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A Model of Corporate Governance As a System

by

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Abstract*

This paper provides a rationale for the coexistence of different systems of corporate governance based on the multitude of agency problems typically to be governed within a given firm. Because there are complementarity and substitution relationships between governance instruments, specific combinations of instruments which reinforce each other in minimizing agency costs fit together better than alternative combinations. We derive comparative static results showing how various governance instruments can be combined to form a coherent system of corporate governance and how changes in exogenous parameters can lead to simultaneous, systemic changes in the instruments used.

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List of Variables

$\overline{K}$	total investment
K_C	investment financed by debt
K_O	investment financed by equity
s	leverage (share of debt finance); at the same time the creditor's share in the liquidation value
D	liability created by debt finance
k_i	share of owner i in total equity K_O
e_1	manager's first period choice of investment project
x	1st period project return in the good state
p	probability of the 1st period good state
e_2	managerial effort in the 2nd period
Y	stochastic project return in 3rd period
y	mean of Y
s_y^2	variance of Y
m_O	owner monitoring of management
L	liquidation value of the project
m_C	creditor monitoring of the project
U	manager's utility function
A	stochastic managerial pay-off
r	manager's coefficient of absolute risk aversion
MCE	manager's certainty equivalent
$\overline{A}$	manager's expected pay-off
R	manager's ex ante risk premium
f	owners' share of the second period pay-off
c_O	unit cost of monitoring by owners
c_C	unit costs of monitoring by creditors
Π_O	vector of parameters determining unit monitoring costs of owners
Π_C	vector of parameters determining unit monitoring costs of creditors
$\hat{k}$	measure of ownership concentration
b	managerial bargaining power in case of willful default; captures leniency of bankruptcy law
R_D	the manager's ex post risk premium when bargaining after a willful default
TEPO	total 1st best expected pay-off
CEPO	creditor's expected pay-off
OEPO	owner's expected pay-off
TCE	total certainty equivalent pay-off of the project

1 Introduction*

The ongoing debate about reforming corporate governance has so far remained largely inconclusive. On the one hand, more active involvement by large investors with a long-term interest in firms has been advocated as a way to improve the performance of the market-based U.S. system of corporate governance (Jensen 1993, Chew 1997). On the other hand, relationship-based systems of corporate governance have come under criticism in the wake of the recent financial meltdown in several East Asian countries (Rajan and Zingales 1999). Issues of corporate governance have also come to the fore in the transition economies of Eastern Europe and the former Soviet Union (Aoki 1998).[1] The formal literature studies mostly individual governance instruments in isolation. Hence it is unable to explain satisfactorily the existence and use of such a variety of different instruments as is observed in reality. Nor is it able to explain what determines the choice of different combinations of instruments and what determines the efficacy of a system of corporate governance (Zingales 1998: 17). A systematic answer is missing to the questions why we typically see a menu of governance instruments at work in any given firm and in any given system, how different governance instruments interact to provide sound governance, and how inconsistencies within a system of corporate governance can lead to serious control failures. To answer these questions, it is necessary to focus on the *interdependencies* between various instruments of corporate governance (Berglöf 1997).

The present paper argues that the economic rationale for using combinations of governance instruments is that there is typically more than just one agency relationship to be governed within a given firm. Any one governance instrument will tend to mitigate one agency problem at the possible expense of aggravating others. In particular, we will argue that there are complementarity and substitution relationships between various governance instruments. Hence there are specific combinations of instruments which reinforce each other in minimizing agency costs and which therefore fit together better than alternative combinations.

For empirical research this implies that in order to capture the effects of a given governance instrument, care has to be taken to control for the presence or absence of other instruments which may substitute or complement the instrument under study. For the policy debate about reforming corporate governance it implies that reforms targeting single governance instruments in isolation may fail because they destroy the coherence of the governance system and that in

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1 Corporate governance reform is also on the agenda in the European Union (CAG 1998).

order to be successful, reforms may have to address the whole system of governance instruments.

In the following section, we present a model simultaneously featuring agency problems between managers and owners and between owners and creditors. The model builds on Gertner et al. (1994) and Holmström and Milgrom (1994). The third section derives comparative static results based on the notion that governance instruments can be complements or substitutes in reducing agency costs. The model shows how the choice of capital structure with its attendant liquidation threat, the ownership structure and the monitoring and control rights it creates, and pecuniary incentives for management interact with bankruptcy legislation and its enforcement and the regulation of the stock market. We show how various governance instruments can be combined to form a coherent system of corporate governance and how changes in exogenous parameters can lead to simultaneous, systemic changes in the instruments used. The fourth section concludes and suggests possible extensions of the model.

2 The Model

Our model has three periods. At the beginning of the first, manager, owners and creditors sign a contract specifying their mutual responsibilities and claims. Creditors and owners invest a total of $\overline{K} = K_c + K_o$ in the firm. The capital structure can be measured by the degree of leverage, i.e. the share of debt finance $s = \frac{K_C}{\overline{K}}$, so that $\overline{K} = \frac{1}{1-s} K_O$ with $0 \leq s \leq 1$. Debt finance creates a fixed liability of D (hence the interest rate agreed on in the contract is $\frac{D - K_C}{K_C}$).

The ownership structure is given by the distribution of K_O among n owners with ownership shares $k_i, \quad i = 1, \ldots n, \quad \sum_1^n k_i = K_O$. Ownership concentration will be measured below by a parameter $\hat{k}$ which could be e.g. the largest or the sum of the five largest k_i.

After the contract has been signed, the manager chooses among two alternative investment projects by making an unobservable decision $e_1 \in \{e_1^L, e_1^H\}$ (period 1). For reasons that will become clear below, this decision is assumed not to carry a direct cost of effort for the manager. The two alternatives are common knowledge. They differ only in their pay-offs in the third period.

In the second period, any chosen project generates a return of x with probability p and a return of zero with probability *1-p*. We assume that the first period return is non-contractible ex ante, which means that the manager cannot be forced directly to pay out the return to owners or creditors. This captures the free cash flow problem of Jensen (1986).

At the end of the second period, a decision is made whether to continue the project or to liquidate it. Continuation requires repaying the debt to creditors out of the first period cash flow. Obviously, if the first period return is zero, the debt cannot be repaid, and the firm is liquidated. Thus, as in Jensen (1986), debt can be used to extract part of the non-contractible free cash flow. If the project is continued, the manager chooses how much costly effort e_2 to exert in the second period. This decision is again unobservable.

In the third and final period, a further pay-off is realized and shared between owners and manager. We assume that owners are risk-neutral whereas managers are risk-averse. Together with the unobservability of managers' decisions this gives rise to the agency problem of separating control from ownership. Creditors get no further pay-off. The third period pay-off depends on the managers choices in the first and second period, but is measured with a stochastic error. Specifically, let the measure of the third period pay-off be Y and let its distribution be characterized by its mean $y(e_1, e_2)$ and variance σ_y^2.

The manager is assumed to be risk-averse. This, together with the stochastic nature of the third period return, implies that monitoring by risk-neutral owners and creditors can be valuable. By expending resources on monitoring m_O, owners can reduce the variance with which managerial effort is measured, i.e. $\frac{\partial \sigma_y^2}{\partial m_O} < 0$. This improves the trade-off between optimal managerial performance incentives and optimal allocation of risks along the lines of Holmström (1979).

If the project is liquidated, owners are assumed to get nothing. Creditors' pay-off depends on the liquidation value of the project. However, it is plausible to assume that their pay-off is not invariant to the size of their investment. Thus we assume that the creditors' pay-off is $s\,L$, with the balance *(1-s)L* going to management, e.g. as a form of severance payment. Since creditors do not care about the project return in the third period, but do care about the project's liquidation value, it is natural to assume that their monitoring efforts m_C not only reduce the variance of the third period return, but also have the effect of raising the liquidation value, i.e. $\frac{\partial L}{\partial m_C} > 0$ and $\frac{\partial \sigma_y^2}{\partial m_C} < 0$. We also assume that the returns to monitoring are decreasing. Moreover we assume that monitoring by owners and monitoring by creditors are substitutes in reducing the variance of the third period return: $\frac{\partial^2 \sigma_y^2}{\partial m_C \partial m_O} > 0$.

As will be seen below, the differences in pay-offs between creditors and owners give rise to an agency problem of debt because creditors prefer low-risk projects while owners prefer high-risk projects (Jensen and Meckling 1976).

Figure 1: Time Path of the Model

0	1	2	3
contract signed	project chosen; monitoring outlays chosen	state of nature realized; debt repayment or liquidation decision; manager chooses effort	state of nature realized; continuation value shared between owners and manager or liquidation value shared between creditor and manager

The manager is assumed to have constant absolute risk aversion.

(1) $$U(A) = -\exp(-rA),$$

where r is the coefficient of absolute risk aversion and A is the sum of pay-offs.[2] By contrast, we assume owners to be risk neutral. As discussed above, this assumption creates a role for monitoring in solving the agency problem of the separation of ownership from control. The manager's utility measure can be re-written in a certainty equivalent form which involves the sum of the agent's expected pay-offs corrected for a risk premium. The certainty equivalent of the manager is the hypothetical certain pay-off which would yield the same utility as the actual uncertain pay-off. In other words, the manager's certainty equivalent MCE satisfies

(2) $$U(MCE) = E\left[U(A)\right].$$

The certainty equivalent is

(3) $$MCE = \overline{A} - R,$$

where $\overline{A}$ is the expectation value of pay-offs and R is the risk premium.[3]

Under the simplifying assumption that the market interest rate available to investors outside the firm is zero, no discounting of future pay-offs to the present is required. Thus, expected pay-offs for a given project are as shown in Table 1.

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2 The coefficient of absolute risk aversion is defined as the negative of the ratio of second and first derivatives of the utility function: $r = -\frac{\partial^2 U/\partial A^2}{\partial U/\partial A}$.

3 This expression is an approximation for cases where the variance is not too large relative to the agent's coefficient of risk aversion and so the risk premium is relatively small. The expression as well as the expression for the risk premium R are derived from Taylor series expansions of the utility function around the expectation value and around the certainty equivalent. To specify R in more detail, specific assumptions on the variances and covariances of pay-offs would have to be introduced (see for instance Milgrom and Roberts 1992).

Table 1 — Expected Certainty Equivalent Pay-Offs

Agent	Expected Certainty Equivalent
Manager	$p\left[x - D + (1-f)y(e_1, e_2, K) - e_2\right] + (1-p)(1-s)\,L(m_C, e_1) - R$
Owners	$p\left[f\ y(e_1, e_2, K)\right] - c_O m_O - K_O$
Creditors	$pD + (1-p)sL(m_C, e_1) - c_C m_C - K_C$
Total	$p\left[x + y(e_1, e_2, \overline{K}) - e_2\right] + (1-p)L(m_C, e_1) - c_O m_O - c_C m_C - \overline{K}$

In Table 2, x is the first period return in the good state of nature, D is the debt repayment, y is the expected second period pay-off, assumed to be concave in second-period effort and in the capital outlay K, e_i, i = 1,2 are the manager's decisions, f is the owners' share of the second period pay-off, s is leverage, L is the project's liquidation value, $m_i, \quad i = O, C$ are monitoring efforts, R is the manager's ex ante risk premium, and $c_i, \ i = O, C$ are the unit costs associated with monitoring by owners and creditors, respectively.

Monitoring costs c_i will depend parametrically on vectors Π_i of parameters capturing the institutional environment. For creditors, these can include banks' access to inside information, and the toughness of the bankruptcy law.[4] For owners, monitoring costs can depend on the comprehensiveness of disclosure requirements, the stringency of accounting standards, and the transparency of the stock market.[5] Moreover, monitoring costs of owners will depend on the concentration of ownership.

In the case of monitoring by owners, we distinguish two scenarios. The first scenario is one of a highly transparent stock market with stringent disclosure and accounting rules and regulations protecting the rights of minority shareholders against potential abuse by large shareholders. By implication, the opportunities for large shareholders to influence the firm are tightly circumscribed in this stock market. A real world example would be the U.S. market.[6] We associate this with high values of the parameter vector Π_O. In this scenario on the one hand, the stock market can provide monitoring services (Holmström and Tirole 1993). On the other hand, even large shareholdings may not significantly reduce the costs of monitoring because of the limitations the stock market regulation imposes on large shareholder activity. In the extreme, concentrated shareholdings may even raise the costs of monitoring in this scenario

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4 For instance a tough bankruptcy law giving far-reaching control rights to creditors and imposing substantial penalties on managers in the event of financial distress can prompt managers to actively try to conceal the true financial situation of the firm from its creditors (Aghion et al. 1998). This non-cooperative behavior would raise monitoring costs for creditors.

5 Further parameters capturing aspects of the institutional environment in the model will be introduced below.

6 Large shareholder influence can be limited for instance by rules requiring investors to disclose their intention of building up a significant position in a firm, or by creating the opportunity for minority shareholders to sue for damages if large shareholder influence has led to a decline in the share price. See for instance Shleifer and Vishny (1997) or La Porta et al. (1997) for surveys of the regulation of stock markets in different countries.

because they reduce the liquidity of the stock and hence reduce the incentives for speculative traders to collect information on the firm.

In the second scenario, disclosure rules and accounting standards are less far-reaching and large shareholders are less regulated in their activity, as is typical of many continental European markets. We associate this with low values of the parameter vector Π_O. Under this scenario, ownership concentration clearly reduces monitoring costs because the stock market will at best provide limited monitoring services. Failing this, owners must monitor at their own expense. Since monitoring is a public good, it is most effectively provided by large shareholders. Avoiding wasteful duplication of monitoring with large numbers of small owners would entail substantial coordination costs.

Thus with high values of the parameters Π_O, an increase in ownership concentration will result in a small decrease in monitoring costs at best (and may even result in an increase). With low values of the parameter vector by contrast, an increase in ownership concentration will achieve a significant reduction in monitoring costs, i.e.

(4) $$\frac{\partial^2 c_O}{\partial \hat{k}\, \partial \Pi_O} > 0,$$

where $\hat{k}$ is a measure of ownership concentration such as the largest single stake or the sum of the five largest stakes.

The liquidation value L is assumed to be a decreasing function of the manager's project choice

(5) $$\frac{\partial L}{\partial e_1} < 0.$$

By contrast, the expected second-period pay-off is assumed to be increasing in the manager's project choice

(6) $$\frac{\partial y}{\partial e_1} > 0 \quad \forall e_2.$$

We thus have

(7) $$y\left(e_1^H, e_2\right) > y\left(e_1^L, e_2\right) > L\left(e_1^L, m_C\right) > L\left(e_1^H, m_C\right) \quad \forall e_1^H > e_1^L.$$

Thus projects chosen by low e_1 are less risky from the point of view of society than projects chosen by high e_1. This assumption creates the agency problem of debt. The creditor would expect to benefit from a higher liquidation value, whereas the owners would not. Therefore, owners will prefer more risky projects associated with high e_1, while creditors will tend to favor less risky projects associated with low e_1. In particular, we will assume that the agency problem of debt gets more severe, the more strongly the firm relies on debt financing. The severity of the agency problem of debt can be measured by comparing the first-order conditions (FOCs) of owners and creditors with respect to first period effort e_1. The presence of the agency problem implies that creditors will prefer a lower e_1 than owners. The agency problem is more severe the greater the gap between the effort levels desired by creditors and owners. We return to this below when we discuss the FOCs of the various parties.

Moreover, the fact that the liquidation value is decreasing in the first period effort and the trade-off this creates between raising e_1 to achieve a high third period pay-off and lowering it to achieve a high liquidation value means that we do not need to assume e_1 to be costly to the manager in order to get an interior solution. Hence we assume that the only opportunity cost of high e_1 is a low liquidation value.

Since the continuation value exceeds the liquidation value in both projects, liquidation is always inefficient. Therefore the parties have an incentive to renegotiate in the second period in order to avoid liquidation. However, we introduce a commitment problem in that the creditor cannot force the manager or the owner to share the third period cash flow ex post. Hence renegotiation is feasible only if it involves an ex ante payment from the manager or the owner to the creditor. We assume that neither the manager nor the owner has any free wealth outside the firm. As a consequence, liquidation cannot be avoided in the bad state of nature when the first period return is zero.[7]

By contrast in the good state of nature the manager has the first period return x available and so is able to make an upfront payment to the creditor.[8] Thus inefficient liquidation can be avoided in the good state. But the possibility of ex post renegotiation in the good state will be recognized at the initial contracting stage. Thus any outcome that could be achieved through renegotiation will be anticipated and will be implemented in the original contract already. In other words, the possibility of renegotiation constrains the debt contracts which are feasible at the beginning. The amount of debt repayment D which prevents liquidation is agreed on in the initial contract. The manager will not agree to a payment which exceeds what he would have to pay the creditor in the good state in order to induce him not to liquidate the project after a default. In other words, the contractually agreed debt repayment must be renegotiation-proof.

If he liquidated the project, the creditor would obtain $s L$. Therefore this is what the manager has to pay to make the creditor enter renegotiations in the first place. Creditor and manager can then bargain over the surplus which project continuation is expected to yield over

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7 Without the commitment problem, the parties to the contract could always bargain out of liquidation and so a conflict of interest between creditors and owners would not arise.

8 In an extension it would be possible to distinguish between alternative allocations of residual control and income rights. For instance, if the owners had the right to the first period return x, they would be the ones who could bargain with the creditor and could decide whether or not to default.

liquidation. Given that part of the continuation value has to be paid to owners, this expected surplus is $(1-f)y-L-e_2$, where both sides anticipate that, once continuation has been assured, the manager will choose second period effort e_2 according to his own best interest. Moreover, continuation of the project leads to the random return with expectation value y, whereas liquidation leads to the certain return *L*. Therefore the manager, being risk-averse, will subtract a risk premium from his willingness to pay R_D. Hence in order to avoid liquidation the manager will pay at most

$$\begin{aligned} D &= s\,L+(1-b)\left[(1-f)\,y-L-e_2\right]-R_D \\ &= (b-[1-s])\,L+(1-b)\left[(1-f)\,y-e_2\right]-R_D \end{aligned} \tag{8}$$

where b with $0 \le b \le 1$ captures the manager's bargaining power in the hypothetical event of a willful default. As such, b can be interpreted as a measure of how effectively bankruptcy can be enforced, or whether the bankruptcy law is more oriented towards the interests of debtors or towards those of creditors.[9] If bankruptcy enforcement is weak, or if the bankruptcy law favors debtors, the manager is in a strong bargaining position relative to the creditor (b is large), and the amount of debt repayment that can be enforced is low.

The risk premium R_D the manager would bear in the event of default and renegotiation can be shown to be

$$R_D = \frac{1}{2} r(1-b)^2\,(1-f)^2\,s_y^2\,, \tag{9}$$

where s_y^2 is the variance of the second period return.[10] The risk premium the manager requires is increasing in his degree of risk aversion as measured by *r*, as well as in the riskiness of the second period return, measured by its variance s_y^2. Moreover, the risk premium decreases in the manager's bargaining power, because a stronger bargaining power means that c.p. the manager gets to keep a higher portion of the certain first period return. The risk premium increases in the manager's share $1-f$ of second period pay-offs, because of the riskiness of second period pay-offs.

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9 Real world bankruptcy laws differ considerably in the extent to which they favor creditors or debtors. There is a vigorous debate about the relative merits of both approaches (Aghion et al. 1992, Bandhari 1996, Bebchuk 1998, Bebchuk and Fried 1998, Berkovitch and Israel 1998, Povel 1996). On the one hand, procedures that favor debtors, such as chapter 11 in the U.S. have the advantage of being more likely to avoid premature liquidation of viable firms. They achieve this by staying creditors, by leaving incumbent management in control during the bankruptcy proceedings, and through debtor-in-possession clauses which subordinate existing debt to any new debt the firm may take on. On the other hand, procedures favoring debtors run the risk of inhibiting the quick liquidation of unviable firms. Conversely, procedures that favor creditors tend to facilitate quick liquidations of unviable firms but may also result in unnecessary closures of viable firms.

10 Again, this is an approximation for cases where the variance is not too large relative to the agent's coefficient of risk aversion. Like the certainty equivalent itself, the expression is derived from Taylor series expansions of the utility function (Milgrom and Roberts 1992). See the appendix for a derivation of this result.

Finally note that in keeping with the argument that leverage is a way to extract free cash flow, higher *s* leads to more of the free cash flow being extracted from the manager, i.e. $\frac{\partial D}{\partial s} > 0$.

Solving the Model

As a benchmark, the total expected pay-off from society's point of view in the absence of agency problems would be

(10) $$TEPO = px + y(e_1, e_2) - e_2 - \overline{K}\,.$$ [11]

The first best solution would require marginal returns to effort to equal the respective marginal costs

(11a) $$\frac{\partial y}{\partial e_1} = 0\,,$$ [12]

(11b) $$\frac{\partial y}{\partial e_2} = 1\,.$$

Due to the agency problems discussed above, the first best solution will not be attainable. We now solve the model backwards by starting with the manager's maximization problem for a given contract. In the next step, the optimization problem of creditors will be solved in the same way. This will give rise to participation and incentive constraints which owners will have to take into account when maximizing their pay-offs by designing a suitable contract.

The Manager's Problem

The certainty equivalent managerial pay-off is

(12) $$MCE = p\left[x - D(e_1, e_2) + (1-f)\, y(e_1, e_2) - e_2\right] + (1-p)(1-s)\, L(e_1, m_C) - R\,.$$

The ex ante risk premium *R* is a non-linear increasing function of the coefficient of risk aversion r, the share of the manager in the stochastic third period output $1-f$, the variance of his pay-off and the owner's share in the liquidation value *s*.

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11 Note that no risk premium would be incurred because, in a first best world, risk would be allocated efficiently. Given that investors are risk neutral, this implies that they bear the entire risk at no cost.

12 If the third period pay-off is strictly increasing in first period effort throughout, then this condition implies a corner solution with infinite first period effort. This is natural given our assumption that the only cost of high first period effort is a low liquidation value, which does not matter in the first best, because there liquidation is always avoided.

Using equation (8) in (12), and remembering that D is a certain payment agreed at the contracting stage, the manager's certainty equivalent can be expressed as

(12') $$MCE = p\left[x + b\left(\left[1-f\right]y\left(e_1, e_2\right) - e_2 - L\left(e_1, m_C\right)\right) - R_D\right] + (1-s)L\left(e_1, m_C\right) - R .$$

The manager maximizes this by appropriately choosing first and second period efforts, selecting a particular project in the process. The FOCs are

(13a) $$\frac{\partial\, MCE}{\partial\, e_1} = pb\left[(1-f)\frac{\partial\, y}{\partial\, e_1} - \frac{\partial\, L}{\partial\, e_1}\right] + (1-s)\frac{\partial\, L}{\partial\, e_1} = 0$$ and

(13b) $$\frac{\partial\, MCE}{\partial\, e_2} = (1-f)\frac{\partial\, y}{\partial\, e_2} - 1 = 0 .$$

The solutions to (13a) and (13b) give the manager's effort supply functions $e_1(f, 1-s)$ and $e_2(f, 1-s)$.[13] Note that (13a) can be satisfied only if $1-s \geq pb$. If this condition is not met, there is no interior solution and the optimal first period effort from the manager's point of view is infinite, as it would be in the first best scenario. In order to guarantee the existence of distortions to be minimized, we will therefore assume $1-s \geq pb$ in the remainder of the paper.[14]

Since the factor by which $\frac{\partial\, y}{\partial\, e_2}$ is multiplied in (13b) is less than unity, the optimal marginal return to second period effort is larger than in the first-best case given by (11b). Therefore actual second period effort will be lower than first-best and so the third period pay-off will be lower as well. These distortions reflect the inefficiencies introduced by the agency relationships. The contract between the three groups of stakeholders in the firm will be designed to minimize these inefficiencies.

The creditor's expected pay-off is

(14) $$CEPO = pD + (1-p)sL - c_C\left(\Pi_C\right)m_C - K_C .$$

Using (8) this can be written as

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13 To keep the model tractable, we assume that the marginal impact of managerial effort on the liquidation value does not depend on the amount of monitoring undertaken by creditors. If we allowed for such an effect optimal managerial efforts would be depending on the level of creditor monitoring as well as on the pecuniary incentive and the capital structure.

14 Since s is a design variable chosen endogenously by controling investors, the condition should not simply be imposed on the model. However, for the time being we will assume that the free cashflow problem which gives rise to leverage in the first place is such that the condition is met in the optimal contract.

(14’)
$$CEPO = p\Big[(1-b)\big\{(1-f)y[e_1(1-s,f),e_2(f)] - L[m_c,e_1(1-s,f)]\big\} - R_D\Big] + sL[m_C,e_1(1-s,f)] - c_C(\Pi)m_C - K_C .$$

where $K_C = s\overline{K}$.

Finally, the owners’ expected pay-off is

(15)
$$OEPO = p\{f\ y[e_1(1-s,f),e_2(f)]\} - c_O\left(\hat{k},\Pi_O\right)m_O - K_O ,$$

where $K_O = \frac{1-s}{s}K_C$.

Comparing (14’) and (15) it is apparent that owners on their own care only about a project’s continuation value and thus have a preference for the riskier project, whereas creditors on their own also care about the liquidation value and tend to prefer less risky projects. Again, this gives rise to the agency problem of debt. Specifically, if owners could choose first period effort at will, they would do so according to the FOC

(16)
$$\frac{\partial\ OEPO}{\partial\ e_1} = pf\frac{\partial\ y}{\partial\ e_1} = 0 \Leftrightarrow \frac{\partial\ y}{\partial\ e_1} = 0 ,$$

whereas the creditors’ corresponding FOC would be

(17)
$$\frac{\partial\ CEPO}{\partial\ e_1} = p(1-b)(1-f)\frac{\partial\ y}{\partial\ e_1} + \left(s - p(1-b)\right)\frac{\partial\ L}{\partial\ e_1} = 0$$
$$\Leftrightarrow \frac{\partial\ y}{\partial\ e_1} = -\left[\left(s - p(1-b)\right)\right]\frac{\partial\ L}{\partial\ e_1}\frac{1}{p(1-b)(1-f)} .$$

With y concave in e_1, this implies that creditors will prefer a lower e_1 than owners iff $s \geq p(1-b)$. So in order to generate an agency problem of debt in our model, we have to assume that the free cashflow problem is serious enough to warrant leverage in excess of $p(1-b)$. Clearly, $\frac{\partial\ y}{\partial\ e_1}$ is increasing in s under this assumption, so that higher leverage exacerbates the agency problem of debt as argued above.

Equations (14’) and (15) do not yet take into account the participation constraints of the respective participants. In order to do so, we need to introduce further assumptions about the outside options of the parties. Specifically, we derive the solution of the model by assuming that the outside options of creditors and managers are zero, and that equity owners design the contract.

Since the manager’s outside option and hence his (certainty-equivalent) reservation wage is zero, the manager’s certainty equivalent will be reduced to his reservation wage, and from (12) we have

(12“) $$D = x + (1 - f)y + \frac{1-p}{p}(1-s)\ L - e_2 - \frac{R}{p}.$$

As mentioned above, the market interest rate has been assumed to be zero as well, and so if there is competition between creditors at the contracting stage, their return will be competed down to zero as well. Hence

(17’) $$s\overline{K} = pD + (1-p)sL - c_C m_C$$

Plugging (12“) and (17’) into (15), we get the owners’ expected pay-off

(15’) $$OEPO = p\left[x + y(e_1, e_2) - e_2\right] + (1-p)L(e_1) - c_O m_O - c_C m_C - R - \overline{K} = TCE\ .$$

This implies that by maximizing his expected pay-off, owners are maximizing the total certainty-equivalent pay-off *TCE* of the project (see Table 1). This is of course as it should be since at the contracting stage the parties have a joint interest in maximizing the total expected pay-off corrected for risk, which can then be distributed among the participants.

Optimal Monitoring

Owners will choose their optimal monitoring in the second period according to

(19) $$\frac{\text{¶}\ OEPO}{\text{¶}\ m_O} = -c_O\left(\Pi_O, \hat{k}\right) - \frac{\text{¶}\ R}{\text{¶}\ s_y^2}\frac{\text{¶}\ s_y^2}{\text{¶}\ m_O} = 0\ ,$$

which leads to optimal monitoring as a function of the institutional environment and the incentive parameters entering the risk premium R:

(19’) $$m_O = m_O\left(\Pi_O, \hat{k}, 1-s, f\right).$$

Specifically, lower leverage and hence a higher severance payment provides some insurance for the manager against the income risk associated with liquidation. This reduces the responsiveness of his risk premium to monitoring by owners and so leads to less monitoring by owners. In a similar vein, the risk borne by the manager will be the lower the lower his share in the stochastic third period output y, and so a higher f also leads to less monitoring by owners.[15]

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15 This is a standard result of agency theory: stronger pecuniary incentives make monitoring more desirable because monitoring can help to offset the greater risk to which higher pecuniary incentives expose risk-averse managers (Holmström 1979).

With owners designing the contract, creditors maximize their pay-off (equation (14)) by choosing how much monitoring to provide for given values of the design variables. Their first order condition is

$$(18)\qquad \frac{\partial\, CEPO}{\partial\, m_C} = -c_C\left(\Pi_C\right) + (1-p)s\frac{\partial\, L}{\partial\, m_C} - p\frac{1}{2}r(1-b)^2(1-f)^2\frac{\partial\, s_y^2}{\partial\, m_C} = 0\,.$$

where $\frac{\partial\, s_y^2}{\partial\, m_C}$ by assumption is an isotone function of monitoring by owners m_O.

This yields the optimal monitoring by creditors as a function of the costs of monitoring as captured by the institutional environment and the actions of owners, as well as the incentives of management:

$$(18')\qquad m_C = m_C\left(\Pi_C, 1-s, 1-f\,,\, m_O\left(\Pi_O, \hat{k}, 1-s, f\right)\right).$$

Designing the Contract

Taking into account (13a), (13b), (18'), and (19') the owner maximizes the total certainty equivalent (15') by choosing optimal values of the design variables. These are the pecuniary incentive $1-f$, the capital structure s, and the ownership structure $\hat{k}$. The FOCs are

$$(20a)\qquad \begin{aligned}\frac{\partial\, TCE}{\partial\, s} &= p\left(\frac{\partial\, y}{\partial\, e_1}\frac{\partial\, e_1}{\partial\, s}\right) + (1-p)\left(\frac{\partial\, L}{\partial\, e_1}\frac{\partial\, e_1}{\partial\, s} + \frac{\partial\, L}{\partial\, m_C}\frac{\partial\, m_C}{\partial\, s}\right)\\ &\quad -\frac{\partial\, e_1}{\partial\, s} - c_O\frac{\partial\, m_O}{\partial\, s} - c_C\frac{\partial\, m_C}{\partial\, s} - \frac{\partial\, R}{\partial\, s} = 0\end{aligned}$$

$$(20b)\qquad \begin{aligned}\frac{\partial\, TCE}{\partial\, f} &= p\left[\frac{\partial\, y}{\partial\, e_1}\frac{\partial\, e_1}{\partial\, f} + \frac{\partial\, y}{\partial\, e_2}\frac{\partial\, e_2}{\partial\, f} - \frac{\partial\, e_2}{\partial\, f}\right] + (1-p)\left(\frac{\partial\, L}{\partial\, e_1}\frac{\partial\, e_1}{\partial\, f} + \frac{\partial\, L}{\partial\, m_C}\frac{\partial\, m_C}{\partial\, f}\right)\\ &\quad - c_C\frac{\partial\, m_C}{\partial\, f} - \frac{\partial\, R}{\partial\, f} = 0\end{aligned}$$

and

$$(20c)\qquad \frac{\partial\, TCE}{\partial\, \hat{k}} = -\frac{\partial\, c_O}{\partial\, \hat{k}}m_O - c_O\frac{\partial\, m_O}{\partial\, \hat{k}} = 0\,.$$

Thus, lowering leverage has several counterveiling influences on the total certainty equivalent pay-off (20a). First, by raising the marginal return for the manager from a higher liquidation value (13a), it encourages the manager to pick the project with the high liquidation value and the low expected continuation value *y*.

Second, lower leverage and hence a higher severance payment may have an impact on the choice of effort in the second period. This will be the case if the level of first period effort influences the slope of the expected second-period pay-off y, i.e. if the cross-partial $\frac{\partial^2 y}{\partial e_2 \partial e_1}$ does not vanish. Specifically, if the two efforts are complements (substitutes) in the production of second period pay-offs ($\frac{\partial^2 y}{\partial e_2 \partial e_1} > (<)\, 0$), a higher severance payment, by reducing first period effort, will reduce (encourage) second period effort. Similar effects obtain for the cost of second period effort. Moroever, a higher severance payment directly discourages first period effort. In addition, a higher severance payment lowers the share creditors can expect of the liquidation value in the bad state of nature and hence discourages monitoring by creditors. By the same token, a higher severance lowers the incentive for owners to engage in monitoring because it is a substitute for the insurance otherwise provided to the manager through monitoring. Finally, the risk premium is reduced directly by a higher severance payment for the same reason.

Variations in the pecuniary incentive $1-f$ influence pay-offs via their influence on managerial effort, but also via their influence on monitoring incentives, and via their influence on the risk premium (20b). The most obvious effect is the direct encouragement of second period effort through a higher share in the respective pay-offs. Similar to the case with the severance payment, the pecuniary incentive for the second period can have a positive (negative) influence on first period effort if the two are complements (substitutes).

Changes in the concentration of ownership have the effect of reducing the unit costs of monitoring and hence raising the optimal amount of monitoring (20c).

3 Complementarities and Comparative Statics

In the following, we show how complementarity and substitution relationships can give rise to characteristic variations not just in the use of particular governance instruments in isolation, but in groups of governance instruments which fit together. The importance of various governance instruments differs widely across countries. For instance, the market for corporate control is far more active in the US and the UK than in continental Europe or in Japan. By contrast, monitoring by banks plays a far greater role in Germany and in Japan than in the U.S.. These and other differences in combinations of governance instruments have led to the identification of different *systems* of corporate governance (Berglöf 1997, La Porta et al. 1998b: 37, Mayer 1998, Prowse 1998: 80, Zingales 1998).[16]

At the risk of gross oversimplification, Table 1 gives a highly stylized summary of the features which distinguish the two generic types of governance systems identified in the literature.[17]

Table 1 — Stylized characteristics of alternative models of corporate governance

"Anglo-Saxon"/ "market-based"/ "transactions-based"/"arm's length"/"outsider" system	"Japanese-German"/ "bank-centered"/ "relationship-based"/"control-oriented"/"insider" system
A. Instruments chosen at the firm level	
1. dispersed stock ownership, primarily by households and institutional investors	concentrated stock ownership or proxy control by banks
2. little cross-shareholdings between firms and little bank ownership of firms, active market for corporate control	substantial cross-ownership between firms, substantial direct and indirect bank ownership, no significant market for control
3. little bank involvement in firms' operations	substantial direct involvement of banks in firm operations (monitoring, decision making, restructuring)
4. high-powered management incentives (through pay-performance link at the firm and through market for managers)	low-powered management incentives
5. high ratio of bonds to loans in firm liabilities	low ratio of bonds to loans in firm liabilities
B. Instruments chosen at the policy level	
1. far-reaching disclosure and accounting requirements in stock market, substantial minority shareholder protection, barriers to large shareholder activity	limited disclosure and accounting requirements, limited minority shareholder protection, few barriers to large shareholder activity
2. rules favorable to or at least not actively hostile to corporate bond market	may have legal obstacles limiting the size of the corporate bond market
3. bankruptcy legislation tends to emphasize protection from creditors	bankruptcy legislation tends to emphasize protection of creditor claims

16 An attempt at a comprehensive survey of corporate governance systems in Europe and the U.S. is currently being undertaken by the European Corporate Governance Network (ECGN). For preliminary survey papers on Austria, Belgium, France, Germany, Italy, the Netherlands, Spain, Sweden, the UK and the US see the ECGN website at http://www.ecgn.ulb.ac.be/book/.

17 See also Mayer (1998), Berglöf (1997), Shleifer and Vishny (1997).

Thus corporate governance exhibits systemic features in the sense that there are characteristic groups of governance instruments which are complementary to each other in simultaneously mitigating several agency problems typically incurred by firms. We now proceed to show how our model can generate such characteristic groups of governance instruments depending on the institutional environment.

According to the distinction between control-oriented and arms's-length systems of corporate governance (see e.g. Berglöf 1997), there should be more bank monitoring in systems with less liquid and transparent stock markets. Also, several authors have associated control-oriented systems with higher leverage (see e.g. Berglöf 1990 or Borio 1990), although these results have been challenged recently (Rajan and Zingales 1995). Another comparative static proposition is that if stock market regulation is on the side of weak disclosure standards and few limits to influence by large shareholders, then ownership will end up being relatively concentrated.

Rather than imposing conditions that guarantee the existence and uniqueness of an optimum solution and then doing the comparative statics on the FOCs using the implicit function theorem, we employ a method which uses general monotonicity properties of the objective function and which is based on modular functions on lattices (Topkis 1978, Holmström and Milgrom 1994, Milgrom and Shannon 1994).[18] One advantage of the present method of doing comparative statics is that - unlike the implicit function theorem - it can be applied even with discrete variables, as long as the values these variables can take can be ordered at least partially. For instance this makes it possible to do comparative statics even if the parameter vector Π_O consists of „messy" and potentially discontinuous elements. Another advantage of this new method of doing comparative statics is that it remains valid in the presence of multiple local optima. An application of this is also suggested at the end of the present section in that complementarities can give rise to situations where the economic system is stuck in an inferior local maximum from which piecemeal reforms do not offer a way-out, but where coordinated reforms can achieve a better outcome.

If the objective function is supermodular in (a subset of) the parameters and (a subset of) the design variables, then these parameters and design variables are Edgeworth complements. Hence the marginal benefits from raising the value of any of the design variables are increasing in the levels of any of the other design variables and of the parameters. It follows that all the optimal values of complementary design variables will move together whenever there is a shock in one of the complementary parameters. Hence in order to derive comparative static results, we have to find conditions under which the objective function above will be supermodular in certain subsets of the design variables and parameters.

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18 See the appendix for definitions of these concepts and the main theorem on which our comparative static analysis is based.

At a general level, the source of supermodularity and hence complementarity can be in the total certainty equivalent revenue function or in the cost function or in an interplay between them. For instance, if the marginal costs of using one design instrument are decreasing in the level of another design instrument, then whenever the level of the second instrument is increased it will pay to also increase the level of the second instrument. By the same token, if the marginal revenue from using one design instrument is increasing in the level of another instrument, then whenever the level of the second instrument is increased it will pay to also increase the level of the second instrument. Similarly, if the marginal cost (revenue) of using one instrument is decreasing (increasing) in the level of a parameter, then whenever the level of the parameter rises, it will pay to increase the level of the design instrument in question.

Taken together, these relationships imply that whenever a parameter rises which is complementary with a subset of design variables which are also complementary among each other, then all these design instruments should optimally be increased. Relationships like these can account for the stylized fact that we tend to observe a limi ted number of characteristic combinations of governance instruments being used together, rather than seeing instruments used in isolation, or seeing arbitrary combinations of instruments used together.

The total certainty equivalent being maximized in the model is a function of the design variables conditional on parameters reflecting the institutional environment.

(15') $$TCE = OEPO = p\left[x + y(e_1, e_2) - e_2\right] + (1-p)L(e_1) - c_O m_O - c_C m_C - R - \overline{K} .$$

The *design variables* are pecuniary performance incentives, the capital structure, and the ownership structure. The *parameters* are the stringency of bankruptcy legislation captured by managerial bargaining power b and institutions impacting on monitoring costs for creditors and owners captured through the parameter vectors Π_i. As mentioned above, these institutions can include the disclosure rules and other regulations protecting minority shareholders, accounting standards, creditors' access to information, e.g. via relationship lending, and again the toughness of the bankrutpcy code.

The comparative propositions can be established by checking the conditions under which TCE will be pairwise supermodular in $\hat{k}$, s, m_C and $-\Pi_O$.

To obtain specific results, we assume that for higher leverage, the negative effect on first period effort via the liquidation value dominates the positive effect via the third period pay-off, so that $\frac{\partial e_1}{\partial s} \leq 0$. In addition, we assume that the incentive variables $1-f$ and s are Edgeworth complements in the effort supply functions, i.e. $\frac{\partial^2 e_i}{\partial f \partial s} \leq 0$, and that the first-order cross-partials are non-negative, i.e. $\frac{\partial e_1}{\partial f} \geq 0, \frac{\partial e_2}{\partial s} \geq 0$.[19]

The intuition underlying these assumptions is that a given desirable activity can be encouraged either by directly providing incentives for it, or by discouraging an activity which is complementary in costs for the agent, or which is a substitute in terms of benefits for the agent; it can also be encouraged by encouraging an activity which is a substitute in costs for the agent, or which is a complement in terms of benefits (Holmström and Milgrom 1991).

I.e. in the present context, if direct incentives for effort e_i are reduced, then less effort e_i will be forthcoming. If this lowers the marginal cost of effort e_j (i.e. if efforts are complements in costs) then more effort e_j will be supplied; by the same token, if lower e_i raises the marginal benefit to the agent from effort e_j (i.e. if efforts are substitutes in benefits), then more e_j will be supplied. In our particular model, costs are simply linear in efforts, and so the marginal costs of any given effort are independent of the level of the other effort. However, efforts can be complements or substitutes in terms of benefits in our model.

That the total certainty equivalent pay-off function is supermodular in the pair $(-\Pi_O, s)$ is easily verified by observing that the objective does not contain any terms involving both elements of this pair. Checking the second order cross partial with respect to stock market institutions and creditor monitoring yields

(21) $$\frac{\partial^2 TCE}{\partial m_C \partial(-\Pi_O)} = \frac{\partial m_O}{\partial \Pi_O}\left[\frac{\partial^2 R}{\partial m_C \partial m_O} + \frac{\partial^2 R}{\partial^2 m_C^2}\frac{\partial m_C}{\partial m_O}\right],$$

where $$\frac{\partial^2 R}{\partial m_C \partial m_O} = \frac{\partial R}{\partial s_y^2}\left[\frac{\partial^2 s_y^2}{\partial m_C \partial m_O} + \frac{\partial^2 s_y^2}{\partial m_C^2}\frac{\partial m_C}{\partial m_O}\right].$$ [20]

By definition the risk premium rises with the variance of the return. Moreover by assumption, owner and creditor monitoring are substitutes and so the cross-partial of the variance is positive. The second indirect effect in brackets is negative since the returns to monitoring have been assumed to be decreasing and because creditor monitoring and owner monitoring are substitutes. Therefore the cross-partial of the risk premium with respect to monitoring levels will be positive as long as the direct effect is stronger than the indirect effect. Further, the indirect effect in (21)

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19 See Holmström and Milgrom (1994).

20 Note that the risk premium is linear in the variance. See appendix.

$\frac{\partial^2 R}{\partial^2 m_C^2}\frac{\partial m_C}{\partial m_O} = \frac{\partial R}{\partial \sigma_y^2}\frac{\partial^2 \sigma_y^2}{\partial m_C^2}\frac{\partial m_C}{\partial m_O}$ is negative by the same reasoning as above. Hence the term in brackets will be positive if the indirect effect is overcompensated by the direct effect. In this case, the sign of the comparative static derivative depends on the impact of the stock market parameter on monitoring by owners. If more transparency leads to more owner monitoring, then the cross-partial will be positive and there will be complementarity between creditor monitoring and an illiquid, intransparent stock market.

Above we have argued that the costs of monitoring to owners will depend on the degree of ownership concentration. With ownership dispersed, monitoring will be possible only through the stock market if it is sufficiently transparent. Conversely, if ownership is concentrated, then monitoring will be possible even with an intransparent, illiquid stock market. Indeed regulations designed to protect minority shareholders and hence to create and maintain a liquid stock market may inhibit active monitoring by large concentrated owners. Hence, the present result says that when ownership is dispersed, then lowering the liquidity and transparency of the stock market will may a stronger monitoring role for creditors more desirable. This result is in line with developments in Japan after the second world war, where ownership was rather dispersed, and where the liquidity of the stock market was actively suppressed by regulatory policies. As a result, banks emerged as the main corporate monitors (Heinrich 1999).

Turning to the pair $\left(-\Pi_O, \hat{k}\right)$ and using the FOC for optimal monitoring (19), we have

(22) $$\frac{\partial^2 TCE}{\partial \hat{k}\partial\left(-\Pi_O\right)} = \frac{\partial^2 c_O}{\partial \Pi_O \partial \hat{k}} m_O + \frac{\partial c_O}{\partial \Pi_O}\frac{\partial m_O}{\partial \hat{k}}.$$

The first term on the RHS is positive by assumption (4), reflecting the intuition that the impact of more concentrated ownership on unit monitoring costs depends on the regulation of the stock market. The second term reflects the impact of the stock market regulation on the marginal responsiveness of monitoring to ownership concentration. This will be positive if either unit costs are increasing in the regulation parameter and monitoring is increasing in ownership concentration, or if unit costs are decreasing in regulation and monitoring is decreasing in ownership concentration. The intuition behind these conditions is that by our assumptions unit costs are more likely to be increasing in the regulation parameter at high levels of ownership concentration, and that monitoring is more likely to be increasing in ownership concentration at low levels of Π_O, and so these conditions favor high concentration and low Π_O going together.

Having established conditions for the supermodularity of the total certainty equivalent pay-off in all pairs involving the stock market regulation variable Π_O, we now consider pairs involving creditor monitoring m_C. The only terms in the objective function depending on m_C

are the liquidation value, the creditor's monitoring cost and the risk premium. Of these only the risk premium also depends on the concentration of ownership. Hence

(23) $$\frac{\partial^2 TCE}{\partial m_C \partial \hat{k}} = -\frac{\partial m_O}{\partial \hat{k}} \left[\frac{\partial^2 R}{\partial m_C \partial m_O} + \frac{\partial^2 R}{\partial^2 m_C^2} \frac{\partial m_C}{\partial m_O} \right].$$

The sign of the term in brackets has been discussed in connection with equation (22). The term in front of the brackets will be positive if higher ownership concentration leads to less owner monitoring. This will be the case in our model for high levels of stock market transparency and liquidity.

Supermodularity in the pair (m_C, s) requires

(24) $$\frac{\partial^2 TCE}{\partial m_C \partial s} = (1-p) \frac{\partial^2 L}{\partial m_C \partial s} \geq 0 .$$

Since first period effort is decreasing in leverage s by assumption, the condition will hold if creditor monitoring and low first period effort are complementary in generating a high liquidation value. To assume this is immediately plausible because the creditor's pay-off is such that he cares about a high liquidation value and therefore prefers a low first period effort. Hence if creditor monitoring is to make sense, it should result in strengthening the incentives for low first period effort.

We also need to establish conditions under which the objective function will be supermodular in pairs of variables and parameters involving the ownership concentration $\hat{k}$. Since supermodularity is symmetric, all that remains to be done is check the pair $(\hat{k}, s)$. Supermodularity is satisfied weakly since the terms which vary with $\hat{k}$ (m_O and R) are invariant in s.

Thus, under the conditions imposed in our model, exogenous, policy-induced changes in the regulation of the stock market will trigger adjustments not just in some but in all the governance instruments identified above, and those adjustments will all be in the same direction. A reform which strengthened the rights of minority shareholders at the expense of controling shareholders would c.p. lead simultaneously to a less concentrated ownership structure, less leverage, stronger pecuniary incentives and less creditor monitoring. By the same token, a reform which conversely strengthened the control rights of large shareholders would c.p. lead to a more concentrated ownership structure, more leverage, weaker pecuniary incentives and more creditor monitoring. Similar arguments can be applied to the impact of changes in other parameters of the model, such as bankruptcy legislation and its enforcement, or regulations governing the control rights and access to information of creditors.

Moreover, to the extent that Π_O is a parameter vector rather than a scalar, then our theory implies that if for whatever reason it becomes desirable to increase one of the elements of the vector, it c.p. also becomes desirable to increase all the other elements of the vector. In other words, piecemeal institutional reforms may fail to achieve optimal results. For concreteness, among the elements of Π_O might be rules stipulating the duties of corporations as regards the public disclosure of their accounts, regulations governing accounting standards, insider trading rules, duties of investors to disclose share holdings exceeding certain limits and to disclose their intention to build up positions exceeding certain limits, rules governing the proxy process and so on. Complementarity within this vector of institutional parameters then suggests that if e.g. disclosure rules are made tougher, the functioning of the governance system can be improved by also making the other elements of the institutional environment tougher.[21] It is possible even to construct extreme cases where reforming any one element of the institutional environment in isolation worsens the performance of the system, even though a coordinated reform of all complementary elements improves performance.[22]

4 Conclusions and Possible Extensions

The debate about corporate governance is suffering from a certain gap between theoretical analysis and policy discussions. While the theoretical literature has largely focused on studying particular governance instruments in isolation, the policy debate has increasingly centered on the relative merits of alternative systems of corporate governance consisting of characteristic combinations of many instruments. The present paper attempts to narrow this gap by providing a model which explains the use of characteristic combinations of instruments in simultaneously solving several agency problems facing the firm. Our model is able to generate empirically valid covariations in subsets of governance instruments and policy parameters and provides an intuitive explanation of such systematic comovements in terms of the complementary roles of governance instruments in solving a set of agency problems.

On a policy level, the present model or a variant thereof can be used to study the effects of reforms of the institutional environment. In particular, the present analysis strongly suggests that reform attempts need to take into account the complementarity and substitutability relationships among governance instruments and the institutional environment. In addition to affecting the governance system on several dimensions, changes in some aspect of the institutional

21 It might be thought that institutional parameters like these would destroy the convexity of the problem and would therefore make it impossible to derive comparative static conclusions. However, supermodularity generalizes to functions which are not twice continuously differentiable (see appendix).

22 See Gates et al. (1996) for an example pertaining to economic reforms in transition economies and Coe and Snower (1997) for a similar argument applied to European labor market reforms.

environment may have a significant impact on the marginal costs and benefits of other features of the environment and may hence call for complementary reforms in other areas. For instance, reforms in the bankruptcy legislation might be called for in connection with reforms of the stock market regulation.

On a theoretical level, the present model could be extended in several ways. Leverage is used in our model to reduce the agency problem of free cash flow, as in Jensen (1986). This comes at the cost of creating an agency problem of debt. I.e. creditors will prefer the firm to engage in less risky projects than equity owners would like. Then if the firm's management has contracts with strong pecuniary incentives aligning their interests with those of owners, the agency problem of debt will be exacerbated. This is because incentive contracts will encourage managers to pick riskier projects than creditors would like. Hence we would expect stronger pecuniary incentives for management to reduce the optimal level of leverage of the firm (John and John 1993).

By the same token, to the extent that leverage mitigates the agency problem arising from the separation of ownership from control, the benefits to owners of stronger managerial incentives may decline. Therefore as long as there are costs of pecuniary incentives, more leverage would be expected to reduce the optimal level of pecuniary incentives. For these reasons, any exogenous shock which makes higher leverage more desirable should c.p. also reduce the optimal level of pecuniary incentives and vice versa. Thus, together with the complementarity result between leverage and ownership concentration, stock market regulation, and bank monitoring derived above, this would imply that pecuniary incentives will tend to be more attenuated if leverage is high, bank monitoring is strong, ownership is concentrated and the stock market regulation favors controling owners.[23]

Commitment problems between managers and owners along the lines of Acemoglu (1994) could be modelled by assuming that owners may not be able to credibly promise to keep $f < 1$. This introduces an explicit role for the allocation of residual rights of control. That owners cannot commit to pecuniary incentives ex post is an assumption which is frequently made in agency models. It can be rationalized by pointing out that once the manager has exerted effort, owners no longer have any incentive to share profits. Moreover, the only measures of profit that might be verifiable in court, such as those based on accounts prepared for tax purposes, may not be meaningful measures of managerial effort. Therefore owners can motivate managers with pecuniary incentives only by giving them stock options before managers have to exert effort. But this is feasible only if ownership is dispersed and if there is a transparent and hence liquid market in the firm's shares. If either ownership is concentrated, so that there is no liquid market in the shares, or the stock market is intransparent, the stock price is assumed not

23 In keeping with this, Schmid (1997) finds a relatively weak influence of performance on top management compensation in Germany.

to be a suitable proxy for managerial effort either. In these cases it would be difficult to motivate managers by pecuniary incentives in the second period. As a result, other incentive instruments would have to play a greater role in these cases.

In a similar vein, the positive ex ante incentive effects of leverage stressed by Dewatripont and Tirole (1994a) could be incorporated by allowing for residual rights of control. In a further extension takeovers should be incorporated as an additional instrument which plays a prominent role in some corporate governance systems. Aghion, Dewatripont and Rey (1990) have a model where equity plays a role complementary to debt in that equity favors value-increasing transfers of control via takeovers, while debt makes sure such transfers of control take place even if opposed by management.

5 Appendix

a. Comparative Statics with Modular Functions on Lattices

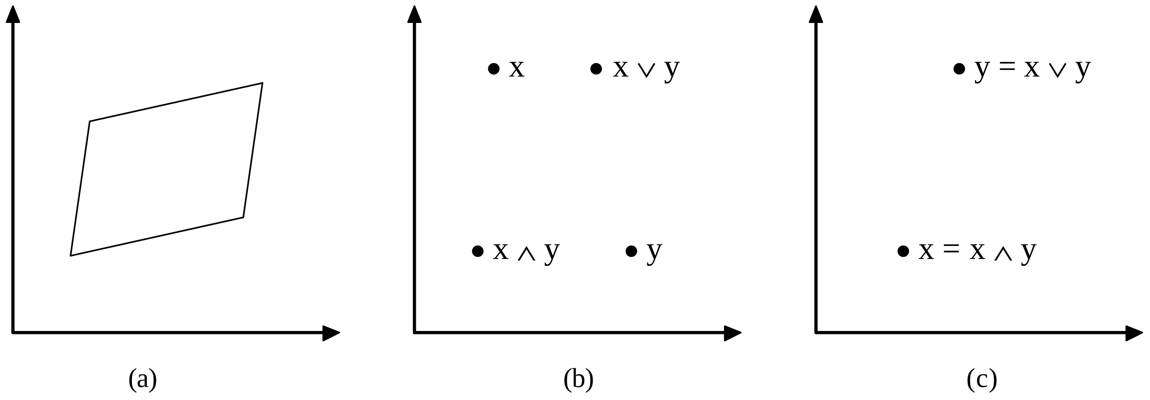
This appendix introduces briefly the mathematical concepts of modular functions and lattices used for the comparative static analysis in the paper.[24]

Definition 1: Let X be a subset of the Euclidean n-space R^n, and let $\propto$ be a (partial) ordering on X so that $\forall x,y \in X$, we have $x \propto y \quad or \quad y \propto x$ or both. $\forall x,y \in X$ let $x \vee y$ ("x join y") be the smallest upper bound of both x and y under the ordering $\propto$. Let $x \wedge y$ ("x meet y") be the largest lower bound of both x and y under the ordering $\propto$. X is a *lattice* iff $\forall x,y \in X$, $x \vee y \in X \quad and \quad x \wedge y \in X$.

Examples of lattices include the sets of natural, whole, rational, and real numbers under the natural ordering (≤) as well as their power sets under the component-wise natural ordering. Additional examples are given in Figure 2, some examples of sets which are not lattices are given in Figure 3.

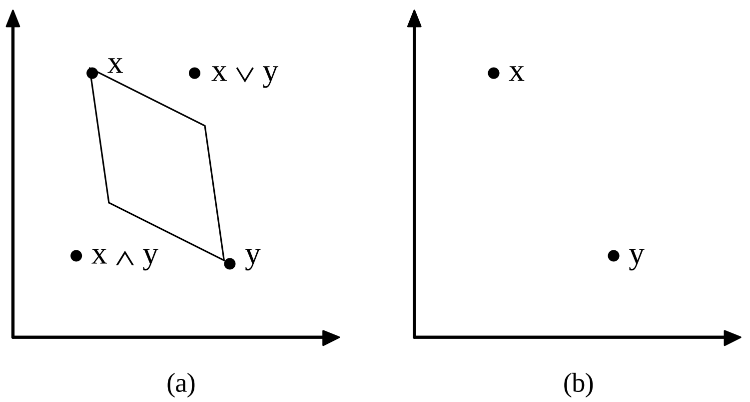
24 The first application in economics is Milgrom and Roberts (1990). For details see Topkis (1978) and Milgrom and Shannon (1994).

Figure 2 — Sublattices of R^2 under the component-wise natural ordering



Note that the lattices depicted in panels b and c of figure 1 are non-convex sets. An example of a lattice under an ordering different from the natural ordering is the set of subsets of an arbitrary set ordered by the operation of set inclusion $\subseteq$: the "join" of two subsets x and y then is their union $x \cup y$, since the union of two sets x and y contains both x and y (and as such is "larger" than both x and y) and is the smallest such set; their "meet" is their intersection $x \cap y$, since the intersection of two sets x and y is contained in both x and y (and as such is "smaller" than both x and y) and is the largest such set.

Figure 3 — 2-dimensional sets which are not lattices



Note that the set depicted in panel (a) of Figure 3 is convex. It is not a lattice since it neither contains the join nor the meet of e.g. points x and y under the component-wise natural ordering.

Definition 2: A real-valued function f is <u>supermodular</u> iff

$f(x \wedge y) + f(x \vee y) \geq f(x) + f(y)$ or equivalently iff $f(x \vee y) - f(y) \geq f(x) - f(x \wedge y)$.

Strict supermodularity obtains with a strict inequality; if f is supermodular, then -f is submodular, i.e. submodularity obtains if the inequality is reversed.

As such modularity merely generalizes the complementarity viz. substitutability restrictions placed on the matrix of second partial derivatives in the traditional approach to comparative statics to the case of arbitrary, i.e. in particular non-differentiable functions. That is to say, for twice continuously differentiable functions, supermodularity is equivalent to positive cross-partial derivatives. By the same token, submodularity is equivalent to negative cross-partials. A generalization to the non-differentiable case is particularly attractive in the context of modelling discontinous choices.

If we have x > y (assuming that the lattice from which x and y have been drawn is ordered by the natural ordering), the join of x and y is x, and the meet of x and y is y. Then the inequalities trivially hold as equalities. If we have neither x > y nor y > x nor x = y (which is of course possible in any set ordered only partially, as e.g. in an at least two-dimensional vector space with the component-wise natural ordering, where e.g. (0,1) is neither greater than, nor smaller than, nor equal to (1,0)), then the meet of x and y will consist of the component-wise smallest elements of both vectors, and a movement from their meet to x involves raising those components of the argument vector in which x exceeds y.

Similarly, the join of x and y consists of the component-wise largest elements of both vectors, and a movement from y to the join of x and y again involves raising those components of the argument vector in which x is larger than y, only this time from a higher level, in that on the RHS of the second inequality the components in which y exceeds x are taken from x, whereas on the LHS they are taken from y. The second inequality thus says that the same increase in some components of the argument vector will yield a larger increase in the value of f if the other components of the argument vector are at a higher level. The first inequality says that the total value will be larger if we consider the sum of f evaluated at a low argument and evaluated at an argument larger in all dimensions than if we consider the sum of f evaluated at two arguments which are high in some dimensions and low in others. Supermodularity thus nicely captures the essence of Edgeworth complementarity, namely that the sum is more than the constituent parts.

Monotone Comparative Statics Theorem (Holmström and Milgrom 1994: 978): Let $\Pi(x, y)$ be a continuous function from $X \times Y$ to R. Let $Y' \subseteq Y$ a partially ordered set , and X' $\subseteq$X a compact sublattice of R^n. Let $\Pi(x, y)$ be continuous and supermodular in (x',y')$\in$ X'xY' for given (x'',y'')$\in (X \setminus X') \times (Y \setminus Y')$. Let X'(x'',y) be argmax of $\Pi(x, y)$ for given x'' $\in (X \setminus X')$. Then the set of maximizers has an infimum and a supremum, they are both in X', and they are both nondecreasing in y' on Y'.

In other words, if we keep those parameters and maximizers fixed which do not exhibit complementarities, both the largest and the smallest (and indeed any) vector of complementary maximizers is monotone non-decreasing in the complementary parameters under the stated assumptions. Notice in particular that the supermodularity property is required of the objective function in general rather than of the objective at the optimum.

A generalization of this theorem to the discontinuous case, as well as necessary conditions and conditions for the existence of optima are also available. It can be shown that a function is supermodular in a subset of variables iff it is supermodular in all pairs of variables from the subset. Moreover, the sum of modular functions is modular (see Milgrom and Shannon 1994).

b. Deriving the Certainty Equivalent and the Risk Premium

The following is based on Milgrom and Roberts (1992: 246-247). Let Y be a random pay-off with mean y and variance σ_y^2 and let $U(Y)$ be a three times continuously differentiable utility function with strictly positive first derivative $\frac{\partial U}{\partial Y} > 0$. Then the certainty equivalent CE of the random pay-off Y is defined by

(A.1) $$U(CE) = EU(Y).$$

For any realization z of Y a Taylor series expansion yields $U(z) = U(y) + (z-y)\frac{\partial U}{\partial y} + \frac{1}{2}(z-y)^2\frac{\partial^2 U}{\partial y^2} + M(z)$ with the remainder term $M(z) = \frac{1}{6}(z-y)^3\frac{\partial^3 U}{\partial \hat{z}^3}$ for some $\hat{z} \in [y, z]$. Assuming that this remainder is negligible, we have the approximation

$$U(z) \approx U(y) + (z-y)\frac{\partial U}{\partial y} + \frac{1}{2}(z-y)^2\frac{\partial^2 U}{\partial y^2}.$$

Taking expectations we find

(A.2) $$EU(Y) \approx U(y) + E(Y-y)\frac{\partial U}{\partial y} + \frac{1}{2}E(Y-y)^2\frac{\partial^2 U}{\partial y^2} = U(y) + \frac{1}{2}E(Y-y)^2\frac{\partial^2 U}{\partial y^2}$$

since $EY = y$.

Assuming that the certainty equivalent will be close to the expectation value of Y, Taylor's theorem yields

$U(CE) = U(y) + (CE-y)\frac{\partial U}{\partial y} + \widehat{M}(CE)$ with the remainder $\widehat{M}(CE) = \frac{1}{2}(CE-y)^2\frac{\partial^2 U}{\partial \hat{z}^2}$ for some $\hat{z} \in [y, CE]$. Again we ignore the remainder on the grounds that CE is close to y, and so get the approximation

(A.3) $$U(CE) \approx U(y) + (CE-y)\frac{\partial U}{\partial y}.$$

Plugging (A.2) and (A.3) into (A.1) we thus have

(A.4) $$\left(CE - y\right)\frac{\partial U}{\partial y} \approx \frac{1}{2}E\left(Y - y\right)^2 \frac{\partial^2 U}{\partial y^2}$$, or after rearranging terms

(A.5) $$CE \approx y - \frac{1}{2}\left[-\frac{\partial^2 U/\partial y^2}{\partial U/\partial y}\right]E\left(Y - y\right)^2 = y - \frac{1}{2}r\left(y\right)\sigma_y^2 .$$

Hence the certainty equivalent of a random pay-off can be approximated as the difference between the mean and a risk premium, where the risk premium is half the product of the coefficient of absolute risk aversion and the variance.

6 References:

Aoki, M. (1998), Controlling Insider Control: Issues of Corporate Governance in Transition Economies, in: K. Ohno et al. (eds.), *Japanese Views On Economic Development: Diverse Paths to the Market*. London.

Acemoglu, D. (1994), *Corporate Control and Balance of Powers*. Mimeo. MIT Department of Economics.

Aghion, P., M. Dewatripont, and P. Rey (1990), *Optimal Incentive Schemes and the Coexistence of Debt and Equity*, CEPR Working Paper Series of the Network on Financial Markets no. 6. London.

Aghion, P., O. Hart and J. Moore (1992), The Economics of Bankruptcy Reform, *Journal of Law, Economics, and Organization* 8 (3): 523-546.

Aghion, P., P. Bolton, and S. Fries (1998). Optimal Design of Bank Bailouts: The Case of Transition Economies. University College and EBRD. mimeo.

Bandhari, J. S. (1996), *Corporate Bankruptcy - Economic and Legal Perspectives.* Cambridge UK.

Bebchuk, L.A. (1998), *Chapter 11*, NBER Working paper no. 6473. Cambridge MA.

Bebchuk, L.A. and J. Fried (1998), *The Uneasy Case for the Priority of Secured Claims in Bankruptcy: Further Thoughts and a Reply to the Critics*, NBER Working paper no. 6472. Cambridge MA.

Berglöf, E. (1990), Capital Structure as a Mechanism of Control: A Comparison of Financial Systems, in: M. Aoki, B. Gustavsson, and O.E. Williamson (eds.), *The Firm as a Nexus of Treaties*.

Berglöf, E. (1997), A Note on the Typology of Financial Systems, in: K. Hopt and E. Wymeersch (eds.), *Comparative Corporate Governance*, pp. 151-164.

Berkovitch, E. and R. Israel (1998), *Optimal Bankruptcy Laws Across Different Economic Systems*, working paper no. 143, William Davidson Institute, University of Michigan Business School.

Borio, C.E.V. (1990), *Leverage and Financing of Non-financial Companies - An International Perspective*, Economic Papers 27, Bank for International Settlements, Basle.

Competitiveness Advisory Group (CAG) (1998), *Capital Markets for Competitiveness - Report to the President of the Commission and the Heads of State and Government for the Cardiff European Council*, June 1998, available at:

http://europa.eu.int/comm/cdp/cag/publications/rapport2/cover_en.htm (downloaded April 1999).

Chew, D. H. (ed.) (1997), *Studies in International Corporate Finance and Governance Systems - A Comparison of the U.S., Japan, and Europe.* New York.

Coe, D. and D. Snower (1997), Policy Complementarities: The Case for Fundamental Labor Market Reform, *IMF Staff Papers* 44(1):1-35.

Dewatripont, M. and J. Tirole (1994a), A Theory of Debt and Equity, *Quarterly Journal of Economics* 109(4): 1027-1054.

Franks, J., C. Mayer and L. Renneboog (1999), *Who Disciplines Bad Management ?* mimeo, London Business School.

Gates, S., P. Milgrom and J. Roberts (1996), Complementarities in the Transition from Socialism; A Firm-Level Analysis, in: J. McMillan and B. Naughton (eds.), *Reforming Asian Socialism: The Evolution of Market Institutions in Transition Economies*. Ann Arbor.

Gertner, R., D. Scharfstein and J. Stein (1994), Internal Versus External Capital Markets, *Quarterly Journal of Economics* 109(4): 1211-1230.

Heinrich, R. (1999), Complementarities in Corporate Governance - A Survey of the Literature with Special Emphasis on Japan, Kiel Institute of World Economics Working Paper forthcoming.

Holmström, B. (1979), Moral Hazard and Observability, *Bell Journal of Economics* 10: 74-91.

Holmström, B. and P. Milgrom (1991), Multi-task Principal Agent Analyses: Incentive Contracts, Asset Ownership, and Job Design, *Journal of Law, Economics and Organization* 7: 24-52.

Holmström, B. and P. Milgrom (1994), The Firm as an Incentive System, *American Economic Review* 84(4): 972-991.

Holmström, B. and J. Tirole (1993), Market Liquidity and Performance Monitoring, *Journal of Political Economy* 101(4): 678-709.

Jensen, M. (1986), Agency Costs of Free Cash Flow, Corporate Finance, and Takeovers, *American Economic Review* 76: 323-329.

Jensen, M. (1993), The Modern Industrial Revolution, Exit, and the Failure of Internal Control Systems, Journal of Finance 48(3): 831-880.

Jensen, M. and W. Meckling (1976), Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure, *Journal of Financial Economics* 3: 305-360.

John, T. and K. John (1993), Top-Management Compensation and Capital Structure, *Journal of Finance* 48(3): 949-974.

La Porta, R., F. Lopez-de-Silanes, A. Shleifer and R. Vishny (1997), Legal Determinants of External Finance, *Journal of Finance* 52: 1131-1150.

La Porta, R., F. Lopez-de-Silanes, and A. Shleifer (1998b), *Corporate Ownership Around the World*, paper presented at the European Corporate Governance Network conference on Corporate Governance and Economic Performance, Fondazione Mattei, Milan, 6–8 November 1998, available at http://www.ecgn.ulb.ac.be/ecgn/.

Mayer, C. (1998), Financial Systems and Corporate Governance: A Review of the International Evidence, *Journal of Institutional and Theoretical Economics* 154(1): 144-176.

Milgrom, P. and J. Roberts (1990), The Economics of Modern Manufacturing: Technology, Strategy and Organization, *American Economic Review* 80(3): 511-528.

Milgrom, P. and J. Roberts (1992), *Economics, Organization and Management*. Englewood Cliffs.

Milgrom, P. and C. Shannon (1994), Monotone Comparative Statics, *Econometrica* 62(1): 157-180.

Ofek, E. (1993), Capital Structure and Firm Response to Poor Performance, *Journal of Financial Economics* 34: 3-30.

Povel, P. (1996). *Optimal 'Soft' or 'Tough' Bankruptcy Procedures*. Discussion Paper 240, Financial Markets Group, London School of Economics. London.

Prowse, S. (1998), Atlantic Systems of Corporate Finance and Governance, in: G.Boyd (ed.), *The Struggle for World Markets - Competition and Cooperation between NAFTA and the EU*. Cheltenham.

Rajan, R. and L. Zingales (1995), What Do We Know about Capital Structure ? Some Evidence from International Data, *Journal of Finance* 50(5): 1421-1459.

Rajan, R. and L. Zingales (1999), Which Capitalism ? Lessons from the East Asian Crisis, *Journal of Applied Corporate Finance* (forthcoming).

Schmid, F. (1997), Vorstandsbezüge, Aufsichtsratsvergütung und Aktionärsstruktur, *Zeitschrift für Betriebswirtschaft* 67(1): 67-83.

Shleifer, A. and R. Vishny (1997), A Survey of Corporate Governance, *Journal of Finance* 52: 737-783.

Stulz, R. (1990), Managerial Discretion and Optimal Financing Policies, *Journal of Financial Economics* 26: 3-27.

Topkis, D. (1978), Minimizing a Submodular Function on a Lattice, *Operations Research* 26(2): 305-321.

Zingales, L. (1998), *Corporate Governance*, CEPR discussion paper no. 1806.