The Macroeconomics of Delegated Management

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Abstract

We are interested in the macroeconomic implications of the separation of ownership and control. An alternative decentralized interpretation of the stochastic growth model is proposed, one where shareholders hire a self-interested manager who is in charge of the firm's hiring and investment decisions. Delegation is seen to give rise to a generic conflict of interests between shareholders and managers. This conflict fundamentally results from the different income base of the two types of agents, once aggregate market clearing conditions are taken into account. An optimal contract exists resulting in an observational equivalence between the delegated management economy and the standard representative agent business cycle model. The optimal contract, however, appears to be miles away from standard practice: the manager's remuneration is tied to the firm's total income net of investment expenses, abstracting totally from wage costs. In order to align the interest of a manager more conventionally remunerated on the basis of the firm's operating results to those of stockholder-workers, the manager must be made nearly risk neutral. We show the limited power of convex contracts to accomplish this goal and the necessity, if the manager is too risk averse (log or higher than log), of considerably downplaying the incentive features of his remuneration. The difficulty in reconciling the viewpoints of a manager with powers of delegation and of a representative firm owner casts doubt on the descriptive validity of the macro-dynamics highlighted in the representative agent macroeconomic model.

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1. Introduction

Standard dynamic macroeconomics has avoided issues raised by the separation of ownership and control. It implicitly assumes either that there is no such separation or, alternatively, that all problems arising from it are totally resolved either by a complete monitoring of managers' decisions or via employment contracts that perfectly align the interest of the managers with those of the firm owners. As a result the crucial intertemporal decisions (and pricing) are all in accord with the intertemporal marginal rate of substitution of the representative shareholder-worker-consumer.

Yet, recent events clearly indicate less than full respect for the interests of shareholders, thus underlining the importance of incentive conflicts resulting from delegation as stressed by modern microeconomics. In the micro literature these incentive issues can take a variety of forms, e.g., shirking of effort, empire building, and/or the pursuit of private benefits. In this paper we observe that, in a macro general equilibrium context with delegated management, a generic conflict of interests arises between shareholders and managers as a result of the priority payments made to workers in modern labor markets; i.e., of what the traditional business literature has termed operating leverage[1]. In the absence of complete markets where this conflict could be resolved (but where all incentive provisions would also be annihilated), it implies that the IMRS of managers and of firm owners differ in equilibrium, and that while the former is relevant for the determination of the firm's investment policy, the latter is at the heart of asset pricing. If this divergence cannot be eliminated by appropriate contracting or by outright monitoring, self-interested managers will make

[1] In Danthine and Donaldson (2002a) we explore another implication of operating leverage taking the hypothesis of limited stock market participation by workers as a starting point.

intertemporal decisions that will not be those favored by shareholders. Imperfect control thus implies that the dynamics at the heart of the standard business cycle model based on the representative agent IMRS will be invalidated[2].

In this paper we illustrate this conflict and explore its implications for economic dynamics in the context of the one good stochastic growth model. This model was originally conceived as a summary of the problem faced by a benevolent macroeconomic central planner. Not until the seminal work of Brock (1982) and Prescott and Mehra (1980) did the model become eligible for use as a vehicle for analyzing data from actual competitive economies. These authors provided a decentralization scheme; that is, a formulation of the model under which its optimal allocations can be interpreted as the market allocations of a competitive economy in recursive equilibrium.

The models of Brock (1982) and Prescott and Mehra (1980) share a number of essential features: both interpretations postulate infinitely lived consumer-worker-investors who rent capital and labor to a succession of identical one period firms. It is these consumer-worker-investors who undertake the economy's intertemporal investment decision. Subsequent, more realistic interpretations admit an infinitely lived firm which undertakes the investment decision usually under the added assumption either than the firm issues and maximizes the value of a complete set of state claims, or that it issues and maximizes the value of a single equity share while otherwise being supplied with the representative shareholder's marginal rates of substitution (see Danthine and Donaldson (2002b) for an elaboration). Here, we relax the complete market hypothesis and discuss the extent to which the stochastic growth model can be viewed as describing the time series properties of a decentralized

[2] This criticism also applies to less standard representative agent models such as those in the younger New Neo-classical Synthesis tradition.

economy in which firms' management is delegated to "firm managers" who cannot be perfectly monitored by firm owners[3].

An outline of the paper is as follows: Section 2 proposes the framework of our inquiry and discusses a number of modeling options. Section 3 focuses on the conflict of interests arising between firm owners and the manager. Section 4 shows that an optimal contract aligning perfectly the interests of the two agent classes exists but that its main feature appears to be wildly at variance with standard contracting practice. Section 5 looks at the problem when the manager is offered a renewable one-period contract based on free cash flow. It details the nature and the implications of the conflict of interest and explores the possibilities to resolve it by including real-world-like, possibly non-linear, contract features. Section 7 concludes the paper.

2. The framework and modeling issues

There is one single firm, acting as a stand-in for a continuum of identical, competitive firms, and a continuum of identical agents. A subset of measure μ of these agents is randomly selected to manage the firm. The rest act as workers and shareholders. When our goal is to compare the delegated management economy with the standard representative agent business cycle model, we typically assume that the manager' measure is $\mu = 0$. The manager is self-interested and, during his (finite) tenure with the firm, he is assumed to make all the relevant decisions in view of maximizing his own intertemporal utility. Upon termination of his contract, he resumes being a worker-shareholder.

The main motive for delegation is, realistically, to relieve shareholders of the day-to-day operation of the firm and the information requirements it entails. This means that shareholders delegate to the manager the hiring and investment decisions

[3] Another extension in the same spirit is provided by Shorish and Spear (1996) who propose an agency theoretic extension of the Lucas (1978) asset pricing model.

and all that goes with them (human resource management, project evaluation, etc..) but that, as a by-product, they lose the informational base upon which to evaluate and monitor the manager's performance and to write complete contracts with him. Here we portray shareholders as detached firm owners, keeping informed of the main results of the firm's activities but not of the "details" of its operations such as the current level of, and future perspectives on, total factor productivity (which is stochastic), its capital stock level, and the level of the investment expenses decided by the manager.

The manager could, in principle, use his informational advantage for several purposes. One particular hypothesis, emphasized in the corporate finance literature, asserts that managers are empire builders (Jensen, 1986) who tend to over-invest and possibly over-hire rather than return cash to shareholders. Philippon (2003) and Dow, Gorton and Krishnamurthy (2003) explore some of the general equilibrium implications of this hypothesis in related contexts. By contrast, we purposefully refrain from postulating "external" conflicts of interests. We rather concentrate on those conflicts arising endogenously as a result of the fact that, by the very nature of delegation, the manager's marginal risk preferences generically differ from those of shareholders or, for that matter, those of the representative agent of the standard stochastic growth paradigm. While such a conflict of interests could arise from intrinsically different preferences, we show that it more fundamentally results from the different income base of both types of agents, once aggregate market clearing conditions are taken into account. Contrary to Philippon (2003) and Dow, Gorton and Krishnamurthy (2003), in our setup there is no equilibrium distortion in the hiring decision, and the (severe) distortions in the investment decision are not manifest in the steady state investment level, as when managers are empire builders, but only in its business cycle properties[4].

Telling a simple and consistent story requires resolving the following three modeling issues. First and least importantly, we assume that managers are not paid an hourly wage and that consequently the labor-leisure trade-off becomes irrelevant for them the day they accept a managerial position. Second is the question of the managers' tenure. We could assume that they have a permanent association (as the manager) with their firm but wish to explicitly confront the problems raised by managers' finite tenure (although this turns out not to be the main issue). With finite tenure the question arises of whether current management decisions have an impact on the managers' situation after they have left the firm. We believe realism dictates a negative answer. Rather than assuming (fairly plausibly) that managers retire or even die after they leave the firm, we model them as resuming their career as worker-shareholders. But we assume that they work in a firm different from the one they formerly managed, and that they hold diversified portfolios. Thus, their previous decisions as managers have no material impact on their situation as worker-shareholders after their tenure as managers has come to an end.

The third and more difficult problem is the issue of the managers' outside income. Outside income influences the marginal attitude toward risk and is relevant in the contracting problem between shareholders and managers. This problem itself has two components. The first one is the permissible asset trades. Clearly, the spirit of our analysis is one of incomplete risk exchange opportunities between the manager and the shareholders. And it is one where managers cannot use the financial markets to "undo" the characteristics of their incentive remuneration. We naturally assume that

[4] Yet, free cash flow is a strong predictor of investment in our context as well as in Dow, Gorton and Krishnamurthy (2003).

the manager cannot trade stocks. This is realistic in the sense that managers have their income disproportionately tied up with the fortunes of the company for which they work, without the possibility of taking equi-proportionate positions in the aggregate market. In particular, managers typically face restrictions in their ability to take (short) positions in the stock of their own firm or to adjust their long positions at specific times. This hypothesis also substitutes for the more difficult assumption that the investments of the firms are not spanned by existing assets, an assumption that is necessary to open up the possibility of disagreement among agents in this economy.

It is more controversial (although customary in the partial equilibrium contracting literature) to assume that the manager is also prevented from taking a position in the risk free asset. The size of the conflict of interests uncovered in this paper, however, implies that were risk-free borrowing and lending the only mechanism bringing the IMRS of the two agent types closer together, unplausibly large trades (relative to the manager's consumption level) between the manager and shareholders would be necessary. For this reason we find it more revealing to detail the potential of simple contracting to resolve the conflict without the help of the risk free asset market.

The second element of outside income is the agent's financial wealth before he becomes a manager. If the representative worker-shareholder becomes a manager, he can be viewed as owning his share of the market portfolio. In the spirit of the above discussion we assume this diversified portfolio is placed in a blind trust. And it is reasonable to assume that, as a manager of an individual firm, he is not preoccupied with the effect of his management decisions on the value of the market portfolio. It nevertheless remains that the existence of this outside income source alters the manager's marginal rate of substitution in a way that would at times render some of our derivations more opaque without bringing in any specific insight. In these cases we abstract from it. We most specifically deal with the quantitative consequences of outside income in Section 5.3.

The worker-shareholders in our economy are potentially differentially risk averse. Complete risk sharing possibilities among themselves, however, guarantees the existence of a representative individual. Besides choosing their optimal consumption and portfolio investment streams, shareholders are in charge of defining the form of the manager's compensation, $g^m(.)$. Managers are offered renewable one-period contracts limiting to the maximum the shareholders' need to collect reliable accounting information on the performance of the firm. The probability that the current management contract will not be renewed is constant at all times and equal to π (possibly zero).

The manager's problem is:

$$
\begin{aligned}
& V^m(k_0,\lambda_0) = \max_{\{n_t^f, i_t\}} E\left(\sum_{t=0}^{\infty} (\beta^m)^t v(c_t^m) \right) \\
& \text{s.t.} \\
& c_t^m \le g^m(.) + \mu d_t \\
(1) \qquad & d_t = f(k_t, n_t^f)\lambda_t - n_t^f w_t - g^m(.) - i_t \\
& k_{t+1} = (1-\Omega)k_t + i_t ; k_0 \text{ given.} \\
& c_t^m, d_t, i_t, n_t^f \ge 0 \\
& \lambda_{t+1} \sim dF(\lambda_{t+1}; \lambda_t).
\end{aligned}
$$

In problem (1) the manager's period utility function is denoted v( ); β^m is his effective period discount factor, the product of (1-π), his probability of "survival" with the firm and of his subjective discount factor[5]. E is the expectations operator (we

[5] We assume the subjective discount rates for both worker-shareholders and the manager are identical. At each date t, the manager is making his decisions in view of their impact on current and future utilities. The manager's utility at date t+1 can be written as $(1-\pi)\beta v(c_{t+1}^m) + \pi\beta v^w(c_{t+1}^s, n_{t+1})$ where the second term represents his utility after resuming being a worker-shareholder. As discussed, we assume that the manager's decision on the levels of the firm's investment and employment at date t have no bearing on

assume rational expectations). The manager's decision variables are i_t, the amount of the current output invested at date t, and n_t^f, the level of employment. The date t state variable vector contains k_t, the beginning of period t capital stock and λ_t the current productivity level; λ_t follows a Markov process whose characteristics are summarized in the transition function F. The expression $f(.) = f(k_t, n_t^f)\lambda_t \equiv k_t^{\alpha}(n_t^f)^{1-\alpha}\lambda_t$ is the aggregate production function, w_t, the market determined wage payment, d_t, the dividend or free-cash-flow, g^m, the contractual payment to the manager; μd_t is the income from the blind trust in which the manager's initial wealth (his share μ of the market portfolio) is invested, and Ω is the constant depreciation rate of physical capital.[6] There is no dividend smoothing in our model and the dividend and free cash flow are thus identical; we use the terms interchangeably.

For the manager's problem to be well defined we have to spell out the link between his remuneration and his decisions. Because the manager is self-interested, aligning the interests of the manager with those of shareholders require tying his remuneration to the operational results of the firm. Furthermore, as we will confirm at a later stage, contracts explicitly linking the manager's remuneration to the level of sales (y_t) or the level of employment (n_t) introduce first-order "empire building" distortions relative to the preferences of firm owners. The more natural contract base is the firm's free cash flow, d_t. This variable adequately reflects the operating results of the firm. When it is used as a basis for the manager's remuneration, it results in first-order conditions that have the same general form as the FOC's obtained in the

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his personal income ($w_{t+1}n_{t+1}+(1-\mu)d_{t+1}$ and consumption after his tenure. The form of the objective function in (1) follows.

[6] Nothing would change materially if we included a fixed amount of managerial input as an additional productive factor with the overall production function being constant returns to scale. This would make comparisons with the standard business cycle model more difficult, however. In the present version of the model, if the manager is not of measure zero, his remuneration decreases the return to stock holding.

standard problem and to steady-state investment and employment levels identical to those of the comparable representative agent economy. Note that a contract $g^m(d_t)$ includes the situation where part of the remuneration of the manager is provided in the form of shares of the firm under management, shares that he is not allowed to sell during his tenure, however. As already mentioned we restrict ourselves for the moment to one-period contracts. In Section 6, we briefly explore the complementary view of making the manager's compensation a function of the pre-dividend value of the firm, $(d_t + q_t)$, a contract that encompasses the situation where the manager holds a tradable position of the stock of the firm he manages.

The form of the representative shareholder-worker's problem is standard although we want to be specific as to the content of his/her information set. We do not assume shareholder-workers to be aware of the aggregate state variables (k_t,λ_t). We rather view them as statisticians able to correctly infer the transition probability functions of the variables that they take as market or firm determined: w_t, q_t and d_t.[7] The representative shareholder-worker problem reads:

(2)
$$V^s(z_0, d_0, q_0, w_0) = \max_{\{z_{t+1}, n_t\}} E\left(\sum_{t=0}^{\infty} \beta^t [u(c_t^s) + H(1 - n_t)]\right)$$

s.t.
$$c_t^s + q_t z_{t+1} \leq (q_t + d_t)z_t + w_t n_t$$
$$d_{t+1}, q_{t+1}, w_{t+1} \sim dG(d_{t+1}, q_{t+1}, w_{t+1}; d_t, q_t, w_t),$$

where $u(\cdot)$ is the consumer-worker-investor's period utility of consumption, $H(.)$ his utility for leisure; c_t^s his period t consumption, n_t his period t labor supply, z_t the fraction of the single equity share held by the agent in period t, and G(.) describes the transition probabilities for the relevant variables. The period utility function is

[7] They can be viewed as the shareholders of a Lucas-tree economy: the firm is a fruit-producing tree. They observe the net output after the labor necessary to shake the trees has been paid and the fruits composted for fertilizing purposes have been set aside.

purposefully assumed to be separable in consumption and leisure to permit comparison with a set-up where the relevant intertemporal decision is made by an agent whose utility for leisure is not specified.

3. A generic conflict of interests

Problem (2) has the following recursive representation

$$V^s(z_t, d_t, q_t, w_t) = \max_{\{z_{t+1}, n_t\}} \{u(z_t(q_t + d_t) + w_t n_t^s - q_t z_{t+1})$$
$$-H(1-n_t^s) + \beta \int V^s(z_{t+1}, d_{t+1}, q_{t+1}, w_{t+1}) dG(d_{t+1}, q_{t+1}, w_{t+1}; d_t, q_t, w_t)\}$$

whose solution is characterized by the following relationships:

(3) $$u_1(c_t^s) w_t = H_1(l - n_t^s),$$

(4) $$u_1(c_t^s) q_t = \beta \int u_1(c_{t+1}^s)[q_{t+1} + d_{t+1}] dG(d_{t+1}, q_{t+1}, w_{t+1}, d_t, q_t, w_t).$$ [8]

From (4), the non-explosive equilibrium ex-dividend stock price takes the form:

(5) $$q_t = E_t^G \left(\sum_{j=1}^{\infty} \beta^j \frac{u_1(c_{t+j}^s)}{u_1(c_t^s)} \right) d_{t+j},$$

where E^G refers to the expectations operator based on the information contained in the probability transition function G. From (4) or (5) it is clear that the pricing kernel relevant for security pricing is the shareholders' IMRS.

Under appropriate conditions, the manager's problem has recursive representation:

(6) $$V^m(k_t, \lambda_t) = \max_{\{i_t, n_t^f\}} \left\{ v\left(c_t^m\right) + \beta^m \int V^m(k_{t+1}, \lambda_{t+1}) dF(\lambda_{t+1}, \lambda_t) \right\}.$$ [9]

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[8] It follows from Blackwell's (1965) Theorem and the results in Benveniste and Scheinkman (1979) that a continuous, bounded $V^s(\ )$ exists and has a unique solution characterized by (3) and (4) provided u( ) and H( ) are increasing, continuously differentiable and concave, and that dG( ) has the property that it is continuous and whenever h(d,q,w) is continuous, $\int h(d', q', w') dG(d', q', w'; d, q, w)$ is continuous as a function of (d,q,w).

The necessary and sufficient first order conditions to problem (6) can be written

(7) $$v_1\left(c_t^m\right)g_1^m(d_t)\left[f_2\left(k_t, n_t^f\right)\lambda_t - w_t\right] = 0,$$

(8) $$v_1\left(c_t^m\right)g_1^m(d_t) = \beta^m \int v_1\left(c_{t+1}^m\right)g_1^m(d_{t+1})\left[f_1\left(k_{t+1}, n_{t+1}^f\right)\lambda_{t+1} + (1-\Omega)\right]dF\left(\lambda_{t+1};\lambda_t\right),$$

where this latter representation is obtained using a standard application of the envelope theorem.

In equilibrium, at all dates t,

(9) $$\int n_t^s d\Phi = n_t = n_t^f \text{, and}$$

(10) $$z_t = 1-\mu$$

(11) $$y_t \equiv f(k_t, n_t)\lambda_t = \int c_t^s d\Phi + c_t^m + i_t = c_t^s + c_t^m + i_t,$$

At this stage, it is useful for the discussion to spell out the equations that characterize the equilibrium in the standard stochastic growth model where the central planner solves

(12) $$\begin{aligned}&\max_{\{n_t, i_t\}} E\left(\sum_{t=0}^{\infty}\beta^t[u(c_t) + H(1-n_t)]\right)\\ &\text{s.t.}\\ &c_t + i_t \le f(k_t, n_t^f)\lambda_t\\ &k_{t+1} = (1-\Omega)k_t + i_t; k_0 \text{ given.}\\ &c_t, i_t, n_t \ge 0\\ &\lambda_t \sim dF(\lambda_{t+1};\lambda_t),\end{aligned}$$

and c_t, n_t, k_t, and i_t have interpretations entirely consistent with problem (1), (2); e.g., c_t denotes the consumption of the representative agent, i_t his period t investment, etc. In this economy, n_t, i_t are fully characterized by, respectively,

[9] It again follows from Blackwell's (1965) Theorem and the results in Benveniste and Scheinkman (1979) that a continuous, bounded $V^m(\,)$ exists that solves (6) provided v( ) and f( ) are increasing, continuous and bounded, and that $g^m(\,)$ is itself continuous and that $dF(\lambda';\lambda)$ is continuous with the property that for any continuous $h(k',\lambda')$, $\int h(k',\lambda')dF(\lambda';\lambda)$ is also continuous in k and λ. In order for (7) and (8) to characterize the unique solution, the differentiability of v( ), $g^m(\,)$ and f( ) is required and $v(g^m(\,))$ must be concave.

(13) $$u_1(y_t - i_t) f_2(k_t, n_t)\lambda_t \;=\; H_1(1-n_t),$$

(14) $$u_1(y_t - i_t) = \beta \int u_1(y_{t+1} - i_{t+1}) \left[f_1(k_{t+1}, n_{t+1}) \lambda_{t+1} + (1-\Omega) \right] dF(\lambda_{t+1}, \lambda_t),$$ where

(15) $$c_t + i_t = f(k_t, n_t)\lambda_t \equiv y_t .$$

The first observation that can be made is a confirmation that, as formulated, the agency problem does not introduce any distortion in the employment decision. Indeed, from (3), (7) and (11) one obtains, in equilibrium,

(16) $$u_1(y_t - i_t - c_t^m)\, f_2(k_t, n_t)\lambda_t \;=\; H_1(1-n_t)$$

The similarity between (13) and (16) confirms that, under our hypotheses, the *form* of the leisure-labor trade-off is not affected by the delegation of management. This result provides support for a contract based on free cash flow. By contrast, suppose that the remuneration of the manager was based on a combination of d_t and y_t or n_t and denote it x_t, then equation (7) would read:

$$v_1\left(c_t^m\right) \frac{\partial g^m(x_t)}{\partial x_t} \frac{\partial x_t}{\partial n_t} = 0 .$$

This does not yield the standard condition that the marginal product of labor should equal the going wage. For example, assume a contract based on sales and dividends, $x_t = \kappa y_t + \nu d_t$, then

$$\frac{\partial x_t}{\partial n_t} = (\kappa + \nu) f_2(k_t, n_t^f)\lambda_t - w_t .$$

The above equation obviously leads to excess-employment (even in the steady state) compared to (7): the manager values employment for its contribution to sales over and above its impact on the firm's financial results[10]. The same sort of steady state "level" distortion is evidently present if the contract is based on employment.

[10] It is straightforward to show that the same sort of problem arises if the contract is based on the wage bill.

With the *form* of the leisure-labor trade-off unaffected by the delegation of management, the labor supply decision will be the same in the delegated management economy as in the standard model *provided that the investment and capital stock levels and the level of consumption of the representative worker-shareholder are all the same*. The assumption that the manager is of measure zero is designed to guarantee that the latter condition holds, i.e., $y_t - c_t^m - i_t \simeq y_t - i_t, \forall t$.

The same sort of assessment cannot be made for the dynamics of investment. Indeed, equation (14) can be written as

(17) $$1 = \beta \int \frac{u_1(y_{t+1} - i_{t+1})}{u_1(y_t - i_t)} \left[f_1(k_{t+1}, n_{t+1}) \lambda_{t+1} + (1-\Omega) \right] dF(\lambda_{t+1}, \lambda_t)$$

while together with (11) equation (8) yields

(18) $$1 = \beta^m \int \frac{v_1(c_{t+1}^m) g_1^m(d_{t+1})}{v_1(c_t^m) g_1^m(d_t)} \left[f_1\left(k_{t+1}, n_{t+1}\right) \lambda_{t+1} + \left(1-\Omega\right) \right] dF\left(\lambda_{t+1}; \lambda_t\right)$$

Again equations (17) and (18) have a similar *form* and this yields further support to a remuneration based on free cash flow. When the remuneration is based on sales, an "empire building" distortion similar to the one shown above for the employment decision would also be manifest in the manager's investment decision[11].

But, while equations (17) and (18) have a similar form, they effectively differ in four possible ways. First the utility functions of manager and shareholders may not be the same; second, the discount factors may differ, in particular as a result of the manager's finite tenure; third, whenever the manager's contract is not linear in d_t, there is a "correction" to the manager's IMRS; fourth and most interestingly, the arguments in the utility functions are different: the representative agent's consumption

[11] For a contract $x_t = \kappa y_t + \nu d_t$, the equivalent to equation (8) becomes
$$v_1\left(c_t^m\right) = \beta^m \int v_1\left(c_{t+1}^m\right) \left[\frac{\kappa + \nu}{\nu} f_1\left(k_{t+1}, n_{t+1}^f\right) \lambda_{t+1} + (1-\Omega) \right] dF\left(\lambda_{t+1}; \lambda_t\right)$$

is necessarily, as a result of market clearing restrictions in a representative agent economy, equal to output net of investment. No such constraint applies to the manager's consumption, which could in principle be anything! It is therefore unlikely, except by design of his contract, that the manager's consumption stream (or the representative manager's for that matter) would possess the same time series properties as the representative shareholder's. This is the source of a generic conflict of interests between the agent and the principals. To see the issue more clearly let us assume for a moment that u( ) and v( ) are identical, $\beta^m = \beta$, and that the manager's contract is linear d_t. We are then essentially comparing

$$\frac{u_1(y_{t+1} - i_{t+1})}{u_1(y_t - i_t)}$$

and

$$\frac{u_1(y_{t+1} - c^s_{t+1} - i_{t+1})}{u_1(y_t - c^s_t - i_t)} = \frac{u_1(y_{t+1} - w_{t+1}n_{t+1} - (1-\mu)d_{t+1} - i_{t+1})}{u_1(y_t - w_t n_t - (1-\mu)d_t - i_t)} = \frac{u_1(\alpha y_{t+1} - (1-\mu)d_{t+1} - i_{t+1})}{u_1(\alpha y_t - (1-\mu)d_t - i_t)}$$

In principle these two IMRS can be very different and lead to highly diverging investment decisions. The key consideration is that the manager's consumption is residual from aggregate income after <u>both</u> investment expenses <u>and</u> income payments to workers and shareholders. On the contrary, shareholders are first and foremost workers, thus entitled to the wage bill. This difference in perspective is not trivial because the priority payment to workers is quantitatively so very large. In Section 5 we detail the extent and the implications of this conflict when the manager's contract is a simple function of free cash flow. First we discuss the possibility and the nature of an optimal contract between the manager and the firm owners.

4. Optimal contracting: sharecropping

Suppose that the manager has no outside income (he had no asset before starting as a manager) and that his contract takes the form $g_t^m = \varphi(y_t - i_t)$. This implies that the worker-shareholders in the aggregate receive a total remuneration of $(1-\varphi)(y_t - i_t)$ entailing compensation both for their labor and for capital ownership[12]. This can be viewed as a sharecropping contract. With this contract, equation (17) takes the form:

$$1 = \beta^m \int \frac{v_1(\varphi(y_{t+1} - i_{t+1}))}{v_1(\varphi(y_t - i_t))} \left[f_1\left(k_{t+1}, n_{t+1}\right)\lambda_{t+1} + (1-\Omega) \right] dF\left(\lambda_{t+1}; \lambda_t\right)$$

which, under standard homogeneity hypothesis for v( ), reduces to

$$1 = \beta^m \int \frac{v_1(y_{t+1} - i_{t+1})}{v_1(y_t - i_t)} \left[f_1\left(k_{t+1}, n_{t+1}\right)\lambda_{t+1} + (1-\Omega) \right] dF\left(\lambda_{t+1}; \lambda_t\right). \tag{19}$$

Equation (19) has exactly the form of equation (17). Before we draw conclusions we have to insure that such a sharecropping contract is compatible with labor being allocated in a competitive labor market. This is the case under a plausible restriction. Indeed under sharecropping,

$$\begin{aligned} c_t^s &= w_t n_t + d_t \\ &= w_t n_t + y_t - w_t n_t - c_t^m - i_t \\ &= y_t - i_t - \varphi(y_t - i_t) \\ &= (1-\varphi)(y_t - i_t). \end{aligned}$$

Moreover, under this scheme and competitively determined wages,

$$\begin{aligned} d_t &= y_t - w_t n_t - c_t^m - i_t \\ &= \alpha y_t - \varphi(y_t - i_t) - (\alpha i_t + (1-\alpha) i_t) \\ &= (y_t - i_t)(\alpha - \varphi) - (1-\alpha) i_t, \end{aligned}$$

[12] Here we assume no outside income for transparency. With outside income μd_t the manager's contract would be $g_t^m = \varphi(y_t - i_t) - \mu d_t$. One could not really talk of sharecropping.

where α is the capital share in value added. Thus, provided φ is sufficiently small relative to α, it will be possible to honor the manager's contract out of capital income in each and every state of the world, that is, $d_t \geq 0, \forall t.$ Sharecropping then is indeed compatible with the working of a competitive labor market. With a capital share of output approximately equal to 30% of value added, the pre-condition should, in principle, be satisfied.

This discussion provides the intuition for the following theorem:

Theorem 4.1: Suppose u( ) = v( ), both being increasing, concave and continuously differentiable. Assume also that $\beta^m = \beta$. Then, a sharecropping contract, $g_t^m = \varphi(y_t - i_t)$, for some positive constant $\varphi \ll \alpha$, is necessary and sufficient for a Pareto optimal allocation of labor and capital.

Proof: see appendix

Theorem 4.1 has the immediate following corollary:

Theorem 4.2 (Equivalence Theorem). Assume that the conditions of Theorem 4.1 are satisfied and that in addition the manager is of measure $\mu = 0$. Under sharecropping, the delegated management economy exhibits the same time series properties as, and is thus observationally equivalent to, the representative agent business cycle model.

This result is important since it extends the realm of application of the standard business cycle model. The measure zero assumption is made for convenience only to facilitate comparison with the standard representative agent model. With a positive measure management one would want to increase the productivity of factors to make up for the consumption of the manager in such a way that the consumption level of shareholder-workers, and consequently their labor supply decision, remain unchanged in equilibrium.

It is interesting to inquire under what conditions some of the assumptions of Theorem 4.1 can be lifted. The following result suggests that it is relatively easy to correct for the manager's short term perspective.

Theorem 4.3. Suppose that the conditions of Theorem 4.1 apply but for the fact that $\beta^m = (1-\pi)\beta < \beta$. Then a time-increasing sharecropping contract, $g_t^m = \varphi_t(y_t - i_t)$, where the manager's share φ_t is growing with time at a rate $\left(\frac{1}{1-\pi}\right)^{\frac{1}{1+\Delta}}$, with Δ the degree of homogeneity of $v_1(.)$, is sufficient for a Pareto optimal allocation of labor and capital[13].

Proof: Follows immediately from observing that with the proposed contract, the FOC (19) becomes

$$1 = \beta^m \int \frac{(\varphi_{t+1})^{1+\Delta} v_1(y_{t+1} - i_{t+1})}{(\varphi_t)^{1+\Delta} v_1(y_t - i_t)} \left[f_1\left(k_{t+1}, n_{t+1}\right)\lambda_{t+1} + \left(1-\Omega\right)\right] dF\left(\lambda_{t+1};\lambda_t\right),$$

and that under the conditions of the Theorem,

$$\beta^m \frac{(\varphi_{t+1})^{1+\Delta}}{(\varphi_t)^{1+\Delta}} = \beta. \blacksquare$$

Extending Theorem 4.1 to different utility functions is not as straightforward. Let us start by observing that sharecropping is sufficient for Theorem 4.2 but not exactly necessary in the sense that a slightly more general contract, which would not, however, yield a Pareto optimal allocation, would also imply the same time series for investment and capital. Suppose indeed that both agents have log utility and the contract g^m takes the form

$$g_t^m = \varphi(y_t - i_t)^\eta,$$

[13] The time-increasing sharecropping contract is sufficient. It may not be necessary: a contract of the type $\varphi(y_t - i_t) + \kappa i_t$ may, under certain circumstances, also achieve the desired correction.

for constants φ, η. Then

$$\begin{aligned} v_1(g_t^m)\frac{\partial g_t^m}{\partial i_t} &= \frac{1}{\varphi(y_t - i_t)^\eta}\varphi\eta(y_t - i_t)^{\eta-1} \\ &= \frac{\eta}{(y_t - i_t)} \\ &= \eta v_1(y_t - i_t) \end{aligned}$$

implying that an intertemporal optimality equation for investment equivalent to equation (19) would obtain and that the manager would choose the same investment function as in the stochastic growth model. Yet his compensation function would not lead to a Pareto optimal allocation of aggregate consumption.

This observation suggests a generalization of Theorem 4.2 to the case where the utility functions of the manager and the shareholders do not coincide, although they must both be of a CES form. We thus have

Corollary 4.1. Suppose the utility functions of the manager and of shareholders are of the form $u(c) = \frac{c^{1-\gamma}}{1-\gamma}$ with rate of risk aversion γ for the manager, γ^s for shareholders. Then the delegated management economy replicates the time series of the standard business cycle model when the manager's contract is an extended sharecropping contract of the form:

$$g_t^m = \varphi(y_t - i_t)^\eta, \text{ for } \eta = \frac{1-\gamma^s}{1-\gamma}.$$

Under these assumptions the competitive equilibrium is not, however, Pareto Optimal.

Proof: see appendix.

In the case of heterogeneous utility functions, it is thus not possible to simultaneously align the interests of the manager to those of shareholders, and to provide optimal risk sharing. Typically if the manager is more risk averse than shareholders, his consumption will be too variable, if he is less risk averse, he will be over-insured.

In this section we have thus showed the existence of an optimal contract in the case where the utility functions of the manager and of shareholders coincide. We have also an observational equivalence result between the delegated management economy and the representative agent business cycle model when the two agent types have different but constant relative rates of risk aversion. In both cases we rely on a contract whereby the manager's remuneration is tied to the firm's total income net of investment expenses.

The basis for these contracts is clear: since the representative shareholder is first of all a worker, and in this respect the beneficiary of the wage bill, there is a sense in which, from the viewpoint of shareholders, wages should not be considered as a cost to the firm's operations. Ignoring the wage bill thus promotes a better alignment of the interests of the agent with those of the principals.

Yet there is no denying that such a contracting perspective is wildly at variance with standard practice: wage costs feature prominently in the appreciation of a firm's performance and are very much a part of incentive-based contracts! This observation motivates us to examine the properties of contracts more in accord with practice, i.e., based on a more standard appreciation of a firm's performance. In the simplified set-up of our model free cash flows or dividends are the best indicator of the firm's results and are the natural basis on which to write incentive contracts. In the next section we explore the nature of the conflict of interests between manager and shareholders when contracts are based on free cash flow and discuss the potential of realistic contract forms to resolve the corporate governance problems raised by delegated management.

5. Contracts based on the firm's operating results

We start this section by quantifying the conflict of interests between firm-owners and managers when the manager's contract is an affine function of free cash flow. Here and in subsection 5.2 we abstract from the possibility of the manager receiving outside income. In subsections 5.2 and 5.3 we explore the potential of more sophisticated contracts based on d_t to approximate the performance of an optimal contract.

5.1. Documenting the implications of the conflict of interests

The fact that the relevant IMRS has free cash flows or dividends as its argument, rather than aggregate consumption, may be expected to have an impact on the investment decision and consequently on the dynamics of the economy for at least two reasons. First, operating leverage, that is, the quantitatively large priority payment to wage earners, makes the residual free cash flow a more volatile variable than aggregate consumption. In the standard Hansen (1985) RBC model the non-filtered quarterly standard deviation of the former is about 14% vs. 3.3% for the latter. This in turn implies that, ceteris paribus, the manager will tend to be excessively prudent in his investment decisions. Second, in the same model the free cash flow is a countercyclical variable. This results almost mechanically from calibrating properly the relative size of investment expenses, of the wage bill, and generating an aggregate investment series that is significantly more variable than output[14]. But this can be expected to have an important impact on investment. Indeed in the standard RBC model, a positive productivity shock has both a push and a pull effect on investment. On the one hand, shock persistence implies that the return to investment between today and tomorrow is expected to be unusually high. This is the pull effect. On the

[14] With $d_t = y_t – w_t n_t – i_t = \alpha y_t - i_t$ and $\alpha = .36$, if investment is about 20% of output on average, an investment series that is twice as volatile as output will make d_t countercyclical.

other hand, the high current productivity implies that output and consumption are relatively high today. The latter signifies that the cost of a marginal consumption sacrifice is small. This is the push effect. While the pull effect is unchanged in the delegated management model, the push effect would be absent, or even negative if the free cash flow variable were to remain countercyclical. This should make for a much weaker reaction of investment to a positive productivity shock.

Another way to express this is to note that as a rational risk averse individual the manager wants to increase his consumption upon learning of a positive productivity shock realization since the latter is indicative of an increase in his permanent income. But, for the manager, such a consumption increase necessitates an increase in dividends, which obtains only if the response of investment to the shock is sufficiently moderate.

Numerical simulation confirms this intuition and permits detailing some of its main implications. Table 1 reports the H-P filtered standard deviations of the main macroeconomic aggregates in the delegated management economy and compares them with those of the Hansen (1985) indivisible labor model.

Table 1 : HP-Filtered Standard Deviations of Main Macro Aggregates – Indivisible Labor vs. Delegated Management

	Hansen indivisible labor		Delegated management economy	
	SD	Relative SD	SD	Relative SD
y	1.80	1.00	1.01	1.00
c	.52	.29	.87	.86
i	5.74	3.19	1.41	1.40
n	1.37	.76	.14	.14
k	.49	.27	.12	.12

Note: same parameters for both economies: u( ) = v( ) = log( ); $H(1-n_t)= Bn_t$, B = 2.85; α = .36, Ω=.025, $\lambda_{t+1} = \rho\lambda_t + \tilde{\varepsilon}_t; \rho = .95, \tilde{\varepsilon}_t \sim N(0;\sigma_\varepsilon^2); \sigma_\varepsilon = .00712$; $g^m(d_t)$=.1d_t ; μ=0.

Figures 1 and 2 display the Impulse response function of both models[15]. The mechanics underlying the delegated management model is seen to be profoundly altered. The starting point is the much more sober reaction of investment to the productivity shock yielding, as expected, a much smoother behavior for the investment series (Relative SD(i) is about one third of its value in the reference Hansen (1985) economy). The natural consequence of this fact is to make consumption absorb a larger proportion of the shock and be more variable (Relative SD(c) is multiplied by almost 3). This in turn means that the marginal utility of consumption is very responsive to the exogenous shock implying that the reaction of labor supply required to maintain the equality in (16) is smaller. That is, the reactivity of employment to the shock is significantly smaller, yielding a weaker propagation mechanism and a smoother output: SD(y) falls from 1.8 % to 1%, and the standard deviation of the exogenous shock process must be increased by about 75% to restore the aggregate volatility of the economy to its observed level.[16]

This discussion underlines the profoundly different dynamics resulting from (18) as opposed to (17) even when u(.) = v(.) and $\beta^m = \beta$. It highlights the fact that the key (for macrodynamics) investment decision is, in a delegated management economy, in the hands of an agent, the manager, whose preferences are inherently very different from those of the representative shareholder-worker. Given the peculiar nature of the optimal contract, one is left wondering under what circumstances the properties of the

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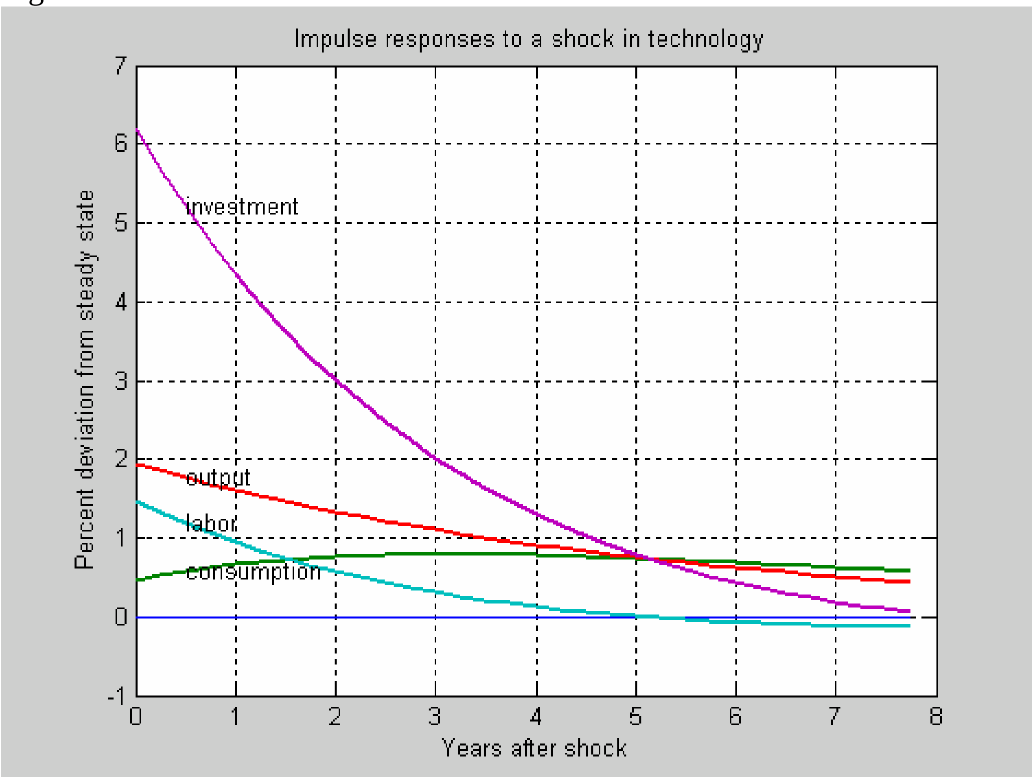
[15] These are the products of computing the dynamic equilibria of the model with the help of the algorithm provided by Harald Uhlig (http://www.wiwi.hu-berlin.de/wpol/html/toolkit/version4_1.html).

[16] These results stand in sharp contrast to the implications of models built upon the Jensen (1986) hypothesis that managers will invest all available free cash flow to build empires, a feature that tends to accentuate the volatility of investment, to enhance its procyclicity and to strengthen the propagation mechanism. The Dow et al (2003) model, in particular, replicates quite well a limited set of business cycle stylized facts, and most especially the volatility of investment. It is a model, however, in which the manager does not undertake an actual investment decision except in the most trivial sense. In addition, the shareholder-owners are presumed to retain a detailed knowledge of the firm's production process, a hypothesis we have, realistically we believe, proposed to relax.

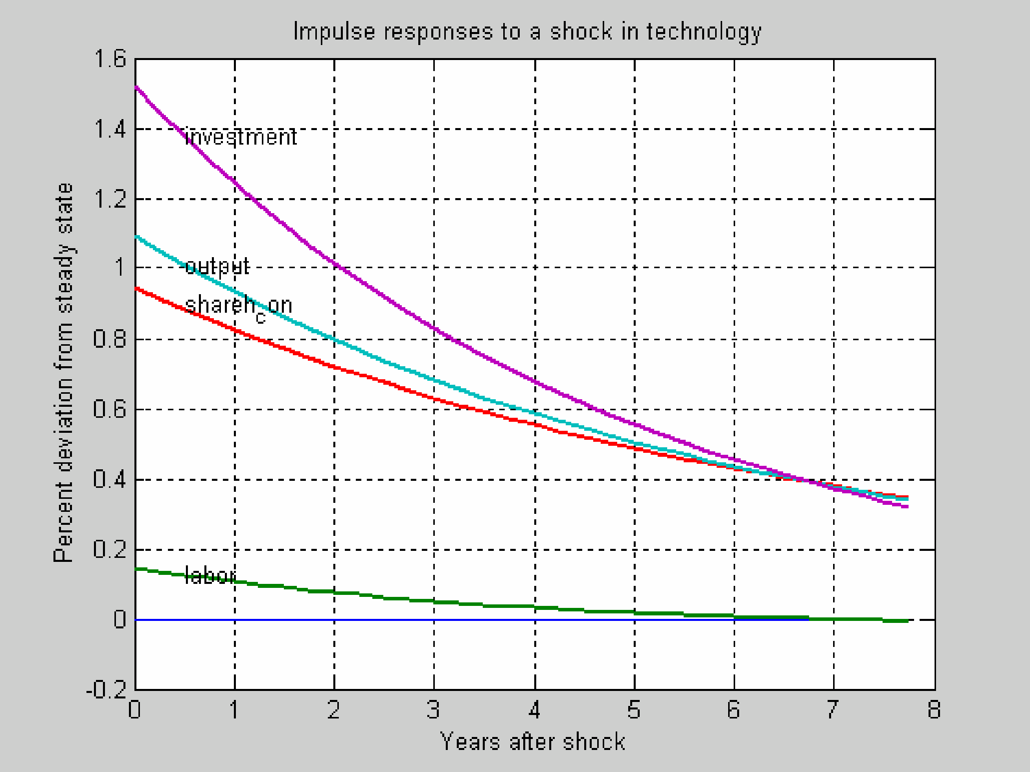
investment series will indeed be compatible with the IMRS of the representative shareholder. In other words, while it is clear that the adjunction of corporate governance considerations does not strengthen the descriptive power of the neo-classical stochastic growth model, one is left with the suspicion that omitting such considerations lead to a massive overstatement of the descriptive performance of the standard RBC paradigm[17].

Figure 1: Indivisible labor model IRF's



[17] This perspective, however, suggests an increase in corporate governance problems as a possible contributing explanation to the decrease in the aggregate volatility of the US economy.

Figure 2: Delegated management model IRF's



5.2 Effects of non linear one-period contracts on free cash flow

It is quite natural to attempt to correct the timidity of the manager in his investment decisions by endowing him with a convex contract. In this subsection we set out to verify the validity of this intuition. To this end, we relax the assumption of a linear g^m contract and explore the extent to which a non-linear one-period contract can mitigate the conflict of interests between firm owners and the manager. We start with contracts of the form

(20) $$g^m(d_t) = M(\bar{d})^{1-\theta}(d_t)^{\theta},$$

where $\bar{d}$ is the average free-cash-flow level when $\theta = 1$. The constant term is designed to insure that the average manager's remuneration is little affected by changes in the curvature of the function; M corresponds to the fraction of free-cash-flows accruing to the manager. Our rationale for exploring the implications of such contracts is the presence of the first derivative of the remuneration function as the modifier to the IMRS of the manager in equation (18). With contract specified as per (20) and a CES utility function for the manager, $v(c_t^m) = \dfrac{(c_t^m)^{1-\gamma}}{1\text{-}\gamma}, \gamma > 0,$ the marginal utility term in the RHS of (8) takes the form:

$$v_1(g^m(d_t))g_1^m(d_t) = \theta[M(\overline{d})^{1-\theta}]^{1-\gamma}(d_t)^{\theta(1-\gamma)-1}$$

and the effective IMRS of the manager becomes:

$$\beta^m \frac{v_1(g^m(d_{t+1}))g_1^m(d_{t+1})}{v_1(g^m(d_t))g_1^m(d_t)} = \beta^m \left(\frac{d_{t+1}}{d_t}\right)^{\theta(1-\gamma)-1}. \tag{21}$$

Expression (21) provides the basis for the following:

Theorem 5.1. Under contract (20), the manager's effective risk aversion results from a combination of his subjective coefficient of risk aversion and the curvature of the contract. It is given by the expression: $1-\theta(1-\gamma)$.

In practice this result implies that an economy with γ = 3 and a linear contract ($1-\theta(1-\gamma)$ =3) is observationally equivalent (except for the volatility of the manager's consumption and its correlation with output) to one where γ = 2 and θ = 2 or γ =4 and θ = 2/3, etc.

It has the following corollary implications:

Corollary 5.1. If the manager has logarithmic utility (γ =1), then his investment decision cannot be influenced by the curvature of the remuneration contract and the results of Section 5.1 apply for all values of θ.

Corollary 5.2. If the manager is less risk averse than the log ($(1-\gamma) > 0$), then indeed a convex contract $\theta > 1$ makes the manager's effective rate of risk aversion smaller than his subjective rate of risk aversion, thus leading to a more aggressive investment policy. For the FOC on investment to be necessary and sufficient, the effective measure of risk aversion must be larger than unity, however, requiring that θ be strictly smaller than $\frac{1}{1-\gamma}$.

Corollary 5.3. If the manager is more risk averse than the log, $(1-\gamma)<0$, then the larger θ, the *more effectively risk averse* the manager becomes.

In this context if one wants the manager to behave more aggressively, that is, for his effective measure of risk aversion to be larger than his subjective rate of risk aversion, one would rather propose a concave contract (θ < 1)! Note that there is no way to make the manager effectively less risk averse than the log if his γ is larger than 1, short of proposing a contract with θ < 0 ! For the exponent of the effective IMRS to be negative, one needs $\theta > \frac{1}{1-\gamma}$.

Corollary 5.4. If the only source of conflict between the manager and the shareholder is heterogeneity in their attitude toward risk, then an appropriately designed (that is, with the right curvature θ) short term contract of the form (20) can perfectly resolve the conflict and insure the desired investment policy will be followed in a delegated management environment. This is true, however, only if the manager's utility function is not logarithmic.

The upshot of these results is that the only plausible case where a short run non-linear contract is likely to have the desired effect is the case where the manager is less risk averse than the log and he is offered a convex contract. Table 2 displays the results obtained for several convex contracts when the manager's rate of risk aversion is ½.

Table 2: Delegated Management Economy: $\gamma = ½$; convex contracts, various θ

	Standard Deviations in %					Correlation with output				
θ	1.5	1.9	1.95	1.96	IL*	1.5	1.9	1.95	1.96	IL*
y	1.07	1.37	1.65	1.77	1.80	1.00	1.00	1.00	1.00	1.00
c^m	1.01	7.53	14.02	16.78		-.81	-.89	-.89	-.89	
d	.67	3.96	7.19	8.56		-.81	-.89	-.89	-.89	
c^s	.85	.73	.69	.70	.52	1.00	.94	.76	.65	.87
i	1.73	3.43	5.09	5.79	5.74	1.00	.98	.97	.96	.99
k	.15	.28	.38	.42	.49	.32	.43	.48	.50	.35
n	.23	.73	1.21	1.42	1.37	.97	.94	.93	.93	.98
w	.85	.73	.69	.70		1.00	.94	.76	.65	
r^k	.037	.047	.06	.06	.06	.99	.98	.97	.97	.96

* Indivisible Labor economy with log utility
Other parameter values as in Table 2

Table 2 shows that it is possible to get very close to the time series properties of the indivisible labor economy, but to obtain that result we have to make the manager effectively almost risk neutral. With $\theta = 1.96$ and $\gamma = ½$, the exponent of dividend growth in the IMRS is $\theta(1-\gamma)-1=-.04$. Note that with these parameter values, the variability of manager's consumption becomes quite extreme[18]. Moreover the manager's consumption is then highly countercyclical. Essentially what these results stress once again is the importance of operating leverage translating into naturally countercyclical free-cash-flows. The incentive dimension of the manager's contract then has the natural property of inducing a countercyclical consumption path. To avoid this undesirable characteristic, a risk averse manager is led to moderate the response of investment to a favorable productivity shock. The more risk averse, that is the lower the elasticity of intertemporal substitution, the more pronounced is this effect. On the contrary, if the manager is almost risk neutral or if his contract makes him effectively close to risk neutral relative to changes in dividends, then he becomes again freer to react to the pull effect on investment of a positive productivity shock.

[18] As an application of Theorem 5.1, let us observe that the same macroeconomic dynamics would be obtained in an economy where the manager's risk aversion is $\gamma = 2$ and the contract curvature is $\theta = -.98$. The only (important) difference is that with such a contract the manager's consumption would turn pro-cyclical: $\rho(y,c^m)=+.89$ instead of -.89.

These results suggest that the RBC model could be reinterpreted as descriptive of the time series of an economy where corporate governance problems are present but have been resolved in the manner just described via appropriately designed remuneration contracts. The problem with this interpretation, as the present context has made clear, is that the right contract has to be extremely precisely fine tuned to the exact degree of risk aversion of the manager. Furthermore, a log-utility manager cannot be so manipulated. Finally Corollary 5.3 suggests that when the manager is too risk averse, that is, too unwilling to substitute consumption intertemporally, there is no recourse but to propose him with a remuneration that is negatively correlated with the growth of free-cash-flows. While this appears counter-intuitive at first sight, it may help rationalize some observed practices that are often heavily criticized in the press and the public.

5.3 Manager's contract with a fixed component and outside income.

The limited power of contract curvature to align the interests of the manager with those of shareholders in this context leads us to explore the potential of contracts that would more clearly mimic the remuneration characteristics of shareholder-workers. In addition we now fully take into account the possibility of the manager deriving outside income from his blind trust portfolio.

In the standard RBC model, shareholder-workers derive the largest fraction of their income from wages. Our discussion so far suggests the importance of attempting to replicate these proportions in order for the manager to enjoy an income base that approximates shareholder-workers'. Because we do not want to propose contracts that would inherently introduce new distortions, we refrain from tying up manager's remuneration to the level of wages, to the wage bill or to the level of output (see Section 3). We rather assume that the proposed remuneration consists of a fixed component and an incentive based component, the latter being, as before, a function of free-cash-flow. We are interested in particular in testing whether such contracts have a better chance to align the interests of the manager with those of shareholders and, if so, what should be the relative proportions of the fixed and the variable parts. The answers to these questions are provided in Table 3 where we assume a log utility manager of measure μ approximately equal to 1%. By this we mean that the baseline case will be one where he receives about 1% of the steady state wage bill (itself corresponding to 70% of income), 1% of aggregate dividends as a result of his portfolio holdings, and 1% of the firm's dividends as incentive compensation. The characteristics of the economy are absolutely identical when this number is 2% or ½ % instead of 1%, that is, if the three components of the manager's income are increased or decreased simultaneously (while maintaining the assumption that he is approximately of measure zero).[19]

The form of the manager's remuneration is thus given by

(22)
$$g^m(d_t) = \ell M(\alpha y^{ss}) + M(\bar{d})^{1-\theta}(d_t)^\theta, \text{ and}$$
$$c_t^m = g^m(d_t) + \mu d_t$$

where ℓ is a parameter representing the relative importance of the fixed component and y^{ss} stands for the steady-state GDP level. When ℓ = 1, the fixed and the incentive components in the manager's remuneration are proportional. For reference we report the results obtained when the fixed component is absent (ℓ = 0). Then we increase the relative size of the fixed component to make it 3% (ℓ = 3) and even 8% (ℓ = 8) of the steady state wage bill.

[19] One may reasonably argue that managers' remuneration should be more than proportional to their measure in the economy: they are better paid than the average worker; M>μ. The adopted hypothesis leads to maximizing the role of outside income without altering the main point of this subsection. See the next footnote, however.

Table 3: Delegated Management Economy: $\gamma = 1$; linear contracts; M=1%; $\mu = 1\%$

	Standard Deviations in %					Correlation with output				
ℓ	0	1	3	8	IL*	0	1	3	8	IL*
y	1.01	1.07	1.20	1.46	1.80	1.00	1.00	1.00	1.00	1.00
c^m	.12	.17	.20	.19		.26	-.88	-.89	-.89	
d	.12	.69	2.04	4.98		.26	-.81	-.88	-.89	
c^s	.87	.85	.79	.71	.52	1.00	1.00	.99	.90	.87
i	1.41	1.74	2.44	3.95	5.74	1.00	1.00	.99	.97	.99
k	.12	.15	.21	.31	.49	.26	.32	.38	.45	.35
n	.14	.23	.44	.88	1.37	.99	.97	.95	.93	.98
w	.87	.85	.79	.71		1.00	1.00	.99	.90	
r^k	.03	.04	.04	.05	.06	.99	.99	.98	.98	.96

* Indivisible Labor economy with log utility; $y^{ss} = 1.12$. Other parameter values as in Table 2

The first lesson of Table 3 is a confirmation of the role played by the natural counter-cyclicity of dividends. Without fixed remuneration the manager decides on investment expenses compatible with his consumption being pro-cyclical. This leads to a very smooth behavior of investment. With a fixed component in his remuneration (proportional to his importance in this economy, but nevertheless much larger than the variable component), the time series properties of dividends and of the manager's consumption are dissociated. When ℓ goes from 0 to 1, the variability of investment increases by 23% and dividends move from being positively correlated with output to a correlation with output of -.81. Yet this change in the parameter ℓ is largely insufficient for the properties of the delegated management economy to approximate those of the standard business cycle model. For that to be the case the relative weight of the fixed component of the manager's remuneration must be larger than 8 times the weight of the variable "incentive-based" component, which is considerable (this case is provided for illustrative purpose only since for this parameter value the hypothesis that the manager's consumption does not directly impact shareholders because he is approximately of measure zero becomes untenable).[20]

We have focused in this paper on the natural conflict of interests between shareholders and managers arising from market clearing conditions. In so doing we have largely bypassed the other sources of conflicts of interests emphasized by the microeconomic literature and motivating incentive-based contracts. The results of this section suggest that to resolve the conflict of interests arising from macro considerations, the incentive component of managers' remuneration should be toned down considerably. There does seem to be a conflict between the incentive compatibility conditions resulting from a micro perspective and those arising from a macro perspective.

In Table 4 we look at alternative parameterizations. First we observe again that if the manager is less risk averse than the log ($\gamma = ½$), it is easier to have him adopt a pro-cyclical investment policy. This translates into the fact that a linear contract with $\ell = 8$ now assures an almost perfect match with the time series properties of the indivisible labor model (the SD(y)=1.78 in this case as opposed to SD(y)=1.46 in the similar case of Table 3 where the rate of risk aversion is $\gamma = 1$). If we assume away the manager's outside income, this result is even achieved with a proportionality parameter $\ell = 4$.[21] Alternatively, with a rate of risk aversion of $\gamma = ½$ it is possible to combine the effects of a convex contract with those of a remuneration with a fixed component. With a fixed component ($\ell = 2$), a small degree of contract curvature ($\theta = 1.052$) is sufficient to achieve an almost perfect match with the time series of the indivisible labor model. In this situation the contract curvature transforms the

[20] In the absence of outside income and with a manager of measure 1%, the time series properties for the case of $\ell = 8$ would be obtained for $\ell = 4$.
[21] The data are identical to those reported in the first column of Table 3.

moderately risk averse manager (γ =1/2) into an agent with effective risk aversion of 1-θ(1-γ) = .474 (Theorem 5.1). The difference is small but sufficient to lead the manager to alter the properties of his investment decisions in a striking fashion. If we abstract away from outside income, the same result is even achieved with ℓ =2 and θ = 1.019, or with ℓ =1 and θ = 1.055. In the case of a less-risk-averse-than-log manager, a remuneration combining appropriately a fixed component with an incentive element that is a convex function of free cash flow thus appears as a powerful way for shareholders to resolve the conflict of interests. It is, however, one that requires a delicate calibration around the manager's exact measure of risk aversion.

Table 4: Delegated Management Economy: γ = 1/2 ; M=1%; μ = 1% except in the case marked No Outside Income (NOI) where μ =0 - Various ℓ and θ

	Standard Deviations in %					Correlation with output				
ℓ/θ	8/1.00	2/1.052	2/1.019 NOI	1/1.055 NOI	IL*	8/1.00	2/1.052	2/1.19 NOI	1/1.055 NOI	IL*
y	1.78	1.78	1.79	1.79	1.80	1.00	1.00	1.00	1.00	1.00
c^m	.34	1.24	.67	1.29		-.89	-.89	-.89	-.89	
d	8.74	8.71	8.83	8.77		-.89	-.89	-.89	-.89	
c^s	.71	.70	.71	.70	.52	.70	.63	.63	.63	.87
i	5.88	5.86	5.93	5.90	5.74	.96	.96	.96	.96	.99
k	.42	.42	.42	.42	.49	.49	.50	.50	.50	.35
n	1.44	1.44	1.46	1.45	1.37	.93	.93	.93	.93	.98
w	.71	.70	.71	.70		.70	.63	.63	.63	
r^k	.06	.06	.06	.06	.06	.97	.97	.97	.97	.96

* Indivisible Labor economy with log utility
Other parameter values as in Table 2

6. Remunerating the manager on the basis of the firm's market value

Here we extend the definition of the one-period contract to the pre-dividend market value of the firm. Indeed this may appear as a natural possibility, one that would better align the interest of the manager with those of the shareholders. In effect this contract is like offering shares of the firm to the manager (with the restriction that he cannot trade them during his tenure as a manager) before also remunerating him with a fraction of the firm's free cash flow. We show presently, under the simplifying assumption that the information of shareholders leads them to value the firm as the representative agent of the standard model, that such a generalization would lead to an investment decision determined by the unweighted sum of the IMRS of the two agent types in our economy.

If the contract is on the pre-dividend market value of the firm, equation (8) takes the form

$$v_1\left(c_t^m\right)g_1^m\left(q_t+d_t\right)\left[-1+\beta E\frac{u_1(c_{t+1})}{u_1(c_t)}(f_1\left(k_{t+1},n_{t+1}^f\right)\lambda_{t+1}+\left(1-\Omega\right))\right]$$
$$+\beta^m E\int v_1\left(c_{t+1}^m\right)g_1^m\left(q_{t+1}+d_{t+1}\right)\left[f_1\left(k_{t+1},n_{t+1}^f\right)\lambda_{t+1}+\left(1-\Omega\right)\right]dF\left(\lambda_{t+1};\lambda_t\right)=0$$

or assuming g^m linear once again:

(23) $$1=E\left\{\left[f_1\left(k_{t+1},n_{t+1}^f\right)\lambda_{t+1}+\left(1-\Omega\right)\right]\left[\beta\frac{u_1(c_{t+1}^s)}{u_1(c_t^s)}+\beta^m\frac{v_1(c_{t+1}^m)}{v_1(c_t^m)}\right]\right\}.$$

Thus with this contract shareholders make sure that their viewpoint (IMRS) is partially represented: in fact the investment decision now reflects the equally weighted *sum* of IMRS of both types of agents in this economy. It is the case, however, that under this contract an extra dollar of investment is valued twice in the manager's remuneration, first because it increases to-day's stock price as the market anticipates higher dividends tomorrow, second when this increase in dividend materializes tomorrow. Consequently relative to condition (8), FOC (23) leads to a substantial amount of overinvestment even in the steady state. Note that the solution to this overinvestment problem is obviously not in a contract that is based only on q_t and not on d_t, since in that latter case the manager would never be willing to payout dividends.

7. Conclusions

In this paper we have shown that in the general equilibrium of an economy where shareholders delegate the management of the firm, the key decision maker, the manager, inherits an income position that inherently leads him to make very different investment decisions than firm owners, or the representative agent of the standard business cycle model, would make. The conflict of interests is endogenous, that is, it does not result from postulated behavioral properties of the manager; it is generic, that is, it characterizes the situation of the "average" manager as a necessary implication of market clearing conditions; and, it is severe in the sense that, if it is unmitigated by appropriate contracting or monitoring, it results in very different macro dynamics.

An optimal contract exists in the case where the utility functions of the manager and of shareholders (but not necessarily their discount factors) coincide. This contract results in an observational equivalence between the delegated management economy and the standard representative agent business cycle model. Unfortunately, the optimal contract appears to be miles away from standard practice: the manager's remuneration should be tied to the firm's total income net of investment expenses, abstracting from wage costs. The intuition for this contract is clear: since the representative shareholder is first of all a worker, and in this respect the beneficiary of the wage bill, there is indeed a sense in which, from the viewpoint of shareholders, wages should not be considered as a cost to the firm's operations. Ignoring the wage bill thus promotes a better alignment of the interests of the agent with those of the principals.

Motivated by the obviously counterfactual properties of the optimal contract, we have explored the potential of simple real-world-like incentive schemes to resolve the conflict of interests. Our main result is as follows. In order to align the interest of a manager remunerated on the basis of the firm's operating results, which are obviously impacted by the wage bill, to those of stockholder-workers, for whom wage payments are not a cost, the manager must be highly willing to substitute consumption across time. If this is the case, he will be prepared to sacrifice his consumption in good times (accepting to delay dividend payments to finance large investment expenses) and he will respond sufficiently vigorously to favorable investment opportunities.

There are two ways to make the manager nearly risk neutral. The first is to offer him a non linear contract. Convex contracts are, however, no panacea. This is true first because a logarithmic manager is insensitive to the curvature of the contract. Second, a less-risk-averse-than-log manager does respond to convex contracts. For the conflict of interests to be fully resolved, however, it appears that extreme fine-tuning of the curvature of the contract is necessary requiring a very precise knowledge (by the firm owners who issue the contract) of his rate of risk aversion (or of his intertemporal elasticity of substitution). Third, if he is more risk averse than log, there is no solution but to propose an unconventional remuneration that is inversely related to the firm's results, paying high compensation when free cash flows are low and conversely.

An alternative way to make the manager less risk averse at the margin, if his preferences are described by a CRRA utility function, is to propose a remuneration with a fixed component in addition to the incentive-based element. This approach appears to have a better chance of realigning the interest of all parties in the contract and of reproducing the dynamics of the standard RBC model without delegation. If the manager is too risk averse (log or higher than log), the macro-based conflict of interests, however, requires a considerable downplaying of the incentive component of the manager's contract, a fact that could prove to be a serious constraint in environments where the more traditional external conflicts between agent and principal are at work.

Reconciling the viewpoints of a manager with powers of delegation and of a representative firm owner is thus no trivial task. Yet, short of an optimal contract or of perfect monitoring, that is, in situations where corporate governance problems between managers and shareholders are not adequately mediated, there is little chance that the IMRS of the representative agent will tell us much about the dynamics of investment.

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Appendix
Proof of Theorem 5.1:

$\Rightarrow$ Suppose that u( ) = v( ) and that the contract is one of pure sharecropping. We want to show that the investment and consumption functions are Pareto-optimal. Under the sharecropping contract,

$$v_1(c_t^m) = v_1(\varphi(y_t - i_t)) \text{, and}$$
$$u_1(c_t^s) = v_1((1-\varphi)(y_t - i_t)) \text{.}$$

By homogeneity,

$$\begin{aligned} v_1(\varphi(y_t - i_t)) &= \varphi^\Delta v_1(y_t - i_t), \text{ for some } \Delta, \\ &= \varphi^\Delta u_1(y_t - i_t), \text{ since u( ) = v( )}, \\ &= \frac{\varphi^\Delta}{(1-\varphi)^\Delta}(1-\varphi)^\Delta u_1(y_t - i_t) \\ &= \frac{\varphi^\Delta}{(1-\varphi)^\Delta} u_1((1-\varphi)(y_t - i_t)), \text{ by homogeneity.} \end{aligned}$$

Or,

$$v_1(c_t^m) = \psi u_1(c_t^s), \text{ for } \psi = \frac{\varphi^\Delta}{(1-\varphi)^\Delta} > 0. \qquad (24)$$

Equation (24) together with equation (19) implies equation (14) which is the Euler equation describing investment in the standard business cycle model. The equilibrium in the latter case is known to be Pareto optimal.

$\Leftarrow$ Suppose the investment function and the consumption allocation define a Pareto Optimum. Then,

$$v_1(c_t^m) = \psi u_1(c_t^s), \text{ or, since u( ) = v( ),}$$
$$u_1(c_t^m) = \psi u_1(c_t^s). \text{ Thus,}$$
$$u_1(c_t^m) = u_1(\psi^{\frac{1}{\Delta}} c_t^s), \text{ for some } \Delta,$$

by the homogeneity property. Since u_1( ) is continuous and monotone decreasing, it has an inverse. We may then write

$$u_1^{-1}(u_1(c_t^m)) = u_1^{-1}(u_1(\psi^{\frac{1}{\Delta}} c_t^s)).$$

Therefore,

$$c_t^m = \psi^{\frac{1}{\Delta}} c_t^s.$$

Since

$$c_t^m + c_t^s = y_t - i_t,$$
$$\psi^{\frac{1}{\Delta}} c_t^s + c_t^s = y_t - i_t$$
$$c_t^s (1+\psi^{\frac{1}{\Delta}}) = y_t - i_t$$
$$c_t^s = \frac{1}{(1+\psi^{\frac{1}{\Delta}})} y_t - i_t$$

Thus we identify

$$\varphi = 1 - \frac{1}{(1+\psi^{\frac{1}{\Delta}})}, \text{ and } 1\text{-}\varphi = \frac{1}{\frac{1}{(1+\psi^{\frac{1}{\Delta}})}}$$

and we have sharecropping. ■

<u>Proof of Corollary 4.1</u>

Let $g_t^m = \varphi(y_t - i_t)^\eta$, then

$$v_1(g_t^m)\frac{\partial g_t^m}{\partial i_t} = \left(\varphi(y_t - i_t)^\eta\right)^{-\gamma} \varphi\eta(y_t - i_t)^{\eta-1}(-1)$$
$$= -\varphi^{1-\gamma}(y_t - i_t)^{-\gamma\eta+\eta-1}$$

For the IMRS to be equal one thus needs $-\gamma\eta + \eta - 1 = -\gamma^s$ or $\eta = \frac{1-\gamma^s}{1-\gamma}$.

Pareto Optimality: It is immediate to observe that unless $\eta = 1$ and $\gamma = \gamma^s$, it will not be true that

$v_1(g_t^m) = \left(\varphi(y_t - i_t)^\eta\right)^{-\gamma} = \chi\left((y_t - i_t) - \varphi(y_t - i_t)^\eta\right)^{-\gamma^s} = \chi u_1(c_t^s), \forall t,$ for some constant χ.

■