

The Role of Entrepreneurship in Productivity Growth: Decentralized versus Centrally Planned Economies

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Abstract:

Trends in GDP and TFP growth in the former socialist economies seem to indicate that these economies were converging to unusually low long-run growth rates in the late 1980s. In this paper we develop an endogenous growth model of entrepreneurship that is able to account for the difference in long-run performance between centrally planned economies and market-oriented ones. Long-run growth rates of output and productivity are determined by the growth of the stock of entrepreneurial knowledge, which in turn depends on the share of the population involved in entrepreneurial activities and on the time that they spend on those activities. We analyze the effect of two characteristics of centrally planned economies on their growth performance. First, in centrally planned economies factors of production are distributed by the central planner to the firms' managers through a contest that uses up some of the managers' productive effort. Second, the leadership is "egalitarian", in the sense that it treats individuals with different abilities equally. We show that these two features reduce the fraction of people becoming entrepreneurs/managers, as well as their entrepreneurial effort, which in turn reduces long-run output and TFP growth. We also find that the centrally planned economies have lower income inequality and slightly higher capital-output ratios.

Key words: endogenous growth, entrepreneurship, centrally planned economies

JEL codes: O4, P5

...there are a variety of roles among which the entrepreneur's efforts can be reallocated, and some of those roles do not follow the constructive and innovative script that is conveniently attributed to that person ... How the entrepreneur acts at a given time and place depends heavily on the rules of the game – the reward structure in the economy – that happens to prevail.

[Baumol (1990), p. 894]

1. Introduction

One of the intriguing aspects of the 20th century's experiments in central planning is the decline over time in the economic performance of socialist economies relative to their more market-oriented, and usually more developed, contemporaries. This economic decline was widespread and significant, and may have contributed to the collapse of the Soviet system [Easterly and Fisher (1995)]. As expected, growth rates for Eastern Europe and the former Soviet Union following World War II declined as the economies of the region recovered from the war. Less expected was that these countries appeared to be converging, if at all, to unusually low long-run growth rates. The most studied of the centrally planned economies was that of the Soviet Union. Its post-war growth experience is summarized in the first row of Table 1, which shows real per capita growth rates based on Western estimates of Soviet GNP. By the 1980s the Soviet Union's growth rate was less than half that of the U.S. and falling. The same general pattern of declining growth can be seen in the official figures of net material product (NMP), though these rates are generally believed to be exaggerated [Easterly and Fisher (1995)].¹

The growth experience of Eastern European countries in Table 1 mimics that of the Soviet Union, but at even lower rates. Furthermore, since their growth rates are in terms of NMP, they may be biased upward as they are for the Soviet Union. This apparent

¹ NMP does not include consumer services.

convergence of growth to very low rates is also seen outside of Eastern Europe. Using official data, Madrid-Aris (1997) estimated Cuba's growth rate of gross material product (GMP) per capita in the period 1980-88 at 2.7 percent despite Soviet subsidies that had reached 30 percent of GMP by the 1980s. In the latter half of that period, before the collapse of the Soviet Union and the end of its subsidies, growth had fallen to 0.3 percent.

More importantly for our work, the same pattern of decline is also seen in total factor productivity (TFP) growth. Based on a Cobb-Douglas production function with labor's share equal to 0.62, Bergson (1989) calculated that TFP growth for the Soviet Union declined from 1.87 percent in the 1950s to 1.51 percent in the following decade, and 0.11 percent in the period 1970-75. Using Western Data and the same procedure (with labor's share set at 0.6), Easterly and Fisher (1995) obtain similar results. For the three decades starting in 1950 they calculate TFP growth rates of 2.8 percent, 0.8 percent and 0.1 percent, with TFP growth turning negative at -0.2 percent for the period of 1980-87. A similar pattern has been found for Cuba. Using an estimated Cobb-Douglas production function instead of assuming a value for labor's share, Madrid-Aris (1997) found that TFP growth for Cuba went from 1.0 percent during 1963-70, to 0.8 percent in 1971-80, and then fell sharply to -1.7 percent during 1981-88.

While it is easy to think of reasons why centrally planned economies should be less productive than market-oriented ones, formal models of the growth process under central planning are not common. Roberts and Rodriguez (1997) models Soviet-type economies as consisting of a self-interested central planner who owns all capital, is a monopsonist in the labor market, has a discount rate that is lower than that of households, and who is interested only in maximizing a discounted stream of unproductive state consumption. In

the transition from market to central planning the planner's bias in favor of capital leads to higher investment and growth. As the economy approaches its new steady state path, the rate of growth declines toward exogenously determined long-run TFP growth.

More recently Brixiová and Bulír (2003) provide a two-period model where the focus is on the incentives for eliciting high effort from managers of enterprises. Exogenous TFP growth makes the low effort equilibrium more likely, which together with (exogenously) declining penalties for underperformance can result in a growth slowdown. As with the model of Roberts and Rodriguez, the centrally planned economy is less efficient than its market-oriented counterpart, but the growth slowdown is simply a temporary phenomenon of the transition to a new steady state.

Unlike previous work, this paper focuses on the effect of central planning on long-run steady state growth paths. Ours is a model of endogenous TFP growth in which central planning leads to a misallocation of entrepreneurial talent that both lowers the level of output and lowers long-run growth rates. Our explanation is very much in the spirit of Baumol (1990), where the allocation of entrepreneurial resources depends on the incentive structure facing inventive and productive individuals. We propose that in centralized economies entrepreneurs must divert some effort to compete for resources for their enterprises from a central authority. This view is consistent with that of Roberts (1990) who states that the main role of the planning apparatus in the Soviet Union was to act as a replacement for the market as a supply mechanism for enterprises. Having to devote effort to this form of nonproductive activity reduces the effort entrepreneurs can devote to productive ones, so that all else equal, output and productivity are reduced. To derive implications for growth, we adapt the model of entrepreneurship in Murphy,

Scheifler, and Vishny (1991), which in turn builds on that of Lucas (1978). In their model, as in ours, productive entrepreneurial activities contribute to a society's stock of entrepreneurial knowledge, which in turn directly increases productivity. The stock of entrepreneurial knowledge is a public good, and its growth leads to output and TFP growth.

The aim of this paper is to provide a unified framework for studying decentralized and centrally planned economies that we believe will prove useful for analyzing the differences in performance between these two types of economies. Our framework highlights two main differences between decentralized and centrally planned economies: the mechanism used to distribute resources among enterprises, and the “social weight” given to individuals of different characteristics.

We consider a model economy with infinite lived individuals who differ in their level of entrepreneurial ability. Individuals with high ability become entrepreneurs and those with low ability become production workers. Individuals are endowed with one unit of time that they can devote to production or to lobbying for resources. In the decentralized framework, the resources that each entrepreneur gets are determined by the market and, thus, no lobbying is necessary. In the centralized economy, where the government owns and distributes all resources, managers (the equivalent to entrepreneurs in a decentralized society) need to spend time lobbying the central planner to obtain inputs for their enterprises, which reduces the amount of time devoted to productive activities and, thus, output. Even if the government distributes output in an “efficient” way (that is, in a way that distorts individuals' decisions the least, compared to the decentralized economy), the reduction in production effort translates into a reduction in the rate of accumulation in the

stock of entrepreneurial knowledge. Therefore, our framework shows the lack of a market mechanism to redistribute resources as one of the sources of inefficiencies in centrally planned economies. The second source of inefficiency derives from the weight given to each individual in determining social welfare. If centralized economies tend to seek a more egalitarian distribution of resources, it will further distort the behavior of individuals by reducing the incentives to work as entrepreneurs and reduce the country's productive activity. Our framework is able to capture this effect.

The paper is organized as follows: section 2 presents the decentralized framework and characterizes the balanced growth path of our model economy. Section 3 describes the centrally planned economy, characterizes its balanced growth path, and develops a framework for comparing the balanced growth paths of decentralized and centralized economies. In section 4 we calibrate the parameters of the model to U.S. data and compare the generated balanced growth paths for both types of economies. Section 5 concludes.

2. The Economy Under Decentralized Decision-Making

This section introduces the basic structure by modeling the economy under decentralized decision-making. The environment is one of infinite horizon with infinitely-lived consumers. There is a measure N of consumers in the economy. Individuals are born with an innate level of entrepreneurial ability, a . The ability level is private information to the individual, with ability levels distributed among the population according to a distribution function $G(a)$ with continuous density $g(a)$ and support $S \subset \mathbb{R}_+$. The distribution function is exogenously given and does not change over time.

Individuals of ability a are endowed with $k_0(a)$ units of capital in the initial period.

Individuals are also endowed with one unit of time every period that they can use either in the production of the economy's single good or in lobbying activities (in situations where lobbying generates some benefit). Individuals also have a level of education h which we assume is homogeneous across ability levels.

Individuals derive utility from consumption, with CES period utility function $u(c) = (c^S - 1)/S$. Every period they choose an occupation (worker or entrepreneur), time devoted to production activities, x , consumption, and savings in order to maximize the present discounted value of their utility. In all specifications of our model, workers cannot gain anything from lobbying activities and, therefore, they choose to devote all of their time to the production process. We assume that markets are complete, implying that people can borrow and lend from each other in order to smooth consumption. All savings in the economy are done by accumulating capital.

The problem faced by an individual with ability a is:

$$\begin{aligned} \max_{c_t, b_{t+1}} \sum_{t=0}^{\infty} u(c_t(a)) \\ \text{s.t.} \quad c_t(a) + b_{t+1}(a) = m_t(a) + (1 + r_t^b) b_t(a) \end{aligned} \quad (1)$$

where c_t is consumption, b_t is savings, r_t^b is the interest rate, and m_t is labor income earned in period t . The labor income of an individual of ability a is equal to $w_t h$ if the individual chooses to work as a laborer or it is equal to $\mathbf{p}_t(a)$ if the individual chooses to be an entrepreneur, where $\mathbf{p}_t(a)$ represents the profits of an entrepreneur of ability a .

From the first order conditions of the consumer we obtain:

$$\frac{c_t(a)}{c_{t+1}(a)} = \left[\mathbf{b} (1 + r_{t+1}^b) \right]^{1/(S-1)} \quad (2)$$

Notice that this ratio is also independent of the ability of the consumer: the marginal rate of substitution between consumption at different points in time is the same for all consumers.

Entrepreneurs have access to a productive technology that uses capital, raw labor, and the entrepreneur's ability. The production function faced by an entrepreneur who devotes a fraction x of his time to the production process is given by:

$$y_{xt}(a) = \mathbf{I}_t (xa)^{1-q} \left[k_t^a (n_t h)^{1-a} \right]^q \quad (3)$$

where k_t is the amount of capital rented by the entrepreneur, n_t is the number of workers the entrepreneur employs, \mathbf{I}_t is a technology parameter (discussed below), and $\mathbf{a}, \mathbf{q} \in (0,1)$. Notice that this production function exhibits constant returns to scale in entrepreneurial ability, capital and labor, but decreasing returns in capital and labor alone.²

Let r_t be the rental rate of capital at period t . An entrepreneur chooses how much capital and raw labor to hire in order to maximize profits. Formally, the entrepreneur solves the problem³:

$$\mathbf{p}_{xt}(a) = \max_{n_t, k_t} \left\{ \mathbf{I}_t (xa)^{1-q} \left(k_t^a (n_t h)^{1-a} \right)^q - w_t n_t h_t - r_t k_t \right\}, \quad (4)$$

where $\mathbf{p}_{xt}(a)$ are the profits made in period t by an entrepreneur of ability a who spends a fraction of time x working, k_t is the capital rented and n_t is the number of workers

² The individual firm's production function is similar to Lucas (1997).

³ In the decentralized version of the model there is no gain from lobbying and, therefore, all entrepreneurs choose $x = 1$. We keep the notation, though, since it is useful for the analysis of the centralized version of the problem.

hired by the entrepreneur. In what follows, we eliminate the subscript x for simplicity.

We recover this explicit notation in proposition 2.

Let $\mathbf{k} = k / nh$ be the capital-labor ratio. From the first order conditions on the entrepreneur's problem we obtain:

$$\mathbf{k}_t = \frac{\mathbf{a}}{1-\mathbf{a}} \frac{w_t}{r_t}. \quad (5)$$

Notice that the capital labor ratio employed by an entrepreneur depends only on the economy's wage-rental ratio and not on his ability. Therefore, all entrepreneurs use the same capital-labor ratio in any given period. From here, we obtain the capital and labor hired by each entrepreneur:

$$\begin{aligned} k_t(a) &= \mathbf{I}_t^{1/(1-q)} x a \mathbf{k}_t^{1-a} \Delta_t \\ n_t(a) &= \frac{\mathbf{I}_t^{1/(1-q)} x a \mathbf{k}_t^{-a} \Delta_t}{h}, \end{aligned} \quad (6)$$

where $\Delta_t = \left[\mathbf{q} (\mathbf{a} / r_t)^{\mathbf{a}} / ((1-\mathbf{a}) / w_t)^{1-\mathbf{a}} \right]^{\frac{1}{1-q}}$ is a function of prices and the capital-labor

ratio. The output produced by an entrepreneur of ability a , and his profits are given by:

$$y_t(a) = \mathbf{I}_t^{1/(1-q)} x a \Delta_t^{\mathbf{q}} \quad (7)$$

and

$$\mathbf{p}_t(a) = (1-\mathbf{q}) y_t(a). \quad (8)$$

An individual of ability a chooses to be a worker or an entrepreneur according to which activity yields the highest income. Let \tilde{a}_t as the ability of an individual in period t whose income is the same independently on whether he becomes an entrepreneur or a worker. Given that entrepreneurs' profits are an increasing function of their ability, all individuals with ability level below the threshold \tilde{a}_t become workers and all individuals

with ability level above the threshold become entrepreneurs. The threshold \tilde{a}_t can be expressed as a function of the period prices, the fraction of the entrepreneur's time used in production activities, and the technology parameter in the following way:

$$\tilde{a}_t = \frac{w_t h}{(1-q) \mathbf{I}_t^{1/(1-q)} \Delta_t^q x}. \quad (9)$$

Given the threshold \tilde{a}_t , the total supply of laborers in period t is equal to $NG(\tilde{a}_t)$.

By aggregating production and demand for inputs over all entrepreneurs we obtain the aggregate output and capital and labor demands. Let us define $\tilde{S}_t = \{a \in A \mid a \geq \tilde{a}_t\}$ and

$M(\tilde{a}_t) = \int_{\tilde{S}_t} a dG(a)$ as the average entrepreneurial ability of practicing entrepreneurs in

the country. By integrating over all entrepreneurs, we obtain that the demand for capital and raw labor at period t is given by:

$$\begin{aligned} L_t^d &= \frac{N}{h} \mathbf{I}_t^{1/(1-q)} x \Delta_t M(\tilde{a}_t) \mathbf{k}_t^{-a} \\ K_t^d &= N \mathbf{I}_t^{1/(1-q)} x \Delta_t M(\tilde{a}_t) \mathbf{k}_t^{1-a} \end{aligned} \quad (10)$$

and

$$Y_t = \mathbf{I}_t^{1/(1-q)} x \Delta_t^q M(\tilde{a}_t) N. \quad (11)$$

The single good produced in the economy is used for both consumption and investment in new capital. Given that all savings is done in the form of capital, the supply of capital in the economy is equal to total savings:

$$K_t^s = N \int_S b_t(a) dG(a). \quad (12)$$

Non-arbitrage opportunities imply that the returns on savings have to be equal to the rental rate of capital, net of depreciation:

$$r_t^b = r_t - \mathbf{d} . \quad (13)$$

Feasibility implies that in equilibrium both the labor and the capital markets clear:

$$L_t^d = NG(\tilde{a}_t) \quad (14)$$

and

$$K_t^d = K_t^s . \quad (15)$$

Finally, the market for the single good in the economy has to clear as well. That is, total expenditure equals total output:

$$C_t + K_{t+1} - (1 - \mathbf{d})K_t = Y_t , \quad (16)$$

where $C_t = N \int_S c_t(a) dG(a)$ is the economy's aggregate consumption.

In order to close the model, we need to explain how the technology parameter I_t changes over time. Following Murphy, Scheifler, and Vishny (1991), the change in the level of the stock of entrepreneurial knowledge depends on current entrepreneurial practice.⁴ In particular, we assume that the parameter I_t depends on the mean entrepreneurial effort of the entire population, with workers receiving zero weight because they devote no time to entrepreneurial activities.⁵ Formally,

$$I_{t+1} - I_t = \mathbf{g} I_t \int_{\tilde{S}_t} ax dG(a) - \mathbf{m} I_t \quad (17)$$

where \mathbf{g} is a parameter and \mathbf{m} is the rate of depreciation of entrepreneurial knowledge.

With this formulation I_t will grow more rapidly the more effort is devoted to

⁴ In Murphy, Scheifler, and Vishny (1991) I_t takes on the value of the previous period's "best practice", which is simply the highest ability.

⁵ An alternative formulation would be $I_{t+1} - I_t = \mathbf{g} I_t \int_{\tilde{S}_t} ax (dG(a)/1 - G(\tilde{a}_t)) - \mathbf{m} I_t$. Here the rate of growth of I_t depends on the mean entrepreneurial effort of entrepreneurs only.

entrepreneurship, x_t , as well as the greater the fraction of the population that are entrepreneurs (the smaller is \tilde{a}_t). Entrepreneurial effort provides a positive externality in this model, helping generate perpetual growth.

Definition 1. *Given the fraction of human capital spent in production activities, x , and a distribution of initial capital stocks, $\{k_0(a)\}$, a competitive equilibrium for this economy is a set of sequences: savings and consumption for each ability level for each period, $\{c_t(a), b_{t+1}(a)\}$, prices, $\{r_t^b, r_t, w_t\}$, a threshold separating workers from entrepreneurs, $\{\tilde{a}_t\}$, entrepreneurial choices, $\{y_t(a), k_t(a), n_t(a)\}$, and technology levels, $\{\mathbf{I}_t\}$, such that:*

- (i) *Given prices and technology levels, $\{c_t(a), b_{t+1}(a)\}$ solve the consumer's problem (1).*
- (ii) *Given prices and technology levels, entrepreneurial choices $\{y_t(a), k_t(a), n_t(a)\}$ solve the profit maximization problem (4).*
- (iii) *Given prices and technology levels, \tilde{a}_t solves (9).*
- (iv) *Feasibility conditions (14)-(16) are satisfied.*
- (v) *The technology level \mathbf{I}_t evolves according to the law of motion in (17).*

The equilibrium of this economy is characterized by a set of equations that is listed in the Appendix.

Solving for the equilibrium of this economy may be complicated, since it involves a continuum of heterogeneous agents. The fact that capital-labor ratios and marginal rates

of substitution do not depend on the ability level, together with the homotheticity assumptions, simplify the resolution of the problem, since they allow the use of aggregation theory. In particular, equilibrium prices and aggregate variables in this model are equivalent to the equilibrium prices and aggregate variables of a representative agent's problem with a single type of producer. The next proposition states this result formally. The proofs of all propositions are in the Appendix.

Proposition 1. *Assume that there exists an equilibrium of our model economy and let $\{\tilde{a}_t\}$ be the sequence of occupational thresholds in this equilibrium. Then, the equilibrium prices and aggregate variables of the model economy are also an equilibrium solution of an economy with the same characteristics as our model economy but with a representative consumer and a single producer (who takes the evolution of \mathbf{I}_t as exogenously given and behaves competitively) that uses the technology*

$$Y_t = \mathbf{I}_t (M(\tilde{a}_t)N)^{1-q} x^{1-q} \left[K_t^a (hL_t)^{1-a} \right]^q. \quad (18)$$

From the first order conditions of this problem we obtain an expression of the rental rates of capital and labor in terms of the aggregate variables:

$$\begin{aligned} r_t &= \mathbf{a}q A_t K_t^{\mathbf{a}q-1} H_t^{(1-\mathbf{a})q} \\ w_t &= (1-\mathbf{a})q A_t K_t^{\mathbf{a}q} H_t^{(1-\mathbf{a})q-1}, \end{aligned} \quad (19)$$

where $A_t = \mathbf{I}_t x^{1-q} N^{1-q} M(\tilde{a}_t)^{1-q}$. This formulation will be useful in comparing the solution of the decentralized economy to the centrally planned economy that we describe in section 4.

Combining equations (9), (10) and (14) we obtain that

$$\frac{\tilde{a}_t G(\tilde{a}_t)}{M(\tilde{a}_t)} = \frac{\mathbf{q}(1-\mathbf{a})}{1-\mathbf{q}} \quad (20)$$

which states that the value of the occupational threshold depends only of the distribution of abilities and the input shares in production. It is easy to see that the equation above has only one solution and, therefore, there is a unique equilibrium threshold and it is constant over time.

Given that the equilibrium occupational threshold is easy to compute, we can solve for the aggregate variables and prices of the model by solving a one-sector closed economy model with the technology described in equation (18). Notice that this technology presents constant returns to scale in capital, labor, and entrepreneurial effort. The next proposition shows how to derive individual variables from the aggregate ones. It complements proposition 1 in showing that any solution to the representative consumer economy can be disaggregated into a solution of the decentralized economy.

Proposition 2. *Assume that an equilibrium exists for the economy with a representative consumer and a single firm. Then, for any initial distribution of capital $\{k_0(a)\}$ satisfying $\int_S k_0(a)dG(a) = \hat{K}_0$, there exists an equilibrium of the decentralized economy with the same prices and aggregate variables as the equilibrium of the representative consumer economy. Furthermore, let $\hat{\mathbf{n}}_t$ be any generic equilibrium variable of the representative agent problem. Then, the equilibrium consumption of an individual with ability a is given by:*

$$c_t(a) = \frac{\hat{c}_t}{\hat{c}_0} c_0(a) \quad (21)$$

where consumption at period zero is obtained as:

$$c_0(a) = \frac{\sum_{t=0}^{\infty} \hat{p}_t m_t(a) + (1 + \hat{r}_t^b) k_0(a)}{\sum_{t=0}^{\infty} \hat{p}_t \hat{m}_t + (1 + \hat{r}_t^b) \hat{k}_0} \hat{c}_0 \quad (22)$$

with $\hat{p}_t = 1 / \left(\prod_{s=0}^t (1 + \hat{r}_s^b) \right)$, and $m_t(a)$ is the income of an individual with ability a at period t when prices are the equilibrium prices of the representative consumer's economy.

Proposition 2 states that in this framework equilibrium prices and aggregate variables are independent of the initial distribution of capital across ability levels. The distribution of capital only affects individuals' income *levels* and, therefore, their consumption levels.

2.1. Balanced growth in the decentralized economy

In this section we investigate the behavior of balanced growth paths in the decentralized economy. We define a balanced growth path as an equilibrium where all variables are either constant or grow at the same rate over time. From the conditions that characterize equilibrium we observe that under such conditions the wage and rental rate of capital, the capital-labor ratio, and the ability threshold that separates workers from entrepreneurs have to be constant over time. Productivity grows at a rate $\mathbf{I} = \mathbf{g}xM(\tilde{a}) - \mathbf{m}$, where $\mathbf{I}_t = (1 + \mathbf{I})^t \mathbf{I}_0$ and \tilde{a} is the ability threshold. By manipulating the equations that characterize equilibrium, we obtain that output, consumption, capital and wage rates, at

both the disaggregated and aggregate level grow at the rate $\mathbf{h} = (1 + \mathbf{I})^{1/(1-\mathbf{a}q)} - 1$. Given the nature of our production functions, the balanced growth path can be solved analytically as a function of the equilibrium threshold. In particular, from the first order conditions for the consumer, we obtain that the value of the interest rate in the balanced growth path is constant and equal to:

$$r^b = \frac{(1+\mathbf{h})^{1-s}}{\mathbf{b}} - 1 \quad (23)$$

The wage rate is $w_t = (1 + \mathbf{h})^t w_0$, where

$$w_0 = (1-\mathbf{a})(1+\mathbf{h}) \left[\frac{\mathbf{q}^{1/(1-\mathbf{q})} x M(\tilde{\mathbf{a}})}{hG(\tilde{\mathbf{a}})} \right]^{(1-\mathbf{q})/(1-\mathbf{a}q)} \left(\frac{\mathbf{a}}{r_0} \right)^{\mathbf{a}q/(1-\mathbf{a}q)} \quad (24)$$

and $r_0 = r^b + \mathbf{d}$. The rest of the equilibrium variables can be computed by using the equations that characterize equilibrium listed in the Appendix.

2.2. Sources of growth in the decentralized economy

In what follows we use growth accounting techniques to decompose the growth rate of output into the portion due to factor accumulation, and the portion due to total factor productivity growth. It is the latter that we are interested in measuring.

Taking logs in equation (18) and comparing the value of the log of output between two consecutive periods, we obtain the growth accounting equation:

$$\bar{y}_{t+1} - \bar{y}_t = \left[(\bar{\mathbf{I}}_{t+1} - \bar{\mathbf{I}}_t) + (1-\mathbf{q})(\bar{\mathbf{M}}(\tilde{\mathbf{a}}_{t+1}) - \bar{\mathbf{M}}(\tilde{\mathbf{a}}_t)) + (1-\mathbf{a})\mathbf{q}(\bar{\mathbf{G}}(\tilde{\mathbf{a}}_{t+1}) - \bar{\mathbf{G}}(\tilde{\mathbf{a}}_t)) \right] + (1-\mathbf{a}q)(\bar{\mathbf{N}}_{t+1} - \bar{\mathbf{N}}_t) + \mathbf{a}q(\bar{\mathbf{K}}_{t+1} - \bar{\mathbf{K}}_t), \quad (25)$$

where $\bar{\mathbf{n}} = \log \mathbf{n}$ for any generic variable \mathbf{n} .

The right hand side of the equation shows the contribution of changes in capital, labor, and total factor productivity to output growth. We observe that each percentage increase in the labor force contributes $1 - \mathbf{a}q$ percentage points to output growth. The corresponding number for capital is $\mathbf{a}q$. Notice that the weights corresponding to the growth rates of capital and labor force add up to one, even though the production function does not exhibit constant returns to scale in capital and labor. The term in brackets on the right hand side of (25) represents growth in total factor productivity. Along a balanced growth path this term becomes $\mathbf{g}xM(\tilde{a}) - \mathbf{m}$. From this expression we observe that TFP growth depends on entrepreneurial effort and on the value of the ability threshold \tilde{a} : the higher the threshold, the lower TFP growth, and the higher the time spent in lobbying, $1 - x$, the lower the TFP growth.

The model in this paper is, therefore, a model of endogenous growth, where economies have the potential of converging to different long-run growth rates of TFP and output. This growth rate depends on the average effort in entrepreneurial ability,

$$xM(\tilde{a}) = \int_{\tilde{a}} xadG(a).$$

Notice that for all decentralized economies $x = 1$ and \tilde{a} is determined by parameter values. Therefore, the model predicts the same long-run growth rate for all decentralized economies.⁶ Furthermore, since $\tilde{a}_t = \tilde{a}$ for all t , the model is equivalent to an exogenous growth model where the rate of growth is determined by the input shares in production and the distribution of ability across the population. In the next section we show that a similar result applies for centrally planned economies. All

⁶ Assuming, of course, that all decentralized economies have the same distribution of ability and do not differ in x .

centrally planned economies grow at the same rate in the long-run, but will differ from the long-run growth rate of the decentralized economies.⁷

Using more general production functions we could get x and \tilde{a} to differ across countries. In that case, we could interpret I_t as a common parameter across countries that interact with each other through trade and technology transfers, and that is determined by the average entrepreneurship effort in the world. This interpretation would deliver the same long-run growth rate across countries, as long as they interact commercially with each other. Given that the interactions of centrally planned economies and decentralized economies were limited, this more general framework would still deliver different long-run growth rates across both organizational systems. In this paper we would interpret the “decentralized economy” as being an aggregate of all decentralized economies, and the “centrally planned economy” as being an aggregate of all centrally planned economies.

3. The Centrally Planned Economy

In autocratic societies where the top leadership has considerable control over the allocation of resources, one would expect such a leadership to be quite interested in efficiency. Olson (1982) refers to such leaders as having an “encompassing interest,” for they can capture and allocate much of an economy’s output. The ability to capture much or all of an economy’s total output, however, will not be enough to achieve efficiency. One difficulty is that the top leadership will have to delegate much of the entrepreneurial and managerial functions to others (even more so for the top leader). Under such a

⁷ Given the different organization of both types of economies, we believe that this is a plausible

centrally organized economy, individuals who would have been entrepreneurs in a decentralized economy now may become managers for the top leadership, with the accompanying problems that such a relationship entails. Specifically, we assume that entrepreneurial ability is private information, unknown to the leadership. In order to allocate factors of production to managers, each period the leadership holds a contest in which the more effort a manager exerts, and the greater his ability, the more resources he receives. We refer to the effort devoted to these contests as *lobbying*.

The production structure of the model remains the same as in the decentralized economy: people are born with an exogenous level of entrepreneurial ability and they decide whether to use their ability and become managers of the production technology or not to use it and work as laborers. The main feature of the centrally planned economy is the existence of an entity, which we call the *leadership*. The leadership owns the capital stock and receives all production in the economy, which it distributes between investment and consumption goods to be delivered to the country's consumers. As in Roberts and Rodriguez (1997), we assume that there is no storage technology and individuals cannot borrow and lend from each other.⁸ Therefore, in each period individuals consume all the income distributed to them by the leadership.

The centrally planned economy works as follows: at the beginning of each period t the leadership announces a compensation scheme to be delivered at the end of the period. We assume that the compensation scheme used by the leadership is such that it pays a fixed amount of goods, \bar{m}_t , to all individuals who work as laborers in period t and compensates managers depending on their production level: a manager who produces

interpretation of the data.

output y_t in period t will receive compensation $m_t = \bar{\tau}_t y_t$.⁹ Furthermore, we assume the existence of a perfect commitment mechanism, so that the leadership cannot change previously announced policies.¹⁰ Once the compensation scheme is announced individuals make their occupational choices. We describe the individuals and leadership decisions in detail in what follows.

3.1. Individuals' decisions

As in the decentralized economy, workers devote their unit of time working as laborers. The problem of the managers is more complicated than in the decentralized economy. In the centrally planned economy, managers cannot rely on the market to obtain their inputs, and have to get them directly from the leadership, through lobbying. The leadership cannot distinguish a manager's ability ex-ante and, thus, it holds a contest in which resources are distributed according to the manager's lobbying efficiency. The lobbying efficiency of a manager depends on his lobbying effort (the fraction of his time spent in lobbying), as well as on his ability, and on the total lobbying efficiency in the economy. In particular, the fraction $z(a)$ of the available capital and raw labor in the period obtained by a manager with ability level a , who spends $1-x$ of his time in lobbying activities, is given by the following contest success function:

⁸ Roberts and Rodriguez (1997) state that savings were used "to finance the purchase of expensive consumer durables ... and ... goods appearing unexpectedly on the market".

⁹ This compensation scheme, even though not necessary here, would be optimal in a more generalized framework where the leadership could not infer the manager's ability. It ensures that individuals are going to reveal their true ability level, that managers are going to maximize their production, and that only the most able individuals become managers.

¹⁰ It is well known that commitment is a problem in any framework with government policy. We make the assumption in order to avoid time-inconsistency problems. A possible justification is to assume that failure to deliver pre-announced compensations would cause revolt, leading to a change in government.

$$z(a) = \frac{(1-x)a}{v} \quad (26)$$

where $v = N \int_A (1-x(a))adG(a)$ is the total efficiency units of lobbying.¹¹ Here we assume that $x(a) = 1$ for individuals of ability a who become workers. Notice that under this distribution scheme entrepreneurs receive the same amount of resources as they would in a decentralized economy that had the same threshold \tilde{a} and initial levels of endowments.

A manager of ability a chooses a production effort level x so as to maximize his utility, taking the compensation scheme as given. In our set up, this is equivalent to maximizing his production level. Formally, the manager solves the maximization problem:

$$\max_{x_t} \left\{ \bar{E}_t \mathbf{I}_t (x_t a)^{1-q} [z_t(a) K_t]^{aq} [z_t(a) H_t]^{(1-a)q} \right\} \quad (27)$$

where $H_t = NhG(\tilde{a}_t)$ is the total amount of efficiency units of labor available in the economy.

Using the expression for $z(a)$ derived in (26) the manager's problem becomes:

$$\max_{x_t} B_t a x_t^{1-q} (1-x_t)^q \quad (28)$$

where $B_t = \bar{E}_t \mathbf{I}_t K_t^{aq} H_t^{(1-a)q} / v_t^q$ does not depend on the manager's ability. From the first order condition of the previous maximization problem we obtain that $x_t = 1-q$ for all t .

That is, the effort level devoted to production is homogeneous across managers and over time. Notice that since all managers choose to use the same fraction of time q in lobbying activities, the fraction of resources that a manager of ability a obtains for production is:

$$z_t(a) = \frac{a}{NM(\tilde{a}_t)}, \quad (29)$$

which is linear in his ability level.

The output produced by a manager of ability a in period t can be written as a function of aggregate variables in the following way:

$$y_t(a) = \mathbf{I}_t a(1-\mathbf{q})^{1-\mathbf{q}} \frac{K_t^{a\mathbf{q}} H_t^{(1-a)\mathbf{q}}}{N^{\mathbf{q}} M(\tilde{a}_t)^{\mathbf{q}}} \quad (30)$$

Notice that this expression is exactly the same one obtained for a decentralized economy where the entrepreneur devotes a fraction $x = 1 - \mathbf{q}$ of his time to productive activities.

The ability threshold above which an individual becomes an entrepreneur is thus determined by:

$$\bar{\mathbf{E}}_t y_t(a) \geq \bar{m}_t \quad (31)$$

or, using (30),

$$\frac{\tilde{a}_t}{M(\tilde{a}_t)} = \frac{\bar{m}_t N^{\mathbf{q}}}{\bar{\mathbf{E}}_t (1-\mathbf{q})^{1-\mathbf{q}} \mathbf{I}_t K_t^{a\mathbf{q}} H_t^{(1-a)\mathbf{q}}}. \quad (32)$$

3.2. Leadership's decisions

The objective function of the leadership is difficult to assess. Roberts and Rodriguez (1997) consider that the objective of the leadership (they refer to it as the central planner) is to maximize its own consumption (unproductive state consumption). Brixiová and Bulír (2003) do not specify the leadership's (the ruler, or Party) objective function. They only state that the role of the leadership is to fine its agent, the planner, for not meeting production targets. In this paper, our objective is to keep the centrally planned economy

¹¹ This is a special case of the widely used ratio form of the contest success function. See Hirshleifer (1989) and Baik (1998) for a comparison with other forms.

as close as possible to the decentralized framework in order to isolate the effects of the differences in entrepreneurial activity in both systems. Therefore, we assume that the leadership is a benevolent planner whose objective is to choose a compensation scheme $\{\bar{m}_t, \bar{\mathbf{E}}_t\}_{t=0}^{\infty}$ in order to maximize a weighted average of individuals' discounted utility. Furthermore, we assume that the leadership does not internalize the effect of lobbying on the growth of entrepreneurial knowledge. That is, the leadership takes I_t as exogenously given.

Let $\mathbf{j}(a)$ denote the weight that the social planner gives to an individual with entrepreneurial ability a . In this paper we assume that the leadership weights all individuals equally, so that $\mathbf{j}(a) = 1$ for all $a \in S$. Nevertheless, we derive the equilibrium conditions under the more general notation since it is useful in later stages of the paper.

The welfare function that the leadership faces is:

$$W = N \int_S \left[\mathbf{j}(a) \sum_{t=0}^{\infty} \mathbf{b}^t u(c_t(a)) \right] dG(a) \quad (33)$$

where $c_t(a)$ is the consumption level of an individual with ability a in period t .

As we mentioned above, the leadership chooses a compensation scheme $c_t(a) = \bar{m}_t$ for individuals who work as laborers, and $c_t(a) = \bar{\mathbf{E}}_t y_t(a)$ for individuals with ability a who work as managers. In our set-up the leadership, by solving the manager's problem, can infer a manager's type from the amount of resources that he receives during the lobbying process. Therefore, given that a manager's output is linear with respect to his ability level, our compensation scheme is equivalent to one in which a manager's compensation is a linear function of his revealed ability. Due to the fact that individuals

do not have incentives to misrepresent their type, a manager's compensation scheme will be a linear function of his own ability. Let us redefine the compensation scheme as follows. The leadership assigns resources $m_t(a)$ to an individual of ability a such that:

$$m_t(a) = \begin{cases} m_t & \text{if } a \leq \tilde{a}_t \\ \mathbf{t}_t a & \text{if } a > \tilde{a}_t \end{cases} \quad (34)$$

where \tilde{a}_t is the balanced growth path threshold that separates managers from workers, $m_t = \bar{m}_t$, and $\mathbf{t}_t = \bar{\mathbf{t}}_t \mathbf{I}_t (1-\mathbf{q})^{1-\mathbf{q}} \left(K_t^{\mathbf{a}\mathbf{q}} H_t^{(1-\mathbf{a})\mathbf{q}} / N^{\mathbf{q}} M(\tilde{a}_t)^{\mathbf{q}} \right)$. Using this simplification we can write the leadership problem as:

$$\begin{aligned} & \max_{m_t, \mathbf{t}_t, K_{t+1}} \int_S \sum_{t=0}^{\infty} \mathbf{b}^t N \mathbf{j}(a) u(\zeta(a)) dG(a) \\ & \text{s.t.} \\ & N [m_t G(\tilde{a}_t) + \mathbf{t}_t M(\tilde{a}_t)] + K_{t+1} - (1-\mathbf{d})K_t = Y_t \\ & Y_t = \mathbf{I}_t (1-\mathbf{q})^{1-\mathbf{q}} N^{1-\mathbf{q}} M(\tilde{a}_t)^{1-\mathbf{q}} K_t^{\mathbf{a}\mathbf{q}} H_t^{(1-\mathbf{a})\mathbf{q}} \\ & H_t = N h G(\tilde{a}_t) \\ & \tilde{a}_t = m_t / \mathbf{t}_t \end{aligned} \quad (35)$$

The objective function in the problem above can, then, be written as:

$$\max_{m_t, \mathbf{t}_t, K_{t+1}} \sum_{t=0}^{\infty} \mathbf{b}^t N \left[\int_{S \setminus \tilde{S}_t} \mathbf{j}(a) u(m_t) dG(a) + \int_{\tilde{S}_t} \mathbf{j}(a) u(\mathbf{t}_t a) dG(a) \right] \quad (36)$$

Let V_t be the Lagrange multiplier for the period- t resource constraint equation. The first order conditions for the problem in (35) are:

$$V_t = \frac{\mathbf{b}^t \left[\tilde{a}_t u'(m_t) \int_{S \setminus \tilde{S}_t} \mathbf{j}(a) dG(a) + \int_{\tilde{S}_t} \mathbf{j}(a) u'(\mathbf{t}_t a) a dG(a) \right]}{\tilde{a}_t G(\tilde{a}_t) + M(\tilde{a}_t)} \quad (37)$$

$$\mathbf{b}^t N u'(m_t) \int_{S \setminus \tilde{S}_t} \mathbf{j}(a) dG(a) - V_t \left[N G(\tilde{a}_t) - \frac{g(\tilde{a}_t) Y_t}{\mathbf{t}_t} \left(\frac{\mathbf{q}(1-\mathbf{a})}{G(\tilde{a}_t)} - (1-\mathbf{q}) \frac{\tilde{a}_t}{M(\tilde{a}_t)} \right) \right] = 0 \quad (38)$$

$$\frac{V_t}{V_{t+1}} = 1 - d + aq \frac{Y_{t+1}}{K_{t+1}} \quad (39)$$

which together with the leadership's budget constraint in (35), the relationship

$\tilde{a}_t = m_t / t_t$, and the equation for the evolution of the factor I_t characterize the solution to the leadership's problem.

3.3. Balanced growth in the centrally planned economy

The balanced growth assumption implies that the technology level grows at a constant rate $I_c = g(1 - q)M(\tilde{a}) - m$.¹² All other variables grow at the rate

$h_c = (1 + I_c)^{1/(1-aq)} - 1$. Given the constant elasticity of substitution assumption in utility, the conditions that characterize equilibrium are consistent with the balanced growth assumptions.

The next proposition relates the equilibrium threshold of the centrally planned economy with the equilibrium threshold of the decentralized economy. It states that the former is higher than the latter, indicating that the centrally planned economy has fewer entrepreneurs than the decentralized economy.

Proposition 3: *Let \bar{a} be the threshold solution of the planner's problem. Then $\bar{a} > \tilde{a}$.*

The proof uses the fact that the term in brackets in equation (38) is decreasing and it is equal to zero at \tilde{a} and that the first two terms in the equation combined are positive for

¹² Notice that, given \tilde{a} , this is the same rate of growth as a decentralized economy with $x = 1 - q$.

all $\bar{a} \leq \tilde{a}$. Therefore, if there is a solution to the equation, it has to satisfy $\bar{a} > \tilde{a}$. The details of the proof are in the Appendix.

As it can be immediately seen by looking at the equations, the solution to the leadership problem depends on the weights given to each type ability level. Different sets of weights imply different equilibrium aggregate variables, different thresholds \tilde{a} , and different distributions of income across agents. Notice that, given a threshold \tilde{a} , the aggregate production function of the centrally planned economy coincides with the aggregate production function of the decentralized economy, with an entrepreneurial effort $x = 1 - q$. Therefore, the long-run TFP growth rate of the centrally planned economy is also equal to $g^x M(\tilde{a}) - m$. This implies that there are two sources of discrepancy between TFP growth rates of the decentralized and centrally planned economy. First, for any given level of \tilde{a} the centrally planned economy has a lower TFP growth due to the fact that entrepreneurs need to spend a fraction of their time lobbying for resources instead of in productive activities. Second, a higher level of \tilde{a} in the centrally planned economy further lowers its TFP growth level with respect to the decentralized economy.

In the centrally planned economy, the threshold \tilde{a} is directly linked to the weights given to each individual by the leadership. The higher the weight on low ability workers, the higher the threshold value \tilde{a} . Therefore, by changing the weights that the planner assigns to people with different abilities, we can obtain different levels of \tilde{a} . In order to isolate the effects of the two sources of discrepancy between the decentralized and the centrally planned economies, we consider an intermediate step where the leadership's distribution scheme mimics the distribution of resources of the decentralized economy's

equilibrium. In this case, the only difference between both economies comes from the reversion of productive time towards lobbying that managers have to incur in the centrally planned economy. This exercise isolates the lobbying effect. We achieve this purpose by choosing weights $\mathbf{j}(a)$ so that the equilibrium variables of the centrally planned economy coincide with the equilibrium variables of a decentralized economy where entrepreneurs spend the same fraction of their time in production activities as in the centrally planned economy (that is, $x = 1 - \mathbf{q}$). The next proposition establishes the set of weights for which the equilibrium of the centrally planned economy coincides with the decentralized equilibrium. In the proposition we denote by $\mathbf{n}_{1-\mathbf{q}}$, for any generic variable \mathbf{n} , the balanced growth path solution of a decentralized economy where entrepreneurs spend a fraction $x = 1 - \mathbf{q}$ of their time in entrepreneurial activities.

Proposition 4: *Let $\mathbf{n}_{1-\mathbf{q}}$ denote any generic variable from the balanced growth path equilibrium of a decentralized economy where $x = 1 - \mathbf{q}$. Let $\hat{c}_{1-\mathbf{q},0}$ and $\hat{m}_{1-\mathbf{q},0}$ be, respectively, the average consumption and the average income per person in such equilibrium. Let $\mathbf{t} = w_{1-\mathbf{q},0} \hat{c}_{1-\mathbf{q},0} / \tilde{a}_{1-\mathbf{q}} \hat{m}_{1-\mathbf{q},0}$ and $m = w_{1-\mathbf{q}} h$. Then the balanced growth path equilibrium of the decentralized economy with $x = 1 - \mathbf{q}$ is also the balanced growth path equilibrium of a leadership problem where the leadership weighs individuals of different abilities using the weights:*

$$\mathbf{j}(a) = \begin{cases} \mathbf{j}_m = 1/u'(m) & \text{for } a \leq \tilde{a}_{1-\mathbf{q}} \\ 1/u'(\mathbf{t}a) & \text{for } a > \tilde{a}_{1-\mathbf{q}}. \end{cases}$$

Notice that since $u'' < 0$, $\mathbf{j}_w < \mathbf{j}(a)$ for all $a > \tilde{a}$. That is, in order to mimic the decentralized equilibrium, the planner has to give higher weights to managers with higher ability levels. Therefore, assuming that the leadership treats all individuals equally introduces inefficiencies in the centrally planned economy. In the next section we parameterize and simulate the model economy and analyze the relative importance of such inefficiency.

4. Simulations

In this section we parameterize the economy and solve for the balanced growth path in three scenarios: a decentralized economy, a centrally planned economy, and a centrally planned economy with a planner that uses the weights described in proposition 4. The latter scenario differs from the decentralized economy scenario only in the fraction of time that entrepreneurs spend in productive activities and, therefore, it isolates the effect on output and TFP growth of the time spent lobbying for resources. We denote this scenario as the *weighted centrally planned economy*.

In order to parameterize the model, we need to choose a functional form for the distribution of abilities across the population. We assume that ability levels follow a Pareto distribution. We pick a Pareto distribution because it has the desirable property that the income distribution for entrepreneurs implied by the model is also Pareto. Furthermore, existing literature reports that a Pareto distribution is a good approximation for the upper tail of the distribution of income (see for instance, Levy 2003 and Steindl 1965). Given that in our model all workers earn the same labor income we believe this is a reasonable distribution to consider. The Pareto distribution has two parameters: a

location parameter, a_m , that determines the lowest value with a positive probability of occurring and a shape parameter, s , that determines the thickness of the tail of the distribution. The density function is given by:

$$g(a) = \begin{cases} 0 & a < a_m \\ \frac{sa_m^s}{a^{s+1}} & a \geq a_m \end{cases} . \quad (40)$$

We take the support of abilities to be $S = [1, \infty)$, which implies that $a_m = 1$.

Detailed and accurate data on centrally planned economies are hard to obtain.

Therefore, as a first approximation, we consider parameter values so that the balanced growth path of the decentralized economy matches long-run trends for the U.S. economy.

We choose a discount factor $\mathbf{b} = .95$, intertemporal elasticity of substitution of 1.25,

which implies $\mathbf{s} = .2$, and a depreciation rate of 6 percent, all in line with the real

business cycle literature. The rest of the parameters are jointly calibrated in order to

match the following long-run features of the U.S. economy: a growth rate of output per

working-age person of 2.0 percent ($\mathbf{h} = 1.02$), a capital share of income of 1/3, a share of

employment in entrepreneurial activities of 20 percent and a Gini coefficient for the

distribution of earnings of .35.¹³ Table 2 presents the list of parameters and their

corresponding values. The Appendix shows in more detail the relationship between the

data and the parameters. Given the calibrated parameters, the distribution of abilities is

plotted in figure 1.

Table 3 presents the results of the simulations. The first two columns present the

balanced growth path values for the decentralized and centrally planned economies.

¹³ DeNavas-Walt and Cleveland (2002) find a Gini coefficient of household income for 2001 of .466. We adjust this coefficient downwards in order to get an estimate of the Gini coefficient for individual earnings.

Values for the weighted centrally planned economy are in the third column. The variables for the decentralized economy are listed only for informational purposes, since we have parameterized the model so that the decentralized economy matched the data perfectly in all the reported dimensions.

From the table 4 we observe that the market economy has higher TFP and GDP growth than the centrally planned economy. The lower growth of the centrally planned economy comes from two sources: first, the reduction in the time that each entrepreneur spends in entrepreneurial activities, due to the need to spend time lobbying for resources; second, the incentives from greater redistribution arising from the desire to treat all individuals equally. We can isolate the first effect by comparing the decentralized economy with the weighted-centralized economy (columns 1 and 3). We observe that the reduction in the time spent in entrepreneurial abilities is responsible for 87 percent of the difference in output growth between the decentralized and the centrally planned economy. Only 13 percent of the difference is due to the change in the fraction of entrepreneurs in the economy caused by the fact that the centralized economy is a more egalitarian regime. This implies that the inefficiencies associated with the time spent in lobbying activities are responsible for the differences in TFP and GDP growth. The lower time spent by managers in productive activities reduces the contribution to the stock of knowledge and, therefore, it reduces growth rates. Regarding inequality differences, notice that the Gini coefficients for the decentralized and the weighted centrally planned economies are the same. Therefore, all the reduction in inequality is driven by the leadership's allocation of

income across ability levels. Lorenz curves representing earnings distribution are depicted in figure 2.

Gini coefficients for a large number of countries are reported by Deininger and Squire (1996). Our results are consistent with their observation of lower Gini coefficients in Eastern European countries compared to the U.S. (.26 versus .35 in the US). In terms of magnitude, the Gini coefficients in our simulations are smaller than the ones reported by Deininger and Squire (1996). In terms of our framework, this is an indication that maybe the leadership did not have a completely egalitarian welfare function. Since the results on growth are mainly driven by the need for lobbying activities, this is not a “problem” for us.

Notice also that the capital-output ratio is higher in the centrally planned economy. The planner supplements the lower productivity with higher levels of capital.

4.1. Sensitivity analysis

In this section we run some sensitivity analyses on the free parameters. The most important free parameter is the parameter m from the evolution of the productivity parameter I_t . Table 4 presents results on TFP and output growth as well as the Gini coefficients for the centrally planned economy for different values of the parameter m . Notice that since m is calibrated jointly with other parameters, changing m implies a recalibration of the whole set of parameters in order for the decentralized economy to match the long-run trends of the U.S. economy. Table 4 presents the TFP and GDP growth rates as well as the Gini coefficient for the centrally planned economy under different values of the parameter m . Given that the decentralized economy is calibrated

to match U.S. trends, the values of these variables will not change with a change in m , and are the same as in table 3. We observe that the TFP growth rate for the centrally planned economy decreases as m increases, and it becomes negative for slightly positive values of m .

5. Conclusion

In this paper we present a unified framework for comparing decentralized and centrally planned economies and we use it to analyze the different long-run economic performance of the two types of regimes. In our framework, the long-run growth rates of output and productivity are determined by the growth of the stock of entrepreneurial/managerial knowledge, which in turn depends on the share of the population involved in entrepreneurial activities and on the time that they spend in those activities.

We analyze the effect of two characteristics of centrally planned economies on their growth performance. First, in centrally planned economies factors of production are distributed by the central planner to the firms' managers through a contest that uses up some of the managers' productive effort. Second, the leadership is "egalitarian", in the sense that it treats individuals with different abilities equally. We show that these two features reduce the fraction of people becoming entrepreneurs/managers, as well as their entrepreneurial effort which, in turn, reduces long-run output and TFP growth. We also find that the centrally planned economies have lower income inequality and slightly higher capital-output ratios.

In this paper we also analyze the effect on economic performance of each of these characteristics separately. We find that the reduction in entrepreneurial effort accounts for about 85 percent of the decrease in long-run growth rates, whereas the egalitarian leadership accounts for the difference in income inequality between both regimes.

In this paper we take the stand that entrepreneurship activity is essential for long-run economic growth. By discouraging entrepreneurial effort in their countries and closing themselves off to new ideas and technologies developed in market-oriented economies, centralized economies seriously impaired their ability to sustain long-run growth, perhaps contributing significantly to their regimes' eventual collapse.

The framework developed in this paper is quite general and can be used to analyze issues of economic growth other than those considered here. Our framework introduces a channel through which entrepreneurial activity has long-run economic effects that could be used, for example, to study the growth effects of policies that affect entrepreneurial incentives, such as industrial regulation and taxation.

This paper is about long-run trends. Two important issues regarding transitions are not analyzed there. First, we do not explain the transition from high growth rates in the 1960s to increasingly lower growth rates in the output and TFP growth in the 1970s and 1980s that centrally planned economies experienced. Inefficiencies built into the system that did not allow for the evolution or implementation of new ideas that naturally come with free markets and competition are probably crucial to this evolution. Papers like Atkeson and Kehoe (1995) and Chu (2001) introduce such inefficiencies in decentralized economies. Similar techniques could be used in this framework. Second, our paper does

not address the issue of transitioning from one economic regime to the other. This is the subject of further research.

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	1950-60	1960-70	1970-80	1980-88
USSR, GNP ¹	5.7	3.9	3.6	1.2
USSR, NMP	8.2	6.3	4.6	2.8
Czechoslovakia, Hungary, Poland & Yugoslavia, NMP ²	6.4	4.8	4.5	0.9
Cuba, GMP ³		0.7	5.2	2.7
USA, GDP ⁴	1.7	2.9	2.1	2.5

¹ GNP and NMP growth rates from Easterly and Fisher (1995), population growth rates calculated from data in Mitchell (1992). Last period covers 1980-87.

² Based on calculations from data in Mitchell (1992). Average growth rates are unweighted.

³ GMP is Gross Material Product. Madrid-Aris (1997).

⁴ Bureau of Economic Analysis.

Table 2. Parameter values

<i>b</i>	<i>s</i>	<i>a_m</i>	<i>s</i>	<i>d</i>	<i>q</i>	<i>a</i>	<i>g</i>	<i>m</i>
.95	.2	1	1.35	.06	.67	.49	.005	0

Table 3. Balanced growth path comparisons

	Decentralized	Centrally planned	Weighted Centrally planned
TFP growth (%)	1.3	.31	.44
output growth (%)	2	.46	.66
Capital/output	2.55	2.83	2.79
Entrepreneurs (%)	20	5	20
Gini earnings	.35	.13	.35
Lobbying time (%)	0	67	67

Table 4. Sensitivity analysis, parameter m .

	$m=0$	$m=0.005$	$m=0.01$
TFP growth (%)	.31	-.08	-.47
GDP growth (%)	.46	-.12	-.7
entrepreneurs (%)	5	5	5
Gini	.124	.123	.122

Figure 1. Distribution of abilities

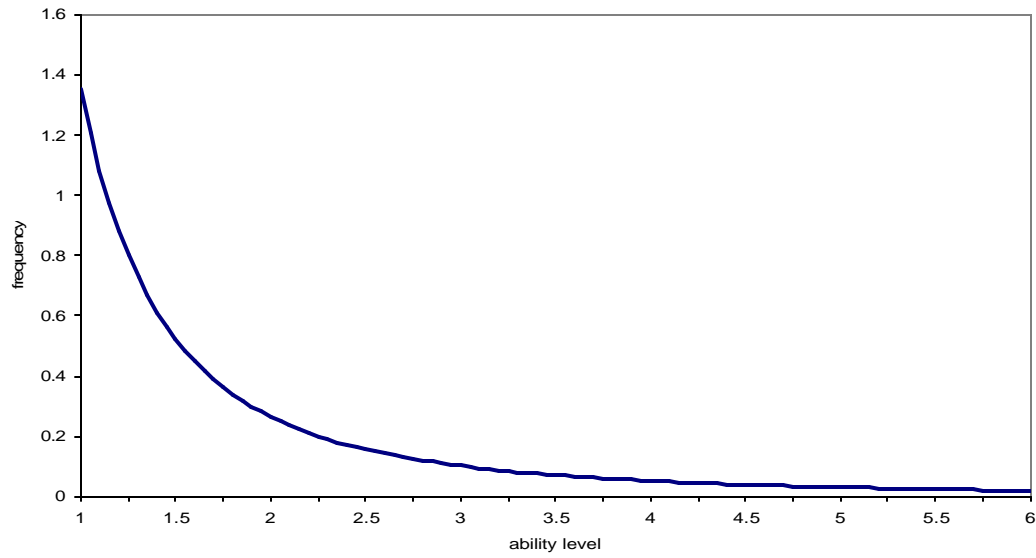
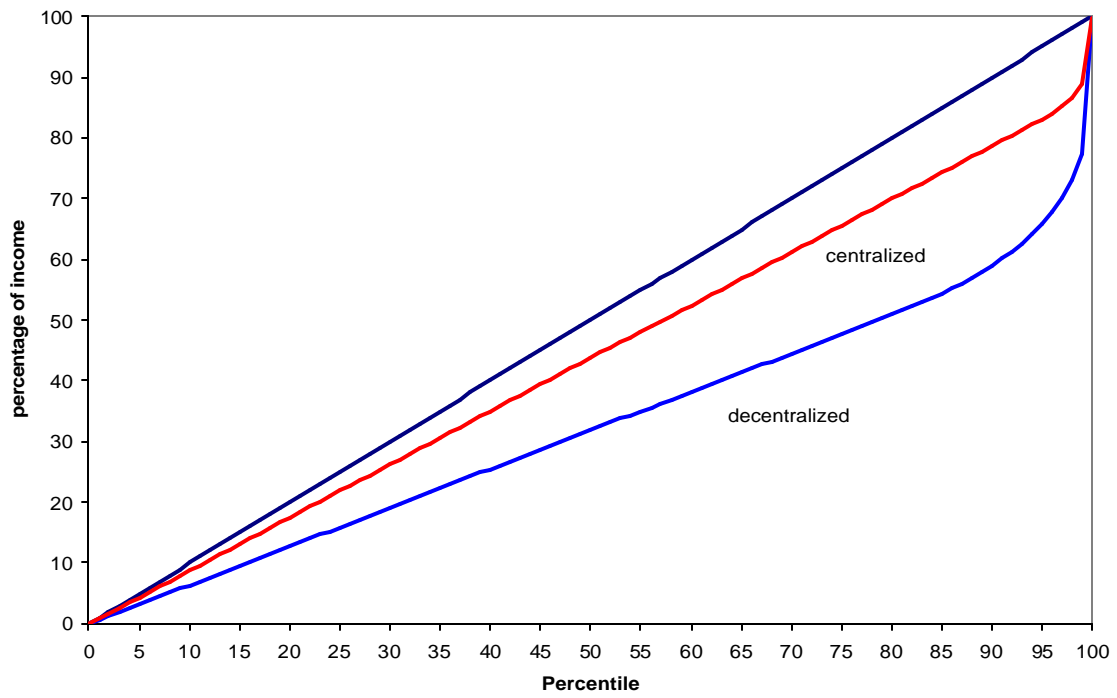


Figure 2: Lorenz curves



APPENDIX

1. Characterization of equilibrium of the decentralized economy

In this section of the appendix we list the equations that characterize the equilibrium of a decentralized economy where entrepreneurs spend a fraction $x \in [0,1]$ in productive activities and with an initial distribution of capital stocks $\{k_0(a)\}$, for $a \in S$.

First order conditions for entrepreneurs:

$$\mathbf{k}_t = \frac{\mathbf{a}}{1-\mathbf{a}} \frac{w_t}{r_t} \quad (41)$$

$$\Delta_t = \left[\mathbf{q} \left(\frac{\mathbf{a}}{r_t} \right)^{\mathbf{a}} \left(\frac{1-\mathbf{a}}{w_t} \right)^{1-\mathbf{a}} \right]^{1/(1-\mathbf{q})} \quad (42)$$

$$n_t(a) = xa \frac{1}{h} \mathbf{l}_t^{1/(1-\mathbf{q})} \mathbf{k}_t^{-\mathbf{a}} \Delta_t, \quad a \in \tilde{S}_t \quad (43)$$

$$k_t(a) = xa \mathbf{l}_t^{1/(1-\mathbf{q})} \mathbf{k}_t^{1-\mathbf{a}} \Delta_t, \quad a \in \tilde{S}_t \quad (44)$$

$$y_t(a) = xa \mathbf{l}_t^{1/(1-\mathbf{q})} \Delta_t^{\mathbf{q}}, \quad a \in \tilde{S}_t \quad (45)$$

$$\mathbf{p}_t(a) = (1-\mathbf{q})y_t(a), \quad a \in \tilde{S}_t \quad (46)$$

Individual with ability \tilde{a}_t is indifferent between being an entrepreneur and an worker:

$$\frac{\tilde{a}_t G(\tilde{a}_t)}{M(\tilde{a}_t)} = \frac{\mathbf{q}(1-\mathbf{a})}{(1-\mathbf{q})} \quad (47)$$

First order conditions for the consumer:

$$\frac{c_t(a)}{c_{t+1}(a)} = \left[\mathbf{b} (1+r_{t+1}^b) \right]^{1/(s-1)}, \quad a \in S \quad (48)$$

$$r_t^b = r_t - \mathbf{d} \quad (49)$$

$$m_t(a) = \max \{ w_t h, \mathbf{p}_t(a) \}, \quad a \in S \quad (50)$$

Consumer's budget constraint:

$$c_t(a) + b_{t+1}(a) = m_t(a) + (1 + r_t^b) \mathbf{b}_t(a), \quad a \in S \quad (51)$$

Aggregate variables:

$$M(\tilde{a}_t) \equiv \int_{\tilde{S}_t} a dG(a) \quad (52)$$

$$K_t \equiv N \int_{\tilde{S}_t} k_t(a) dG(a) = Nx \mathbf{I}_t^{1/(1-q)} \mathbf{k}_t^{1-a} \Delta_t M(\tilde{a}_t) \quad (53)$$

$$L_t \equiv N \int_{\tilde{S}_t} n_t(a) dG(a) = \frac{N}{h} x \mathbf{I}_t^{1/(1-q)} \mathbf{k}_t^{-a} \Delta_t M(\tilde{a}_t) \quad (54)$$

$$Y_t \equiv N \int_{\tilde{S}_t} y_t(a) dG(a) = Nx \mathbf{I}_t^{1/(1-q)} \Delta_t^q M(\tilde{a}_t) \quad (55)$$

Feasibility conditions:

$$NG(\tilde{a}_t) = L_t \quad (56)$$

$$N \int_S b_t(a) dG(a) = K_t \quad (57)$$

$$N \int_S [c_t(a) + b_{t+1}(a) - (1 - \mathbf{d}) b_t(a)] dG(a) = Y_t \quad (58)$$

Evolution of the stock of knowledge:

$$\frac{\mathbf{I}_{t+1} - \mathbf{I}_t}{\mathbf{I}_t} = \mathbf{g} \int_{\tilde{S}_t} x a dG(a) - \mathbf{m} \quad (59)$$

2. Characterization of equilibrium of the centrally planned economy

In this section of the appendix we list the equations that characterize the equilibrium of a centrally planned economy with an initial distribution of capital stocks $\{k_0(a)\}$, and individual weights $\mathbf{j}(a)$, for $a \in S$.

From the first order conditions for the planner's problem:

$$\mathbf{b}^t N u'(m_t) \int_{S \setminus \tilde{S}_t} \mathbf{j}(a) dG(a) - V_t \left[NG(\tilde{a}_t) - \frac{g(\tilde{a}_t) Y_t}{\mathbf{t}_t} \left(\frac{\mathbf{q}(1-\mathbf{a})}{G(\tilde{a}_t)} - (1-\mathbf{q}) \frac{\tilde{a}_t}{M(\tilde{a}_t)} \right) \right] = 0 \quad (60)$$

$$V_t = \frac{\mathbf{b}^t \left[\tilde{a}_t u'(m_t) \int_{S \setminus \tilde{S}_t} \mathbf{j}(a) dG(a) + \int_{\tilde{S}_t} \mathbf{j}(a) u'(\mathbf{t}_t a) a dG(a) \right]}{\tilde{a}_t G(\tilde{a}_t) + M(\tilde{a}_t)} \quad (61)$$

$$\frac{V_t}{V_{t+1}} = 1 - \mathbf{d} + \mathbf{a}\mathbf{q} \frac{Y_{t+1}}{K_{t+1}} \quad (62)$$

Feasibility conditions:

$$N [m_t G(\tilde{a}_t) + \mathbf{t}_t M(\tilde{a}_t)] + K_{t+1} - (1-\mathbf{d})K_t = Y_t \quad (63)$$

$$Y_t = \mathbf{I}_t (1-\mathbf{q})^{1-\mathbf{q}} N^{1-\mathbf{q}} M(\tilde{a}_t)^{1-\mathbf{q}} K_t^{\mathbf{a}\mathbf{q}} H_t^{(1-\mathbf{a})\mathbf{q}} \quad (64)$$

$$H_t = N h G(\tilde{a}_t) \quad (65)$$

Individuals of type \tilde{a}_t are indifferent between being managers or workers

$$\tilde{a}_t = m_t / \mathbf{t}_t \quad (66)$$

Evolution of the stock of knowledge:

$$\frac{\mathbf{I}_{t+1} - \mathbf{I}_t}{\mathbf{I}_t} = \mathbf{g}(1-\mathbf{q}) \int_{\tilde{S}_t} a dG(a) - \mathbf{m} \quad (67)$$

Individual variables:

$$y_t(a) = \mathbf{I}_t a (1-\mathbf{q})^{1-\mathbf{q}} \frac{K_t^{\mathbf{a}\mathbf{q}} H_t^{(1-\mathbf{a})\mathbf{q}}}{N^{\mathbf{q}} M(\tilde{a}_t)^{\mathbf{q}}}, \quad a \in \tilde{S}_t \quad (68)$$

$$m_t(a) = \begin{cases} m_t & \text{if } a \leq \tilde{a}_t \\ \mathbf{t}_t a & \text{if } a > \tilde{a}_t \end{cases}, \quad a \in S \quad (69)$$

$$c_t(a) = m_t(a), \quad a \in S \quad (70)$$

3. Proofs of the propositions

Proof of proposition 1. Assume that we have an equilibrium of the decentralized economy. Define an equilibrium of the economy with a representative consumer in the following way (here $\hat{\mathbf{n}}$ represents a generic variable of the economy with a representative consumer): $\hat{c}_t = \int_S c_t(a) dG(a)$, $\hat{m}_t = \int_S m_t(a) dG(a)$, $\hat{b}_t = \int_S b_t(a) dG(a)$, $\hat{K}_t = K_t$, $\hat{L}_t = L_t$, $\hat{r}_t = r_t$, $\hat{r}_t^b = r_t^b$, $\hat{w}_t = w_t$, $\hat{\mathbf{k}}_t = \mathbf{k}_t$, $\hat{\mathbf{I}}_t = \mathbf{I}_t$.

It is easy to see that with these definitions the feasibility conditions and the first order conditions for the consumer are satisfied. Define $A_t \equiv \hat{\mathbf{I}}_t h N^{1-q} M(\tilde{a}_t)^{1-q}$ and $\hat{H}_t = h \hat{L}_t$.

The first order conditions for the single producer are:

$$\begin{aligned} \hat{r}_t &= \mathbf{a} \mathbf{q} A_t \hat{K}_t^{\mathbf{a} \mathbf{q} - 1} \hat{H}_t^{(1-\mathbf{a}) \mathbf{q}} \\ \hat{w}_t &= (1-\mathbf{a}) \mathbf{q} A_t \hat{K}_t^{\mathbf{a} \mathbf{q}} \hat{H}_t^{(1-\mathbf{a}) \mathbf{q} - 1}, \end{aligned}$$

which are satisfied, given (41), (42), and (54). †

Proof of proposition 2: Assume now that we have an equilibrium of the aggregate economy and an initial distribution of capital $\{k_0(a)\}$. Let us set $r_t = \hat{r}_t$, $r_t^b = \hat{r}_t^b$, $w_t = \hat{w}_t$, $\mathbf{k}_t = \hat{\mathbf{k}}_t$, $\mathbf{I}_t = \hat{\mathbf{I}}_t$, $K_t = \hat{K}_t$, and $L_t = \hat{L}_t$. Define Δ_t and \tilde{a}_t as given by (42) and (47). Using equations (43)-(46) and (50) we can disaggregate production among ability levels.

Define

$$c_0(a) = \frac{\sum_{t=0}^{\infty} p_t m_t(a) + (1+r_0^b) k_0(a)}{\sum_{t=0}^{\infty} p_t \hat{m}_t + (1+r_0^b) k_0(a)} \hat{c}_0$$

where $m_t(a) = \max\{w_t h, \mathbf{p}_t(a)\}$ and $p_t = \prod_{s=1}^t (1/(1+r_s^b))$.

The sequence disaggregated sequence of consumptions is then equal to:

$$c_t(a) = \frac{\hat{c}_t}{\hat{c}_0} c_0(a) \text{ for all } t > 0. \dagger$$

Proof of proposition 3: The proof is by contradiction. Assume first that $\bar{a}_t < \tilde{a}$. The term in brackets in equation (60) is strictly decreasing and equal to zero at \tilde{a} . Therefore, it is positive at \bar{a}_t . Therefore, since equation (60) is satisfied at \bar{a}_t , it has to be the case that $\mathbf{b}' u'(m_t) - V_t < 0$. Using (61) this implies that

$$u'(m_t) M(\bar{a}_t) < \int_{\bar{S}_t} u'(t, a) adG(a).$$

But:

$$\int_{\bar{S}_t} u'(t, a) adG(a) = \int_{\bar{S}_t} u'\left(\frac{m_t}{\bar{a}_t} a\right) adG(a) \leq u'(m_t) M(\bar{a}_t),$$

where the last inequality holds since u' is strictly decreasing and $a \geq \bar{a}_t$ for all $a \in \bar{S}_t$.

This contradicts the previous inequality.

Assume now that $\bar{a}_t = \tilde{a}$. The term in brackets in (60) is then zero. Therefore, it has to be the case that $u'(m_t) M(\bar{a}_t) = \int_{\bar{S}_t} u'(t, a) adG(a)$. Following the same argument above, this is only true if $\bar{S}_t = \{\bar{a}_t\}$, that is, if the distribution of abilities among entrepreneurs is degenerate. Given our assumptions on the distribution of abilities, this cannot be the case.†

Proof of proposition 4: The key of the proof is to find a distribution of capital across ability levels for which consumption is the same for all workers and is linear in ability for all entrepreneurs. Let $\hat{\mathbf{n}}$ be a generic equilibrium price or aggregate variable for a

balanced growth path of the representative version of the model economy with $x = 1 - q$.

Define $\bar{a} = \tilde{a}$, and $B = \tilde{a}G(\tilde{a}) + M(\tilde{a})$. Define:

$$m = \frac{\tilde{a}}{B} \hat{c}_0$$

and

$$t = ma$$

It is easy to see that with these definitions all the conditions for the equilibrium of the centrally planned economy are satisfied. Furthermore, the disaggregated consumption levels:

$$c_0(a) = \begin{cases} ta & a \geq \tilde{a} \\ m & a < \tilde{a} \end{cases}$$

are initial consumption levels corresponding to a balanced growth path of the decentralized economy with distribution of capital:

$$k_0(a) = \begin{cases} \frac{a}{B} & a \geq \tilde{a} \\ \frac{\tilde{a}}{B} & a \leq \tilde{a} \end{cases}$$

4. Calibration: relationship between data and parameter values

Parameters b , d , a_m , d and m are exogenously given. In order to calibrate the other parameters of the model we use the following algorithm:

- Pick a value for s
- Calibrate \tilde{a} by setting $G(\tilde{a}) = .8$, which is consistent with a 20 percent of the population being entrepreneurs, in the Pareto distribution.
- Calibrate q using equation (47)

- Compute $B \equiv \frac{\tilde{a}G(\tilde{a})}{M(\tilde{a})}$
- Set $n \equiv \mathbf{a}q$, the capital share, to 1/3
- Solve for q in equation (47)
- Calibrate g from equation (59)
 - Set the growth rate of output to 2 percent
 - Solve for g in equation (59)
- Find the Gini coefficient implied by the decentralized economy, g
- Adjust the parameter s until the Gini coefficient is equal to .35