Human Capital Underaccumulation

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1 Colin & Weil, 2020

The Effect of Increasing Human Capital Investment on Economic Growth and Poverty: A Simulation Exercise

1.1 How Human Capital Enters the Model

For each cohort, quality-adjusted years of education at time 0 are calculated as a product of adjusted years of schooling and educational quality:

$$\mathrm{AdjEd}_{a,0} = \mathrm{EA}_{a,0} \times \mathrm{EQ}_0. \tag{1}$$

Human capital from education for each cohort at time 0 is:

$$\mathrm{HCSchool}_{a,0} = e^{\phi \times (\mathrm{AdjEd}_{a,0} - 12)}, \tag{2}$$

where ϕ is the Mincerian return to human capital, assumed to be 0.08.

The proportion of children who are stunted and adult survival rates (ASR) and Stunting are used to construct human capital of health:

$$\mathrm{HCHealth}_{a,0} = e^{\frac{\gamma_{\mathrm{ASR}} \times (\mathrm{ASR}_a - 1) - \gamma_{\mathrm{Stunting}} \times \mathrm{Stunting}_a}{2}}. \tag{3}$$

or in absence of stunting data:

$$\mathrm{HCHealth}_{a,0} = e^{\gamma_{\mathrm{ASR}} \times (\mathrm{ASR}_a - 1)}. \tag{4}$$

They use values of $\gamma_{\mathrm{ASR}} = 0.6528$ and $\gamma_{\mathrm{Stunting}} = 0.3468$ on the basis of Weil (2007) and Kraay (2019).

Total human capital for an age cohort is the product of human capital from schooling and human capital from health

$$\mathrm{HC}_{a,0} = \mathrm{HCSchool}_{a,0} \times \mathrm{HCHealth}_{a,0}. \tag{5}$$

Productivity at time 0 is a function of human capital as follows:

$$A_0 = \frac{\mathrm{GDPperWorker}_0}{\mathrm{KperWorker}_0^{\alpha} \times \mathrm{HCperWorker}_0^{(1-\alpha)}}, \tag{6}$$

which can be rewritten as:

$$y = A_t \cdot k_t^{\alpha} h_t^{1-\alpha}, \tag{7}$$

and in the long run is

$$A_t = A_0(1+g)^{5t}. \tag{8}$$

where $g = 0.013$

The model has a stationary growth path where y grows at the rate of growth of a because h is assumed to be constant (otherwise this would be an endogenous growth model). The model also makes no distinction between private and public capital.

1.2 Experiments

Different levels of human capital are tested: replacement investment (effectively flat human capital), median human capital, 75th percentile country human capital, and non-realistic jump to HCI = 1. GDP per capita and poverty rate time paths are assessed.

They show that the higher the human capital level, the higher the GDP per capita relative to baseline, as GDP per capita increases both because of the higher human capital and induced physical capital per worker to new higher stationary state. As a corollary, the higher the human capital level, the lower the poverty rate relative to baseline. Poverty headcount is measured as amount below a certain income threshold assuming that household income is distributed lognormally and using the Gini coefficient to derive the standard deviation of the log of income. As a result of income or GDP per capita moving higher, the corresponding distribution of all income will also shift higher, reducing the amount of people in poverty.

1.3 Human Capital Underaccumulation Analysis

In this model, steady-state output is essentially proportional to the assumed constant level of human capital because h is being held constant. However, the model does not have endogenous human capital, therefore leaves out the costs of increasing the level of human capital as well as the induced increase of human capital when saving for physical capital increases. As a result, this tilts the analysis in favor of investing in human capital (see Prof. O'Connell's note to see further analysis of this phenomenon). NOTE: clarify when they look at welfare they look at two things (when underaccumlated) NOTE: answer 1 and 2 OC questions

2 Buffie et al., 2020

Debt, Investment, and Growth in Developing Countries with Segmented Labor Markets

2.1 Model

This model captures a skill-constrained labor market in which secondary education investment determines the supply of skill and this in turn influences the formal sectors for both capital and there is unemployment of unskilled labor because the formal, non-traded sector firms pay an efficiency wage and unskilled labor cannot move between the formal non-traded sector and other sectors.

Investment in basic education i_b enters the basic education stock with a six year lag and similarly in eight years for investment in upper-level education i_u. Note that the investment in upper education investment is never constrained by the supply of people with basic education. Dynamic complementary between the types of education does not exist. Investment in basic education also does not alter the subsequent cost of increasing upper-level education.

$$S_{b,t} = i_{b,t-6} + (1-\delta_b)S_{b,t-1} \quad \text{and} \quad S_{u,t} = i_{u,t-8} + (1-\delta_u)S_{u,t-1}. \tag{9}$$

Increases in education capital translate to increases in the supply of high-skill labor S and the productivity of low-skill labor e_b:

$$S_t = S_0 + \phi_1(S_{u,t-1} - S_{u,0}) \quad \text{and} \quad e_{b,t} = 1 + \phi_2(S_{b,t-1} - S_{b,0}). \tag{10}$$

Human capital enters the production function through these transformations into high-skill labor labor and productivity of labor. There are three different output equations for the three different sectors:

$$q_{x,t} = a_x z_{t-1}^{\psi_x} k_{x,t-1}^{\alpha_x} S_{x,t}^{\theta_x} H^{\chi} (e_{b,t} L_{x,t})^{1-\alpha_x-\theta_x-\chi}, \tag{11}$$

$$q_{n,t} = a_n z_{t-1}^{\psi_n} k_{n,t-1}^{\alpha_n} S_{n,t}^{\theta_n} (e_{n,t} e_{b,t} L_{n,t})^{(1-\alpha_n-\theta_n)}, \tag{12}$$

$$q_{j,t} = a_j z_{t-1}^{\psi_j} k_{j,t-1}^{\alpha_j} S_{j,t}^{\theta_j} (e_{b,t} L_{j,t})^{(1-\alpha_j-\theta_j)}. \tag{13}$$

where L is low-skilled labor, S is high-skilled labor, z is public infrastructure, H is sector-specific input, x denotes the formal traded sector (the ”primary” sector in this model), n denotes the formal non-traded sector, j denotes the informal non-traded sector, $e_{n,t}$ is effort of unskilled workers (the formal non-traded sector has an efficacy wage for unskilled labor).

2.2 Experiments

In one the experiments they analyze the GDP, unemployment rate, real wages, sectoral employment time paths for different front-loaded paths of resources denoted to basic education and upper education.

They find in the long run, investment in basic education increases GDP, formal sector employment, real wages, by 2-2.5x as much as investment in infrastructure.

A welfare analysis is also conducted with the following welfare criterion:

$$SW = \sum_{t=0}^{\infty} \beta_s^t \frac{(c_t + \zeta EAPY_t)^{1-1/\tau}}{1-1/\tau} \tag{14}$$

where c_t is aggregate consumption, β_s is the social discount factor, $EAPY_t$ is income of the ex ante poor, and ζ is a measure of the relative welfare weight placed on income of the ex ante poor. They report the compensating variation.

2.3 Human Capital Underaccumulation

Investment in human capital takes much longer to pay off than investment in infrastructure. Especially in the case of front-loading investment, which places a substantial and sustained fiscal burden on the economy during the intial period. Thus, the gains output and consumption per capita and real wages over the first decade are pretty minimal.

However, in the long run, there are outsized gains from potent, positive, mutually-reinforcing general equililbrium effects. The formal sector is capital intensive and has relatively flat supply curve for hiring low-skill labor, so gets immense gains significantly from an increased supply of skilled labor. Therefore, investment in upper-level education (IUE) significantly reduces unemployment and results in greater increases in GDP, aggregate consumption, real wages for low-skill labor, and real income for the ex ante poor compared to other investments. IUE is also much more effective in attracting private capital and boosting the availability of high-wage formal sector jobs for low-skill labor.

3 Li et al., 2017

Investing in Public Infrastructure: Roads or Schools?

3.1 Model

The addition of human capital via schooling is modeled as:

$$A^e \left(z^e_{t-1}\right)^{\phi} \left(e^{\chi}_t u_t\right)^{\nu}, \tag{15}$$

where χ is positive and where the human capital ξ_t accumulation function is expressed as:

$$(1+g)\xi_t = (1-\omega)\xi_{t-1} + A^e \left(z^e_{t-1}\right)^{\phi} \left(e^{\chi}_t u_t\right)^{\nu}. \tag{16}$$

The human capital that turns into finished schooling positively impacts labor effectiveness, as shown in the following equation:

$$e_t = (1-\delta_e)\frac{e_{t-1}}{1+g} + \omega\xi_{t-1}, \tag{17}$$

where δ_e is the depreciation rate of effectiveness of labor e. Notice that for given steady-state values of public education infrastructure investment, z^e, and time by households spent accumulating human capital (going to school), u, equations (11) and (12) can be jointly solved for the steady-state values of ξ and e.

Effective labor ($e_t^\chi l_t$) is part of the production function, representing how human capital transforms raw labor into effective units of labor. This relationship is modeled as:

$$y_t = A^y \left(z_{t-1}^i\right)^\psi (k_{t-1})^\alpha (e_t^\chi l_t)^{1-\alpha} \tag{18}$$

where economic infrastructure (roads) is z_{t-1}^i.

3.2 Experiments

Li et. al sets up a positive analysis. Two scenarios are examined: 100 percent investment in schools and alternatively completely investing in roads. They find that short-term, roads increase consumption, GDP growth more than schools, but long term schools increase most metrics more. They then conduct a welfare analysis where they numerically simulate different constant over time splits of school/road investment on overall welfare. This leads to the results that without a "big push" ("big push" nearly doubles public expenditure from 6 percent to almost 13 percent in the first 2 years and it remains over 8 percent for about 14 years) , optimal school spending is 76 percent of public investment and under a "big push", optimal school spending is 51 percent of public investment.

3.3 Human Capital Underaccumulation

Human capital/education investment is under invested because of the delay in education investment being fully realized. Road investment immediately enters the production function thereby initially dominates returns to GDP growth and consumption in earlier periods, while school investment feeds through slowly into the productivity of labor in producing both human capital and output. Schools contribute to long-term productivity, although it takes on average $1/\omega$ for their effects to become fully productive (15 years on average to fully enter).

Schools relative to roads are more underaccumulated the more patient the social planner (lower discount rate) is.