Online Appendix: A Theory of Cultural Values and Economic Growth

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April 5, 2013

1 A Theoretical Framework

In this appendix we construct the theoretical model that guides our thinking about why respect and responsibility are important for economic development. Our theory is based on a concept of firm production with variety of labor teams in which scale – firm size – plays a key role in generating aggregate productivity.

1.1 The Firm

Scale raises output per worker by increasing the ability of firms to organize into different labor teams that cooperate with a stock of capital. To formalize this idea, assume that the output y_m of firm m is given by:

$$y_m = (k_m)^\alpha \sum_{n=1}^{M_m} (hl_{nm})^{1-\alpha} \tag{1}$$

where we suppress the country subscript. In this expression, k_m is the firm's physical capital, h is individual human capital – which does not vary across workers – and l_{nm} is the number of workers in team n of firm m. There are M_m distinct labor teams in firm m.[1] This production function is similar to that introduced by Ethier (1982), who adapted the utility function of Dixit and Stiglitz (1977) to the theory of production. Functions in which variety plays a key role have been applied to the problem of economic growth by several authors, most notably Paul Romer (1987, 1990), but also Grossman and Helpman (1993), Goodfriend and McDermott (1995, 1998), and Acemoglu (1998), among many others. It is a way to build in the effect of scale on specialization in production, the great insight of Adam Smith (1776).

[1] We follow most of the literature in assuming that human capital augments labor directly, converting raw labor l into effective labor hl. One alternative is to assume human capital enters separately, as in Mankiw et al. (1992).

We make two simplifying assumptions. The first is that there is a *minimum team size* l_c. This is a technical constraint: any department within a firm, we assume, requires a certain scale to be viable. For example, $l_c = 5$ means that it takes at least 5 people to constitute a group capable of interacting with other teams and the fixed capital stock to produce output y_m. Because of the nature of the production function, it never pays to form teams in excess of l_c members. Therefore, we may set $l_{nm} = l_c$ for all n and m.

The second assumption is that there is a *maximum number of workers per firm.* This *firm size*, which we call L_{fj}, is specific to each country j. This is a tractable way to model our main effect: that scale is limited by trust. If, for example, $L_f = 20$ then a firm can only have a total of 20 employees before it becomes impossible to monitor them against theft and shirking. As emphasized in the text, the strict limit of L_f is meant to reflect the idea that in some societies reliable workers can be found only in a small circle of trusted family members, or friends who are bound to employers by years of service. In other societies, where there is a culture of respect for others, it is possible to have a much larger workforce in each firm.

These two assumptions mean that each firm in country j will have the same number of teams M_j. This allows us to express the number of teams for each firm within Country j as:

$$M_j = \frac{L_{fj}\left(R_{c,j}\right)}{l_c} = M\left(R_{c,j}\right) \tag{2}$$

We explicitly note the dependence of firm size $L_{f,j}$ on the cultural value respect $R_{c,j}$. Given the same l_c in every country, societies with more respect – and more trust – will have a greater number of teams per firm M_j.[2]

The market for the produced good is competitive, so that the rental rate on capital r_K and the wage of a unit of human capital (the "base wage") w_b are equal to the marginal products of the two factors. They are given, respectively, by:

$$r_{Kj} = M\left(R_{c,j}\right)\alpha\left(\frac{h_j l_c}{k_{m,j}}\right)^{1-\alpha} \tag{3}$$

$$w_{bj} = (1-\alpha)\left(\frac{h_j l_c}{k_{m,j}}\right)^{-\alpha} \tag{4}$$

where we assume for convenience that α and l_c – the minimum size of a labor team – are technological constants that do not vary across countries. We note that the number of teams per firm M enters positively in the expression for the return to capital, but not in the base wage. The more teams there are in a firm, the more productive is the capital that cooperates

[2]We abstract from the integer constraint. That is, if $L_{fj} = 22$ and $l_c = 4$, we assume there are 5 teams – one of which has 7 members.

with each team.

1.2 Aggregate Output

Aggregate output is increasing in the number of teams per firm M. To see this, first note that the number of *firms* in economy j is:

$$N_j = \frac{L_j}{L_{fj}} \tag{5}$$

where L_j is the labor force of country j.

National output Y for country j is the product of the number of firms and the output per firm:

$$Y_j = N_j y_{m,j} = N_j M_j {k_{m,j}}^{\alpha} (h_j l_c)^{1-\alpha} = M_j (N_j k_{m,j})^{\alpha} (N_j h_j l_c)^{1-\alpha} \tag{6}$$

The second equality is true by the symmetry of the labor teams in (1). We may write this as:

$$Y_j = M_j^{\alpha} {K_j}^{\alpha} {H_j}^{1-\alpha} \tag{7}$$

where $K \equiv N k_m$ is total capital in the economy and $H \equiv hL$ is the total human capital in the economy.[3]

We may re-write (7) as we did in Equation (1) in the text:

$$Y_j = K_j^{\alpha} (A_j H_j)^{1-\alpha} \tag{8}$$

where *productivity* A is defined as follows:

$$A \equiv M^{\frac{\alpha}{1-\alpha}} \tag{9}$$

Production function (8) is identical to the function used by Hall and Jones (1999) as well as many others. The economy's level of *Respect* R_c determines scale M, which raises productivity A.

1.3 Optimal Growth

In this section we derive the balanced growth equilibrium.[4]

[3] To derive (7), use (5) for the last N in (6) and express $l_c = L_f/M$ from (2).

[4] Our treatment in this section is a decentralized version of the solution in Barro and Sala-i Martin, Section 5.1. They do not, however, deal with the concept of labor teams, which is important for factor prices and capital intensity in our model.

We assume that output can be used for consumption or accumulation of either physical or human capital. Ignoring the country subscript, we have:

$$Y = C + I_K + I_H \tag{10}$$

where C is aggregate consumption and I_K and I_H are gross investment flows, respectively, of physical and human capital.[5] We also assume that all capital depreciates at the same rate δ so that we have the following motion equations:

$$\begin{aligned} \dot{K} &= I_K - \delta K \\ \dot{H} &= I_H - \delta H \end{aligned} \tag{11}$$

We derive the dynamic, decentralized equilibrium by allowing households facing market prices to decide how to invest in both types of assets.

Households maximize discounted total utility

$$U = \int_0^\infty u\left(c\left(t\right)\right) e^{-\rho t} dt \tag{12}$$

where c is the individual's consumption, $u\left(c\right)$ is her instantaneous utility, and ρ is the rate of discount and is a function of R_n, as noted explicitly in the text.

The representative individual can accumulate capital or knowledge by using output that she might instead have consumed. Let $z = \frac{K}{L}$ be capital per worker (not per firm) and h, as above, be individual human capital. There is no population growth, so personal assets grow according to:

$$\dot{z} = i_z - \delta z \tag{13}$$

and

$$\dot{h} = i_h - \delta h \tag{14}$$

where i_z and i_h are individual investment (saving) in each stock. Each household is constrained by her income in the following manner:

$$r_K z + w_b h = c + i_k + i_h \tag{15}$$

Formally, households maximize (12) subject to the constraint (15) and the motion equations (13) and (14). Utility is assumed to be of the standard type: $u\left(c\right) = \frac{c^{\theta-1}-1}{\theta-1}$. The

[5] We follow Mankiw et al. (1992) and Rivera-Batiz and Romer (1991) in assuming that education primarily requires output – lab equipment and computers – to increase human capital.

Hamiltonian (Lagrangian) for this problem is:

$$\mathcal{H} = u(c) + q(i_z - \delta) + \mu(i_h - \delta h) + \lambda(r_K z + w_b h - i_z - i_h - c) \tag{16}$$

where q and μ are co-states and λ is a Lagrangian multiplier.

The first-order conditions for i_z and i_h require that $q = \mu = \lambda$ in the interior, which means that $\frac{\dot{q}}{q} = \frac{\dot{\mu}}{\mu}$.

The arbitrage conditions are:

$$\frac{\dot{q}}{q} = \rho + \delta - \frac{\lambda}{q} r_K \tag{17}$$

$$\frac{\dot{\mu}}{\mu} = \rho + \delta - \frac{\lambda}{\mu} w_b \tag{18}$$

Equating these two means that $r_K = w_b$.

The first order conditions for investment and consumption require that $\frac{\dot{c}}{c} = -\frac{1}{\theta}\left(\frac{\dot{q}}{q}\right) = \frac{1}{\theta}(r_K - \delta - \rho)$.

A balanced-growth equilibrium exists in this model. In this equilibrium, the household chooses paths for c, i_z, and i_h such that output, consumption, and human capital all grow at the same rate γ given by:

$$\gamma = \frac{\dot{c}}{c} = \frac{\dot{y}}{y} = \frac{\dot{h}}{h} = \frac{1}{\theta}(r_K - \delta - \rho) \tag{19}$$

In the interior – that is, if both forms of investment are positive – then the return to physical capital r_K must equal the return to human capital, or the base wage w_b. From (3) and (4), $r_K = w_b$ means that:

$$\frac{hl_c}{k_m} = \frac{\beta}{M} \tag{20}$$

where $\beta \equiv \frac{1-\alpha}{\alpha}$ is constant across countries. We assume that this ratio condition is met at the outset, so it will be true always.[6] If (20) holds at the firm level, then in the aggregate economy the following must be true:[7]

$$H = \beta K \tag{21}$$

[6] If the ratio is not initially at its equilibrium level, then there will be a period during which there is investment of only one type until the ratio condition is satisfied. We assume that transitional period is over.

[7] To derive (21), take (20) and cross multiply, then multiply both sides of the result by the number of firms N. Then use (2) for M in the term that involves h.

Using (3), (19), and (20), we can express the growth rate in country j as:

$$\gamma_j = \frac{1}{\theta}\left(BM^{\alpha} - \delta - \rho\right) \tag{22}$$

where $B \equiv \alpha^{\alpha}(1-\alpha)^{1-\alpha}$. To get from (22) to the growth equation (2) in the text, we note that $M^{\alpha} = A^{1-\alpha}$ by (9). In the text, moreover, we write A and ρ as functions of, respectively, R_c and R_n.

Respect raises the growth rate by raising the return to capital of both types. Responsibility raises the growth rate by reducing the rate of time preference. These core values work by increasing saving and investment, which have permanent effects on the growth rates of y, z, and h.[8]

1.4 Capital Intensity

We conclude with a demonstration that capital intensity $\kappa \equiv \left(\frac{K}{Y}\right)^{\frac{\alpha}{1-\alpha}}$ is lower in countries with a higher degree of respect.

To see this, put (21) into the output expression (7) to eliminate H, and then put the resulting expression for Y into the definition of κ to see that capital intensity can be written as

$$\kappa = M^{\frac{-\alpha^2}{1-\alpha}}\beta^{-\alpha} = A^{-\alpha}\beta^{-\alpha} \tag{23}$$

As noted in the text, the inverse relationship between respect R_c and capital intensity κ is a testable implication of our theory.[9]

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[8] We can recast the model to a form similar to that of Mankiw et al. (1992) with constant saving, exogenous technical change, and a separate human capital factor. In each firm, output would be $y_m = A(0)\,e^{gt}{k_m}^{\alpha}{h_m}^{\beta}\sum_{n=1}^{M_m}{l_{nm}}^{1-\alpha-\beta}$. There would still be a role for R_c through trust in the formation of the labor teams, which raises productivity and the steady state *levels* of income and capital.

[9] It should be noted, however, that it holds perfectly only in balanced growth. If capital is deficient in the sense that $K < \left(\frac{1}{\beta}\right)H$, then the model behaves like the optimizing neoclassical model with one factor, capital. There is a period during which only K is being accumulated (and H falls through depreciation). In this phase, capital intensity rises over time. It does so faster the greater is A and the lower is ρ. In a cross-section, then, it is possible that respect and responsibility are related positively to capital intensity. On the other hand, H might be deficient, in which case K/Y depends on neither. It is not clear which sort of deficiency is more likely in a developing country.

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