Human Capital Underaccumulation Through a Covid Lens Literature Review

Michael Pham

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1 Buffie et al., 2023

Loss-of-learning and the post-Covid recovery in low-income countries

1.1 The Model

In Buffie et al, 2023, authors model different sectors similarly to Buffie et al., 2020. Buffie et al, 2023 employs the same three sectors as in the previous paper (see previous note: "Human Capital Accumulation"). However, in addition to the tradables sector (mainly agriculture), the informal nontradables sector, and the formal nontradables sector, this paper implements an additional tradable formal sector, the tourism sector, which only sells to foreign customers. The tourism sector's Cobb-Douglas production function is

$$q_{b,t} = a_b z_{t-1}^{\Psi_b} k_{b,t-1}^{\alpha_b} S_{b,t}^{\theta_{bb}} A_t^{\theta_a} \left(e_{n,t} e_{b,t} L_{n,t}\right)^{(1-\alpha_b-\theta_b-\theta_a)} \tag{1}$$

where z denotes government infrastructure stock, k is physical capital, S is skilled labor, L is low-skilled labor, A is sector specific inputs (such as beaches in the case of the tourism production function), e_n is work effort, and e_b is productivity of low skill labor which is a function of healthcare and low-skilled labor as explained further on.

As in the previous paper, there is unemployment of low-skilled labor because the formal, non-traded sector firms pay an efficiency wage and workers can only move in between the informal sector and agricultural sector. Low-skilled formal labor expresses more gratitude when they are paid higher wages, informal sector has lower wage, and there is high unemployment.

Similarly, 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. However, this paper introduces a new form of human capital in addition to educational human capital: health human capital (G_t). Public investment in health human capital enters the health capital stock with a three year lag as follows:

$$G_t = i_{g,t-3} + (1 - \delta_g)G_{t-1} \tag{2}$$

Fixed input–output coefficients, (ϕ_1, ϕ_2, ϕ_3) connect increases in education capital and health capital to the supply of high-skill labor and the productivity of low-skill labor:

The supply of high-skill labor S is modeled in the same way as before:

$$S_t = S_0 + \phi_1(S_{u,t-1} - S_{u0}) \tag{3}$$

However, the productivity of low-skill labor e_b is no longer solely a function of the increase in low-skill education S_b and now also takes into account increases in health capital (showing complimentarity between health and education) as follows:

$$e_{b,t} = [1 - ES_t + \phi_2(S_{b,t-1} - S_{b0})][1 - HS_t + \phi_3(G_{t-1} - G_0)] \tag{4}$$

where ϕ_2 and ϕ_3 are fixed input-output coefficients. HS_t and ES_t are Covid-19 shocks to the health and education capital stocks, respectively.

1.2 Shocks

The authors mimic the Covid-19 lockdown shocks firstly as a negative GDP/output shock, which hits the various sectors with different intensities. The formal sectors, of which tourism (40 percent downturn in the first year) is included, are hit the hardest. Other Covid-19 specific shocks such as reduction in commodity prices, reduction in remittances, suspension of efficiency wage mechanism (setting "greek 3 parameter" to 0 in wage curve equation), debt payments suspension (via interest rate shock to 0 percent), SDR allocation, and human capital reduction (Figure 1) are modeled.

The payment of interest is represented as the following formula:

$$\frac{\vartheta r_{dc} - g}{1 + g} d_{ct-1} \tag{5}$$

where d_{ct-1} is the commerical debt stock at time t-1. ϑ is zero when interest payments on commercial/semi-concessional loans are temporarily suspended.

Figure 1: Education and Health Human Capital Shocks in Simulation

Health and education shocks.[a]
(Percentage decrease in effective labor e_b).

Shock	Year																
	1	2	3	4	5	6	7	8	9–46	47	48	49	50	51	52	53	54
Education	0.2	0.5	0.9	1.4	2.0	2.7	3.5	4.4	5.4	5.2	4.9	4.5	4.0	3.4	2.7	1.9	1.0
Shock	Year																
	1–5	6	7	8	9	10	11	12	13	14	15	16	17–49				
Health: Current Adults	1	0.97	0.94	0.91	0.88	0.85	0.82	0.79	0.76	0.73	0.70	0.68	0.66…0.02				
Shock	Year																
	1–9	10	11	12	13	14	15	16	17	18–54	55	56	57	58	59	60	61
Health: Children	0	0.034	0.067	0.1	0.133	0.166	0.192	0.211	0.224	0.230	0.196	0.163	0.130	0.097	0.64	0.038	0.019
Shock	Year																
	1–9	10	11–16	17	18–49	50–61											
Health: Combined	Adult Shock	0.88	0.89	0.88	0.87…0.25	Child Shock											

[a]For years not shown, all shocks are assumed to be zero.

The shocks Covid-19 had on education, adult health, and childrens' health are implemented as shocks by estimating the effects each of these categories had on effective low-skilled labor, e_b, and then summing their e_b to get the shock for a given year.

The authors estimate the human shock to school in a simplistic manner that doesn't account for inter-generational transmission of learning losses and assumes higher education is unaffected and simply apply a negative shock to the effective low-skilled labor e_b. They assume a 8 percent return per year of schooling, so a three month school closure represents a 2.67 percent decrease in future income. 20 percent of the population is low-skilled labor so .0267 * .20 = decrease in e_b by 0.53 percent. However, this model lacks any sort of dynamic complimentarity of youth education, which exists empirically, so they use Kaffenberger's estimate of cumulative learning loss results to get the long term 5.5 percent decrease in e_b. The education shock grows in absolute value at an accelerating rate, peaking when the youngest member of the affected cohort enters the workforce. The second phase, where the shock stays at its peak, continues until the oldest member of the cohort reaches retirement age. In the final phase, the shock diminishes at an increasing rate, following a pattern similar to Phase 1, and returns to zero when the last cohort member retires.

The authors use ballpark estimates combining a paper on how disability days in Cote d'Ivoire and Ghana affect earnings with the guess that Covid-19 reduces effective work time by five days annually to get adults' health contribution reduces e_b by 0.7–1.5 percent. So, e_b declines by 1 percent in the first five years, then slowly returns to 0 as the affected adult cohort gradually exits the workforce.

They use estimates more aggresive than empiral studies to estimate the affect childrens' health shock affects e_b.

1.3 Fiscal Policies

The following fiscal policies are assessed:

- Government rides out pandemic
- Government repairs Covid's shocks by ramping up investment in health and basic education via adjusting consumption tax and domestic public borrowing.
- Government repairs Covid's shocks by ramping up investment in health and basic education via adjusting external concessional borrowing.
- Government repairs Covid's shocks by ramping up investment in health and basic education via adjusting external concessional borrowing, which is capped at 10 percent of GDP over 6 years, and then resorts to adjusting consumption tax and domestic public borrowing.

In the riding out the pandemic situation, public policy does not change even as the tax base decreases. The ratio of public investment to GDP stays the same even as GDP decreases. In the first year, GDP, the real high-skill wage, real informal wage for low-skill labor decrease 7.2, 9.1, and 6 percent, respectively; the private investment rate and formal sector employment plunge by around 10 percent. The collapse of the domestic economy sees the debt to GDP ratio jump from around 53 to 58 percent of GDP. The overall welfare decrease is the greatest in this scenario (decreases of roughly 3.5-5.5 percent).

Of these varying strategies, ramping up investment adjusting external concessional borrowing reduces welfare by the least with a welfare loss of roughly 0.5 to 1.5 percent as a result of the Covid-19 shocks.

1.4 Human Capital Underaccumulation

Physical infrastucture public investment is set at 0.06 percent of GDP, total education public investment was set at 0.04 percent of GDP and healthcare public investment at 0.019 percent of GDP at the baseline. Based on the previous Buffie et al., 2020, education spending was underaccumulated from a social welfare perspective as education should optimally be a majority of infrastucture spending. This likely holds in this model too - this model is calibrated to an initial pre-pandemic equilibrium where human capital is under-accumulated.

A limitation of this paper, is that instead shocking the human capital supply or investments to human capital itself, the effectiveness of labor productivity is shocked to mimic the effects of a shock on human capital. This firstly doesn't capture any heterogeneity between generations as all generations share an effectiveness of productivity state variable at any given period. It's also generous to assume that the effectiveness of labor gradually returns to its baseline values down the line.

2 Jang and Yum, 2024

Aggregate and Intergenerational Implications of School Closures: A Quantitative Assessment

2.1 Human Capital Dynamic Complimentarity

They employ a general equilibrium overlapping generations model. The life cycle lasts 16 periods, where each period is equivalent to 5 real years. The first 4 periods are childhood and the next 12 periods are adulthood. Individuals provide labor during periods 5-13.

Adulthood begins (period 5, period j=1 of adulthood) with a given human capital stock h_t and learning ability ϕ. Learning ability is a state variable which does not affect economic decisions, however is relevant for being passed down to their children. Individuals that undertake college at the start of adulthood become skilled workers.

In the third period of adulthood (period 7, period j=3 of adulthood), individuals have children. They inherit part of their parents' learning ability ϕ plus a term that is drawn from a probability distribution. In the first three periods, there is dynamic complimentarity of human capital formation. Parents choose to invest in their children, but there is also complimentary inputs from public investment. From the adults' perspective, total investment I_j in period j is written as

$$I_j = \left\{ \theta_j^p \left[\theta_j^x \left(\varsigma^x \frac{x_j}{\bar{x}} \right)^{\zeta_j} + (1-\theta_j^x) \left(\varsigma^e \frac{e_j}{\bar{e}} \right)^{\psi/\zeta_j} \right]^{\frac{\psi}{\zeta_j}} + (1-\theta_j^p) \left(\varsigma^g \frac{g_j}{\bar{g}} \right)^{\psi} \right\}^{\frac{1}{\psi}} \tag{6}$$

where x_j is parental time investments, e_j is parental monetary investments, g_j is public education investment, $\{\zeta^x, \zeta^e, \zeta^g\}$ are the productivity of each corresponding input, $\theta_j^p \in (0,1)$ is the share of private education inputs relative to public inputs, and $\theta_j^x \in (0,1)$ is the relative share of time investments in period j. Each input is entered after being normalized by its baseline unconditional mean.

Human capital investment is then transformed into human capital in the following manner

$$h_{c,j+1} = \begin{cases} \phi I_j^{\theta_j^I} h_{c,j}^{1-\theta_j^I}, & \text{if } j = 5; \\ I_j^{\theta_j^I} h_{c,j}^{1-\theta_j^I}, & \text{if } j = 3, 4, \end{cases} \tag{7}$$

where $\theta_j^I \in (0,1)$. Human capital is initially set to 1 for every child. Higher human capital increases human capital in future periods. There is also dynamic complementarity in human capital investment - higher human capital increases the effectiveness of investments.

2.2 Shocks

Education being shot down by Covid-19 is expressed as a shock by reudcing the productivity of public education investment ζ^g by 20 percent for each year of school closures.

2.3 Human Capital Underaccumulation

Human capital is initially set to 1 for every child, but the nature of the self-productivity of human capital and parents investing more into child's human capital the higher their own human capital, means that shocks/cuts to government human capital investment persist beyond just the generation that was directly affected. Government cuts in education investment in a given year would directly reduce the human capital of that given generation in the present period and in the future. Dynamic complimentarity and self-productivity of human capital reduces future human capital even further than without those two. Assuming government investment returns to normal in the next period, the next generation born whose parents were unaffected would not have their human capital affected. However, the generation affected by the cuts would have lower human capital, which means they would invest less in their children's human capital. As a result, their children would start with a lower human capital stock than they would have in the absence of the cuts. This cycle of reduced human capital investment would continue, affecting subsequent generations.

3 Fuchs-Schündeln et al., 2022

Loss-of-learning and the post-Covid recovery in low-income countries

3.1 Human Capital Dynamic Complimentarity

They employ a partial equilibrium overlapping generations model of two generations: children and adults. This is a partial equilibrium model because children don't make any decisions themselves when they're in the parent household.

Parents start out with exogenous state variables marital status m, education level s, initial idiosyncratic productivity states and , and initial assets a drawn from a population distribution.

Children are born with an initial human capital stock that is a function of their parents' marital status and education. Parents can alter their childrens' human capital by investing their time, resources, and furthur resources by sending the child to private school (which gives a higher return on human capital for the child). Government investment in human capital also affects the formation of human capital.

The CES aggregate of $i^m(j)$, is parental resource investment at time j, $i^t(j)$ is parental resource investment at time j, and $i^s(j)$ schooling input at time j is expressed as

$$i^p(j) = \left(\kappa_j^m \left(\frac{i^m(j)}{\bar{i}_{m,d}}\right)^{1-1/\sigma^m} + (1-\kappa_j^m)\left(\frac{i^t(j)}{\bar{i}_{t,d}}\right)^{1-1/\sigma^m}\right)^{1/(1-1/\sigma^m)} \tag{8}$$

where κ is the weight on time investments into children. There is then another CES function that aggregates this total parental investment time and resource investment $i^m(j)$ with schooling input:

$$i(j,s) = \bar{A}\left(\left(\kappa^s(j)\left((1_{j\geq j_s}B^s + (1-1_{j\geq j_s}))i^s(j)\right)^{1-\frac{1}{\sigma^S}} + (1-\kappa^s(j))\left(\frac{i^p(j)}{\bar{i}^p}\right)^{1-\frac{1}{\sigma^S}}\right)\right)^{\frac{1}{1-\frac{1}{\sigma^S}}} \tag{9}$$

where A (1.19) is computational normalization parameter chosen such that average acquired human capital is equal to 1, B reflects that one unit of time leads to a higher productivity so B^s is calibrated to be higher for private schools than public schools, σ^x is the elasticity of subst. between x and CES invest. aggregate, s is school type. This aggregate is then combined with current human capital stock to produce

$$h'(j) = \left(\kappa_j^h h^{1-1/\sigma^h} + (1-\kappa_j^h)i(j)^{1-1/\sigma^h}\right)^{1/(1-1/\sigma^h)} \tag{10}$$

(what is h prime? next period?) There is self-productivity as higher human capital impacts future human capital. There is dynamic complimentarity as human capital investment is more effective the higher the level of human capital.

3.2 Shocks

They perform covid-19 shocks on children by changing their state variables: education s, income realisation η, assets a and human capital h. Consumption equivalent variation is used to calculate welfare loss from covid-19 shocks (against welfare of non-shocked).

3.3 Human Capital Underaccumulation

They find that due to dynamic complimentarity and self-productivity, when there is underinvestment of human capital, younger children and those with disdvantaged backgrounds (those with less human capital?) are more adversely affected.