I_{s,t}$), is potentially different from one. We represent these costs by *exogenous* investment prices $p_{e,t}$ and $p_{s,t}$.⁴

The problem of the household is to choose sequences of consumption, the fractions of household members who are skilled and unskilled, the quantity of goods allocated to affect the productivity of each skilled member, and the amount of capital of different types to carry over to the next period. Formally the household problem is to select $\{C_t, I_{e,t}, I_{s,t}, \hat{z}_t, x_t\}_0^\infty$ to maximize (1) subject to (3), (4),

$$C_t + p_{e,t} I_{e,t} + p_{s,t} I_{s,t} + N_t(1 - G(\hat{z}_t))x_t = (W_{U,t}U_t + W_{S,t}S_t) + R_{e,t}K_{e,t} + R_{s,t}K_{s,t},$$

$$h_{t+1} = Bx_t^\phi,$$

$$K_{i,t+1} = (1 - \delta_i)K_{i,t} + I_{i,t}, \quad i = e, s$$

with

$$S_0, U_{-1}, K_{i,0} > 0.$$

for $i = e, s$.

The solution to the household problem is then characterized by the following First Order Conditions:

$$\frac{p_{e,t}}{C_t/L_t} = \beta \frac{[R_{e,t+1} + (1 - \delta_e)p_{e,t+1}]}{C_{t+1}/L_{t+1}} \quad (5)$$

$$\frac{p_{s,t}}{C_t/L_t} = \beta \frac{[R_{s,t+1} + (1 - \delta_s)p_{s,t+1}]}{C_{t+1}/L_{t+1}} \quad (6)$$

$$\frac{W_{U,t} \hat{z}_t + x_t}{C_t/L_t} = \beta \frac{W_{S,t+1} \hat{z}_t Bx_t^\phi}{C_{t+1}/L_{t+1}} \quad (7)$$

⁴Alternatively, these investment prices different can be modeled as investment taxes with tax collections returned as lump-sum rebates to the representative household.

$$\frac{(1 - G(\hat{z}_t))}{C_t/L_t} = \beta \frac{W_{S,t+1} [\int_{\hat{z}_t}^{\bar{z}} z g(z) dz] \phi B x_t^{\phi-1}}{C_{t+1}/L_{t+1}} \quad (8)$$

Conditions (5) and (6) are standard Euler equations for capital accumulation of both types. Condition (7) states that the discounted compensation of the household member with marginal skill $\hat{z}_t$ at t must be equal to the compensation of an unskilled household member *plus* the cost of skill conversion, x_t . Figure 4 represents the determination of the threshold value $\hat{z}_t$. Finally, condition (8) states that the marginal cost of investing one unit of the consumption good in the quality of a skilled worker must equal its discounted marginal benefit. This benefit depends on the rental price of skilled labor at $t + 1$ and the total 'raw' addition to the pool of skilled labor at $t + 1$, $[\int_{\hat{z}_t}^{\bar{z}} z g(z) dz]$.

Equilibrium In competitive equilibrium, the markets must clear and factor prices are paid their marginal products. Equilibrium in the markets for unskilled and skilled labor implies

$$U_t^* = U_{t-1}^* + N_t \int_0^{\hat{z}_t^*} z g(z) dz \quad (9)$$

$$S_t^* = S_{t-1}^* + N_t h_t^* \int_{\hat{z}_{t-1}^*}^{\bar{z}} z g(z) dz, \quad (10)$$

for all $t = 0, 1, 2, \dots$, where an $(*)$ over a variable denotes its equilibrium value. Equilibrium in the goods market implies

$$C_t^* + p_{e,t} I_{e,t}^* + p_{s,t} I_{s,t}^* + N_t (1 - G(\hat{z}_t^*)) x_t^* = Y_t^*,$$

Factor prices equal

$$W_{U,t}^* = \frac{\partial F(K_{e,t}^*, K_{s,t}^*, S_t^*, U_t^*)}{\partial U_t} \quad (11)$$

$$W_{S,t}^* = \frac{\partial F(K_{e,t}^*, K_{s,t}^*, S_t^*, U_t^*)}{\partial S_t} \quad (12)$$

$$R_{e,t}^* = \frac{\partial F(K_{e,t}^*, K_{s,t}^*, S_t^*, U_t^*)}{\partial K_{e,t}} \quad (13)$$

$$R_{s,t}^* = \frac{\partial F(K_{e,t}^*, K_{s,t}^*, S_t^*, U_t^*)}{\partial K_{s,t}}, \quad (14)$$

for all $t = 0, 1, 2, \dots$. It is now possible to define a competitive equilibrium. A competitive equilibrium is a collection of sequences $\{C_t^*, K_{e,t}^*, K_{s,t}^*, \hat{z}_t^*, x_t^*, W_{U,t}^*, W_{S,t}^*, R_{e,t}^*, R_{s,t}^*\}_0^\infty$, such that (i) given $\{W_{U,t}^*, W_{S,t}^*, R_{e,t}^*, R_{s,t}^*\}_0^\infty$, the sequences $\{C_t^*, K_{e,t}^*, K_{s,t}^*, x_t^*, \hat{z}_t^*\}_0^\infty$ solve the household problem; (ii) factor prices are competitive for all t ; (iii) markets clear for all t .

Balanced Growth Along a balanced growth path, aggregate investment of both types as well as output, consumption, skilled and unskilled labor grow at the constant population growth rate g_L . Factor prices, equipment capital per worker ($k_e \equiv K_e/L$), structure capital per worker ($k_s \equiv K_s/L$), investment per new skilled worker x , and the threshold z are constant.

Note that the laws of motion for unskilled labor imply that unskilled labor per worker ($u \equiv U/L$) equals $G(\hat{z}^*)$ along the balanced growth path. Similarly, skilled labor per worker, ($s \equiv S/L$), equals

$$s^* = \frac{h^* \int_{\hat{z}^*}^{\bar{z}} z g(z) dz}{1 + g_L}$$

Along the balanced growth path, (5) and (6), and competitive factor prices imply

$$\frac{\partial F(k_e^*, k_s^*, s^*, u^*)}{\partial k_e} = p_e \left(\frac{1}{\beta} - (1 - \delta_e) \right). \quad (15)$$

$$\frac{\partial F(k_e^*, k_s^*, s^*, u^*)}{\partial k_s} = p_s \left(\frac{1}{\beta} - (1 - \delta_s) \right). \quad (16)$$

Similarly, condition (7) and competitive prices imply

$$\frac{\partial F(k_e^*, k_s^*, s^*, u^*)}{\partial u} + x^* = \beta \frac{\partial F(k_e^*, k_s^*, s^*, u^*)}{\partial s} \hat{z}^* B x^{*\phi} \quad (17)$$

Likewise,

$$(1 - G(\hat{z}^*)) = \beta \frac{\partial F(k_e^*, k_s^*, s^*, u^*)}{\partial s} \left[\int_{\hat{z}}^{\bar{z}} z g(z) dz \right] \phi B x^{*\phi-1} \quad (18)$$

Hence, (15), (16), (17) and (18) can be used to solve for a steady state equilibrium. They determine uniquely the steady-state capital stocks per worker of both types, the threshold value $\hat{z}^*$ and the investment in labor quality x^* .

4 Skill Premia in the Model

We now construct a notion of skill premia within our model that is consistent with the data we focus on. Recall that earnings of a unskilled worker are given by $W_U^* z$, whereas the

earnings of a skilled worker are given by $W_S^* z h^*$. Then, the skill premium (SP) defined as the ratio of per-worker earnings of skilled workers to per-worker earnings of unskilled workers, is given by

$$SP = \frac{(W_S^* h^* \int_{\hat{z}^*}^{\bar{z}} z g(z) dz) / (1 - G(\hat{z}^*))}{(W_U^* \int_0^{\hat{z}^*} z g(z) dz) / G(\hat{z}^*)}$$

Hence, we can write skill premia as the product of a *wage ratio*, a *labor ratio* and a *bodies ratio*:

$$SP = \underbrace{(W_S^* / W_U^*)}_{\text{wage ratio}} \times \underbrace{(s^* / u^*)}_{\text{labor ratio}} \times \underbrace{(G(\hat{z}^*) / (1 - G(\hat{z}^*)))}_{\text{bodies ratio}} \quad (19)$$

Note that changes in the division of the labor force by skill will generate movements in the three components above. An increase in the fraction of unskilled workers (i.e. an increase in $\hat{z}^*$) increases the wage ratio and the bodies ratio, but *reduces* the labor ratio. Moreover, under a skewed distribution of abilities, movements in the labor ratio more than compensate changes in the bodies ratio. Henceforth, changes in skill premia driven by changes in the division by skill are the result of two opposing forces. We show in section 7 that in our parameterized version of the model that changes in skill premia are moderate, despite substantial changes in the wage ratio.

5 Parameter Values

We start by setting the model period equal to *four* years, a compromise regarding the time it takes to become a skilled worker. For our preliminary results below, we set the growth rate in population equal to zero. We choose the discount factor so that the steady state annual interest rate equals 6%. This implies a discount factor (β) equal to 0.9433, or about 0.792 at the four-year frequency.

We use a CES production technology with constant capital share α (i.e. a single capital good), and elasticity of substitution between skilled and unskilled labor $1/1 - \sigma$. Thus,

$$Y = F(K, S, U; A) = A K^\alpha [\mu U^\sigma + (1 - \mu) S^\sigma]^{(1-\alpha)/\sigma}$$

We set the capital share α to 0.33. Empirical studies indicate a elasticity of substitution between skilled and unskilled labor of about 1.5 (Katz and Murphy (1992), Heckman, Lochner, and Taber (1998)). Then, we select $\sigma = 1/3$. The depreciation rate is set to 4% on an annual basis.

It remains to calibrate the distribution of innate productivity levels, the curvature parameter in the production of skills (ϕ) and the share parameter in the production function (μ). We assume that innate productivity is distributed according to a Pareto distribution with location parameter $\underline{z}$ and shape parameter θ . That is, $G(z) = 1 - \left(\frac{z}{\underline{z}}\right)^{-\theta}$.

We then proceed to choose $\{\underline{z}, \theta, \phi, \mu\}$ so that in stationary equilibrium the model reproduces four observations of interest for the U.S. economy. These are (i) the skill premium; (ii) the fraction of unskilled workers; (iii) the variance of log-earnings, and; (iv) expenditures per tertiary student as a fraction of GDP per worker.

Table 1 below shows the resulting parameter values. It is not problematic for the model to reproduce the data, as the Table illustrates.

6 Preliminary Results

Variations in Productivity In our first set of experiments, we focus on the implications of changes in productivity across countries. Specifically, given the parameters that we calibrate to reproduce U.S. observations, we vary TFP country by country in order to reproduce observed differences in output per worker in stationary equilibrium.

A reduction in TFP generates a reduction in optimal investments in the ‘quality’ of skills. Across steady-state equilibria, these changes in quality have effects upon relative prices and the division of the labor force by skill. The net effect is that skilled labor becomes relatively more scarce; the ratio s/u falls as the fraction of unskilled workers increases and the quality of the skilled labor pool drops. The fact that skilled labor becomes relatively more scarce implies an increase in the wage ratio, W_S^*/W_U^* .

To assess the quantitative effects of changes in productivity, consider first the case of moving TFP from the U.S. level to the level of Argentina. This reduction in TFP leads to an increase in the fraction of unskilled workers of about 6.8%, and an increase in skill premia of about 4.7%. As explained in section 4, the changes in skill premia are driven by changes in the wage ratio, the labor ratio and the bodies ratio. The wage ratio increases by about 23%, while the labor ratio drops by about 26%. Hence, there are large, opposing forces that moderate the increase in skill premia. In particular, we note here that the ‘quality’ of skilled labor falls substantially with the reduction in TFP, by about 19%.

Table 2 below displays the findings for the composite of rich and middle income countries. We find that the fraction of unskilled workers in middle-income countries is about 6.5% relative to the rich group, and that differences in the quality of the skilled workforce are 18.8% lower in the middle income group. Skill premia is about 4% higher in the middle-

income group relative to the rich. Overall, the model succeeds in getting at the relatively small variation in the fraction of unskilled workers, and the nearly constant fraction of (tertiary) expenditures across countries. The model so far generates changes in skill premia that are too small relative to the data.

Variations in Relative Prices From Penn World Tables v. 6.2 we obtain data on the real GDP per worker and the price of consumption and investment goods (p_C and p_I) for each country in our sample for 1996. As in Restuccia and Urrutia (2001) we compute the relative price of investment goods in international dollars with respect to the U.S. as $(\frac{p_I}{p_C})_i / (\frac{p_I}{p_C})_{US}$. These relative price measures are used as an approximation for the distortions in the accumulation of physical capital across countries. Figure 5 shows the variation in prices for the countries we focus on. On average, middle income countries have relative prices of investment that are about 50% higher than those from the rich country group.

Changes in relative prices lead to results that are equivalent to those stemming from productivity differences. As steady state output falls with increases in the relative price of capital, investment in the quality of skills falls also. This process is accompanied by a reduction in the fraction of skilled workers and an increase in the skill premia. Table 3 below displays the findings for the composite of rich and middle income countries when prices vary as in the data. Given the observed movements in prices, the model generates too little variation in the division of the labor force by skill and skill premia.

The Role of Capital-Skill Complementarity TO BE COMPLETED

Table 1: Calibration

Parameter	Value	Target	Model	Data
μ	0.32	Skill premium	1.74	1.74
$\underline{z}$	0.63	Portion of unskilled workers	0.53	0.53
θ	0.56	Variance of log-earnings	0.80	0.80
ϕ	0.28	Expenditure per tertiary student (% GDP per worker)	0.19	0.24

Table 2: Productivity Differences: rich versus middle-income countries

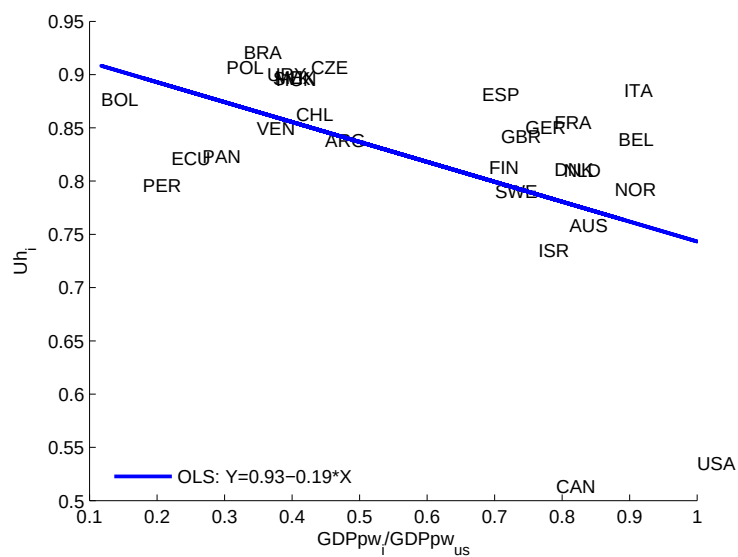
Parameter	Rich	Middle Income
<u>Fraction Unskilled</u>		
Model	100	106.5
Data	100	105.1
<u>Skill Premium</u>		
Model	100	104.1
Data	100	163.1
<u>Expenditure Share</u>		
Model	100	104.0
Data	100	118.7
Wage Premium	100	123.5
Quality (h)	100	80.2

Table 3: Differences in the Price of Investment: rich versus middle-income countries

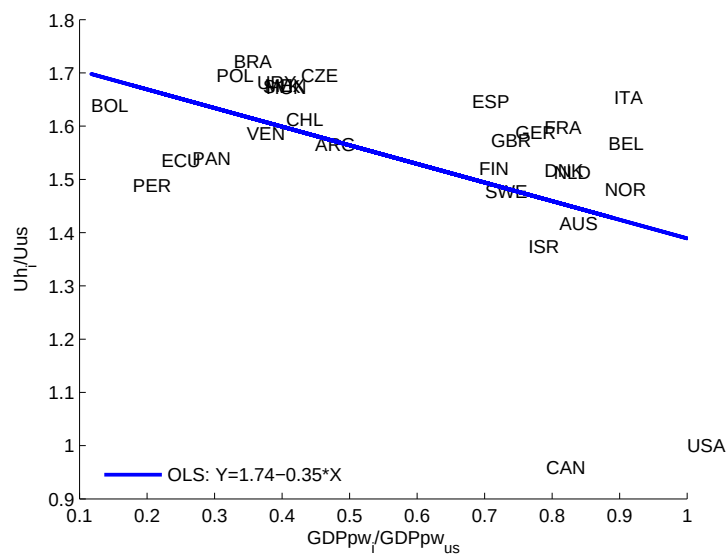
Parameter	Rich	Middle Income
<u>Fraction Unskilled</u>		
Model	100	101.8
Data	100	105.1
<u>Skill Premium</u>		
Model	100	101.3
Data	100	163.1
<u>Expenditure Share</u>		
Model	100	101.2
Data	100	118.7
Wage Premium	100	105.3
Quality (h)	100	94.9

References

- Barro, R. J., & Lee, J.-W. (2001). International Data on Educational Attainment: Updates and Implications. *Oxford Economic Papers*, 53(3), 541–63.
- Caselli, F., & Coleman, W. J. (2006). The World Technology Frontier. *American Economic Review*, 96(3), 499–522.
- Fernandez, R., Guner, N., & Knowles, J. (2005). Love and Money: A Theoretical and Empirical Analysis of Household Sorting and Inequality. *Quarterly Journal of Economics*, 120(1), 273–344.
- Heckman, J., Lochner, L., & Taber, C. (1998). Explaining Rising Wage Inequality: Explanations With A Dynamic General Equilibrium Model of Labor Earnings With Heterogeneous Agents. *Review of Economic Dynamics*, 1(1), 1–58.
- Hendricks, L. A. (2008). Why Does Education Differ Across Countries?. manuscript, Iowa State University, Department of Economics.
- Katz, L. F., & Murphy, K. M. (1992). Changes in Relative Wages, 1963-1987: Supply and Demand Factors. *The Quarterly Journal of Economics*, 107(1), 35–78.
- Krusell, P., Ohanian, L., Ríos-Rull, J.-V., & Violante, G. (2000). Capital-Skill Complementarity and Inequality: A Macroeconomic Analysis. *Econometrica*, 68(5), 1029–1053.
- Manuelli, R., & Seshadri, A. (2005). Human Capital and the Wealth of Nations. manuscript, University of Wisconsin, Department of Economics.
- Restuccia, D., & Urrutia, C. (2001). Relative prices and investment rates. *Journal of Monetary Economics*, 47(1), 93–121.

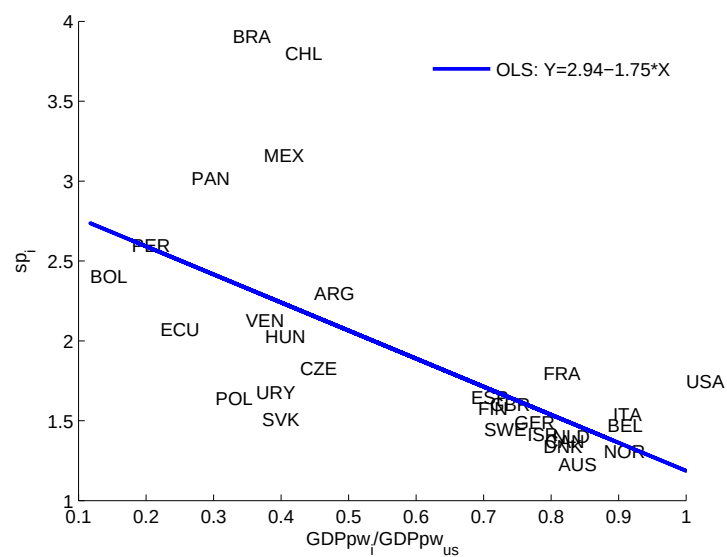


(a) Proportion of unskilled workers

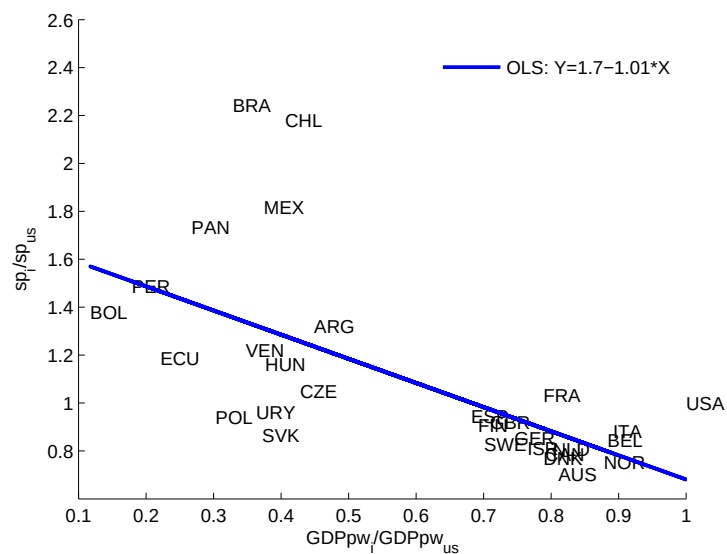


(b) Proportion of unskilled workers relative to the U.S.

Figure 1: Unskilled workers

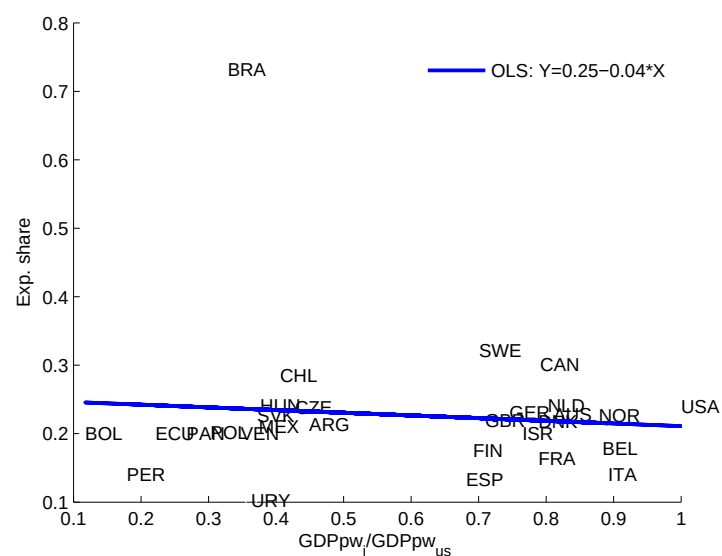


(a) Skill premium

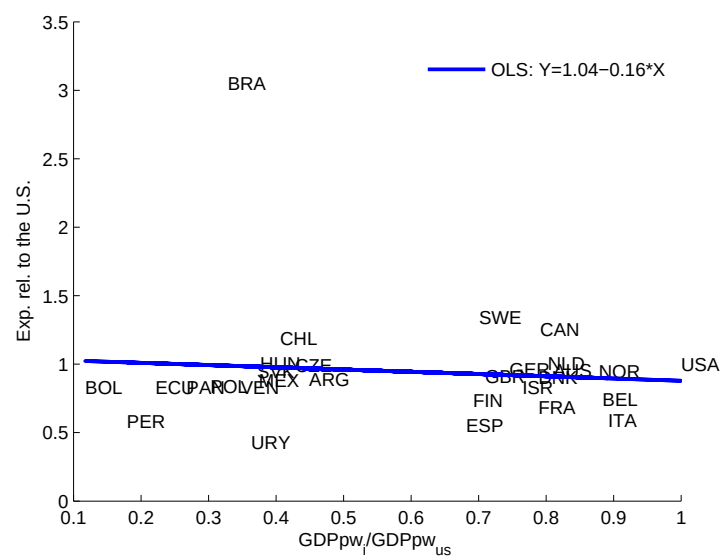


(b) Skill premium relative to the U.S.

Figure 2: Skill premium



(a) Expenditures in tertiary education as a percentage of GDP



(b) Expenditures in tertiary education as a percentage of GDP relative to the U.S.

Figure 3: Expenditure in tertiary education

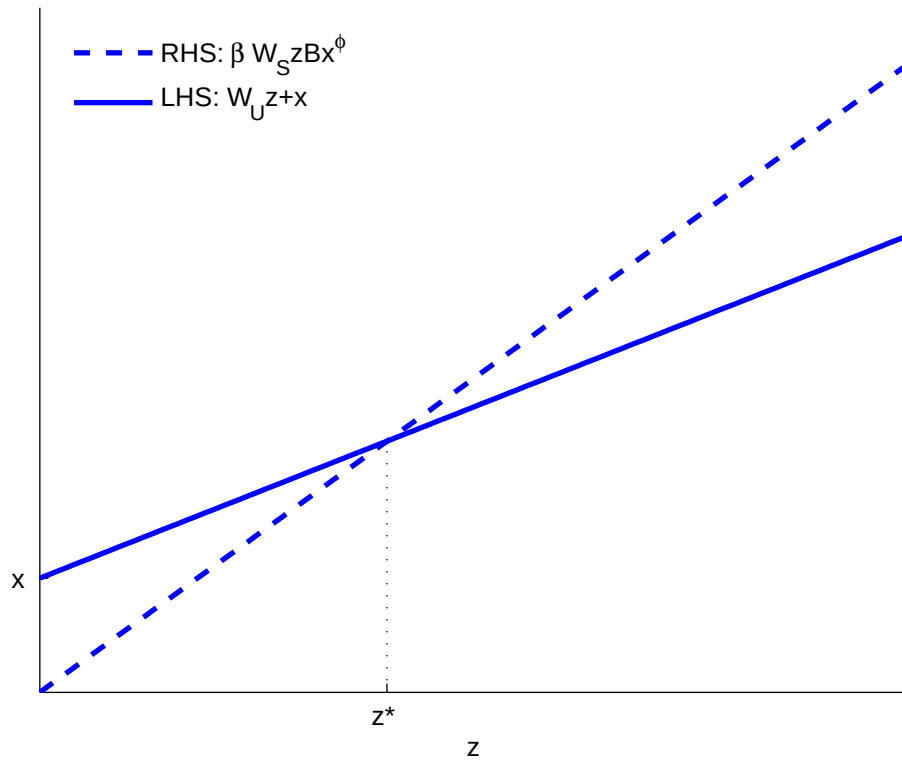


Figure 4: Solving for z^*

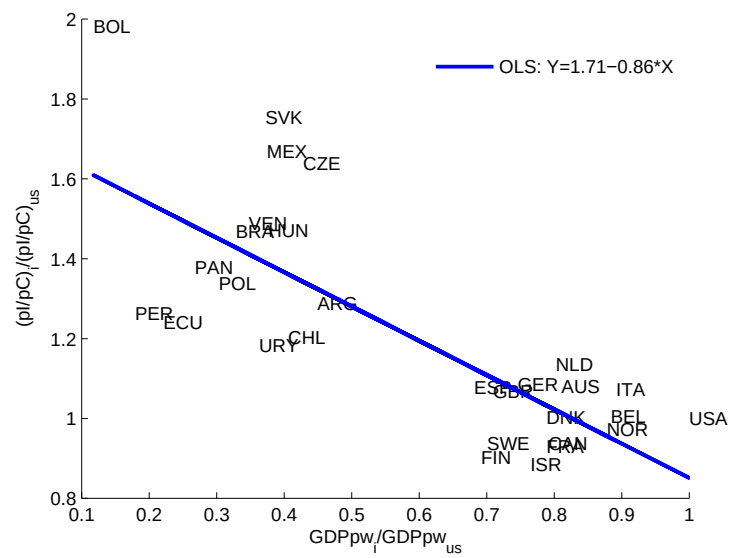


Figure 5: Relative price of investment goods relative to the U.S.