Written exam at the Department of Economics, winter 2020-2021
Advanced Development Economics – Macro aspects

Individual 12-hour take-home exam
12 December 2020 from 10:00 to 22:00.

Answer guidelines

As a guideline, each question (A, B, and C) has a total weight of about $\frac{1}{3}$, although the final grade is determined by an overall assessment of all the answers provided.

ANSWER A. Income and population dynamics in the pre-industrial era.

Readings:

- Ashraf, Quamrul, and Oded Galor (2011), Dynamics and Stagnation in the Malthusian Epoch. *American Economic Review* 101: 2003-41.
- Galor, Oded, and David Weil (1999), From Malthusian stagnation to sustained growth. *American Economic Review* 89: 150-54.
- Galor, Oded (2012), The demographic transition: causes and consequences, *Cliometrica* 6: 1-28.

The model in this question is an adapted version of Ashraf and Galor (2011) Part I. The two main differences are related to (*a*) the characteristics of technological progress – which is now endogenous to population pressure, following the arguments in Ester Boserup's (1965) "The Conditions of Agricultural Progress"; and (*b*) the presence of infant mortality – which is incorporated as part of the households' optimization problem.

A.1.

The optimal number children born in the typical household (b_t^*) can be found by inserting the equation for net fertility

$$n_t = \pi b_t \tag{1}$$

and the budget constraint

$$y_t = \rho n_t + c_t$$

into the utility function

$$u_t = \gamma \ln(n_t) + (1-\gamma)\ln(c_t),$$

and solving the household's optimization problem.

That is:

$$b_t^* = \arg\max_{b_t} \left\{ \gamma \ln(\pi b_t) + (1-\gamma)\ln(y_t - \rho\pi b_t) \right\}.$$

To solve the household's optimization problem compute the first order condition (FOC), by setting the first derivative of the objective function with respect to b_t equal to zero:

$$
\begin{aligned}
\frac{\gamma}{b_t} - \frac{(1-\gamma)\rho\pi}{y_t - \rho\pi b_t} &= 0 \\
\frac{\gamma}{b_t} &= \frac{(1-\gamma)\rho\pi}{y_t - \rho\pi b_t} \\
\frac{y_t - \rho\pi b_t}{\rho\pi b_t} &= \frac{1-\gamma}{\gamma} \\
\frac{y_t}{\rho\pi b_t} &= \frac{1}{\gamma} \\
b_t^* &= \frac{\gamma}{\rho\pi} y_t. \qquad (2)
\end{aligned}
$$

The resulting level of net fertility is obtained by replacing (2) into (1):

$$
\begin{aligned}
n_t^* &= \pi b_t^* \\
n_t^* &= \frac{\pi\gamma}{\rho\pi} y_t \\
n_t^* &= \frac{\gamma}{\rho} y_t. \qquad (3)
\end{aligned}
$$

The optimal level of consumption can be found by replacing n_t^* in the budget constraint:

$$
\begin{aligned}
c_t^* &= y_t - \rho n_t^* \\
c_t^* &= y_t - \rho \frac{\gamma}{\rho} y_t \\
c_t^* &= (1-\gamma) y_t.
\end{aligned}
$$

Interpretation: The value of optimal consumption represents a proportion $1-\gamma$ of total income, while the total costs of raising n_t^* surviving children (ρn_t^*) represent a proportion of γ. The positive effect of income on fertility decisions (b_t^*) reflects that the economy operates under Malthusian mechanisms, which, following Ashraf and Galor (2012), describes well the characteristics of an economy in the preindustrial era.

A.2.

A decline in child mortality (a higher probability π that children will survive infancy) reduces b_t^* but has no effect on n_t^*:

$$\frac{\partial b_t^*}{\partial \pi} = -\frac{\gamma}{\rho\pi^2} y_t < 0$$

and

$$\frac{\partial n_t^*}{\partial \pi} = 0$$

respectively.

Intuition: In an environment characterized by infant mortality, households are motivated to maintain a relatively higher level of fertility as a precautionary measure to attain an optimal number of surviving children. If the risk of infant mortality decreases, the precautionary motivations reduce, and with them the optimal level of fertility b_t^*. Given that a higher probability of survival does not have any other effect in the economy (in particular it does not affect optimal consumption c_t^* nor the average level of household income y_t), the decline in infant mortality fully balances with a reduction in optimal fertility (b_t^*), leaving net fertility (n_t^*) unchanged.

A.3.

Yes. Galor (2012) presents historical evidence for Western Europe, showing that the decline in mortality, which started at the beginning of the eighteenth century in this region, was not strongly associated with systematic changes in fertility. The cases of England and Sweden illustrate that well. Figure 2 in Galor (2012), for instance, shows that the decline in mortality that started in England in the 1730s was accompanied by a steady increase fertility over a period of more than 150 years, and that it was followed by a sharp decline in fertility. Similarly, the decline in fertility that started during the last part of the eighteenth century in Sweden was accompanied by fertility fluctuating around a flat trend until the 1870s, which is when the country started to experience a rapid decline in birth rates.

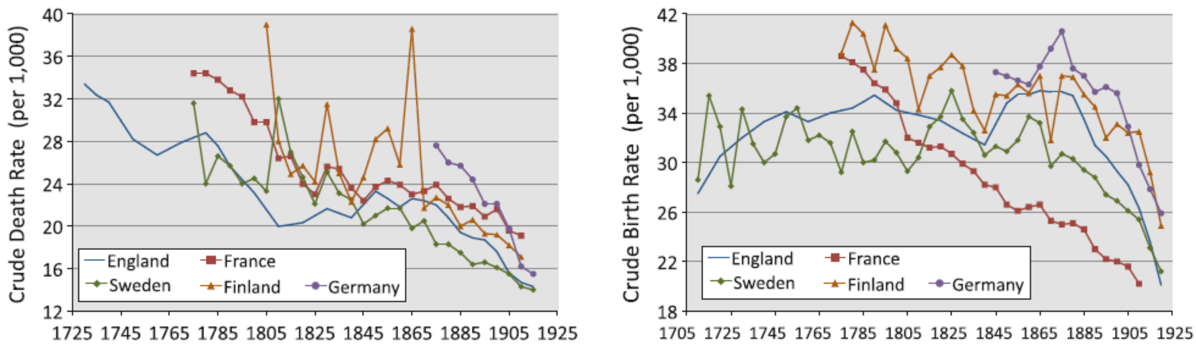


Fig. 2 Mortality and fertility across Western Europe, 1705–1925. *Data sources*: Chesnais (1992); Maddison (2008)

Source: Galor (2012).

A.4.

To determine the steady state level of population density $\frac{L^*}{X}$, first compute the average level of household income y_t, using the production function and the equation for A_t:

$$\begin{aligned} y_t &= \frac{Y_t}{L_t} \\ y_t &= \frac{A_t X^\alpha L_t^{1-\alpha}}{Lt} \\ y_t &= \frac{(AL_t^\beta) X^\alpha L_t^{1-\alpha}}{Lt} \\ y_t &= \frac{AX^\alpha}{L_t^{\alpha-\beta}}. \end{aligned} \tag{4}$$

Now use the equation for the dynamics of total population:

$$L_{t+1} = n_t L_t \tag{5}$$

and insert the optimal level of n_t^* (3) and the level of y_t (4) to find the law of motion for the population level, $L_{t+1} \equiv \phi(L_t; \text{parameters})$:

$$\begin{aligned} L_{t+1} &= \frac{\gamma}{\rho}\left(\frac{AX^\alpha}{L_t^{\alpha-\beta}}\right) L_t \\ L_{t+1} &= \frac{\gamma}{\rho} AX^\alpha L_t^{1+\beta-\alpha} \equiv \phi(L_t;\ A,\ X,\ \gamma,\ \rho,\ \alpha,\ \beta) \end{aligned}$$

where A and $X > 0$; $\gamma,\ \rho,\ \alpha$ and $\beta \in (0,1)$; and $\alpha > \beta$.

Check the Inada conditions for ϕ: $\phi(0) = 0$, $\phi_{L_t} > 0$, $\phi_{L_t L_t} < 0$, $\lim_{L_t \to 0} \phi_{L_t} = \infty$, $\lim_{L_t \to \infty} \phi_{L_t} = 0$:

- $\phi(0) = 0$
- $\phi_{L_t} = \frac{\partial L_{t+1}}{\partial L_t} = \frac{\gamma}{\rho} AX^\alpha (1+\beta-\alpha) L_t^{\beta-\alpha} > 0$ since $0 < 1+\beta-\alpha < 1$.
- $\lim_{L_t \to 0} \phi_{L_t} = \infty$, and
- $\lim_{L_t \to \infty} \phi_{L_t} = 0$ since $\beta - a < 0$.
- $\phi_{L_t L_t} = \frac{\partial}{\partial L_t}\left(\frac{\partial L_{t+1}}{\partial L_t}\right) = \frac{\gamma}{\rho} AX^\alpha (1+\beta-\alpha)(\beta-\alpha) L_t^{\beta-\alpha-1} < 0$, since $\beta - \alpha < 0$ and $0 < 1+\beta-\alpha < 1$.

Given that the Inada conditions are fulfilled (or that ϕ starts in the origin and it is strictly concave), we can apply the fixed point theorem and be sure that the 45 degree line will intersect ϕ twice: at 0, and at some steady state level $L^* > 0$.

The trivial steady state $L^* = 0$ is unstable and will not be an absorbing state for the population dynamics, so we can discard it as a steady state.

In contrast, $L^* > 0$ is globally stable: wherever L_t starts (other than 0), it converges to L^*. Therefore the system has a unique stable steady state at $L^* > 0$, which can be calculated by setting $L_{t+1} = L_t = L^*$ in the law of motion for L:

$$\begin{aligned} L^* &= \frac{\gamma}{\rho} A X^{\alpha} (L^*)^{1+\beta-\alpha} \\ L^* &= \left(\frac{\gamma}{\rho} A X^{\alpha}\right)^{\frac{1}{\alpha-\beta}} \end{aligned} \tag{6}$$

With this, we can compute the steady-state level of population density, by dividing (6) by X:

$$\begin{aligned} \frac{L^*}{X} &= \left(\frac{\gamma}{\rho} A X^{\alpha}\right)^{\frac{1}{\alpha-\beta}} X^{-1} \\ \frac{L^*}{X} &= \left(\frac{\gamma}{\rho} A X^{\alpha} X^{-(\alpha-\beta)}\right)^{\frac{1}{\alpha-\beta}} \\ \frac{L^*}{X} &= \left(\frac{\gamma}{\rho} A X^{\beta}\right)^{\frac{1}{\alpha-\beta}}. \end{aligned}$$

A.5.

To determine the steady state of the average household income level, use (4), (5) and (3) to calculate its law of motion, $y_{t+1} = \psi(y_t;\text{parameters})$:

$$\begin{aligned} y_{t+1} &= \frac{AX^{\alpha}}{L_{t+1}^{\alpha-\beta}} \\ y_{t+1} &= \frac{AX^{\alpha}}{(n_t^* L_t)^{\alpha-\beta}} \\ y_{t+1} &= \frac{AX^{\alpha}}{L_t^{\alpha-\beta}} \frac{1}{(n_t^*)^{\alpha-\beta}} \\ y_{t+1} &= y_t \frac{1}{(n_t^*)^{\alpha-\beta}} \\ y_{t+1} &= y_t \left(\frac{\gamma}{\rho} y_t\right)^{\beta-\alpha} \\ y_{t+1} &= \left(\frac{\rho}{\gamma}\right)^{\alpha-\beta} y_t^{1+\beta-\alpha} \equiv \psi(y_t;\ A,\ X,\ \gamma,\ \rho,\ \alpha,\ \beta) \end{aligned}$$

where A and $X > 0$; $\gamma,\ \rho,\ \alpha$ and $\beta \in (0,1)$; and $\alpha > \beta$.

Check the Inada conditions for ψ: $\psi(0) = 0$, $\psi_{y_t} > 0$, $\psi_{y_t y_t} < 0$, $\lim_{y_t \to 0} \psi_{y_t} = \infty$, $\lim_{y_t \to \infty} \psi_{y_t} = 0$:

- $\psi(0) = 0$

- $\psi_{y_t} = \frac{\partial y_{t+1}}{\partial y_t} = (\frac{\rho}{\gamma})^{\alpha-\beta}(1+\beta-\alpha)y_t^{\beta-\alpha} > 0$ since $0 < 1+\beta-\alpha < 1$.
- $\lim_{y_t \to 0} \psi_{y_t} = \infty$, and
- $\lim_{y_t \to \infty} \psi_{y_t} = 0$ since $\beta - \alpha < 0$.
- $\psi_{y_t y_t} = \frac{\partial}{\partial y_t}\left(\frac{\partial y_{t+1}}{\partial y_t}\right) = (\frac{\rho}{\gamma})^{\alpha-\beta}(1+\beta-\alpha)(\beta-\alpha)y_t^{\beta-\alpha-1} < 0$, since $\beta - \alpha < 0$ and $0 < 1+\beta-\alpha < 1$.

Given that the Inada conditions are fulfilled (or that ψ starts in the origin it is strictly concave), we can apply the fixed point theorem and be sure that the 45 degree line intersects ψ twice: at 0, and at some steady-state level $y^* > 0$.

The trivial steady state $y^* = 0$ can be discarded because it is unstable and will not be an absorbing state.

However, $y^* > 0$ is globally stable: wherever y_t starts (other than 0), it converges to y^*. Therefore the system has a unique stable steady state at $y^* > 0$, that can be calculated by setting $y_{t+1} = y_t = y^*$ in the law of motion for y:

$$\begin{aligned} y^* &= \left(\frac{\rho}{\gamma}\right)^{\alpha-\beta} (y^*)^{1+\beta-\alpha} \\ y^* &= \frac{\rho}{\gamma}. \end{aligned}$$

A.6.

An exogenous positive technological shock will take the economy to a permanently higher level of population density in the long-run, but not to a permanently higher level of average household income:

$$\begin{aligned} \frac{\partial}{\partial A}\left(\frac{L^*}{X}\right) &= \frac{\partial}{\partial A}\left[\left(\frac{\gamma}{\rho}AX^{\beta}\right)^{\frac{1}{\alpha-\beta}}\right] \\ \frac{\partial}{\partial A}\left(\frac{L^*}{X}\right) &= \frac{1}{\alpha-\beta}\left(\frac{\gamma}{\rho}X^{\alpha}\right)^{\frac{1}{\alpha-\beta}} A^{\frac{1}{\alpha-\beta}-1} > 0 \end{aligned}$$

and

$$\frac{\partial y^*}{\partial A} = \frac{\partial}{\partial A}\left(\frac{\rho}{\gamma}\right) = 0.$$

Interpretation: A positive technological shock (for example, an increase in the exogenous component of technology from A to $A^h > A$), will increase the average household income temporarily:

$$\frac{\partial y_t}{\partial A} = \frac{\partial}{\partial A}\left(\frac{AX^{\alpha}}{L_t^{\alpha-\beta}}\right) = \frac{X^{\alpha}}{L_t^{\alpha-\beta}} > 0.$$

Higher household income will increase net fertility, in accordance with the Malthusian features of the economy, but given that the increase in technology will not raise income permanently ($\frac{\partial y^*}{\partial A} = 0$), the increase in net fertility will only be temporary. This will trigger a gradual transition to a higher level of population density in the long-term, as depicted in Figure 1 in Ashraf and Galor (2011).

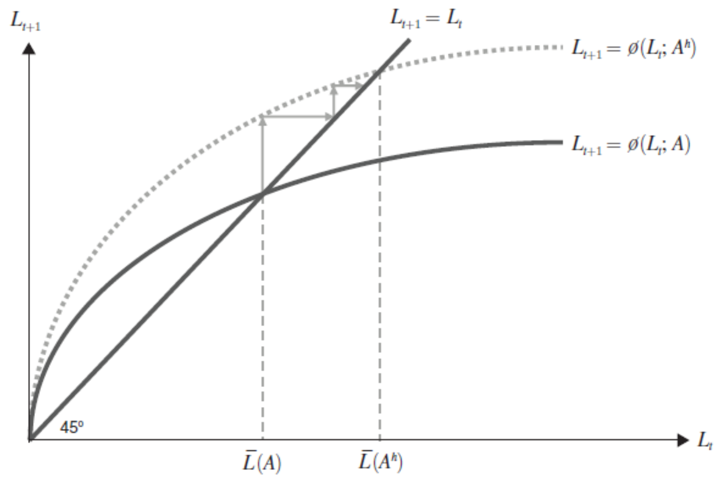


FIGURE 1. THE EVOLUTION OF POPULATION SIZE

Source: Ashraf and Galor (2011).

A.7.

Yes. The theoretical predictions in **A.6.** are consistent with the broad pattern of preindustrial economic development observed empirically and studied in the course. For example, Galor and Weil (1999) describe how the relatively slow pace of technological progress during preindustrial times was associated with slow increases in population growth and, at the same time, how the standard of living was roughly constant and did not differ much across countries for most of human history.

Ashraf and Galor (2011) model this pattern theoretically, and provide empirical evidence corroborating it. Using differences in the timing of the Neolithic Revolution as a measure of differences in land productivity and technological progress across countries, they show that improvements in the technological environment during the preindustrial era generated only temporary gains in income per capita, which eventually led to larger but not significantly richer populations. For example, Table 5 in Ashraf and Galor (2011) displayed below reports the results of a series of cross-country comparisons during the years 1, 1000, and 1500. The results show that technological advantages and higher land productivity levels were associated with significant differences in population density in all those periods, but not with significant differences in income per capita.

Table 5—Effects on Income per Capita versus Population Density

Dependent variable is:	Log income per capita in:			Log population density in:		
	1500 CE	1000 CE	1 CE	1500 CE	1000 CE	1 CE
	OLS	OLS	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)
Log years since Neolithic transition	0.159	0.073	0.109	1.337**	0.832**	1.006**
	(0.136)	(0.045)	(0.072)	(0.594)	(0.363)	(0.481)
Log land productivity	0.041	−0.021	−0.001	0.584***	0.364***	0.681**
	(0.025)	(0.025)	(0.027)	(0.159)	(0.110)	(0.255)
Log absolute latitude	−0.041	0.060	−0.175	0.050	−2.140**	−2.163**
	(0.073)	(0.147)	(0.175)	(0.463)	(0.801)	(0.979)
Mean distance to nearest coast or river	0.215	−0.111	0.043	−0.429	−0.237	0.118
	(0.198)	(0.138)	(0.159)	(1.237)	(0.751)	(0.883)
Percentage of land within 100 km of coast or river	0.124	−0.150	0.042	1.855**	1.326**	0.228
	(0.145)	(0.121)	(0.127)	(0.820)	(0.615)	(0.919)
Continent dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	31	26	29	31	26	29
R^2	0.66	0.68	0.33	0.88	0.95	0.89

Notes: This table establishes, consistently with Malthusian predictions, the relatively small effects of land productivity and the level of technological advancement, as proxied by the timing of the Neolithic Revolution, on income per capita in the years 1500 CE, 1000 CE, and 1 CE, but their significantly larger effects on population density in the same time periods, while controlling for access to navigable waterways, absolute latitude, and unobserved continental fixed effects. Log land productivity is the first principal component of the log of the percentage of arable land and the log of an agricultural suitability index. A single continent dummy is used to represent the Americas, which is natural given the historical period examined. Regressions (2)–(3) and (5)–(6) do not employ the Oceania dummy due to a single observation for this continent in the corresponding regression samples, restricted by the availability of income per capita data. Robust standard error estimates are reported in parentheses.

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Source: Ashraf and Galor (2011)

ANSWER B. Dictatorship.

Readings:

- Acemoglu, Daron (2009), Chapter 4: Fundamental Determinants of Differences in Economic Performance, in Introduction to Modern Economic Growth, Princeton University Press.
- Acemoglu, Daron and James A. Robinson (2010), The Role of Institutions in Growth and Development. *Review of Economics and Institutions* 1(2): 1-33.
- Dell, Melissa (2010), The Persistent Effects of Peru's Mining Mita. *Econometrica* 78(6): 1863-1903.
- Bautista, María Angélica, Felipe González, Luis R. Martínez, Pablo Muñoz, and Mounu Prem (2020), Technocratic autocracy, higher education and social mobility. Manuscript. U Chicago.
- Alesina, Alberto, Paula Giuliano and Nathan Nunn (2013). On the origins of gender roles: Women and the plough. *Quarterly Journal of Economics* 128(2): 469-530.
- Ravallion, Martin (2014), Income inequality in the developing world. *Science* 344(6186): 851-855.

B.1.

The institutions literature highlights the importance of different types of institutions as a fundamental cause of differences in long-term economic development. This literature defines institutions as the broad cluster of societal arrangements (social, economic, political, legal, etc.) that influence interactions among economic agents (Acemoglu 2009). Democracy, autocracy, and the different political regimes that Posner cites in his analysis are primordial examples of political institutions. Political institutions are central to understand long-term differences in economic development because they define the political equilibrium and the allocation of *de jure* and *de facto* political power, which are essential to define the type of economic institutions that ultimately determine the type of development outcomes an economy observes in the long-term (Acemoglu and Robinson, 2012).

The empirical literature on institutions shows that extractive institutions are a fundamental cause of worse development outcomes (Acemoglu and Robinson 2012, Dell, 2010). This is because extractive institutions do not foster the broad participation of society in economic, social, and political life; do not tend to protect private property to a sufficient extent, and to create the conditions to maintain effective systems of checks and balances against government's actions.

Dictatorships are likely to preserve extractive institutions (Acemoglu and Robinson, 2012), and institutions tend to have persistent effects on economic outcomes – consider for example the case of the mining *mita*, an extractive labor institution during the colonial period in Peru and Bolivia, which Dell (2010) shows to have had negative development effects until the present.

Then, in light of the empirical literature on institutions, and contrary to Posner's conclusion, dictatorships do not seem optimal for the development of any society, and in particular not optimal for the development of very poor countries. Very poor countries probably already suffer from an excess of extractive institutions. They may have even been struggling to abandon them. If that is the case, it would be contradictory to argue that they will benefit from political systems that tend to preserve the institutions they are trying to get rid of.

B.2.

Bautista *et al.* (2020) focus on the capture of higher education during Pinochet's dictatorship in Chile (1973-1990), which took place during the first 8 years of the regime. The authors explain that the dictatorship's capture of universities started with repression and control to reduce the political threat that universities represented. They also explain that those actions turned rapidly into a set of policies to reduce government spending in higher education.

To get identification, Bautista *et al.* (2020) exploit the facts that (*a*) the dictatorship's reduction in government spending represented a sudden reversal in the trajectory of government support to universities – which Chile had maintained until then, and that (*b*) the reversal materialized rapidly on lower university enrollment rates – which happened because the reduced government spending led to significantly less openings for incoming university students. This led to a reversal (or a kink) of the positive trend observed in university enrolment in Chile until then. The main identifying assumption in Bautista *et al.* (2020) is that without a coup there would be no reason to expect a kink in the trend of university enrollment. If the intervention was sudden, the kink provides a valid and external source of variation to estimate the causal effects of lower university enrolment on subsequent socioeconomic outcomes (such as participation in the labor force, income, place in the income distribution, and the probability of having children enrolled in higher education). Therefore the authors also use the kink as an IV for university education attainment.

B.3.

Table 2 in Bautista *et al.* (2020) shows reduced-form and IV estimates of the effects of lower university enrollment after the coup in 1973, on labor market outcomes in 1992, and yearly income levels between 1990 and 2015.

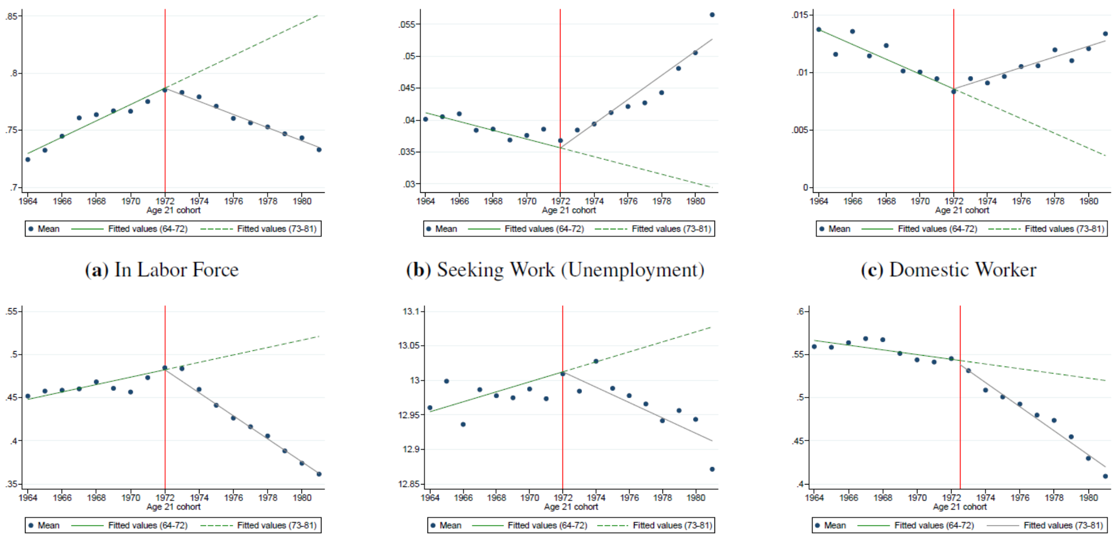
All results in Table 2 control for a set of interaction of county of birth and gender fixed effects (which reduces the concerns that differences in gender and socioeconomic background might be confounding the effects of reduced access to university education).

The results show that younger cohorts of people reaching university age (21) *before* the coup were more likely to be employed, less likely to be unemployed, less likely to work as a domestic worker, and more likely to have a job as a high-skilled white-collar worker in 1992 (columns 1-4). Columns 5-6 also show that they were more likely to have a higher annual income between 1990 and 2015. Table 2 also shows that *after* the coup all those trends are reversed, and that they change signs in net terms.

For example, column 1 shows that the probability of being employed in 1992 grew at 0.8% per cohort before the coup, but that this trend reversed and decreased at -1.2% per cohort after the coup (which gives a net rate of -0.4% per cohort after the coup). Using the kink in the trend of university enrollment as an instrument for the probability of having any university education, the bottom part of column 1 also shows that university education leads to an increase of 0.33% in the probability of being employed in 1992 – which is equivalent to 43% ($= 0.333/0.758$) of the sample mean of employment. Similarly, column 5 shows that yearly income between 1990 and 2015 grew at 1.1% per cohort before the coup, but at -0.9% ($= 0.011 - 0.020$) per cohort in net terms after the coup. The IV results at the bottom of column 5 show that university education leads to an increase of 0.76% in annual income over that period, which is equivalent to 5.6% of the sample mean ($= 0.76/\ln(740530)$).

Graphs (a) to (e) in Figure 9 in the paper provide a visualization of the kink for all the labor market outcomes considered in Table 2.

Figure 9: Visualization of kink: Labor market and wealth distribution



(a) In Labor Force **(b)** Seeking Work (Unemployment) **(c)** Domestic Worker

(d) White-collar, high-skilled **(e)** Log Total Income **(f)** Top wealth quintile

Note: Panels show averages by cohort for the variable in the caption. Solid green line corresponds to line of best fit for cohorts reaching college age before 1973. Dashed green line shows extrapolation for later cohorts. Solid grey line corresponds to line of best fit for cohorts reaching college age in 1973 or afterwards. All outcomes from 1992 population census, except income (panel e) from CASEN survey, which corresponds to the averages of all generated income across survey years.

Source: Bautista *et al.* (2020)

B.4.

The main results in Bautista *et al.* (2020) show that the reduction in university enrollment that followed Pinochet's capture of higher education in Chile significantly lowered the probabilities of (*a*) being employed after the end of the dictatorship, (*b*) having jobs demanding high skills, (*c*) having higher a annual income in the future, as well as the probability to ascend in the income distribution, and to have children enrolled in higher education when they reach university age. Their IV regressions show the value of higher education on all those outcomes, and therefore value lost because of the regime's capture of universities. These costs stretch over the life cycle and, importantly, also affected women significantly more than men, which could help to preserve detrimental gender norms (Alesina et al., 2013).

Posner admits potential benefits of having a dictatorship as a better adaptation to specific economic environments – for example, the potential advantages he considers in terms of managerial efficiency could eventually map into innovation, and thereby GDP growth. However, the costs of exposure to Pinochet's dictatorship presented by Bautista *et al.* (2020) are well identified, and also cut across dimensions of welfare that go beyond efficiency gains in economic production. Some of their additional results also reveal that the dictatorship exacerbated inequalities – which can be particularly detrimental at early stages of development, given that high inequality tends to reduce the effectiveness of policies to fight against poverty (Ravallion, 2014).

Comparing the potential benefits and the costs of dicatorships is not straightforward. But Bautista *et al.* (2020) certainly contribute with additional arguments against Posner's conclusion that dictatorship will often be optimal for very poor countries.

ANSWER C. Intergenerational mobility in Africa.

Readings:

- Alesina, Alberto, Sebastian Hohmann, Stelios Michalopoulos, and Elias Papaioannou (2020), Intergenerational Mobility in Africa. Forthcoming in *Econometrica*.
- Alsan, Marcella (2015). The effect of the tsetse fly on African development. *American Economic Review* 105(1): 382-410.
- Dalgaard, Carl-Johan, Anne Sofie Knudsen, and Pablo Selaya (2020), The bounty of the sea and long-run development. *Journal of Economic Growth* 25(3): 259-295.
- Alesina, Alberto, Paula Giuliano and Nathan Nunn (2013). On the origins of gender roles: Women and the plough. *Quarterly Journal of Economics* 128(2): 469-530.
- Bautista, María Angélica, Felipe González, Luis R. Martínez, Pablo Muñoz, and Mounu Prem (2020), Technocratic autocracy, higher education and social mobility. Manuscript. U Chicago.
- Gershman, Boris (2017), Long-Run Development and the New Cultural Economics. Chapter 9 in "Demographic Change and Long-Run Development", Matteo Cervelatti and Uwe Sunde (eds.), Cambridge, MA: MIT Press.

C.1.

Alesina *et al.* (2020) show two sets of correlations between IM and proxies for the level of development, all measured at the moment of independence (during the 1950s and 1960s for most African countries).

In the first set they show correlations of IM with the level of population density and the share of urban population. Both variables are interpreted as proxies of local development. The results show that both population density and the share of urban population correlate positively with upward IM, and negatively with downward IM. Interestingly, these results loose almost all statistical and economic significance once the authors control for the level of educational attainment (literacy) of the old generation. This makes sense, as the authors explain, since literacy of the old generation is the strongest correlate of IM, explaining about half of its variation.

The second set of correlations is motivated by the literature on structural transformation, and shows that upward IM is positively correlated with the share of population working in the services and the manufacturing sectors, and negatively correlated with the share of population working in agriculture. The results for upward IM again practically disappear after controlling for literacy of the old. The results are slightly stronger for downward mobility – the share of population working in agriculture is positively correlated with IM, and the share of population working in the services sector is negative correlated with IM, even after controlling for old generations' literacy.

These results suggest that IM is positively associated with economic development and structural transformation, but also suggest that the relationship is largely channeled through the deeper effects of economic development on education of the old generation.

C.2.

Yes. Alesina *et al.* (2020) show that ruggedness of the terrain and malaria ecology are significant geographic correlates of IM, along with distance to the capital and distance to the coast. These variables are significantly related to both upward and downward mobility in an intuitive way – for example, upward mobility is higher where malaria is less prevalent, and in regions that are closer to the capital and the coast. As in **C.1.**, these correlations are strongly reduced in magnitude after controlling for the literacy of the old generation. In this case, however, they retain statistical significance after controlling for old generations' literacy.

The authors show that historical variables have a similar type of explanatory power. For example, regions closer to colonial roads and railroads, and closer to Christian (Catholic and Protestant) colonial missions, show higher upward mobility and lower downward mobility. Similar to geographic variables, these historical variables have smaller but still significant correlations with IM after controlling for literacy of the old generation.

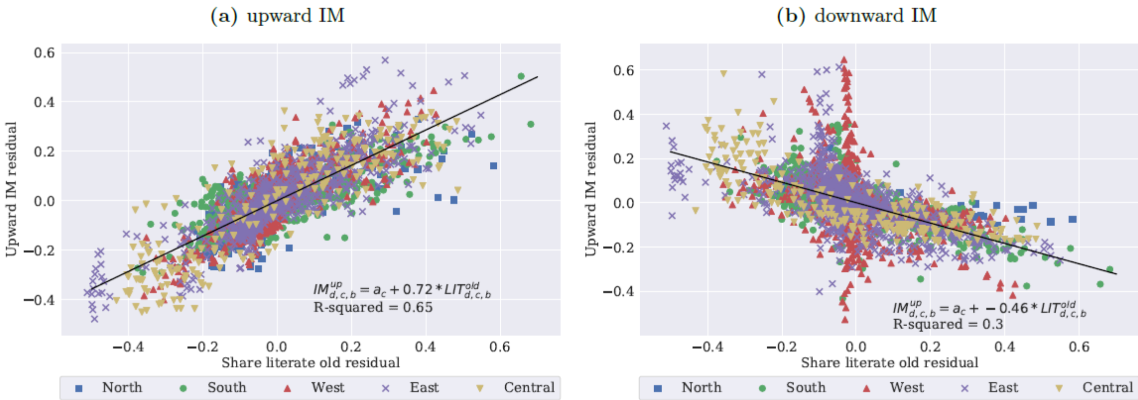
Given that malaria ecology, ruggedness of the terrain, distance to colonial railroads, and missionary activity are historical characteristics of regions in Africa, Alesina *et al.*'s (2020) results reveal an important pattern of *persistence* in the determinants of IM. Persistence is also a salient feature in the empirical literature on the effects of geography and culture as fundamental determinants of economic development. For example, Alsan (2015) shows that the historical climatic conditions that determined the survival of the tsetse fly had a long-term impact on economic development across cultural regions in Africa. Dalgaard *et al.* (2020) show that historical access to resources from the ocean can explain differences in cross-regional economic development around the globe today. In the case of culture, Alesina, Giuliano and Nunn (2013) show that the historical characteristics of agriculture explain current differences in gender norms. Gershman (2017) provides an extensive description and discussion of the effects of culture on economic outcomes, and the mechanisms that facilitate cultural persistence, transmission, and change.

C.3.

Alesina *et al.* (2020) show that both upward and downward mobility are strongly related to the share of the old generation that has completed primary education. These findings are robust to controlling for census year and decade of birth fixed-effects for young and old. Panels (a) and (b) in Figure 7 in the paper illustrate these results by showing a strong positive correlation between upward mobility and literacy of the old across countries, and a weaker but still significant negative association between literacy of the old and downward mobility. The results also show that literacy of the old explains 56% of the variation observed in upward IM across countries, and 24% of the variation in downward IM.

These results also hold strongly when looking at spatial differences within countries. For example, as explained in the paper, an increase of 10% in educational attainment of the old is associated with a 7% increase in upward mobility, and a 4% decrease in downward mobility, across regions in Africa. Educational attainment of the old explains 65% of the variation in upward mobility across regions, and 30% of the variation in downward mobility – which are both larger percentages as those obtained in the cross-country analysis. Figure 8 below illustrates these results.

Figure 8: Literacy of the Old Generation and IM at the District Level



The figures plot district-level upward IM (left panel) and downward IM (right panel)against the share of the "old" generation with completed primary education ($\hat{\alpha}^{o}_{cr}$) net of census and cohort effects. The figures also show the unweighted linear regresion line fit, net of country fixed effects; $\hat{\alpha}^{y}_{cr} = \alpha_c + \beta \times \hat{\alpha}^{o}_{cr} + \epsilon_{cr}$. Dots are color-coded by African region.

Source: Alesina *et al.* (2020)

The positive correlation between literacy of the old and upward mobility suggests that development in education in Africa has been supported by historical determinants of educational attainment – or at least by the determinants of educational attainment of the old generations. The negative relationship with downward mobility also suggests that the historical determinants of educational attainment may have also supported a faster speed in educational attainment in Africa. The likely importance of historical determinants of educational attainment is probably also part of the explanation of the direct effects that Alesina *et al.* (2020) find for regions per se.

Related to these findings, Bautista *et al.* (2020) find a similar relationship between the educational attainment of old and young generations, but which holds for higher education instead of primary education. These authors use census data for Chile in 2017, and show that children of parents with less university education were also more likely to attain less university education (see Table 4 in Bautista *et al.*, 2020). Given that they identify a plausible source of external variation to explain educational attainment among old generation, the effect can be interpreted as causal and running from the educational attainment of parents to the educational attainment of children.

Finally, the fact that the correlation between literacy of the old generation and IM is stronger in the comparison within countries than in the comparison between countries in Africa, also suggests that the role of time-invariant geographic, cultural, and institutional characteristics is not as relevant to understand spatial disparities in IM. This implies that the dynamic dimensions of these fundamental factors, and the interaction and coevolution between them, probably have important potential to explain the dynamics of intergenerational mobility in Africa.