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 has two components: an incentive component that must be proportional to free-cash-flow and a variable 'salary' component indexed to the aggregate wage bill. The incentive component is akin to a non-tradable equity position in the firm. In our context it is not sufficient to resolve the 'micro' level agency issues raised by delegation. Failure to properly index the 'salary' component of the manager's may result in severe distortions in the investment policy of the firm and significant macroeconomic consequences. Specifically if the 'salary' component is fixed the manager adopts an excessively passive investment policy resulting in a very smooth economy. If on the other hand the 'salary' component of the manager's remuneration is pro-cyclical and more volatile than in the optimal contract the reactivity of investment to the productivity shocks is exacerbated and the amplification mechanism can be increased significantly.

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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 entirely 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.

In the present paper we question the abstraction behind the standard framework. In reality, separation of ownership and control is the rule, at least for the all-important publicly traded companies, and it is all too clear that the degree of monitoring exercised by shareholders can be very loose. For the IMRS of the shareholder-worker-consumer to be represented, let alone predominant in the day-to-day operations of the firm, a contracting framework must be put in place which results in aligning the interests of managers and shareholders. We delineate the characteristics of such a contract and detail the macroeconomic implications of deviating from it.

In the micro literature, 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 may arise 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]. It implies that the IMRS of managers and of firm owners tend to 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, self-interested managers will make 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, delineate the optimal contract and explore the implications of deviating from it for the dynamic properties 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

[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. See also Guvenen (2003).
[2] This criticism also applies to less standard representative agent models such as those in the younger New Neo-classical Synthesis tradition.

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 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 sources of conflict between firm owners and the manager thereby setting the stage for the identification of an optimal contract in Section 4. The optimal contract requires not only endowing the manager with a non-tradeable equity share of the firm but also ensuring that the time series properties of the manager's stochastic discount factor and thus his consumption are identical to those of the firm owners. This latter condition in turn requires that the manager's remuneration also include a time-varying salary-like component whose properties are indexed on those of the aggregate wage bill. Section 5 looks at the consequences of deviating from the optimal contract. It highlights the strength of the generic conflict of interest that exists between managers and shareholders and various alternative ways to resolve it. Section 6 generalizes the set-up to a world with multiple firms while Section 8 concludes the paper.

2. The framework and modeling issues

For ease of exposition we start with the assumption that the entire economy's output is produced by a single perfectly competitive firm, a stand-in for a continuum

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[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.

of identical competitive firms. Section 6 discusses the extension to many firms. There is a continuum of identical agents, a subset of which – of measure μ - was selected at the beginning of time to manage the firm. We view these managers as acting collegially and thus refer to them collectively as "the manager".[4] The rest act as workers and shareholders. The manager is self-interested and he is assumed to make all the relevant decisions in view of maximizing his own intertemporal utility.

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 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. In particular, they lack sufficient information to compute optimal employment and investment levels and to issue contracts that would deter the manager from deviating from their preferred decisions.[5]

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

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[4] Nothing would be lost with making the assumption of a single manager (of measure zero) managing the firm and we will adopt it later on, particularly when our goal is to compare the delegated management economy with the standard representative agent business cycle model. Our approach is meant to make clear where the measure zero assumption turns out to matter.

[5] Importantly managers' superior information would make Arrow-Debreu markets non viable. We are in a world where assuming the manager should maximize Arrow-Debreu profits is not an option.

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. Our managers have standard preferences defined over consumption and their innate risk tolerance is identical to that of the shareholders. We rather concentrate on those conflicts that could arise endogenously as a result of the fact that, by the very nature of delegation, the manager's marginal risk preferences may differ from those of shareholders or, for that matter, those of the representative agent of the standard stochastic growth paradigm.

Telling a simple and consistent story requires resolving the following two 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[6].

The second 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 as will be obvious from what follows. 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 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

[6] This is a minor point in the sense that the optimal contract would lead to a first best labor supply decision on the part of the manager.

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 potential 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 to resolve the conflicts. 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. Note that these restrictions are part and parcel of the optimal contract detailed in Section 4. And since the optimal contract attains the first-best there are no welfare consequences attached to them.

Besides choosing their optimal consumption and portfolio investment streams, worker-shareholders are in charge of defining the form of the manager's compensation function, $g^m(.)$. 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. In line with much of the contracting literature, we assume that the base contract is made of two parts, a fixed ("salary") component that is potentially time-varying but is not dependent on variables influenced by the manager's decisions, and an incentive component that is a (linear or non-linear) function of some measure of the firm's performance. The latter is clearly affected by the manager's decisions. In general terms,

$$g^m(x_t) = A_t + g(x_t)$$

where A_t represents the manager's salary and x_t an appropriate measure of the firm's performance, a function of the manager's actions $x_t = x(i_t, n_t^f; k_t, \lambda_t)$. Given these considerations, the manager's problem can be written:

$$V^m(k_0,\lambda_0) = \max_{\{n_t^f, i_t\}} E\left(\sum_{t=0}^{\infty} \beta^t u(c_t^m)\right)$$

(1)

$$\begin{aligned}
&\text{s.t.} \\
&c_t^m \le g^m(x_t) = A_t + g(x_t) \\
&x_t = x(i_t, n_t^f; k_t, \lambda_t) \\
&d_t = f(k_t, n_t^f)\lambda_t - n_t^f w_t - \mu g^m(x_t) - i_t \\
&k_{t+1} = (1-\Omega)k_t + i_t; k_0 \text{ given.} \\
&c_t^m, d_t, i_t, n_t^f \ge 0 \\
&A_{t+1}, \lambda_{t+1} \sim dF(A_{t+1}, \lambda_{t+1}; A_t, \lambda_t).
\end{aligned}$$

In problem (1) the manager's (homogeneous) period utility function is denoted u( ); β is his discount factor, E is the expectations operator (we 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; (A_t,λ_t) follows a Markov process whose characteristics are summarized in the transition density 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, μg^m, the aggregate contractual payment to the managers and Ω is the constant depreciation rate of physical capital.[7] There is no dividend smoothing in our model and the dividend and free cash flow are thus identical; we use the terms interchangeably.

[7] 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

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 are aware of the aggregate state variables (k_t,λ_t) per se. 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 (the equilibrium share price) and d_t.[8] The representative shareholder-worker problem reads:

(2)
$$V^s(z_0, d_0, q_0, w_0) = \max_{\{z_{t+1}, n_t\}} E\left(\sum_{t=0}^{\infty} \beta^t [u(c_t^s) + H(1 - n_t^s)] \right)$$
$$\text{s.t.} \quad \begin{array}{l} c_t^s + q_t z_{t+1} \le (q_t + d_t) z_t + w_t n_t^s \\ d_{t+1}, q_{t+1}, w_{t+1} \sim dG(d_{t+1}, q_{t+1}, w_{t+1}; d_t, q_t, w_t), \end{array}$$

where u(·) is the consumer-worker-investor's (homogeneous) period utility of consumption, H(.) his utility for leisure; c_t^s his period t consumption, n_t^s 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 indicated variables. The period utility function is 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. The sources of conflict of interests

Problem (2) has the following recursive representation

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

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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.

[8] 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.

whose solution is characterized by the following relationships:

(3) $$u_1(c_t^s)w_t = H_1(1-n_t^s),$$

(4) $$u_1(c_t^s)q_t = \beta\int u_1(c_{t+1}^s)[q_{t+1}+d_{t+1}]dG(d_{t+1},q_{t+1},w_{t+1},d_t,q_t,w_t).$$ [9]

Note from (3) that the worker-shareholder (static)labor supply decision is independent on the probability distribution summarizing their information. 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) $$V^m(k_t,\lambda_t) = \max_{\{i_t,n_t^f\}}\left\{u\left(c_t^m\right)+\beta^m\int V^m(k_{t+1},\lambda_{t+1})dF(\lambda_{t+1},\lambda_t)\right\}.$$ [10]

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

(7) $$u_1\left(c_t^m\right)g_1^m(x_t)\frac{\partial x_t}{\partial n_t^f} = 0,$$

[9] 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).

[10] 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 u( ) and f( ) are increasing, continuous and bounded, and that $g^m(\ )$ is itself continuous and that dF(λ';λ) is continuous with the property that for any continuous h(k',λ'), $\int h(k',\lambda')dF(\lambda';\lambda)$ is also continuous in k and λ. In order for (7) and (8) to characterize the unique solution, the differentiability of u( ), $g^m(\ )$ and f( ) is required and $u(g^m(\ ))$ must be concave.

$$(8) \quad u_1\left(c_t^m\right)g_1^m(x_t)\frac{\partial x_t}{\partial i_t} = \beta\int u_1\left(c_{t+1}^m\right)g_1^m(x_{t+1})\left[f_1\left(k_{t+1},n_{t+1}^f\right)\lambda_{t+1} + (1-\Omega)\right]dF\left(\lambda_{t+1};\lambda_t\right),$$

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

In equilibrium, at all dates t,

$$(9) \quad (1-\mu)n_t^s = n_t = n_t^f \text{, and}$$

$$(10) \quad z_t = 1$$

$$(11) \quad y_t \equiv f(k_t, n_t)\lambda_t = (1-\mu)c_t^s + \mu c_t^m + i_t,$$

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

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

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,

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

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

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

Comparison of equations (13) with (3) and (7) make clear that for the standard optimality condition for employment to obtain, the measure of firm performance x_t must satisfy

$$\frac{\partial x_t}{\partial n_t^f} = \left[f_2\left(k_t, n_t^f\right)\lambda_t - w_t \right]$$

Similarly, for equation (14) to obtain from (8) it is necessary and sufficient that $\frac{\partial x_t}{\partial i_t} = -1$

Integrating these two conditions with respect to n_t^f and i_t, respectively, yields (up to a constant term):

$$x_t = f(k_t, n_t^f)\lambda_t - w_t n_t - i_t \equiv d_t$$

In other words if there is to be no first-order distortion, that would be manifest even in the steady state of this economy, the only appropriate measure of firm performance in our economy is free-cah-flow or dividend.

The intuition for this result is clear. Absent strong extraneous sources of conflicts of interest, it is sensible, in order to align the interests of managers and shareholders, to endow the former with a non-tradeable equity position, hence to a claim to a fraction of present and future dividends. For the rest of the paper we adopt this identification which is also consistent with the minimal information requirement we may want to impose on worker- shareholders.

Therefore, (3), (7) and (11) yield, in equilibrium,

(16) $$u_1\left(\frac{y_t - i_t - \mu c_t^m}{1-\mu}\right) f_2(k_t, n_t)\lambda_t = H_1(1-n_t)$$

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 <u>and</u> 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., $\frac{y_t - \mu c_t^m - i_t}{1-\mu} \simeq y_t - i_t, \forall t$.

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

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

while, together with (11), equation (8) yields

$$1 = \beta \int \frac{u_1(c_{t+1}^m) g_1^m(d_{t+1})}{u_1(c_t^m) g_1^m(d_t)} \left[f_1 \left(k_{t+1}, n_{t+1} \right) \lambda_{t+1} + \left(1 - \Omega \right) \right] dF\left(\lambda_{t+1}; \lambda_t \right) \tag{18}$$

Again equations (17) and (18) have a similar *form* and they yield the same steady state levels of investment and capital stock. In this sense we can assert that with the proposed contract there are no "micro"- incentive issues. But, while equations (17) and (18) have a similar form, they effectively differ in that the relevant IMRS need not be the same. In (17) the argument in the utility function of the representative agent is, of necessity the result of market clearing restrictions and equal to output net of investment, i.e., to aggregate consumption. No such "discipline" is necessarily imposed in the case of the consumption of the manager in a delegated management economy. In addition there is an additional distortion or "correction" to the manager's IMRS in the case of a non-linear incentive contract. All this suggests that it is unlikely, except by design of his contract, that the manager's consumption stream (or the representative manager's for that matter) will 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 principal.

4. Optimal contracting

The preceding discussion has placed us in position to outline the characteristics of an optimal contract. We know that the incentive component of the contract should be based on d_t , while the 'salary' component should be designed to achieve the equality

$$\frac{u_1(g^m(d_{t+1}))}{u_1(g^m(d_t))}\frac{g_1^m(d_{t+1})}{g_1^m(d_t)}=\frac{u_1(y_{t+1}-i_{t+1})}{u_1(y_t-i_t)}$$

It is easy to see that these conditions are satisfied with a linear contract of the form $g^m(d_t)=A_t+\psi d_t$, where the above condition, together with the homogeneity of the utility function, imposes

$$A_t+\psi d_t=\varphi(y_t-i_t)=\varphi(w_t n_t+d_t),\forall t\text{, for some } 0<\varphi\ll 1.$$

This is satisfied for

$$\varphi=\psi,\text{ and } A_t=\varphi w_t n_t$$

In other words, the link between the “fixed” salary component of the manager’s contract and the aggregate wage bill must be given by the power of the incentive component, that is, the fraction of free-cash-flow allocated to the manager. We thus obtain the following

Theorem 4.1: A contract $g^m(d_t)=A_t+\varphi d_t$ with $A_t=\varphi w_t n_t$ is necessary and sufficient for a Pareto optimal allocation of labor and capital.

Proof: see the 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 $\mu = 0$. Then under the linear contract $g^m(d_t)=A_t+\varphi d_t$ with $A_t=\varphi w_t n_t$, the delegated management economy exhibits the same time series properties as, and is thus observationally equivalent to, the representative agent business cycle model.

If we further assume a Cobb-Douglas production function: $f(k_t, n_t^f) = k_t^{\alpha}(n_t^f)^{1-\alpha}$. Then, the optimal contract effectively stipulates $A_t = \varphi(1-\alpha)y_t$. It may thus be interpreted as one where the incentive element is linear in free cash flow and the fixed component is pro-cyclical with $CORR(A_t, y_t) = 1$ and $SD_{\%}(A_t) = SD(y_t)$.

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.[11] With a positive measure of managers, it would be necessary 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.

In concluding this section it is worth stressing that the optimal contract must be understood as one where the incentive component depends on firm level performance as measured by free-cash-flow while the 'salary' component depends on the aggregate wage bill. In Section 6 we formalize this distinction in a more realistic economy with many firms each managed by a separate manager.

5. Consequences of deviating from the optimal contract

In this section we illustrate the depth of the potential conflict of interests between managers and shareholders and the consequences of deviating from the optimal contract by discussing the properties of an economy where the manager is offered a

[11] The measure zero assumption also eliminates any need to consider a possible participation constraint for the manager. There is no issue to make the manager at least as well off being a manager as the typical worker-shareholder.

linear contract on free cash flow with a constant through time salary component. In other words the precise form of the contract is

$g^m(d_t) = A + \varphi d_t = \varphi(1-\alpha)y^{ss} + \varphi d_t$. We show that the performance of the model deteriorates strikingly. Understanding why leads us to examine the case where

$g^m(d_t) = M\,\varphi(1-\alpha)y^{ss} + \varphi d_t$; that is, where the 'salary' component is fixed but takes a more than proportional importance in the remuneration of the manager.

We then discuss the potential of convex contracts for alleviating the investment distortions induced by a constant through time salary component.

5.1. A constant salary component

If the 'salary' component of the manager's remuneration is constant, the manager's IMRS essentially shares the time series properties of free cash flows or dividends, rather than those of aggregate consumption. This 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[12]. 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.

[12] 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.

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 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 under the circumstances of this subsection, such a consumption increase necessitates an increase in dividends, which obtains only if the response of investment to the shock is moderate enough.

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	1.14	1.00
c	.52	.29	.82	.72
i	5.74	3.19	2.11	1.85
n	1.37	.76	.34	.30
k	.49	.27	.18	.16

Note: same parameters for both economies: u( ) = log( ); $H(1-n_t)= Bn_t$, B = 2.85; α = .36, Ω=.025, $\lambda_{t+1} = \rho\lambda_t + \tilde{\varepsilon}_t; \rho = .95, \tilde{\varepsilon}_t \sim N(0;\sigma_\varepsilon^2); \sigma_\varepsilon = .00712$; φ = .01; y^{ss} = 1.14.

Figures 1 and 2 display the Impulse response function of both models[13]. 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 1.14 %, and the standard deviation of the exogenous shock process must be increased by about 62% to restore the aggregate volatility of the economy to its observed level.[14]

This discussion underlines the fact that if the 'macro' conflict of interests, originating in the specific income position of the manager, is not attended to, profoundly different dynamics result from (18) as opposed to (17). The key (for macrodynamics) investment decision is, in a delegated management economy, in the hands of an agent, the manager, whose income stream (and thus marginal preferences) are inherently very different from those of the representative shareholder-worker.

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[13] 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).

[14] 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.

Figure 1: Indivisible labor model IRF's

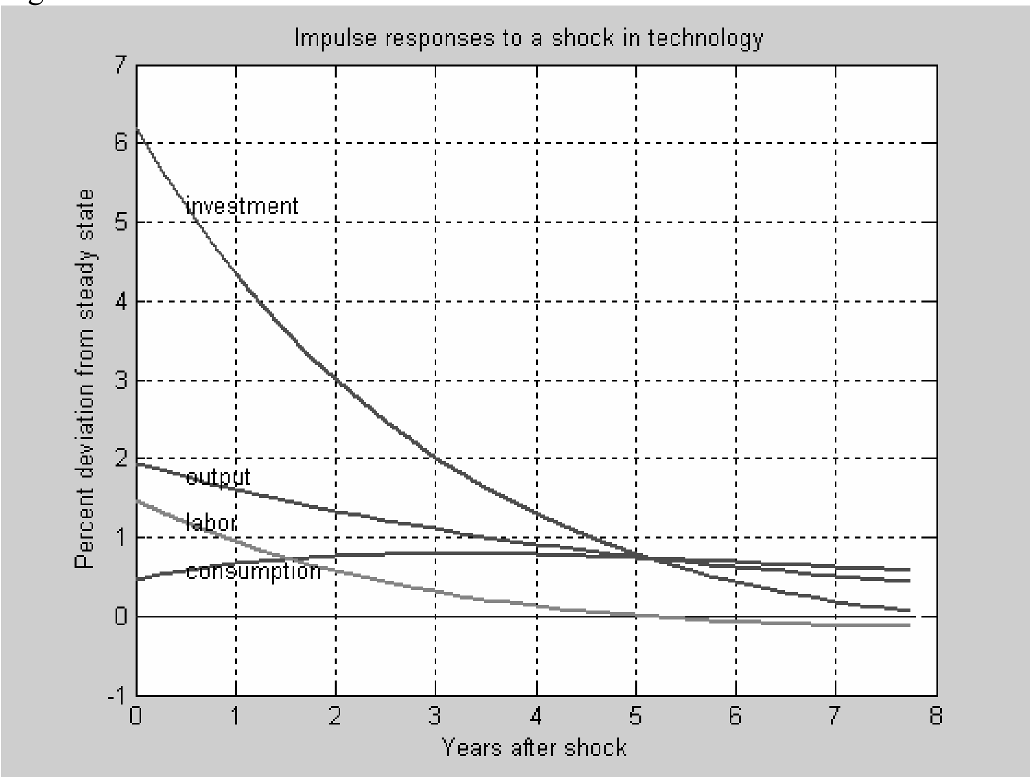
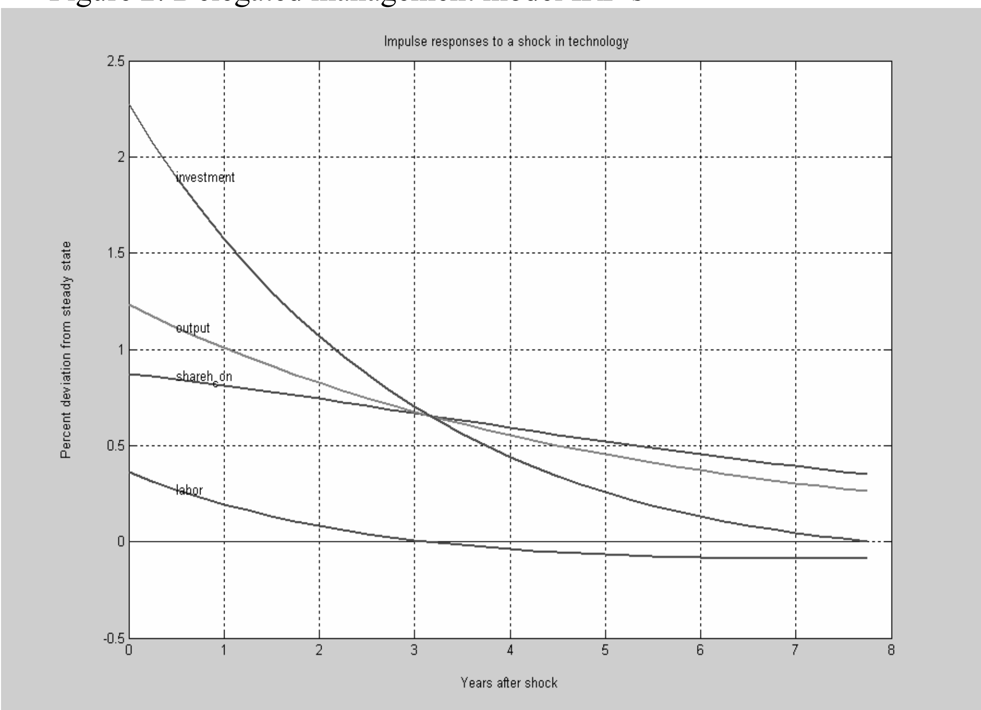


Figure 2: Delegated management model IRF's



In a sense these observations serve to underline the fact that in a general equilibrium principal-agent economy there may be a tension between the 'micro' necessity of aligning the interests of agent and principal - which we has led us to define the incentive component of the manager's remuneration as a function of counter-cyclical free-cash-flow - and the 'macro' conflict of interests that results when the time series properties of the manager's consumption are not close to those of the (pro-cyclical) aggregate consumption.

Is there a possibility of resolving the tension without resorting to the optimal contract? Increasing the size of the fixed component of the manager's remuneration may be an option. By doing so, we make the manager effectively less risk averse at the margin, or, in other words, more willing to substitute consumption across time. That is, he is prepared to accept a counter-cyclical consumption pattern consistent with the first best investment policy.

This intuition is borne out in the results of Table 2 where we assume a log utility manager contractually entitled to 1% of free-cash-flow. In the baseline case of Table 1, he would thus also receive 1% of the steady state wage bill.[15] We then progressively increase the relative importance of the 'salary' component by setting M to 3, and then 8 in the contract $g^m(d_t) = M\varphi(1-\alpha)y^{ss} + \varphi d_t$. We further illustrate the issue by also setting M=0, i.e., altogether dispensing with the fixed component of the contract.

[15] The characteristics of the economy are absolutely identical when this number is 2% or ½ % instead of 1%, that is, if the two components of the managers' income are increased or decreased simultaneously (while maintaining the assumption that they are approximately of measure zero).

Table 2: Delegated Management Economy: $\gamma = 1$; linear contracts; $\varphi = .01$; various M

	Standard Deviations in %					Correlation with output				
M	0	1	3	8	IL*	0	1	3	8	IL*
y	1.01	1.14	1.37	1.78	1.80	1.00	1.00	1.00	1.00	1.00
c^m	.13	.19	.20	.17		.26	-.87	-.89	-.89	
d	.13	1.38	3.89	8.62		.26	-.87	-.89	-.89	
c^s	.88	.82	.74	.71	.52	1.00	.99	.94	.64	.87
i	1.41	2.11	3.40	5.82	5.74	1.00	.99	.98	.96	.99
k	.13	.18	.28	.42	.49	.26	.36	.43	.50	.35
n	.14	.34	.72	1.43	1.37	.99	.96	.94	.93	.98
w	.88	.82	.74	.71		1.00	.99	.94	.64	
r^k	.04	.04	.05	.06	.06	.99	.99	.98	.97	.96

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

Table 2 confirms the role played by the natural counter-cyclicity of dividends. Without fixed remuneration (M=0) the manager decides on investment expenses compatible with *his* consumption being pro-cyclical. This leads to a very smooth behavior of investment. The column M=1 replicates the data of Table 1. The time series properties of dividends and of the manager's consumption are now somewhat dissociated. When M 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. For M=3, the volatility of investment and output increases to 3.4% and 1.37%, respectively. But for the economy's dynamics to approximate those of the indivisible labor model, one needs to increase the relative weight of the fixed component of the manager's remuneration to 8 times the weight of the variable incentive component. With this sort of contract, the manager is willing to accept a countercyclical consumption path and adopts an investment policy that is as responsive to productivity shocks as the representative agent of the indivisible labor model.

We focus in this paper on the natural conflict of interests between shareholders and managers arising from market clearing conditions. In so doing we largely bypass the other sources of conflicts of interests emphasized by the microeconomic literature and motivating incentive-based contracts. The results of this section suggest that the incentive component of managers' remuneration may have to be toned down considerably in order to resolve the conflict of interests arising from macro considerations. In this sense they suggest the possibility of a conflict between the incentive compatibility conditions dictated by micro considerations and those arising from the adopted macro perspective.

5.2 Effects of non linear one-period contracts

Given the prevalent use of convex incentive contracts in managerial compensation, it is natural to check whether convexity can be viewed as an appropriate response to the manager's timidity in his investment decisions whenever the salary component of his remuneration does not have the appropriate cyclical properties. 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 help align the interests of firm owners and managers. It turns out the intuition can be made sharper when the manager's contract has no fixed or salary component. We thus study contracts of the form

$$g^m(d_t) = \varphi(\overline{d})^{1-\theta}(d_t)^{\theta}, \qquad (19)$$

where $\overline{d}$ 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, θ, of the function; φ corresponds to the fraction of free-cash-flows accruing to a representative 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 a contract specified as per (19) and a CES utility function for the manager,

$v(c_t^m) = \frac{(c_t^m)^{1-\gamma}}{1-\gamma}, \gamma > 0,$ the marginal utility term in the RHS of (8) takes the form:

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

and the effective IMRS of the manager becomes:

$$\beta^m \frac{v_1(g^m(d_{t+1}))g_1^m(d_{t+1})}{v_1(g^m(d_t))g_1^m(d_t)} = \beta^m \left(\frac{d_{t+1}}{d_t}\right)^{\theta(1-\gamma)-1}. \qquad (20)$$

Expression (20) provides the basis for the following:

Theorem 5.1. Under contract (19), 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 $\gamma = 3$ 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 $\gamma = 2$ and $\theta = 2$ or $\gamma = 4$ and $\theta = 2/3$, etc.

It has the following corollary implications:

Corollary 5.1. If the manager has logarithmic utility ($\gamma = 1$), then his investment decision cannot be influenced by the curvature of the remuneration contract.

Corollary 5.2. If the manager is less risk averse than the log ($(1-\gamma) > 0$), then 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 $\theta > \frac{1}{1-\gamma}$.

This discussion suggests that, if an additional source of conflict between the manager and the shareholder is heterogeneity in their attitude toward risk, then that specific source of conflict can be resolved by appropriately (that is, with the right curvature θ) designing a short term contract of the form (19). This is true, however, only if the manager's utility function is not logarithmic, and it ignore the effects of any potential fixed component of remuneration.

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 3 displays the results obtained for several convex contracts when the manager's rate of risk aversion is ½.

Table 3: Delegated Management Economy: γ = ½ ; convex contracts with no salary component, 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 3 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.[16] With θ = 1.96 and γ = 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[17]. Moreover the manager's consumption then is 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.

[16] Here we rely, without proof, on the intuition that similar time series are likely to be the outcome of equally similar investment policies. Note that the capital stock process in the case of θ =1.96 of Table 3 is $k_t=.8023k_{t-1}+.1674\lambda_t$, while it is $k_t=.7986k_{t-1}+.1706\lambda_t$ in the m/θ = 1/1.054 case of Table 4.

[17] 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 γ =2 and the contract curvature is θ = -.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.

In Table 4 we check the possibility of combining the two dimensions discussed so far, a more than proportional fixed 'salary' component and a convex incentive component. First we observe again that if the manager is less risk averse than 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 M = 4 now assures an almost perfect match with the time series properties of the indivisible labor model.

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. A very close match with the time series of the indivisible labor model is obtained with M =3 and a degree of contract curvature $\theta = 1.007$, or with M= 2 and $\theta = 1.019$ or even with M=1 and $\theta = 1.054$.

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 in circumstances where the optimal contract cannot be offered. It is, however, one that requires a delicate calibration around the manager's exact measure of risk aversion.

Table 4: Delegated Management Economy: $\gamma = 1/2$; convex contracts with a fixed salary component; various M and θ

	Standard Deviations in %					Correlation with output				
M/θ	4/1.00	3/1.007	2/1.019	1/1.054	IL*	4/1.00	3/1.052	2/1.19	1/1.055	IL*
y	1.79	1.79	1.79	1.79	1.80	1.00	1.00	1.00	1.00	1.00
c^m	.34	.46	.67	1.29		-.89	-.89	-.89	-.89	
d	8.75	8.88	8.85	8.79		-.89	-.89	-.89	-.89	

c^s	.71	.71	.71	.70	.52	.63	.62	.63	.63	.87
i	5.88	5.95	5.94	5.91	5.74	.96	.96	.96	.96	.99
k	.42	.42	.43	.42	.49	.50	.50	.50	.50	.35
n	1.44	1.47	1.46	1.45	1.37	.93	.93	.93	.93	.98
w	.71	.71	.71	.70		.63	.62	.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

5.3. **What if the salary component is more variable than GDP?**

As a final step with this set-up, we study the implications of a contract where the salary component is appropriately tied to the behavior of the aggregate wage bill but whose relative size in relation to the incentive component is larger than in the optimal contract.

The contract we study is $g^m(d_t) = M\varphi(1-\alpha)y_t + \varphi d_t$, where

M is a proportionality coefficient taking values 1.2 or 1.5. In this context the salary component has the right degree of cyclicity but it is more variable in percentage terms than what is prescribed in the optimal contract. The results for the case of a logarithmic manager are collected in Table 5 .

In conformity with the intuition developed thus far one observes that with a pro-cyclical 'salary' component that is more variable than the aggregate wage bill, or alternatively whose time-series properties overcome those of the (counter-cyclical) incentive component, the investment decision can become significantly more reactive to the productivity shock than in the standard indivisible labor model. As a result the amplification mechanism is increased and with the same shock size the economy becomes much more variable.

Table 5 : Delegated Management Economy with variable salary component; $\gamma = 1$; Various M

	Standard deviation in %				Correlation with output			
M	1	1.2	1.5	IL*	1	1.2	1.5	IL*
y	1.79	2.09	2.86	1.80	1.00	1.00	1.00	1.00

c^m	.52	.64	.90		.87	.88	.87	
d	8.05	11.09	19.02		-.97	-.97	-.97	
c^s	.52	.47	.64	.52	.87	.64	-.18	.87
i	5.74	7.37	11.62	5.74	.99	.99	.99	
k	.49	.63	.97	.49	.35	.37	.38	.35
n	1.37	1.82	3.03	1.37	.98	.98	.98	.98
w	.52	.47	.64		.87	.64	-.18	
r^k	.06	.07	.10	.06	.96	.96	.94	.96

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

The lesson of this latter exercise is that if the non-incentive portion of the manager's remuneration is more variable than what is prescribed by the optimal contract, then separation of ownership and control may help rationalize observed macroeconomic fluctuations with a lower exogenous shock volatility than typically needed in the standard business cycle model.

6. Many firms

Our understanding of the interplay between the micro incentive issues and the potential macro conflict of interests between shareholders and managers justifies lifting the assumption of a single perfectly competitive firm. In this section we therefore explicitly model an economy with many firms, each of which is managed by a single manager of measure zero. The total measure of managers is μ. Each manager is offered a linear contract based on d_t^j as the measure of firm j's performance.

The representative manager j solves

$$V^j(k_0^j,\lambda_0^j,A_0^j;w_t) = \max_{\{n_t^j,i_t^j\}} E\left(\sum_{t=0}^{\infty}\beta^t u(c_t^{mj})\right)$$

s.t.

$$
\begin{aligned}
& c_t^{mj} \le g(d_t^j)=A_t^j + \varphi d_t^j \\
(21) \qquad & d_t^j = f(k_t^j,n_t^j)\lambda_t^j - n_t^j w_t - i_t^j \\
& k_{t+1}^j = (1-\Omega)k_t^j + i_t^j;\ k_0^j \text{ given.} \\
& c_t^{mj}, d_t^j, i_t^j, n_t^j \ge 0 \\
& (A_{t+1}^j,\lambda_{t+1}) \sim dF(A_{t+1}^j,\lambda_{t+1};A_t^j,\lambda_t)
\end{aligned}
$$

Worker-shareholders are perfectly diversified. They collectively hold the market whose total value is measured by q_t and are thus entitled to the aggregate dividend that we continue to identify as d_t. In addition, to the extent that individual firms do not go bankrupt (we do not assume limited liability) and that there is a competitive aggregate labor market their income is not tied to the specific firm they work for (alternatively we could make the standard assumption that they share their working time across all firms). Under these assumptions, problem (2) still perfectly represents the problem of the representative worker-shareholder.

We use the same strategy as before to derive the optimal contract. That is, we derive the necessary and sufficient first-order conditions for a solution to the representative agent problem and then insure that these conditions are reproduced in the context of many firms with delegated management under the optimal contract.

The representative agent problem reads[18]

$$\max_{\{n_t^j, i_t^j\}} E\left(\sum_{t=0}^{\infty}\beta^t[u(c_t)+H(1-n_t)]\right)$$

s.t.

$$c_t \le \sum_{j=1}^{J} c_t^j, \quad n_t \le \sum_{j=1}^{J} n_t^j,\ i_t \le \sum_{j=1}^{J} i_t^j, \text{ and } \forall j:$$

$$(22)\qquad c_t^j + i_t^j \le f(k_t^j, n_t^j)\lambda_t^j$$

$$k_{t+1}^j = (1-\Omega)k_t^j + i_t^j;\ k_0^j \text{ given.}$$

$$c_t^j, i_t^j, n_t^j \ge 0$$

$$\lambda_t^1, \lambda_t^2, .., \lambda_t^J \sim dG(\lambda_{t+1}^1, \lambda_{t+1}^2, .., \lambda_{t+1}^J; \lambda_t^1, \lambda_t^2, .., \lambda_t^J).$$

This problem yields the following first-order conditions:

$$(23)\qquad u_1(y_t - i_t)f_2(k_t^j, n_t^j)\lambda_t^j \ = \ H_1(1-n_t)$$

$$(24)\qquad u_1(y_t - i_t) = \beta\int u_1(y_{t+1} - i_{t+1})\left[f_1(k_{t+1}^j, n_{t+1}^j)\lambda_{t+1}^j + (1-\Omega)\right]dG(.,.)$$

By contrast, in recursive form problem (21) can be written as

[18] This central planning representation implicitly assumes that capital cannot be reallocated across firms once it has been installed. It is also implicit in the manager's problem (21).

$$V(k_t^j, \lambda_t^j; A_t^j, w_t) = \max_{i_{t+1}^j, n_t^j} \left\{ u(A_t^j + \varphi d_t^j) + \beta \int V((1-\Omega)k_t^j, \lambda_{t+1}^j, A_{t+1}^j) dF(.) \right\}$$

where we assume that dF(.)includes enough information to permit the manager j 's expectation of the future value of λ^j to be as precise as the expectation of the representative agent in (22). It includes as well the relevant information on the statistical process for A_t^j.

The FOC for this problem are as follows:

$f_2(k_t^j, n_t^j)\lambda_t^j = w_t$, which in conjunction with (3) yields (23) (provided the total measure of managers μ=0 and thus no consumption is "lost" for the shareholder-worker). As to the investment decision, one obtains:

$$u_1(c_t^{mj}) = \beta \int u_1(c_{t+1}^{mj}) \left[f_1(k_{t+1}^j, n_{t+1}^j)\lambda_{t+1}^j + (1-\Omega) \right] dF(.)$$

For the latter to correspond to (24), one must have

$$c_t^{mj} = \varphi c_t = \varphi \left[w_t \sum_{j=1}^{J} n_t^j + \sum_{j=1}^{J} d_t^j \right]$$

or

$$A_t^j + \varphi d_t^j = \varphi \left[w_t \sum_{j=1}^{J} n_t^j + \sum_{j=1}^{J} d_t^j \right], \text{ which requires}$$

$$A_t^j = \varphi \left[w_t \left(\sum_{j=1}^{J} n_t^j \right) + \sum_{j \neq i} d_t^i \right]$$

$$= \varphi(1-\alpha)y_t + \varphi \sum_{j \neq i} d_t^i$$

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 will lead 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.

We derive the properties of an optimal contract. This contract attains the first best and it results in an observational equivalence between the delegated management economy and the standard representative agent business cycle model.

The optimal contract has two components: an incentive component that must be proportional to free-cash-flow and a variable 'salary' component indexed to the aggregate wage bill. The incentive component is akin to a non-tradable equity position in the firm. In our context it is thus not sufficient to resolve the 'micro' level agency issues raised by delegation. Failure to properly index the 'salary' component of the manager's may result in severe distortions in the investment policy of the firm and significant macroeconomic consequences.

Specifically if the 'salary' component is fixed the manager adopts an excessively passive investment policy resulting in a very smooth economy. In order to align the interests of a manager so remunerated with those of firm owners, one must make him 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 more than proportional fixed salary component in addition to the incentive-based element. This approach appears to have a better chance of realigning the interest of all parties to 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.

On the other hand we show that if the 'salary' component of the manager's remuneration is pro-cyclical and more volatile than what is called for by the optimal contract the reactivity of investment to the productivity shocks is exacerbated and the amplification mechanism can be increased significantly.

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.

References

Benveniste, L. and J. Scheinkman, "On the Differentiability of the Value Function in Dynamic Models of Economics," Econometrica, 47, 727-732, 1979

Blackwell, D.,"Discounted Dynamic Programming," Annals of Mathematical Statistics, 36, 226-235, 1965

Blanchard, O. "Debt, Deficits, and Finite Horizons", The Journal of Political Economy, 93, 223-247, 1985

Brock, W.A., "Asset Prices in a Production Economy," in J.J. McCall, ed., The Economics of Information and Uncertainty (University of Chicago Press, Chicago, 1982

Danthine J. P., and J. B. Donaldson, "Labor Relations and Asset Returns," Review of Economic Studies, 69, 2002a, 41-64.

Danthine J. P., and J. B. Donaldson, "Decentralizing the Stochastic Growth Model", Cahier de recherche du DEEP 02.05, University of Lausanne, 2002b

Dow, J., Gorton G., and A. Krishnamurthy, "Equilibrium Asset Prices under Imperfect Corporate Control," NBER Working Paper 9758, June 2003

Guvenen, F., "A Parsimonious Macroeconomic Model for Asset Pricing: Habit Formation or Cross- Sectional Heterogeneity?", mimeo, U. of Rochester, 2003

Hansen, G., "Indivisible Labor and the Business Cycle", Journal of Monetary Economics, 16, 1985, 309-327

Jensen, M., "The Agency Costs of Free Cash Flow: Corporate Finance and Takeovers," American Economic Review, 76, 2, 323-330, 1986

Lucas, R.E.Jr., "Asset Pricing in an Exchange Economy", Econometrica, 46, 1429-1444, 1978

Philippon, Th., "Corporate Governance and Aggregate Volatility", mimeo MIT, 2003

Prescott, E.C. and R. Mehra, "Recursive Competitive Equilibrium: The Case of

Homogeneous Households," Econometrica, 48(1980), 1365-1379.

Shorish, S., and S. Spear, "Shaking the Tree: An Agency-Theoretic Model of Asset Prices", working paper, Carnegie-Mellon University, 1996.

Appendix (incomplete)

Proof of Theorem 4.1

$\Rightarrow$ Suppose the contract is of the form $g^m(d_t) = A_t + \varphi d_t$

Since

$$d_t = f(k_t, n_t^f)\lambda_t - w_t n_t^f - i_t - \mu(A_t + \varphi d_t)$$

$$(1+\mu\varphi)d_t = f(k_t, n_t^f)\lambda_t - w_t n_t^f - i_t - \mu A_t$$

(25) $$d_t = \frac{1}{1+\mu\varphi}[f(k_t, n_t^f)\lambda_t - w_t n_t^f - i_t - \mu A_t].$$

Given this definition, the N/S first order conditions for problem (1)-(6) solve

$$W^m(k_t, \lambda_t) = \max_{i_t, n_t^f} \left\{ \begin{array}{l} u\{A_t + \frac{\varphi}{1+\mu\varphi}[f(k_t, n_t^f)\lambda_t - w_t n_t^f - i_t - \mu A_t]\} \\ +\beta \int W^m[(1-\Omega)k_t + i_t, \lambda_{t+1}]dF(\lambda_{t+1}; \lambda_t) \end{array} \right\}.$$

They are

(26) $$\left(\frac{\varphi}{1+\mu\varphi}\right) u_1\{A_t + \frac{\varphi}{1+\mu\varphi}[f(k_t, n_t^f)\lambda_t - w_t n_t^f - i_t - \mu A_t]\} = \beta \int W_1^m[(1-\Omega)k_t + i_t, \lambda_{t+1}]dF(\lambda_{t+1}; \lambda_t)$$

(27) $$u_1\{\ \} \frac{\varphi}{1+\mu\varphi}[f_2(k_t, n_t^f)\lambda_t - w_t] = 0$$

where

$$W_1^m(k_t, \lambda_t) = u_1\{A_t + \frac{\varphi}{1+\mu\varphi}[f(k_t, n_t^f)\lambda_t - w_t n_t^f - i_t - \mu A_t]\} \frac{\varphi}{1+\mu\varphi}[f(k_t, n_t^f)\lambda_t + (1-\Omega)]).$$

Thus (26) becomes

(28)

$$u_1\{A_t + \frac{\varphi}{1+\mu\varphi}[f(k_t, n_t^f)\lambda_t - w_t n_t^f - i_t - \mu A_t]\} =$$

$$\beta \int u_1\{A_{t+1} + \frac{\varphi}{1+\mu\varphi}[f(k_{t+1}, n_{t+1}^f)\lambda_{t+1} - w_{t+1} n_{t+1}^f - i_{t+1} - \mu A_{t+1}]\}[f_1(k_{t+1}, n_{t+1}^f)\lambda_{t+1} + (1-\Omega)])dF(\lambda_{t+1}; \lambda_t)$$

The corresponding first order condition for labor supply by the shareholder worker is

(29) $$u_1(w_t n_t^s + d_t)w_t = H_1(1 - n_t^s)$$

In equilibrium $z_t = 1$ and $n_t^f = n_t^s$; thus (27) and (29) yield

(30) $$u_1\left(w_t n_t + d_t\right) f_2(k_t, n_t)\lambda_t = H_1(1 - n_t)$$

Substituting for the equilibrium value of $A_t = \varphi w_t n_t$, equations (26) and (30) become

(31) $u_1\{\frac{\varphi}{1+\mu\varphi}w_t n_t + \frac{\varphi}{1+\mu\varphi}[f(k_t,n_t^f)\lambda_t - w_t n_t \ - i_t]\} = u_1\{\frac{\varphi}{1+\mu\varphi}(y_t - i_t)\} =$

$$\beta\int u_1(\frac{\varphi}{1+\mu\varphi}(y_{t+1}-i_{t+1}))[f_1(k_{t+1},n_{t+1}^f)\lambda_{t+1}+(1-\Omega)]dF(\lambda_{t+1};\lambda_t)$$

and

(32) $u_1[\frac{1}{1+\mu\varphi}(y_t - i_t)]f_2(k_t,n_t)\lambda_t = H_1(1-n_t)$.

The homogeneity of u( ) implies that (31) can equivalently be written

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

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

It is well known that (32) and (33) are the necessary and sufficient conditions for the solution to problem (12) if $\mu = 0$. Theorem 4.2 follows. If $\mu \neq 0$, then it is clear that the labor supply decision of the shareholder-worker resulting from condition (32) will not be identical to the one obtained in the RBC model; however, equations (32) and (34) together make clear the fact that the intertemporal marginal rates of substitution of the two agents are identical as required for Pareto optimality. The sufficiency part of Theorem 4.1 follows.

<= Suppose that the joint DM-CWI equilibrium investment and labor service functions are P.O. choices from the perspective of problem (12), and assume $g_1^m(x_t) > 0$.

From the manager's problem (6), the necessary and sufficient first order condition with respect to labor is:

$$u_1(c_t^m)g_1^m(x_t)\frac{\partial x_t}{\partial n_t^f} = 0.$$

In order for labor to be allocated optimally is must be that

(35) $$\frac{\partial x_t}{\partial n_t^f} = f_2(k_t,n_t^f)\lambda_t - w_t$$

Furthermore, since the manager chooses the optimal investment function from the perspective ot problem (12), it must be that

(36) $$-u_1(y_t - i_t) = Lu_1\left(c_t^m\right)g_1^m(x_t)\frac{\partial x_t}{\partial i_t}$$

for some L>0.

Finally, in order for the optimal allocation of consumption to be P.O., we know from the Lemma below that

(37) $$g^m(x_t) = \psi(y_t - i_t)$$

for some $\psi > 0$.

Since u( ) is homogeneous, (36) and (37) imply

$$\begin{aligned} -u_1(y_t - i_t) &= Lu_1[\psi(y_t - i_t)]\psi\frac{\partial x_t}{\partial i_t} \\ &= Lu_1(y_t - i_t)\psi^{1+\Delta}\frac{\partial x_t}{\partial i_t} \end{aligned},$$

where Δ is the degree of homogeneity of u( ). Without loss of generality, choose $L = \frac{1}{\psi^{1+\Delta}}$, and thus

(38) $$\frac{\partial x_t}{\partial i_t} = -1.$$

Integrating (35) and (38), $x_t = x(i_t, n_t^f; k_t, \lambda_t) = f(k_t, n_t^f)\lambda_t - w_t n_t^f - i_t + B_t$, where B_t is unrelated to n_t^f and i_t.

Yet from (37),
$x_t = y_t - i_t$. Thus $y_t - i_t = y_t - w_t n_t^f - i_t + B_t$, and $B_t = w_t n_t^f$.
In equilibrium, $n_t = n_t^f$, thus $B_t = w_t n_t$, and the contract is
$g^m(x_t) = \psi(y_t - i_t) = \psi d_t + A_t$, where $A_t = \varphi w_t n_t$.

Lemma

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

$$\mu c_t^m + (1-\mu) c_t^s = y_t - i_t,$$

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

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

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

Thus we identify

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