Dynastic Management

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Abstract

Dynastic management is the inter-generational transmission of control over assets that is typical of family-owned firms. It is pervasive around the World, but especially in developing countries. We argue that dynastic management is a potential source of inefficiency: if the heir to the family firm has no talent for managerial decision making, meritocracy fails. We present a simple model that studies the macreconomic causes and consequences of this phenomenon. In our model, the incidence of dynastic management depends on the severity of asset-market imperfections, on the economy's saving rate, and on the degree of inheritability of talent across generations. We therefore introduce novel channels through which financial-market failures and saving rates affect aggregate total factor productivity. Numerical simulations suggest that dynastic management may be a substantial contributor to observed cross-country differences in productivity.

1 Introduction

There is broad agreement that differences in aggregate Total Factor Productivity (TFP) constitute a large fraction of the existing cross-country differences in per-capita income. That is, not only do poor countries have fewer productive resources, such as physical and human capital, but they also employ those resources less effectively than rich countries.[1] Naturally, then, attention is increasingly turning to potential explanations for these TFP differences, and various authors have emphasized lags in technology diffusion, inappropriate technology, ethnic conflict, geography, vested interests and other institutional failures, and several other causes. We believe, however, that a potentially critical source of inefficiency has so far been largely overlooked: failures of meritocracy.

Individuals are manifestly heterogeneous in their decision-making skills. Differences across countries in the accuracy with which the best decision makers are selected for important decision-making responsibilities – i.e. differences in meritocracy – can clearly result into differences in the returns countries reap from their productive resources – i.e. differences in TFP. Meritocracy can fail spectacularly in the public sector. But meritocracy can also fail in the private sector. This paper studies the macroeconomic causes and consequences of a particular private-sector non-meritocratic practice: the inter-generational transmission of managerial responsibilities in family firms, a widely observed phenomenon that we call dynastic management.[2]

In a frictionless world there is little economic justification for the fact that many firms are managed by their owners. While the allocation of cash flow rights should depend on the distribution of wealth, and on incentives for risk diversification, the allocation of managers to firms should mainly depend on the distribution of managerial talent (presumably, with more talented managers managing larger assets – as in Lucas, 1978). In reality, it very often occurs that the ownership of firms is concentrated in few

[1]See Islam (1995), Caselli, Esquivel, and Lefort (1996), Klenow and Rodriguez (1997), Hall and Jones (1999), Parente and Prescott (2000), Hendricks (2002), Caselli and Coleman (2002), and Caselli (2003).

[2]Non-meritocracy in the public sector is studied in Caselli and Morelli (2002). Our notion of failures of meritocracy is distinct from the problem of socially inefficient "allocation of talent" studied by Murphy, Shleifer, and Vishny (1991). They are concerned with situations were the most talented individuals succeed at maximizing the private return on their abilities, but this does not lead to social-return maximization. Failures of meritocracy, instead, are situations where the talented are prevented from maximizing both the private and the social return of their skills.

hands – often members of a family – and that these family-owned firms are managed by family members. The combination of family ownership with family management gives rise to dynastic management: not only the property of the asset, but also its management, passes on across generations of the same family. This practice exists virtually everywhere in the world, but is much more prevalent in poorer countries.

It is clear that at any point in time the identification of ownership and management implies a potential inefficiency, if the distributions of talent and wealth do not coincide. When one notices the dynastic aspect of such identification, however, the inefficiency goes from being potential to being a virtual certainty: even allowing for self selected initiators of family businesses, unless managerial talent is perfectly correlated across generations, it is inevitable that assets will sooner or later end up "in the wrong hands," i.e. those of a managerially inept descendant. We propose a growth model where dynastic management arises endogenously, and look at the consequences of this failure of meritocracy for the dynamic evolution of TFP and capital accumulation.

In our model the frictions that give rise to dynastic management are features of a country's financial and contractual infrastructure. Untalented heirs of family firms would like to transfer control to new talented owners, or hire talented managers. However, imperfect financial-contract enforcement discourages ownership changes, and costly monitoring makes it difficult to write managerial contracts. Since the severity of these impediments to the transfer of control depends on the severity of the asset-market imperfections, cross-country variation in the latter will lead to cross-country variation in the incidence of dynastic management, and of TFP with it. Hence, the paper brings out a novel channel through which finance affects development.[3]

[3] An alternative way to generate dynastic management is to assume that members of a family that has historically been associated with a particular firm derive a sense of identity from continuing in the association (see, e.g., Mann, 1901). This is equivalent to putting the "frictions" in the utility function, and would generate dynastic management even in economies with perfectly efficient financial markets, as families would be more tolerant towards untalented heirs. However, cross-country differences in the incidence of the phenomenon should still vary with financial-market imperfections, as there should be thresholds of inefficiency that would be intolerable to even the families with greatest attachment to the firm. Furthermore, the implications of dynastic management for aggregate efficiency and growth would be similar. Another, more benign, view of dynastic management is that it is easier to transmit firm-specific managerial human capital to one's offspring than to outsiders. As we will discuss, the empirical evidence is rather unfavorable to benign views of dynastic management. Moreover, even if family members do have greater firm-specific human capital, it should once again be still be true that – below a certain level of talent – efficiency still requires a transfer of control. Hence, these alternative

Besides the efficiency of financial markets, two other factors that influence the dynamic properties of the model are the intensity of the bequest motive across generations – akin to a Solovian saving rate in the context of our model – and the degree of intergenerational heritability of managerial talent. A higher saving rate generally implies greater bequests received by potential buyers of firms. Since in our model these bequests are used as collateral, in order to overcome contractual imperfections, this tends to facilitate the transfer of control rights among firms, and hence tends to enhance efficiency. Therefore, the model also uncovers a novel source of causation from saving to productivity.

A higher degree of heritability of a parent's talent by her offspring also increases TFP. To see this, consider two extreme cases: the case where talent is perfectly correlated across generations, and the case where the talent of each generation is drawn from independent and identical distributions. With perfect correlation of talent the inefficiencies associated with dynastic management become less and less important over time, and eventually disappear. This is because, in our model, well-run firms increase in size relative to the average firm size, while badly-run firms shrink. Since talent is perfectly persistent this implies that asymptotically well-run firms account for 100% of the capital stock. Not so in the case where talent is independently distributed across generations: here the inefficiencies persist in the long run, as in every period some large firms are inherited by some low-talent individuals, who will in turn hold on to control. Intermediate cases generate intermediate amounts of steady-state inefficiency.

Besides the key insights described above, the model features a wealth of additional testable implications. First, we find that the severity of the effect of financial imperfection on opportunities for transfers of control depends on the firm's size. Ceteris paribus (i.e. for a given degree of contractual imperfection) the inept owners of small firms are more willing to part with their assets than the inept owners of large firms. Intuitively, the outside option represented by the labor market is a more viable alternative when one is parting with a small-scale business than when one is relinquishing control over a large empire. Furthermore, a smaller collateral is requested to purchase a small firm, so more agents in the economy can collateralize the purchase of small firms than of large firms. This size effect has interesting and novel implications for the relation between the size distribution of firms and TFP. For a given economy-wide capital stock, a few large firms imply a larger concentration of assets in inept hands than

stories may mitigate, but not eliminate, the efficiency costs of dynastic management.

in the case of many small-sized firms: countries with more concentrated ownership will be less efficient.

In addition, there are interesting feedback effects between the asset market and the labor market. For example, the larger the overall fraction of the capital stock that is managed competently, the higher is aggregate TFP, and thus the higher is the average wage in the economy. But, in turn, a higher average wage makes it less profitable for a low-talent owner to hold on to managerial responsibilities, leading to even more firms being transferred to talented new owners: the beneficial effect on TFP is thus magnified. The higher average wage also translates into greater bequests, and hence more opportunities for collateralized control transfers, further reinforcing this virtuous cycle.

We conclude the paper with numerical simulations aimed at assessing the potential quantitative relevance of the problem of dynastic management. Under a reasonable calibration of the parameter that regulates the inter-generational inheritability of talent, we find severe potential consequences of dynastic management on TFP. In particular, this channel *alone* can cause a country with very inefficient financial markets to have TFP levels as low as 80% of the TFP levels of a country with well functioning markets. The simulations also generate large variations in steady state capital stocks. Finally, the shape of the steady state size distribution of firms predicted by the simulations is remarkably consistent with empirical evidence.

2 Literature Review

2.1 Empirical

In this sub-section we review empirical studies that document the following facts: (i) Family ownership and family management are pervasive around the world, particularly in developing countries, and in countries with inefficient asset markets; (ii) Dynastic succession is on average associated with declines in performance, both at the micro and at the macro level; (iii) There is a strong positive cross-country relation between financial development and growth. All three sets of facts are important predictions of our model.

(i) *Family ownership around the world.* The most comprehensive data on corporate ownership around the world has been collected by La Porta, De-Silanes and

Shleifer (1999), who look at the control structure of the 20 largest publicly traded companies in 27 (mostly wealthy) economies in 1995. On average across these countries, family ownership is the control structure of 30% of companies. The numbers for the middle-income countries in the sample are especially striking: 65% in Argentina, 50% in Greece, 100% in Mexico, 45% in Portugal; only South Korea, with a 20% incidence, is below the "World" average. Furthermore, in almost 70% of the family-owned firms the controlling family is directly involved in management (CEO, Honorary Chairman, Chairman, or Vice-Chairman).[4] Because this is based on comparisons of the last names of managers and owners, it probably constitutes an underestimate. Finally, countries with low investor protection exhibit a 12% higher share of family firms than countries with high investor protection.[5]

By focusing only on publicly traded companies, and only on middle-to-high income countries, La Porta, De-Silanes, and Shleifer almost certainly underestimate the world-wide importance of family firms. The 3,033 respondents to the *Arthur Andersen/ Mass. Mutual American Family Business Survey '97* account for combined revenues of $67.4 billion, median revenues of $9 million, and modal revenues of $10 million, suggesting that family businesses account for an important fraction of even the US economy. According to *The Economist*, two thirds of Germany's small and medium businesses (*Mittelstand*) are managed by the owners (October 15th, 1998), and 40% of managerial successions involve a relative of the departing CEO (December 13th, 2001). Dreux (1990) and Gersick et al. (1997), using conservative estimates, claim that the proportion of firms owned or managed by families in the world is between 65 and 80%. Perrow and Lansberg (1990) emphasize the importance of the so called Latin American *grupos*, large industrial groups diversified on several sectors that remain under the tight control of the founder and of his heirs, and resort to very little outside equity financiers. *The Economist* reports that family firms generate 70% of total sales and net profits of the biggest 250 Indian private companies (October 5th, 1996), and that the top 15 families control over 60% of listed corporate assets in Indonesia, between 50 and 60%

[4]It is fun to go through a (very incomplete) list of major US corporations where the *descendants* of the founder still hold critical decision-making positions: Hewlett-Packard, Wal-Mart, Motorola, Nordstrom, Coca-Cola (the global symbol of American capitalism), Ford, IBM, and The New York Times (*The Economist*, November 17th, 2001).

[5]In this study a family firm is identified as having a unique private shareholder who controls more than 20% of the voting rights. This is clearly a very restrictive criterion, as much smaller voting shares are usually sufficient to determine control.

in the Philippines and Thailand, over 30% in South Korea and Hong Kong, and over 20% in Singapore, Malaysia, and Taiwan (April 7th, 2001).[6]

(ii) *Dynastic succession and performance.* Clearly this paper takes a fairly negative view of dynastic management, and some formal pieces of empirical evidence lend support to this view. Volpin (2002) examines the determinants of executive turnover and firm valuation for all Italian traded companies from 1986 to 1997, and finds that poor governance – as measured both as a low sensitivity of executives turnover to performance, and as a low Q ratio – is more likely when the controlling shareholders are also top executives. A similar result is found for the US. by Denis and Denis (1994).

Along similar lines, Perez-Gonzales (2001) examines a sample of CEO transitions in family firms. He defines a family firm as one where the retiring CEO is related to the firm's founder, and finds that when the incoming CEO is related to the retiring CEO the firm's performance suffers, relative to the case where incoming and retiring CEOs are unrelated. For example, returns on assets in the "inherited control" cases fall 20% within two years of the new CEO's tenure, while in unrelated transitions they don't change much on average. He also finds that cases where inherited control is accompanied by declines in performance are largely explained by the poor academic record of the inheriting CEO. This suggests – consistent again with the view emphasizing problems of managerial quality – that the efficiency losses are linked to the managerial abilities (or lack thereof) of the heir.[7] These results are also consistent with those obtained by Morck, Strangeland and Yeung (2000), who look at a sample of Canadian firms managed by heirs of the founder and find that they under-perform similar US. firms with dispersed ownership.

The Morck, Strangeland and Yeung study also contains a macroeconomic version of this test. They use information from *Forbes 1000* to show that countries in which billionaires' heirs wealth is large with respect to GDP grow less than countries where it is small. On the other hand, countries where the wealth of self-made business

[6]Consistent with our model, the story on India also speculates that new regulations aimed at enhancing the protection of minority shareholders will lead to a relaxation of the stranglehold of families on the economy.

[7]However, he also finds that firm's size (as measured by assets) does not predict dynastic succession, which is inconsistent with our model (where dynastic succession should be more likely in larger firms). This result is not conclusive, however, as his sample is censored: it only includes firms with more than 5 million dollars in sales. It could be that the probability of dynastic management flattens out above a certain size threshold.

entrepreneurs billionaires is large with respect to GDP, grow more than countries where it is small. These results seem to suggest that hysteresis of control along dynastic lines is an important determinant of macroeconomic performance.

(iii) *Finance and Growth.* King and Levine (1993) documented a positive association between financial development and economic growth. Since then their findings have been replicated many times over, most notably by Rajan and Zingales (1998), who used an instrumental-variable approach to make considerable progress towards establishing a causal link between the two. Traditionally, the literature tends to explain these findings in terms of coordination of saving and investment decisions: financial markets must allocate funds to the best projects. In the context of our model the result emerges instead through the reallocation of managerial control of already existing assets to more talented agents.

2.2 Theoretical

In economics, family firms tend to be viewed as second-best solutions to agency problems.[8] Chami (2001) views the family firm as a principal-agent relationship between parent/owner and child/employee. Trust, altruism, and the prospect of succession (that makes the son a claimant to future profits) all mitigate the agency problem, relative to the situation where the parent hires outside employees. He abstracts from the possibility that the child (and heir) is untalented. This possibility, instead, is considered by Burkart, Panunzi and Shleifer (2002), who view family control as a response to poor shareholder protection. In countries characterized by rampant expropriation of shareholders by managers, the owners of productive assets prefer to hold on to control, even if an outside manager would be better suited to run the firm.

Clearly our paper takes the same view of the second-best problem solved by family firms as Burkart, Panunzi and Shleifer (2002). Our contribution is to take the static and partial-equilibrium model of family succession with poor investor protection, and embed it in a general equilibrium growth model, where we formalize the interactions between the labor market and the asset market, the stochastic process linking the talents of parents and children, and the mechanisms that give rise to capital accumulation over time. This allows us to study the impact of family firms on long-run aggregate

[8] Contributions in business and sociology emphasize the importance of shared cultural values and common beliefs in fostering commitment and long run planning (Gersick 1997, Lansberg 1983, Davis 1983).

efficiency and capital accumulation, a theme that has not so far been explored in either the corporate finance or the growth literature.[9]

As there is an empirical literature on finance and growth, so is there a theoretical one. By stressing financial imperfections as one of the sources of dynastic management, clearly our paper is a contribution in this field. Particularly related to ours are models where financial imperfections affect occupational choice, such as Banerjee and Newman (1993), Ghatak, Morelli, and Sjöström (2001), and especially Ghatak, Morelli, and Sjöström (2002). In the latter paper, as in ours, collateral constraints imply that rich-but-untalented individuals occupy managerial positions, while poor-but-talented ones are "workers." Another similarity is that the wage rate creates a feedback effect between the labor market and the allocation of talent, creating the potential for multiple equilibria and development traps. Indeed, this multiplicity is the main focus of their (static) model. We are more interested in intergenerational linkages, and hence in the economy's dynamics.

3 The Model

We study an economy in discrete time. In each period there is a continuum (of measure 1) of one-period-lived individuals. An individual's managerial talent is θ, and θ can be high, $\overline{\theta}$, or low, $\underline{\theta}$. λ is the fraction of agents of type $\overline{\theta}$. Each agent engages in asexual reproduction of one offspring, who will live next period. To this offspring the agent bequeaths a fraction γ of his or her current income, while consuming the rest. Each agent objective is to maximize current income.

The economy is endowed with a measure f of firms. Each firm i combines managerial input with capital K_i and labor L_i to produce output according to the production function:

$$Y_i = A_i K_i^a L_i^{1-\alpha}.$$

The key assumption is that the efficiency level A_i reflects the ability of the manager:

[9] On the other hand, our micro-model of family succession is much more rudimentary than the one of Burkart, Panunzi, and Shleifer (2002). For example, theirs is rich enough that they can distinguish between two types of family firms: those where both ownership and management are kept in the family, and those where the family maintains a large controlling stake, and exploit it to keep a particularly watchful eye on the outside manager it hires. They find that the former type of family firm prevails when finacial markets are very undeveloped, and the latter when they are at intermediate stages of development (the widely owned company prevails when markets are highly developed).

if the manager is talented then $A_i = \overline{\theta}$, if he is not, then $A_i = \underline{\theta}$. Each firm must have one manager and each manager can only manage one firm. Investments in capital are irreversible and firm-specific: existing capital cannot be reallocated among firms, nor converted back into consumption. Hence, a firm's capital changes only through new investment (and depreciation). We assume that time is required to build, so investment decisions change the capital stock with a one period lag. As a result of this set of assumptions, in a given period K_i is a state variable for firm i. Finally, the number of firms, f, is given and constant. We also assume $f < \lambda$ so that inefficiency does not arise trivially for lack of a sufficient number of potential talented managers.[10]

Given this set up, for the economy as a whole the "state variables" at the beginning of each period are the size distribution of firms, and their allocation to owners with different talent. Given these initial conditions, in each period the following sequence of events and actions take place. First, a market for the ownership of firms meets. Individuals can buy (shares in) firms in exchange for units of output, or in exchange for promises to deliver units of output at the end of the period. This meeting of the asset market determines a new distribution of ownership. Owners then turn to the labor market, where each firm hires workers at a competitive wage, w. This determines L_i.

The resources of the economy having thus been allocated, production takes place, giving rise for each firm to output Y_i and profits π_i. It is here that the contractual frictions bite. People who have borrowed to buy shares in firms decide whether or not to repay their debts. Courts in this economy have the ability of seizing a fraction ϕ of the resources of a party in violation of contractual commitments, such as a debtor that fails to repay the creditor in full. Default decisions take this fact into account, and determine the end-of-period distribution of income. Given their incomes, agents

[10] The one-manager, one-firm assumption simplifies the analysis but is not otherwise crucial. It can be justified, however, on the ground that a manager's time and energy are limited. Similarly, allowing for reversibility of capital would complicate things, but not change the main conclusions. At the same time, irreversibility of the kind we propose is also not unrealistic. The important assumption is that the number of firms is fixed, which allows us to abstract from issues of entry. A cap on the number of firms could be endogenized in this model by introducing (sufficiencly large) fixed costs of entry, which does not seem unrealistic, especially in developing countries. In the present context with no entry one can think of f as the number of licencies issued by the governemnt to operate plants. Or one may think of them as a fixed number of "trees," where the growth and yield of the tree depends on the gardener's ability.

proceed to allocate it to consumption and bequests as detailed above.

In Appendix A.1 we further extend this model to a situation where – as an alternative to selling the firm – untalented firm owners can transfer control by hiring a talented manager. We show that this extension does not change our qualitative results. The reason is that manager-owner relationships are also generally more or less viable, depending on the quality of an economy's contract-enforcement infrastructure. Countries where the courts have a difficult time enforcing debt contracts, will also have a difficult time providing managers with the incentives not to steal a firm's profits – if not its assets – from the owner-principal. Hence, when one solution (transfer of ownership) is unfeasible, so more often than not is the other (hiring a manager).

4 Static Equilibrium

In this section we abstract from bequests and offsprings, we take the state variables (initial distribution of K_i and θ among individuals) as given, and determine the static equilibrium allocation of managerial tasks and overall efficiency. In the next section we look at the dynamic implications.

4.1 Labor Market

It is useful to begin by characterizing firms' behavior on the labor market. All firm owners seek to maximize profits, which in our context are given by $\pi_i = A_i K_i^{\alpha} L_i^{1-\alpha} - wL_i$, taking the wage w as given. The resulting labor demand function can be aggregated among firms, and the aggregate labor demand function turns out to be

$$L^d = \left(\frac{1-\alpha}{w}\right)^{\frac{1}{\alpha}} \left(\underline{s}\underline{\theta}^{\frac{1}{\alpha}} + \overline{s}\overline{\theta}^{\frac{1}{\alpha}}\right) K,$$

where K is the aggregate capital stock (or $K = \int_i K_i di$), $\underline{s}$ is the fraction of the aggregate capital stock in firms run by incompetent managers [$\underline{s} = \int_{i;A_i=\underline{\theta}}(K_i/K)di$] and $\overline{s}$ is the fraction of K in firms run competently [$\overline{s} = \int_{i;A_i=\overline{\theta}}(K_i/K)di$]. Note that $\underline{s} = 1 - \overline{s}$. It should also be clear that the term $\underline{s}\underline{\theta}^{\frac{1}{\alpha}} + \overline{s}\overline{\theta}^{\frac{1}{\alpha}}$ is a measure of the average efficiency in the economy. This makes the aggregate labor demand function very intuitive.

Because there are f firms a fraction f of the population work as managers. Hence, the remaining $1 - f$ constitutes the aggregate labor supply. Setting labor demand equal to labor supply, we can solve for the equilibrium wage rate:

$$w = (1-\alpha)\left(\frac{K}{1-f}\right)^{\alpha}\left(\underline{s}\underline{\theta}^{\frac{1}{\alpha}} + \overline{s}\overline{\theta}^{\frac{1}{\alpha}}\right)^{\alpha}. \tag{1}$$

The equilibrium wage depends on the aggregate capital-labor ratio, $K/(1-f)$, and on the way the capital stock is distributed between talented and non-talented owners: the greater $\overline{s}$, the greater the overall efficiency of the economy, the higher workers' wages.

Plugging the firm's labor demand and the wage functions in the expression for the firm's output, and aggregating across firms, we obtain the following expression for aggregate GDP per worker:

$$\frac{Y}{1-f} = \left(\frac{K}{1-f}\right)^{\alpha}\left(\underline{s}\underline{\theta}^{\frac{1}{\alpha}} + \overline{s}\overline{\theta}^{\frac{1}{\alpha}}\right)^{\alpha}, \tag{2}$$

where $Y = \int_i Y_i di$. This illustrates the nice aggregation properties of the model: despite the existence of arbitrary heterogeneity in the firm distribution of capital and efficiency, aggregate output can be decomposed into the contributions of capital intensity, $K/(1-f)$, and a "TFP" term, $\underline{s}\underline{\theta}^{\frac{1}{\alpha}} + \overline{s}\overline{\theta}^{\frac{1}{\alpha}}$. TFP in this model is entirely determined by the fraction of the capital stock that is managed efficiently, $\overline{s}$ (and by the difference in firm-level TFP between talented and non-talented owners, $\underline{\theta}/\overline{\theta}$). This makes $\overline{s}$ the endogenous variable of greatest interest in this paper.

Firm i's profits are given by

$$\pi_i = \Pi \frac{A_i^{\frac{1}{\alpha}}}{\left(\underline{s}\underline{\theta}^{\frac{1}{\alpha}} + \overline{s}\overline{\theta}^{\frac{1}{\alpha}}\right)}\frac{K_i}{K}, \tag{3}$$

where $\Pi = \int_i \pi_i di$ is aggregate profits. Hence, the share of aggregate profits firm i is able to capture is increasing in the firm's relative size K_i/K and in managerial talent, A_i. Also, and most notably, π_i is decreasing in $\overline{s}$: through the aggregate wage the quality of management in other firms generates an externality on firm i's own profitability.[11]

4.2 Market for Firms

Equilibrium profits and aggregate efficiency depend on the managerial talent of the owner. Managerial responsibilities can be re-allocated from low- to high-talent individuals through transfer of ownership. In this section we assume that individuals (other

[11]Consistent with the Cobb-Douglas flavor of aggregate output, it can also be shown that profits are a fraction α of aggregate output Y, or $\Pi = \alpha Y$. It follows that the aggregate wage bill is $(1-\alpha)Y$.

than firm owners) begin the period with no assets, and hence the only way for them to purchase ownership rights on a firm is through a debt contract. We will relax this restriction when we introduce bequests in the next section. The sale contract for firm i specifies a price p_i that the buyer will transfer to the seller at the end of the period.[12] The buyer will finance this repayment out of the profit flow from the firm. To minimize incentives to default the contract specifies that, if the buyer fails to repay, the seller is entitled to seizing the profits flow from the firm. However, the enforcement of contracts is imperfect. In particular, every time a party to a contract is in default of his contractual obligations, courts are only able to seize and transfer to the plaintiff a fraction ϕ of the debtor's resources. Therefore we will observe default whenever $\phi\pi_i < p_i$.

Clearly only transfers of property from low- to high-ability individuals will take place. We look for transactions that take place at prices that do not trigger default, i.e. that satisfy the condition $p_i \leq \phi\pi_i^H$. Such transactions must be appealing to both the seller and the buyer. The seller's participation constraint is $p_i + w \geq \pi_i^L$. The left hand side is his income if he sells: the proceeds from the sale plus the wages he earns on the labor market once he is free from managerial duties. The right hand side is his income if he does not sell, i.e. the profits from (ineptly) managing the firm. For the buyer, the analogous condition is $\pi_i^H - p_i \geq w$: he compares the profit stream from owning the firm, net of purchasing cost, to his outside option represented by the market wage. Rewriting these three conditions slightly we see that a no-default sale occurs if and only if:

$$\begin{aligned} p_i &\leq \phi\pi_i^H \\ p_i &\geq \pi_i^L - w \\ p_i &\leq \pi_i^H - w. \end{aligned}$$

Combining the first two conditions gives rise to the restriction

$$\phi\pi_i^H + w \geq \pi_i^L. \tag{4}$$

Intuitively, π_i^H is the "pie" created by the talented buyer, and the larger is ϕ the larger is the slice that the seller can carve for herself. In addition, by selling the firm she gains access to a wage w, but loses untalented profits π_i^L. The third condition only

[12]Introducing the possibility of borrowing from third parties (e.g. foreign banks) does not change the results. The reason is that it does not change the Incentive Compatibility, and Buyer and Seller Participation constraints that we state below.

imposes the additional restriction that $\pi_i^H - w > 0$, i.e. that firms are viable. For ease of exposition, we assume that this holds for all firms in the rest of the formal analysis, but will keep track of this condition in the numerical simulations.[13]

While it is clear when control will be transferred, the price at which this transfer takes place is (partially) indeterminate. Clearly the price must be in the range $\left[\pi_i^L - w, \min\left(\phi\pi_i^H, \pi_i^H - w\right)\right]$, and it must depend on the bargaining power of the two parties. In the current context it seems legitimate to assume that all of the bargaining power resides in the seller. This is because we have assumed that there are more talented managers than there are firms, so firms are in excess demand. If one is willing to assume that all of the bargaining power is with the seller, then $p_i = \min\left(\phi\pi_i^H, \pi_i^H - w\right)$.[14]

4.3 Implications for Meritocracy

Equation (4) is the key necessary and sufficient condition for control over an asset to be transferred from a low- to a high-talent individual. Combining this with the profit function (3) we find that sales of firms are feasible for and only for firms that satisfy the condition:

$$\frac{\left(\phi\overline{\theta}^{\frac{1}{\alpha}} - \underline{\theta}^{\frac{1}{\alpha}}\right)}{\left(\underline{s}\underline{\theta}^{\frac{1}{\alpha}} + \overline{s}\overline{\theta}^{\frac{1}{\alpha}}\right)} \frac{K_i}{K}\alpha + \frac{(1-\alpha)}{(1-f)} \geq 0 \tag{5}$$

It is immediate that there are two main cases to consider.

- $\phi\overline{\theta}^{1/\alpha} \geq \underline{\theta}^{1/\alpha}$. In this case (5) is always satisfied. Hence, *all* assets are efficiently

[13] Even if a price that avoids default does not exist, the two parties may still in principle agree to a transfer of property if the outcome of default makes both better off. The conditions that must be satisfied for this to occur are

$$\phi\pi_i^H + w \geq \pi_i^L$$
$$\pi_i^H \geq \phi\pi_i^H + w.$$

Note that whenever the conditions for a transaction featuring default are satisfied, so are the conditions for a transaction with no default. Hence, we can simply focus on transactions with no default, i.e. with $p_i \leq \phi\pi_i^H$.

[14] We have implicitly assumed that there is only one buyer, as opposed to a consortium of buyers. A consortium of buyers would have the exact same collective incentive to default as a single buyer. Furthermore, they would face agency problems with regards to the management of the asset.

managed in equilibrium. This transpires if ϕ is large enough. With good enforcement of contracts the agency problems that give rise to untalented-owner management are solved through swift and efficient recourse to the courts. Untalented owners can sit back and relax while talented new owners run the business. This case also prevails when $\overline{\theta}$ is large relative to $\underline{\theta}$, or the differences in managerial skills are large. These are cases where there is a big surplus from the transfer of managerial tasks, so the gains from trade provide strong incentives to transfer control.

- $\phi\overline{\theta}^{1/\alpha} < \underline{\theta}^{1/\alpha}$. In this case whether control is transferred or not depends on a broader set of parameters, both aggregate and specific to the individual firm. Using the expression for equilibrium wages, equation (5) can be rewritten as

$$\frac{K_i}{K} \leq \frac{1-\alpha}{\alpha} \frac{\underline{s\theta}^{\frac{1}{\alpha}} + \overline{s}\overline{\theta}^{\frac{1}{\alpha}}}{(1-f)\left[(\underline{\theta})^{\frac{1}{\alpha}} - \phi\left(\overline{\theta}\right)^{\frac{1}{\alpha}}\right]}. \tag{6}$$

Hence, there is a threshold size (relative to the size of the economy K) above which managerial control does not shift to talented individuals, even if the owner is untalented. Essentially the intuition is that it is always better to manage a large firm than to be a worker: control rights over large assets generate large returns even if managerial skills are lacking. The threshold size, however, varies with the macroeconomic environment. In particular, the threshold size increases if a large fraction of the capital stock is well managed ($\overline{s}$ large) and if there is much competition (f large) between firms. Both these variables imply higher wages, and hence a more attractive outside option. They therefore have an impact on the incentives to relinquish control by the "marginal" untalented owner. Finally, a large "recovery rate" ϕ, as well as a large differential between $\overline{\theta}$ and $\underline{\theta}$, both increase the maximum size below which control is transferred. The intuition is the same as in the previous case: these parameters increase the gains from trade. Finally, the threshold size falls with α, as a larger capital share increases profits, and thus the return to holding on to control.

In the remainder of the formal analysis, we focus on the interesting case, $\phi\overline{\theta}^{1/\alpha} < \underline{\theta}^{1/\alpha}$, where inefficiencies arise.

4.4 Equilibrium

In the previous subsection we have characterized the set of firms that change managerial control as a function of $\overline{s}$, the fraction of the overall capital stock that is well managed. Clearly, though, $\overline{s}$ is itself an endogenous variable, and indeed it is the variable of interest from a macroeconomic standpoint: it summarizes the overall level of efficiency of the economy, and hence the level of wages, profits, and per-capita income.

In order to determine the equilibrium level of $\overline{s}$, we introduce the following notation. We define $\kappa_i = K_i/K$, the relative size of firm i. We call $\kappa(\overline{s})$ the threshold defined in equation (6), i.e. the level of κ_i such that for $\kappa_i > \kappa(\overline{s})$ the control over firm i does not get transferred. We also define the "state variables" $\overline{s}_0$ and $\underline{G}_0$ as, respectively, the share of the aggregate capital stock *initially* owned by low-talent individuals, and the size-distribution function of the capital in firms initially owned by low talent agents (i.e. $\underline{G}_0(\kappa)$ is the measure of firms with untalented owners and capital share less than κ). Then we have:

$$\overline{s} = \overline{s}_0 + \int_0^{\kappa(\overline{s})} \kappa \, d\underline{G}_0(\kappa). \tag{7}$$

No firms that are initially owned by high-talent agents end up under bad management, so the equilibrium fraction of well-managed capital includes all the capital that was initially allocated to talent, $\overline{s}_0$. In addition, all firms initially allocated to low talent that are below the threshold $\kappa(\overline{s})$ are also transferred to talented management.

Because both sides of (7) are increasing, it is clear that there is a potential for multiple equilibria in $\overline{s}$. For example, there could be "high" equilibria where much of the economy's asset stock is well managed, wages are correspondingly high, and untalented firm owners are therefore willing to part with their assets, thereby supporting the high-talent equilibrium. Vice versa, if most capital is badly managed, wages are low and untalented owners hold on to their assets, confirming the low-talent equilibrium.

While the possibility of multiple equilibria is interesting in its own right, it complicates considerably the treatment of dynamics in the next section. Hence, in the rest of the paper we focus on situations where the equilibrium is unique. We show in Appendix A.2 that a simple restriction on the set of possible initial densities, $\underline{g}_0(\kappa)$ ensures both existence and uniqueness of the equilibrium. In particular, the equilibrium is unique if (but not only if) $\underline{g}_0(\kappa)$ is such that:

$$\max_{\kappa}\left[\kappa \underline{g}_0(\kappa)\right] < \frac{\alpha(1-f)}{1-\alpha}\frac{\left[(\underline{\theta})^{\frac{1}{\alpha}} - \phi\left(\overline{\theta}\right)^{\frac{1}{\alpha}}\right]}{(\overline{\theta}^{\frac{1}{\alpha}} - \underline{\theta}^{\frac{1}{\alpha}})}.$$

This condition imposes a bound on the maximum amount of capital that changes hands for any firm-size level. It rules out multiple equilibria because it avoids "big jumps" in the number of transactions. The condition is likely to hold when the distribution $\underline{G}_0(s)$ is very dispersed with fat enough tails.

When the model's solution $\overline{s}$ is unique, it has the following intuitive comparative-static properties (also established in Appendix A.2):

- $\delta\overline{s}/\delta\phi > 0$. The economy's efficiency improves with the economy's quality of contract enforcement. This is because more untalented owners can transfer managerial control rights without fear of being ripped off.

- $\delta\overline{s}/\delta\overline{\theta} > 0$ (holding $\underline{\theta}$ constant). Large efficiency gains from transferring control increase the gains from trade and induce more contracting.

- $\partial\overline{s}/\partial f > 0$. Increases in the number of firms leads to greater aggregate efficiency. More firms means more competition on the labor market, and hence a higher real wage. This induces more owners to sell.

- $\partial\overline{s}/\partial\alpha > 0$. A larger capital share boosts profits and depresses wages, reducing the incentive to relinquish ownership.

- $\partial\overline{s}/\partial\overline{s}_0 > 0$. Initial conditions matter: because all firms initially in the hand of talented individuals stay in their hands, the equilibrium share of well managed capital is increasing in the share initially allocated to talented owners.

- $\partial\overline{s}/\partial\underline{G}_0(\kappa) > 0$, by which we mean that if the size distribution of firms initially owned by low-talent agents becomes more skewed towards small sizes, overall efficiency increases. This is because in this case a larger fraction of the ineptly-owned capital stock falls below the sale threshold. This is another way in which initial conditions matter.

The static model therefore delivers a rich set of potentially testable predictions on the macroeconomic aspects of family ownership. One could stop here and try to bring these results to the data. However, the last two comparative static results clearly call for a dynamic analysis, as in a dynamic context $\overline{s}$ is nothing but next period's $\overline{s}_0$, and $\underline{G}_0(\kappa)$ is similarly affected by the transactions taking place in the previous period. Hence, a full description of the properties of the model requires a dynamic analysis of the paths of these state variables.[15]

5 Dynamics

We introduce two sources of intertemporal linkages. The first is a bequest motive, and the second is a mechanism for the inter-generational transmission of abilities. One could say that the first regulates the inter-temporal transmission of physical capital, and the latter of human capital.

We assume that parents are altruistic towards their children, and desire to bequeath part of their income. In particular, they have "warm glow" feelings towards their offspring, that induce them to bequeath their children a fraction γ of their current incomes: their wage w_t in the case of workers, and their profits (net of any debt service) in the case of firm owners.[16] We further assume that owners of firms will always leave their bequest in the form of physical capital, embodied in the firm they pass on to their offspring, while workers will bequeath in the form of units of the consumption good.[17]

[15] As discussed in the literature review, of course, there is already substantial evidence for the proposition that aggregate efficiency increases with financial market efficiency, i.e. for $\delta\overline{s}/\delta\phi > 0$. There is also broad agreement that increases in competition lead to TFP gains, or $\delta\overline{s}/\delta f > 0$. However, as noted by Nickell (1996), it is somewhat hard to come up with simple theoretical explanations for this finding. Our result is therefore of interest to the literature on the efficiency-enhancing effects of competition.

[16] We have simulated the model for the much less restrictive case where agents bequeath a fraction of γ of all the resources they receive in their lifetime, including bequests from the previous generation, and the sale price of firms they may have sold. Since we found only trivial changes in the quantitative results, we stick here to the restrictive assumptions, which afford much greater expositional simplicity.

[17] Because of the time-to-build assumption, the two forms of transmitting wealth are different. In particular, bequests left in the form of units of the consumption good cannot be used towards increasing any firm's capital stock in the next period. These choices of bequest vehicles can be rationalized (available upon request) under the assumption that parents care not only for the amount they bequeth, but also for the return to their offspring of the amount bequethed. Under most empirically relevant combinations of parameter values, firm owners bequeth in the form of capital because capital has a higher return for firm owners. Workers bequeth the consumption good because for their offspring, who start out the period without owning a firm, the return to capital is zero.

We also assume that a child's ability depends on the parent's. Specifically, with probability η children will inherit their parents' talent level, and with probability $1-\eta$ they will be of different type. η may reflect both natural and nurtural sources of persistence in ability.[18]

5.1 The Period-t Market for Firms

The introduction of dynamics does not change the analysis of the labor market. However, the presence of bequests changes the situation in the market for firms. Now potential buyers can use the amounts they inherited to pay up front for part of the purchase price of a firm. Loosely speaking, then, bequests create a form of "collateral", that helps buyers circumvent, at least partially, the existing contractual imperfections. As a result, firms that were non-tradeable in the no-bequest scenario can now change hands.

In Appendix A.3 we derive the period-t threshold for ownership transfer. Untalented owners will sell to talented buyers if their firm's relative size is less than

$$\kappa(w_{t-1},\overline{s}_t) = \kappa(\overline{s}_t) + \frac{\left(\underline{s}_t\underline{\theta}^{\frac{1}{\alpha}} + \overline{s}_t\overline{\theta}^{\frac{1}{\alpha}}\right)\gamma w_{t-1}}{\left(\underline{\theta}^{\frac{1}{\alpha}} - \phi\overline{\theta}^{\frac{1}{\alpha}}\right)\alpha Y_t}, \tag{8}$$

where $\kappa(\overline{s}_t)$ was defined above as the threshold size for transfer of ownership in the economy with no bequests. This formula clarifies how more firms can be sold if potential buyers have collateral: the "sale" threshold is increased by a quantity that depends on γw_{t-1}. Recall that γw_{t-1} is the bequest left by workers to their offspring: the stronger the bequest motive γ, the larger the bequest received by the current generation, the more firms can achieve efficiency through ownership change.

It is worth noting that the addition of bequests underscores the generality of the threshold-size result uncovered in this model. Without bequests, only small firms are sold because only for small firms is the outside option represented by the market wage a substantial factor in an owner's decision to transfer control. With bequests, however, or indeed with any other source of collateral, there is an entirely independent additional reason for a threshold size: sales of small firms require little collateral.

[18] Natural extensions to this assumption include making the probability of inheritance different across the two types, as well as to make η also depend on whether the parent is a firm owner or a worker. This last assumption could capture the existence of firm-specific human capital that increases the probability that somebody raised "on the firm premises" be well equipped to run the firm.

Also following the reasoning from the static case, the debt incurred by firm i's buyer is now given by

$$p_{it} = \min(\phi \pi_{it}^{H}, \pi_{it}^{H} - w_t - \gamma w_{t-1}). \tag{9}$$

The new element is the $(-\gamma w_{t-1})$ in the second term. Since γw_{t-1} is cash-on-hand that the buyer transfers to the seller ex-ante, when the buyer's participation constraint is binding the debt falls by a corresponding amount.[19]

5.2 Capital Accumulation

Changes in firm size between periods t and $t+1$ depend on what happened to the firm in the previous period. There are two main cases. The first is the case of firms bequeathed by parents who already owned the firm at the beginning of the previous period (i.e. inherited the firm themselves). The second is the case in which the parent acquired ownership during the period.

In the first case, the parent's income is simply π_i, and the bequest is $\gamma \pi_i$. Assuming, without loss of generality, that capital fully depreciates in one period, this implies

$$K_{i,t+1} = \gamma \pi_{i,t}. \tag{10}$$

If instead the parent purchased the firm, his income is $\pi_{it}^{H} - p_{it}$. Using equation (9) we thus have:

$$K_{i,t+1} = \gamma \max\left[(1-\phi)\pi_{i,t}^{H}, w_t\right]. \tag{11}$$

This equation reveals an unexpected *negative* potential effect of market efficiency on capital accumulation. As ϕ increases, the control of firms is transferred more often, but – for firms that sell at price $\phi \pi_i^H$ – also at a higher price. Since the purchase price must be financed from the firm's profit stream, and since investment in new capital is financed from profits net of debt repayments, a high ϕ implies a fall in investment for these firms. This is a classic form of "debt overhang" familiar to students of corporate finance: leveraged acquisitions are almost always followed by a retrenchment of investment while all cash flow is devoted to debt service. Of course, this negative effect of market efficiency on accumulation is counter-balanced by the positive effect from

[19] This implies that for some firms p_{it} may be negative. This can simply be reinterpreted, without changes is notation, as a situation where the buyer will use less than her entire collateralizable resources to buy the firm. In practice, she buys the entire firm for cash, and is still left with some of the bequest.

greater efficiency, which boosts profits. Hence, the net effect on capital accumulation is theoretically ambiguous.[20,21]

5.3 Equilibrium

The dynamic equilibrium of the model is recursive, and can be computed as follows. Given a beginning-of-period distribution of firm sizes, an allocation of initial talent, and the previous-period wage w_{t-1}, equation (8) determines period t's efficiency level $\overline{s}_t$. Once $\overline{s}_t$ is known, all the other macro variables, such as w_t and Y_t, as well as the entire distribution of firm profits, are readily computed. With firms' profits at hand, the capital accumulation equations of the previous sub-section determine the new distribution of capital for period $t+1$. Furthermore, given the size threshold $\kappa(w_{t-1}, \overline{s}_t)$, as well as the initial assignment of talent, it is easy to determine the end-of-period assignment of talent: all firms whose period-t size is below the threshold end the period under talented ownership, while firms above the threshold end the period under the same talent as they started. At the beginning of period $t+1$, then, the quality of each firm's ownership is determined by a random draw. With probability η (the parameter regulating the intergenerational transmission of talent) the new owner is of the same type as the latest period-t owner, while with probability $1-\eta$ she is of the opposite type. The formal equations governing this recursive equilibrium are reported in Appendix A.4.

5.4 Fully Persistent Types

In general, the model does not allow for closed form solutions for the steady-state values of the endogenous macroeconomic variables. We therefore rely on numerical simulations in order to assess the qualitative properties of the dynamic model, as well

[20] See Ghatak, Morelli, and Sjöström (2001) for a different example of a relaxation of credit-market imperfections that leads to ambiguous effects on aggregate output.

[21] There is a third case represented by firms that did not operate in period t because they were too small to meet the viability constraint $\pi_{it}^H - w_t > 0$. In these cases the owner let the capital depreciate and joined the labor market. His income is thus w_t. Since he still owns a license to produce, he will invest γw_t in new capital for the firm. In these cases we have

$$K_{i,t+1} = \gamma w_t. \tag{12}$$

as its quantitative potential. First, however, we describe one special case that does have a closed form solution. This is the case where children always inherit the talent level of their parents, or $\eta = 1$. In this case, each dynasty is identified with a given talent-level θ, deterministically transmitted from parents to their offsprings. Firms initially assigned to talented families never change hands. Firms initially assigned to untalented families permanently change hands if and when they fall below the "sell" threshold. The basic intuition for what goes on in this case is that the relative size of badly managed firms shrinks, while the relative size of well managed firms increases. This is because the latter have greater profits and therefore in every period they re-invest a larger amount. Hence, inevitably at some point badly-run firms fall below the sell threshold and current members of talented dynasties take over their control, and the firms start growing again. Clearly, the long-run equilibrium of the economy features full efficiency, irrespective of the degree of financial imperfection.[22]

5.5 Simulations Results

In the general case, where $\eta < 1$, in every period some fraction of talented owners produce untalented offsprings. In these cases, the ability of the economy to achieve efficiency depends on its ability to transfer control to new talented buyers. Here we present simulations aimed at assessing how well economies characterized by different parameters tackle this task.

In all our experiments we simulate the dynamic evolution of an economy populated by 1000 firms, and 10000 workers, which is to say that we set the parameter f to 1000/11000=0.09. We also randomly generate an initial (i.e. period-0) distribution of capital stocks across the 1000 firms, using a uniform distribution on the $[0, 1]$ interval. Finally, we randomly assign a talent indicator (low or high) to the first generation of owners. Initial talent is drawn from a binomial distribution with parameter 0.5, which

[22]Indeed, in this economy full efficiency would eventually be achieved even if there was no market for firms. With no market for firms, the share of capital efficiently allocated would follow the difference equation:

$$\overline{s}_{t+1} = \frac{\overline{\theta}^{\frac{1}{\alpha}} \overline{s}_t}{\underline{\theta}^{\frac{1}{\alpha}} + \overline{s}_t (\overline{\theta}^{\frac{1}{\alpha}} - \underline{\theta}^{\frac{1}{\alpha}})}$$

which admits only one stable equilibrium where all the capital is efficiently employed, i.e. $\overline{s}_\infty = 1$. If firms never change hands, since well-managed firms grow faster, eventually they will account for a 100% share of the capital stock. The result generalizes to the case where the market for firms is open except for the fact that now convergence to full efficiency takes place in finite time.

implies that across all economies and across all periods 50 percent of individuals are talented. Given these initial conditions, we observe the evolution of the economy for various combinations of the key parameters γ ("saving rate"), ϕ (market imperfection), $\underline{\theta}$ (inefficiency of untalented individuals), and η (inheritability of talent). Since all the equations of the model could be rewritten in terms of $\underline{\theta}/\overline{\theta}$, we simply hold $\overline{\theta}$ constant and equal to 1. The capital share parameter α is also held constant, at 0.33, in all experiments. For each of these combinations of parameters we let the economy grow over 60 periods (generations), though in practice convergence to steady state seems to occur in less than 10. We then compute steady state values for the endogenous variables as averages over periods 10 to 60, and compare these steady state realizations across combinations of the key parameters.

The remainder of this section describes the results of these experiments. We mostly focus on the two building blocks of per-worker income: the capital stock K_t, and the level of Total Factor Productivity, which in this model is given by the expression $A_t = \left(\underline{s}_t\underline{\theta}^{\frac{1}{\alpha}} + \overline{s}_t\overline{\theta}^{\frac{1}{\alpha}}\right)^{\alpha}$.

Figure 1 plots the model's predicted steady state level of TFP for various values of ϕ and γ. The former is measured on the horizontal axis, while the different curves correspond to values of the latter varying between 10 percent (lowest curve) and 50 percent (highest). $\underline{\theta}$ and η are held constant at 0.8 and 0.7, respectively. The former choice is made arbitrarily, while the latter is motivated by evidence on the inter-generational correlation of IQ scores, as detailed in Appendix A.5. We discuss variation in these parameters below.

The curves are (weakly) upward sloping, indicating that improvements in financial markets lead to improvements in governance: as ϕ increases more inept owners sell their assets to talented managers. The relationship levels off for $\phi = 0.5$, because at this value and above it becomes possible for all inept owners to sell their firms.[23] The curve also reveals that efficiency increases in the bequest rate γ. This is the collateral effect: more bequests turn into more collateral, and more talented individuals can acquire control over the economy's assets.

Quantitatively, the effect of ϕ is rather large: the economy with the most inefficient financial markets has TFP levels as low as 85% of the TFP levels of the most efficient economy. In a 93-country data set for the year 1996, the 10th percentile of the

[23] Recall that the threshold for the economy to be fully efficient is $\phi\overline{\theta}^{1/\alpha} \geq \underline{\theta}^{1/\alpha}$. Above this threshold, all trades take place.

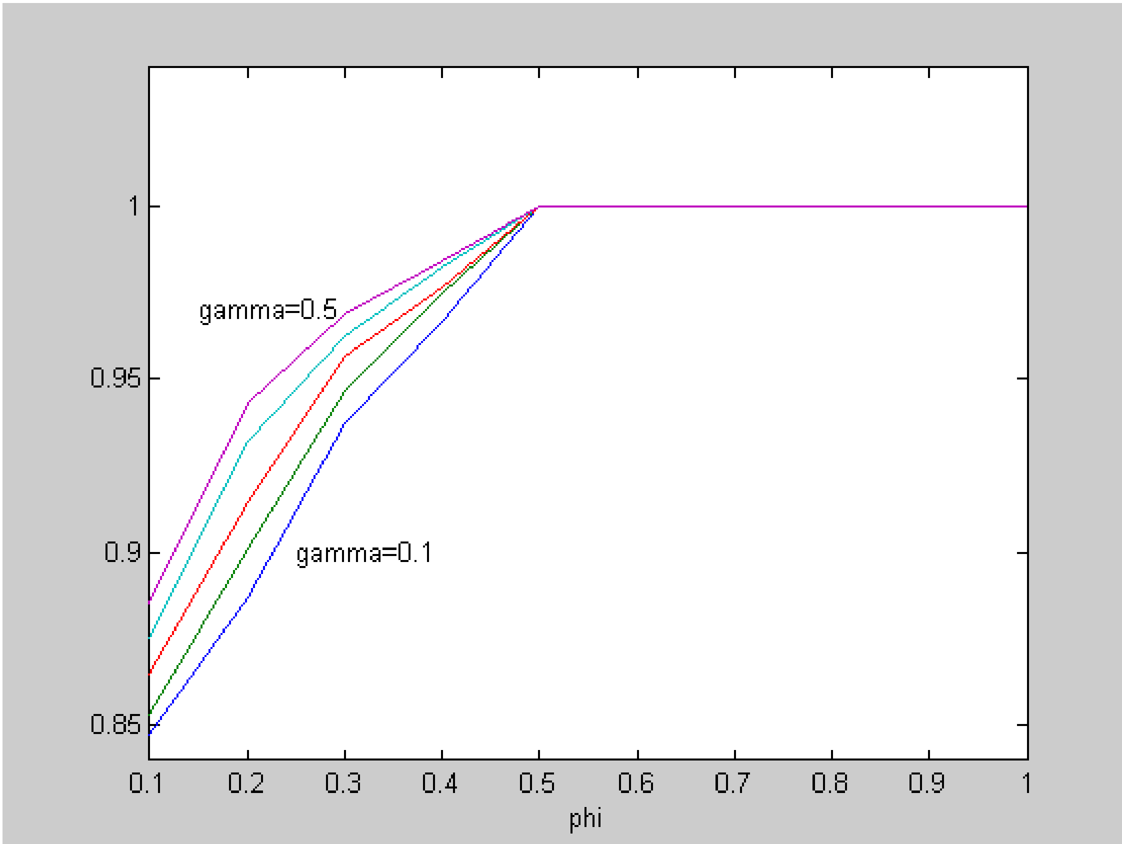

Figure 1: Steady State TFP

TFP distribution is computed to be about 30% of the 90th percentile (Caselli, 2003). Hence, the fraction of the observed TFP gaps potentially explained by the model is quite large. The quantitative effect of γ on TFP is, instead, mostly fairly small.

Figure 2 is analogous to Figure 1, but plots the steady state capital stock, K_t (always for $\underline{\theta} = 0.8$ and $\eta = 0.7$). Higher curves correspond to higher values of γ: a higher saving rate implies a higher steady state capital stock. The capital stock, however, turns out to be always decreasing in the market-efficiency parameter, ϕ. As discussed above, in principle increases in ϕ have ambiguous effects on capital accumulation: by increasing efficiency they increase profits, and this tends to increase accumulation. But by increasing the number of transactions they also increase the number of firms with a "debt overhang" problem, which hurts accumulation. These results show that the second effect always dominates in these simulations.

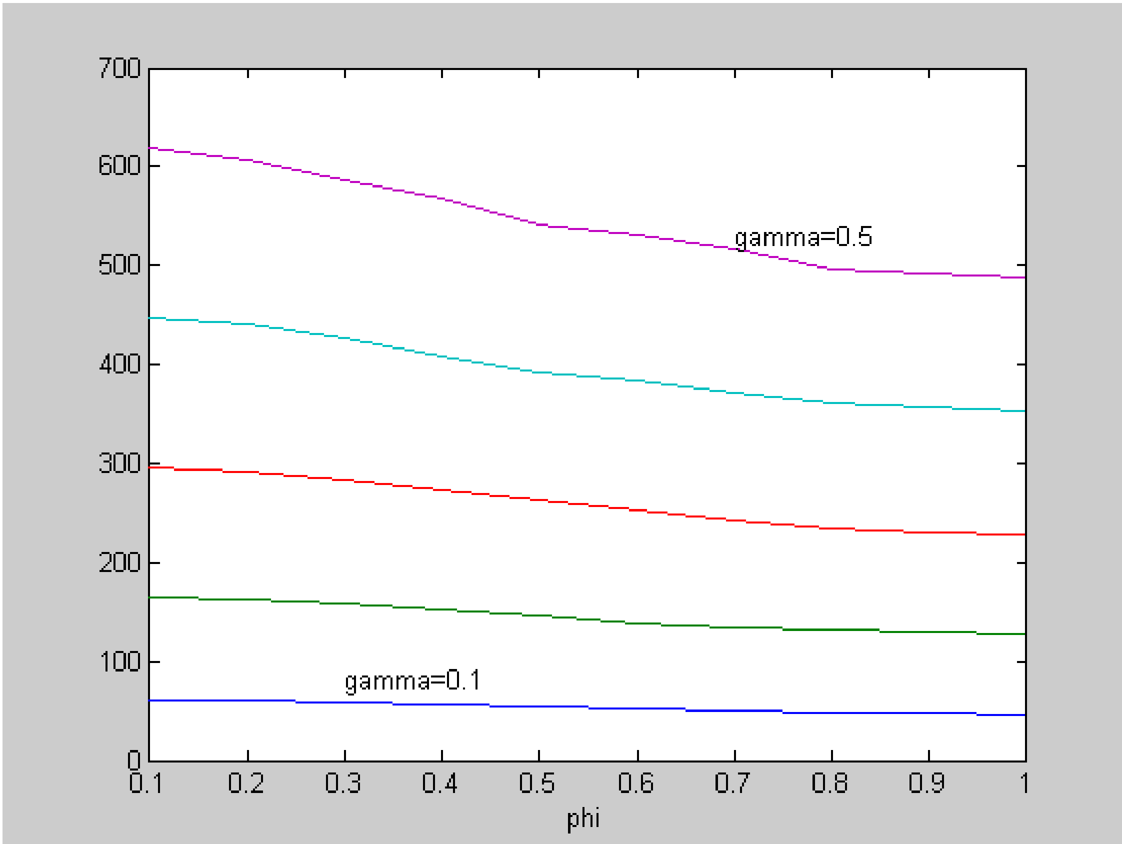

Figure 2: Steady State Capital

Quantitatively, variation in γ generates large variation in capital stocks: for $\phi = 0.10$ the most capital poor country ($\gamma = 0.10$) has roughly 10% of the capital stock of the most capital rich ($\gamma = 0.50$), and this ratio is fairly stable across values of ϕ. In the data, the corresponding 10th/90th percentile ratio is 2 percent, so the model can generate most of the cross-country variation in the capital stock.[24] The quantitative

[24]Clearly one could generate even more variation by letting $\gamma > 0.5$ for the richest countries, but this would be implausible. Note, incidentally, that it would be inappropriate to try to calibrate γ with observed saving rates. While the variation in saving rates across countries is modest, rates of real investment are highly variable because of large diferences in the relative price of investment goods (Hsieh and Klenow, 2002). Our γs should be broadly construed to also reflect this variation. A more rigorous approach to calibratrion would be to calibrate γs on saving rates, but then divide the right-hand-sides of equations (10)-(12) by the country-specific relative price of investment. This is equivalent to having two different γs: one for workers, and one for firm owners. In the Caselli (2003)

effects of ϕ go in the "wrong way": they make it harder to explain the cross-country dispersion of K_t. As it turns out, however, they are dominated quantitatively by the effects of γ: if ϕ and γ move together (as they clearly do), then high ϕ countries will still be relatively capital rich.

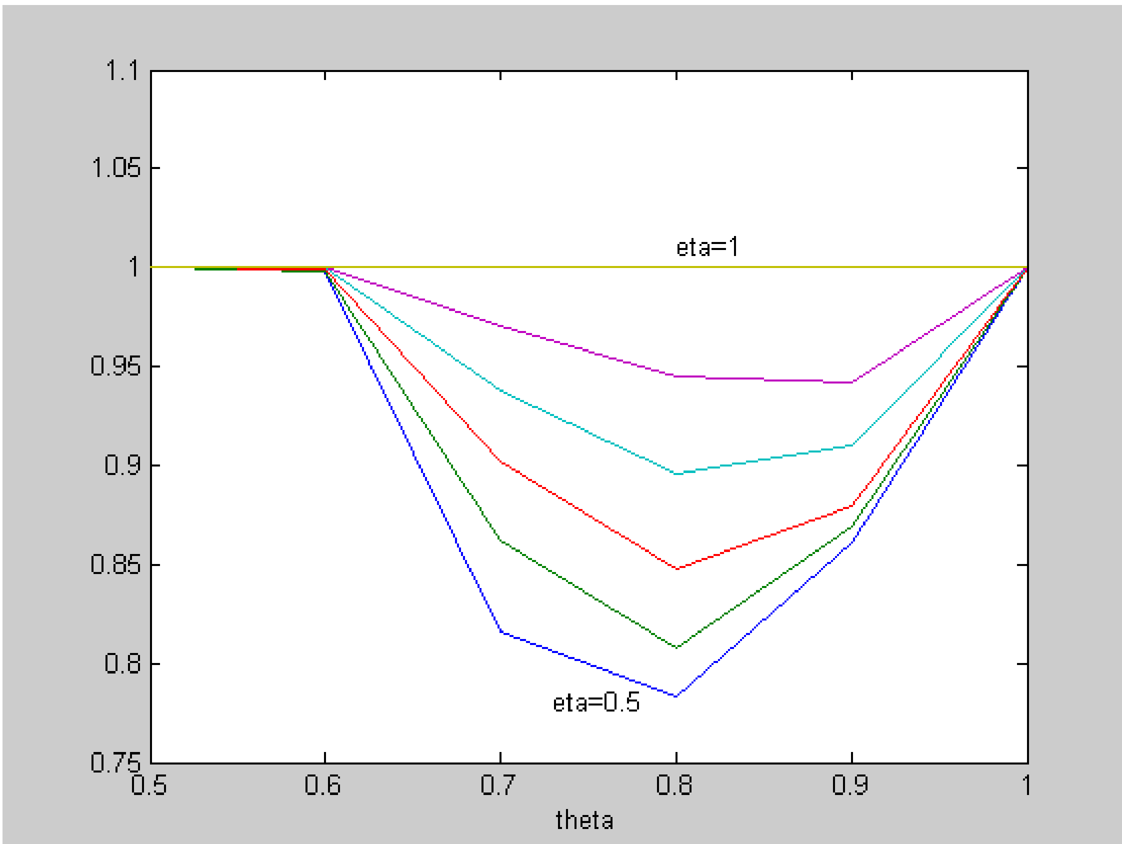

Figure 3: Steady State TFP as function of $\underline{\theta}$ and η.

The conclusion from Figures 1 and 2 is that financial market efficiency can have sizable effects on TFP levels (and small negative effects on capital stocks), while bequest motives have sizable effects on capital stocks (and small positive effects on TFP). Combining variation along both the ϕ and the γ dimension the model's quantitative performance is satisfactory: a country with $\phi = 0.10$ and $\gamma = 0.10$ would have 85% of the TFP, and 13% of the capital stock, of a country with $\phi = 1$ and $\gamma = 0.5$. Output would be roughly 50%. It seems, then, that dynastic management may matter.

data set variation in investment prices exceeds a factor of four.

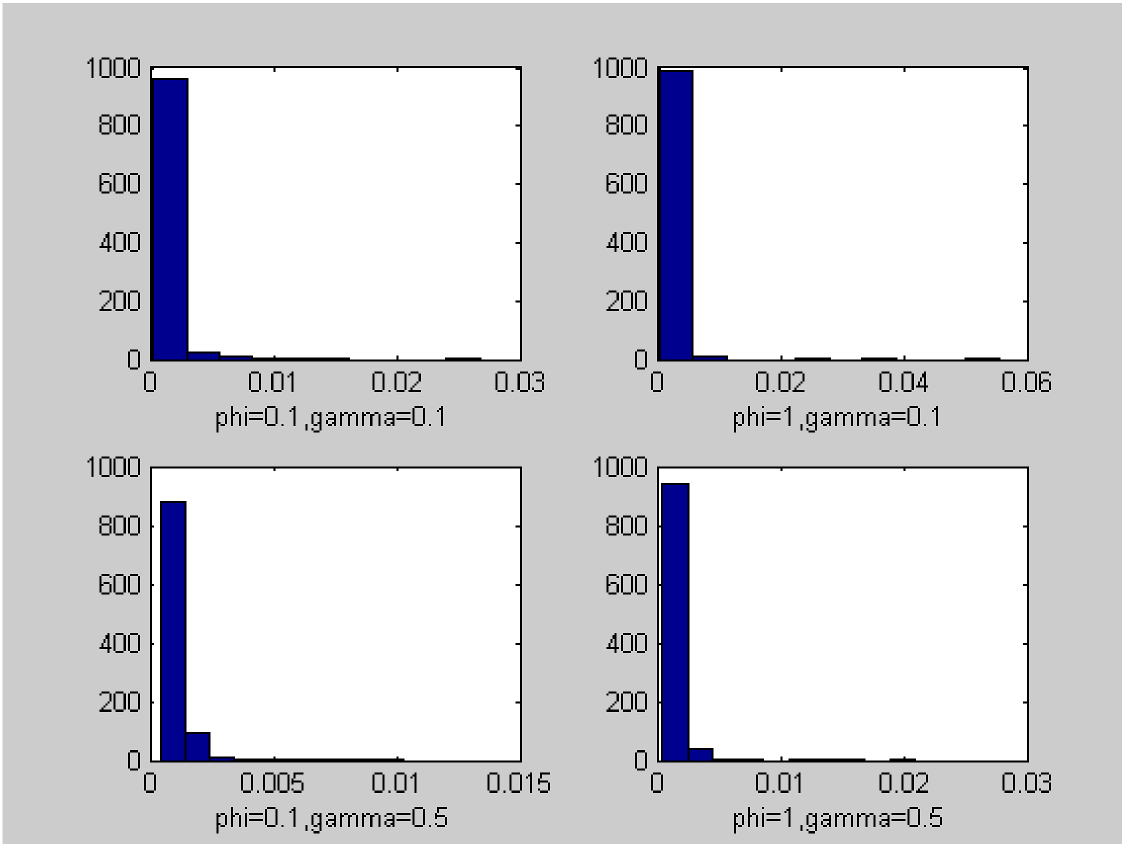

Figure 4: Size Distribution of Firms

Figures 1 and 2 were obtained for particular values of the low-efficiency parameter $\underline{\theta}$ and skill-inheritability η. Variation in $\underline{\theta}$ has ambiguous effects on TFP. On the one hand, increases in $\underline{\theta}$ reduces the "damages" that untalented management provokes. On the other, precisely for that reason, fewer firms are transferred from untalented managers to talented ones. The first effect tends to increase TFP, but the latter tends to reduce it. Increases in heritability, instead, unambiguously increase TFP, because it means that "owning dynasties" will be mostly made-up of talented agents. To quantify these effects, Figure 3 presents – for varying values of $\underline{\theta}$ (horizontal axis) and η (different curves) the of TFP of a country with $\phi = 0.1$ and $\gamma = 0.1$ (recall that the corresponding value for an economy with $\phi = 1$ is 1). We see that the ambiguity in the effects of $\underline{\theta}$ gives rise to a $U-$shaped pattern. In particular, when $\underline{\theta}$ falls below 0.6 the gains from trading firms are so large as to overwhelm even extreme forms of financial imperfection. Conversely, when $\underline{\theta}$= 1 dynastic management is not a problem, as all agents are equally talented. We can also see that, for the intermediate values of $\underline{\theta}$, the TFP consequences of dynastic management can be fairly severe even for relatively high intergenerational inheritability of talent. The effects of variation in ϕ and γ on K_t are both qualitatively and quantitatively fairly insensitive to alternative values of $\underline{\theta}$, and η.

It may also be of interest to examine the size distribution of firms generated by different combinations of parameters. Figure 4 plots the steady-state size distribution of firms (defined as the size distribution in period 60) for the four cases obtained combining $\phi = 0.1$ and $\phi = 1$, with $\gamma = 0.1$ and $\gamma = 0.5$ (ϕ varies by column, γ varies by row). The striking feature of these plots is that in all cases the size-distribution of firms is skewed to the right, and looks approximately log-normal. This is despite the fact that these economies all started out in period 0 with (identically) uniformly distributed firm sizes. This is a notable result because real-world size distributions of firms are also approximately log-normal (Simon and Bonini, 1958, Ijiri and Simon, 1962, and countless others).

6 Conclusions

This paper has argued that one of the adverse consequences of financial-market imperfections is a failure of meritocracy: untalented heirs of productive assets – rather than talented individuals not born to wealth – carry critical decision-making responsibilities. Importantly, this is so even though the untalented heir wishes to transfer control, and would do so enthusiastically were financial markets efficient. Numerical simulations of a growth model featuring dynastic management show that the aggregate efficiency costs of this failure of meritocracy may be severe. The model also explores how the incidence of dynastic management – and of its adverse consequences – varies with the saving rate, and with the inter-generational persistence of talent. In cross-country data, economic performance is clearly positively correlated both with indicators of financial market development, and with saving rates (appropriately defined), and our model provides one candidate source for these correlations.

The model also has a number of interesting new predictions on the relationship between efficiency, firm size, and the size distribution of firms. Since small firms are easier to sell, we expect the dynastic-management problem to be more severe in large corporations, i.e. – on average – large corporations should be less efficient. There is an old tradition in economics of trying to estimate the size-efficiency relationship (e.g. Osborn, 1950), but our searches for recent contributions have delivered nothing in the way of systematic studies with large data sets and an adequate set of controls. It seems that this question is not of current interest to students of the firm. There is also the closely related prediction that smaller firms are more likely to change ownership. Lichtenberg and Siegel (1987) did find this to be the case, and as far as we know this result has not been challenged.[25] A further consequence of these results is that countries with more concentrated ownership of productive assets will be less efficient, a prediction we hope to test in future work.

A seemingly important aspect of dynastic management that we have not fully addressed in the present model is the death of firms at the time of succession. Lotti and Santarelli (2002) show that firm survival-hazard functions dip dramatically around the time of retirements of the owner-founder.[26] They cite succession problem – unprepared or unwilling heirs – and high inheritance taxes as key causes of family-firm death. Our model does feature firm shut-downs for periods in which the firm is too small to operate, but these shut downs are unrelated to the quality of the offspring and to taxes. Furthermore, such shut downs are only temporary. An extension of our model allowing for entry and exit, as well as for cross-country variation in inheritance taxes, will be both realistic, and will lead to additional empirical predictions.[27] We hope to pursue

[25] Lichtenberg and Siegel (1987) also found that inefficient firms tend to change ownership, and that ownership change is followed by above-average efficiency growth. McGukin and Nguyen (1995) confirm the second finding, but reverse the former: more efficient firms tend to change hands. Our model has no definite prdictions on whether it is more efficient or less efficient firms that are tansferred to new owners. If the sale takes place a few years into the untalented heir incumbency, then there will be time for his ineptitude to adversely affect efficiency, leading to a Lichtenberg-Siegel result. However, if the sale takes place early enough, or indeed if the seller is the talented retiring owner – smart enough to see that her progeny will make a mess of things – then we would observe the McGukin–Nguyen result. In either case, above-average growth in efficiency after the sale could be easily accomodated by a simple extension of the model with more than two talent levels. In such a model, new owners would always be drawn from the highest talent category.

[26] See also *The Economist* articles cites in Section 2.

[27] One would think that high inheritance taxes would always be good in our model, as they break up the chain of dynastic successions, and redistribute resources to the truly talented. However, this is not necessarily true. If skills are highly persistent, dynastic succession insures that on average assets are managed by individuals who are more talented than the average individual in society. If the inheritance tax is redistributed randomly, then its efficiency consequences may be adverse. Hence,

these extensions in future work.

inheritance taxes do not necessarily substitute for financial development.

A Appendices

A.1 Opening a Market for Managers

In this appendix we open up a market where untalented owners of firms may hire talented workers to run operations as managers. Does this eliminate the inefficiencies associated with dynastic management? A contract for managerial services for firm i specifies that the manager receives a fixed remuneration $m_i \geq 0$, and that the manager should turn all profits, net of labor and managerial costs, to the owner. Imperfect enforcement of contracts, however, implies that the manager has the ability to appropriate a fraction $(1-\phi)$ of the profits, in which case the owners will only recoup the amount $\phi\pi_i$. If the manager steals, he obviously forfeits the managerial compensation m_i. Clearly, then, we will observe stealing whenever $(1-\phi)\pi_i > m_i$.

Given this agency problem, a talented owner will always prefer to directly manage his own asset. Furthermore, untalented owners will only hire talented managers, if they hire at all. We look for managerial contracts that do not invite stealing, i.e. that satisfy the condition $(1-\phi)\pi_i^H \leq m_i$. Such transactions must be appealing to both the owner and the manager. The owner's participation constraint is $\pi_i^H - m_i + w \geq \pi_i^L$. The left hand side is his income if he hires a manger: the (well-managed) firm profits, net of the manager's compensation, plus the wages he earns on the labor market once he is free from managerial duties. The right hand side is his income if he does not hire, i.e. the profits from (ineptly) managing the firm himself. For the manager, the analogous condition is $m_i \geq w$: he compares his pay as manager to his outside option represented by the market wage. Rewriting these three conditions slightly we see that a no-stealing managerial contract can be concluded if and only if:

$$\begin{aligned} m_i &\geq (1-\phi)\pi_i^H \\ m_i &\leq \pi_i^H - \pi_i^L + w \\ m_i &\geq w. \end{aligned}$$

Combining the first two conditions gives rise to the restriction

$$\phi\pi_i^H + w \geq \pi_i^L. \tag{13}$$

The third condition does not bite.[28]

[28] Even if a m that dissuades from stealing does not exist, the two parties may still in priciple agree

Note that equation (13) is exactly the same as equation (4). Hence, a managerial solution to the untalented-owner problem is possible only is a sale solution is possible, which is to say that introducing managerial contracts does nothing at all to alleviate the inefficiencies generated by dynastic management.

There could have been other – more standard – ways of modelling the owner-manager agency problem. We could have explicitly added uncertainty on ex-post profits, and make it costly for the owners, but not for the manager, to observe the realization of the profit shock. The manager would then have an incentive to under-report profits and steal the unreported amounts. We have verified that this version produces the same results as the simpler one we present here.

A.2 Existence, Uniqueness and Properties of the Equilibrium in the Static Model

Consider the function $M(\overline{s}) = \overline{s}_0 + \int_0^{\kappa(\overline{s})} \kappa \underline{g}_0(\kappa)$. The equilibrium share $\overline{s}$ is a fixed point of this function mapping $[0,1]$ into itself. If $M(\overline{s})$ is a contraction, then an equilibrium exists and is unique. Assume $\underline{g}_0(\kappa)$ is continuous. Let $\overline{s}^1$ and $\overline{s}^2$ be any two points in $[0,1]$ with $\overline{s}^2 \geq \overline{s}^1$. Then we have that:

$$\left|M(\overline{s}^2) - M(\overline{s}^1)\right| = \int_{\kappa(\overline{s}^1)}^{\kappa(\overline{s}^2)} \kappa \underline{g}_0(\kappa)\, d\kappa \leq \left[\kappa\left(\overline{s}^2\right) - \kappa\left(\overline{s}^1\right)\right] \max_{\kappa} \kappa \underline{g}_0(\kappa).$$

Using equation (6), the last expression can rewritten as $c\,(\overline{s}^2 - \overline{s}^1) \max_\kappa \kappa \underline{g}_0(\kappa)$, where

---

to a transfer of managerial duties if the outcome of stealing makes both better off. The conditions that must be satisfied for this to occur are

$$\phi\pi_i^H + w \geq \pi_i^L$$
$$(1-\phi)\pi_i^H \geq w.$$

Note that whenever the conditions for a contract featuring stealing are satisfied, so are the conditions for a contract with no stealing. Hence, we can simply focus on contracts with no stealing.

While it is clear when control will be transferred, the managerial compensation at which this transfer takes place is (partially) indeterminate. Clearly the compensation must be in the range $\left\{\max\left[w, (1-\phi)\pi_i^H\right], \pi_i^H - \pi_i^L + w\right\}$, and it must depend on the bargaining power of the two parties. In the current context it seems legitimate to assume that all of the bargaining power resides in the owner. The reason is that we have assumed that there are more talented managers than there are firms, so managers are in excess supply. If one is willing to assume that all of the bargaining power is with the owner, then $m_i = \max\left[w, (1-\phi)\pi_i^H\right]$.

$c = \frac{1-\alpha}{\alpha} \frac{\overline{\theta}^{\frac{1}{\alpha}} - \underline{\theta}^{\frac{1}{\alpha}}}{(1-f)\left[(\underline{\theta})^{\frac{1}{\alpha}} - \phi\left(\overline{\theta}\right)^{\frac{1}{\alpha}}\right]} > 0$. Hence, if $c \max_\kappa \kappa \underline{g}_0(\kappa) < 1$, M is a contraction. This is the condition we stated in the text.

Also, it is immediate to see that full efficiency ($\overline{s} = 1$) is not an equilibrium (i.e. the equilibrium is interior) as long as $\int_{\kappa(1)}^{\infty} \kappa \underline{g}_0(\kappa) > 0$.

Now consider the function $F(\overline{s}, x) = \overline{s} - \overline{s}_0 - \int_0^{\kappa(\overline{s})} \kappa \underline{g}_0(\kappa)$ where x is a vector of exogenous variables, the equilibrium condition is $F(\overline{s}, x) = 0$. Comparative statics can be carried out as long as $\frac{\partial F}{\partial \overline{s}} \neq 0$. It is immediate to find out that:

$$\frac{\partial F}{\partial \overline{s}} = 1 - c\overline{s}\underline{g}_0(\overline{s})$$

the assumption that allowed us to obtain uniqueness ensures $\frac{\partial F}{\partial \overline{s}} > 0$. Hence, the sign of $\frac{\partial \overline{s}}{\partial x_r}$ is the opposite of the sign of $\frac{\partial F}{\partial x_r}$, for any $x_r \in x$. We have that:

$$\begin{aligned}
\frac{\partial F}{\partial f} &= -\frac{1}{1-f}\left[\kappa(\overline{s})\right]^2 \underline{g}_0(\kappa(\overline{s})) < 0 \\
\frac{\partial F}{\partial \phi} &= -\frac{\overline{\theta}^{\frac{1}{\alpha}}}{\underline{\theta}^{\frac{1}{\alpha}} - \phi\overline{\theta}^{\frac{1}{\alpha}}}\left[\kappa(\overline{s})\right]^2 \underline{g}_0(\kappa(\overline{s})) < 0 \\
\frac{\partial F}{\partial \overline{s}_0} &= -1 \\
\frac{\partial F}{\partial \underline{G}_0} &= -\frac{\left[\kappa(\overline{s})\right]^2}{2} \\
\frac{\partial F}{\partial \overline{\theta}} &= -\frac{1}{\alpha}\overline{\theta}^{\frac{1-\alpha}{\alpha}} \frac{\underline{\theta}^{\frac{1}{\alpha}}}{\underline{s}\underline{\theta}^{\frac{1}{\alpha}} + \overline{s}\overline{\theta}^{\frac{1}{\alpha}}} \frac{\left[\kappa(\overline{s})\right]^2 \underline{g}_0(\kappa(\overline{s}))}{\underline{\theta}^{\frac{1}{\alpha}} - \phi\overline{\theta}^{\frac{1}{\alpha}}} < 0
\end{aligned}$$

where to evaluate $\frac{\partial F}{\partial \underline{G}_0}$ we have considered linear variations $\Delta \underline{G}_0 = \varepsilon\kappa$ where $\varepsilon = \partial \underline{G}_0$.

A.3 Period-t Threshold

A talented prospective buyer, endowed with bequest b, can approach the untalented owner of a firm of size κ, and offer a down payment $\mu \leq b$, as well as a promise to complete the payment of the purchase price out of the profit stream from the firm. Replicating the reasoning of Section (4.2) we find that this transaction will go through if and only if:

$$\phi\pi^H(\kappa) + \mu + w \geq \pi^L(\kappa),$$

Assuming that $\phi\overline{\theta}^{1/\alpha} < \underline{\theta}^{1/\alpha}$ this inequality implicitly defines the maximum firm size κ that can be purchased with collateral μ. In particular, substituting from (3), the largest firm that down payment μ could possibly give access to has size

$$\kappa(\mu, \overline{s}) = \frac{\overline{s}\overline{\theta}^{\frac{1}{\alpha}} + \underline{s}\underline{\theta}^{\frac{1}{\alpha}}}{\Pi} \frac{w + \mu}{\underline{\theta}^{\frac{1}{\alpha}} - \phi\overline{\theta}^{\frac{1}{\alpha}}}. \tag{14}$$

Clearly, the larger the down payment, the larger the firm that can be purchased.

Now consider the optimal bidding policy for a prospective buyer with bequest b. Suppose first she decides to earmark an amount $\mu < b$ for down payment against the purchase of a firm: which firm size κ will she try to target? Given our assumption on bargaining power, the buyer's end-of-period payoff is $b + w$, if the participation constraint is binding, and $(1 - \phi)\, \pi^H (\kappa) + b - \mu$, if the incentive compatibility constraint is binding. Since, this is (weakly) increasing in κ, the buyer will always target the largest available firm among those that can be purchased against a down payment of μ.

Now consider the optimal choice of μ. If the buyer is indeed able to purchase the largest firm he can afford with μ, his utility is either independent of μ, or it is $(1 - \phi)\, \pi^H (\kappa(\mu, \overline{s})) + b - \mu$. Using equations (3) and (14) this can be rewritten as

$$(1 - \phi) \frac{\overline{\theta}^{\frac{1}{\alpha}}}{\underline{\theta}^{\frac{1}{\alpha}} - \phi\overline{\theta}^{\frac{1}{\alpha}}} w + (1 - \phi) \frac{\overline{\theta}^{\frac{1}{\alpha}}}{\underline{\theta}^{\frac{1}{\alpha}} - \phi\overline{\theta}^{\frac{1}{\alpha}}} \mu + (b - \mu),$$

which (using $\overline{\theta} \geq \underline{\theta}$) can be easily seen to be maximized for $\mu = b$. Hence, not only will the buyer try to purchase the largest possible firm given a down payment μ, but he will use his entire resources as down payment. In short, he will always attempt to buy the largest firm he can afford, i.e. a firm of size $\kappa(b, \overline{s})$. This is intuitive, as $\overline{\theta} \geq \underline{\theta}$ is the condition that ensures the existence of gains from trade.

Now recall that we assumed that all workers leave bequest γw_t. Since only children of workers purchase firms, we have $b = \gamma w_{t-1}$ for all buyers. Substituting this for μ in (14), as well as equation (1) for w, and recalling that $\Pi = \alpha Y$, gives equation (8). Since we have already showed that buyers always maximize the size of the firm they buy, all firms with size less than $\kappa(w_{t-1}, \overline{s})$ will also change hands.

A.4 Recursive equilibrium

Define the threshold implied by the viability constraint $\pi_{it}^H - w_t > 0$ as $\kappa_v(\overline{s}_t)$. It can be shown that $\kappa_w(\overline{s}_t) < \kappa(w_{t-1}, \overline{s}_t)$. Define K_t^0 as the amount of capital the economy inherits from the previous period. What fraction of this capital will end up being used in the production process depends on the distribution of firms' sizes, and in particular on the capital share employed by firms that will shut down for the period. Also define $\underline{G}_t$ as the distribution of the firms' sizes (with respect to the beginning of period capital stock) inherited by untalented agents, and $\bar{G}_t$ as the distribution to talented agents. Take these distributions as given at the beginning of the period. Also take the time $t-1$ wage w_{t-1} as given. Finally, let us call the measure of firms operating in period t, f_t. Then the period-t equilibrium is defined by the following set of equations:

$$
\begin{aligned}
K_t &= K_t^0 \left[\int_{\kappa_v(\bar{s}_t)\left(K_t^0/K_t\right)}^{\infty} \kappa d\left[\bar{G}_t(\kappa) + \underline{G}_t(\kappa)\right] \right], \\
\bar{s}_t &= \left[\int_{\kappa_v(\bar{s}_t)\left(K_t^0/K_t\right)}^{\infty} \kappa d\bar{G}_t(\kappa) + \int_{\kappa_v(\bar{s}_t)\left(K_t^0/K_t\right)}^{\kappa(\gamma w_{t-1}, \bar{s}_t)\left(K_t^0/K_t\right)} \kappa d\underline{G}_t(\kappa) \right], \\
f_t &= \int_{\kappa_v(\bar{s}_t)\left(K_t^0/K_t\right)}^{\infty} d\left[\bar{G}_t(\kappa) + \underline{G}_t(\kappa)\right], \\
Y_t &= (1-f_t)^{1-\alpha} \left[K_t(\underline{s}_t \underline{\theta}^{\frac{1}{\alpha}} + \overline{s}_t \overline{\theta}^{\frac{1}{\alpha}}) \right]^{\alpha}, \\
w_t &= (1-\alpha) Y_t / (1-f_t), \\
\kappa(\gamma w_{t-1}, \overline{s}_t) &= \left[\kappa(\overline{s}_t) + \frac{\left(\underline{s}_t \underline{\theta}^{\frac{1}{\alpha}} + \overline{s}_t \overline{\theta}^{\frac{1}{\alpha}}\right) \gamma w_{t-1}}{\left(\underline{\theta}^{\frac{1}{\alpha}} - \phi \overline{\theta}^{\frac{1}{\alpha}}\right) \alpha Y_t} \right] \left(K_t^0/K_t\right), \\
\kappa_v(\bar{s}_t) &= \left[\frac{(1-\alpha)}{\alpha} \frac{\left(\underline{s}_t \underline{\theta}^{\frac{1}{\alpha}} + \overline{s}_t \overline{\theta}^{\frac{1}{\alpha}}\right)}{(1-f_t)\, \bar{\theta}^{\frac{1}{\alpha}}} \right] \left(K_t^0/K_t\right).
\end{aligned}
$$

Given the equilibrium values of the macro variables, the entire distribution of profits for the firms in this economy is given by the set of equations

$$
\pi(A_{it}, \kappa_{it}) = \alpha Y_t \frac{A_{it}^{\frac{1}{\alpha}}}{\left(\underline{s}_t \underline{\theta}^{\frac{1}{\alpha}} + \overline{s}_t \overline{\theta}^{\frac{1}{\alpha}}\right)} \kappa_{i,t} \tag{15}
$$

for firms i such that $K_{it}/K_t^0 \geq \kappa_v(\bar{s}_t)$, and $\pi_{it} = 0$ if $K_{it}/K_t^0 < \kappa_v(\bar{s}_t)$.

Given this profile of profits, equations (10), (11), and (12) describe the new size distribution of firms in period $t+1$, G_{t+1}.Finally, the allocation of talent to firms, $\underline{G}_t$ and $\overline{G}_t$, is governed by the probability η that children inherit their parents' abilities.

A.5 Calibration of η

Bouchard and McGue (1981) survey the genetic research on IQ. Their paper is a summary of 111 studies on familial resemblances in measured intelligence. They argue that the pattern of average correlations in IQ scores is consistent with a polygenic theory of inheritance, which says that the higher the proportion of genes two people have in common, the higher the average correlation between their IQ. In particular, they estimate that the average correlation of Parent-Offspring IQ scores is 0.42.

We calibrate η by assuming that the IQ score of a person is deterministically related to his ability θ. In particular, we assume that $\overline{\theta}$ individuals score "high", or H, in IQ tests, and $\underline{\theta}$ score "low", or L. η can then be set so as to insure that the parent-offspring correlation of talent is 0.42.

Notice first that under the assumed stochastic process for talent, the steady state fraction of talented people in the population must be λ, regardless of η. This is because parent-offspring long-run inheritance patterns satisfy:

$$\begin{aligned} (1-\lambda)(1-\eta)+\lambda\eta &= \lambda \\ (1-\lambda)\eta+\lambda(1-\eta) &= 1-\lambda. \end{aligned}$$

The average score, therefore, is $EIQ = \lambda H + (1-\lambda)L$, and the variance is

$$\begin{aligned} VIQ &= \lambda(H-EIQ)^2 + (1-\lambda)(L-EIQ)^2 \\ &= \lambda(1-\lambda)(H-L)^2. \end{aligned}$$

Furthermore, the parents-children covariance can be computed as follows:

$$\begin{aligned} CIQ &= \lambda\eta(H-EIQ)^2 + [\lambda(1-\eta)+(1-\lambda)\eta]\,(H-EIQ)(L-EIQ) + (1-\lambda)(1-\eta)(L-EIQ)^2 \\ &= \lambda(\eta-\lambda)H^2 + (1-\lambda)(\eta-(1-\lambda))L^2 + HL(1-\eta-2\lambda(1-\lambda)). \end{aligned}$$

Noticing that the variance of scores in the parent population is the same as in the children population, the correlation coefficient of parents' scores (P) with children scores (C), $\rho_{P,C}$, is CIQ/VIQ. For $\lambda = 1/2$, this boils down to $\rho_{F,S} = 2\eta - 1$. Hence, one can estimate η as $\eta = (\rho_{F,S}+1)/2$. For $\rho_{F,S} = 0.42$ this implies $\eta = .71$.

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