INTERNAL GOVERNANCE SYSTEMS AND R&D INVESTMENT: AN INTERNATIONAL COMPARISON

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Abstract

In the theoretical framework of corporate governance, this article studies the efficiency of the control exerted by the ownership structure and the board of directors on managers for the purpose of privileging investment in R&D. This efficiency is sensitive to national systems of governance. Tests realized on a sample of 531 U.S., Japanese and French firms with the canonical method corroborate the existence of positive relationships between concentration of ownership, the internal administrator dominance and the non-dual structure on the one hand, and the investment in R&D, on the other.

Keywords: R&D Investment, ownership structure, board of directors, internal governance systems

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Introduction

The development of new technologies and the role of innovation in the process of firm value creation have become increasingly prominent in recent years. The ability of a firm to innovate and invest in Research and Development (henceforth R&D) is regarded as a determinant of its durability and its international competitiveness (Hall 1998; Aboody and Lev 2000; Yasuda 2009).

However, the works in corporate finance argue that without an appropriate control system, the efficiency of R&D cannot contribute to the improvement of corporate value. Indeed, although R&D investment is a factor for value creation (Lev, 1999) and is synonymous with growth opportunities (Titman and Wessels, 1988), it can, in the absence of effective control on managers, enhance managerial flexibility and exacerbate the problem of asymmetric information[28]. These phenomena are accentuated primarily by the characteristics of R&D: the long time horizon (Xu and Zhang, 2004), a higher risk rate (Nekhili and Poincelot, 2000) and specificity (Williamson 1988; Shleifer and Vishny 1992).

In this regard, David et al. (2001) show that managers and shareholders are potentially in conflict of interest concerning R&D investment because they often differ both in their temporal preferences and in their attitudes toward risk. Shareholders favour such investments because they can diversify inherent R&D risk by holding shares in several firms (Hansen and Hill, 1991) and they can increase a firm's value (Hall and Oriani, 2004). Instead, managers are often preoccupied by their job security, which leads them to underinvestment in risky and long-term projects to the detriment of the objective of profit maximization (Hirshleifer and Thakor 1992; Kor 2006). The increasing mobility of managers motivates them to underinvest in R&D. The long-term effects of this strategy can become manifest only after leaving the firm (Rumelt, 1987). On the contrary, a short-term management enables managers to quickly reveal the financial performance, demonstrate their capacity in the labour market (Campbell and Marino, 1994) and increase their reputation more quickly (Narayanan, 1985).

[28] Charreaux (2001) shows that asymmetry of information is usually considered as the main source of interest conflicts between stakeholders leading to distortions in R & D investment, especially through its features.

Because managers can be induced to under invest in R&D in order to maximize their own utility rather than shareholder wealth, works in finance suppose that different control modes can be used by them to align interests and encourage such investment. The ownership structure and board of directors are two internal control systems over managers. Indeed, most work on the relationship between Corporate Governance Systems[29] and R&D investment are primarily of U.S. (Hill and Snell 1988, Baysinger et al. 1991; Porter 1992a and b; Bushee 1998; Lee and O'Neill 2003; Yasuda 2009) and Japan origin (Hosono et al. 2004; Lee 2005; Yasuda 2009). These studies confirm in part the role played by the internal mechanisms in reducing conflicts of interests between stakeholders (Striukova , 2009), and therefore, they guide the behaviour of managers in R&D investment without reaching unanimity.

Thus, for the aim of proposing an adaptation and extension of Japanese and American research, we will try to study the different national systems of governance (the United States, Japan and France) in order to identify the impact of ownership structure and Board of Directors (henceforth BD) on the reduction of information problems, and therefore, investment in R&D.
Taking into account the rarity of work and the divergent results, our research goal is to answer the following question: To what extent do the internal governance mechanisms (ownership structure and board of directors) control the opportunism of the managers so as to make them target R&D investment, source of performance? And according to what systems of governance?

This article is organized as follows: In the first section on the determinants of investment in R&D, we will outline a series of proposals on the link between, on the one hand, national systems of internal governance, the ownership structure and board of directors, and on the other hand, R&D investment. In the second section, we will present the characteristics of our sample, our methodological approach and interpretation of results.

I. INTERNAL GOVERNANCE SYSTEMS AND R&D INVESTMENT

The level of risk, time horizon and asset specificity that support R&D investments are sources of conflicting interests between shareholders, creditors and managers. Moreover, the informational problems (moral hazard and adverse selection) that exist between them constrain the investment decisions of managers.

Governance mechanisms are therefore necessary to align the interests, influence each source of conflict, and therefore privilege the R&D investment. The tendency of managers to opt for such an investment depends on the degree of ownership concentration and structure of the board of directors which differ from one financial system to another.

1.1. The concentration / dispersion of ownership

Property represents a source of power and influence to support or oppose the strategic decisions made by managers, as the structure is concentrated or dispersed (Salancik and Pfeffer, 1980). An essential element of corporate governance, the concentration of ownership, which differs significantly according to the nature of national governance, acts on managerial latitude to encourage R&D investment.

In the United States, regulations limiting the acquisition of permanent capital by shareholders, make the ownership structure dispersed (Prowse, 1994). The high number of minority shareholders facilitates their exit and weakens their control over the company. According to Berle and Means (1932), a little concentrated and less stable ownership is a barrier to the control and monitoring of management rules. Freed from the controlling shareholder because of the problem of stowaways and investment costs, U.S. managers are encouraged to pursue their own interests at the detriment of shareholders (Baumol, 1962), protect their personal capital risk (Amihud and Lev, 1981) and initiate entrenchment strategy, destructive

[29] At firm level, any decision to invest in R & D requires financing which can be either: financing based on the market (Anglo-Saxon system) or a financing bank oriented (Germano-nippen system). These two forms of financing are two alternative systems of corporate governance in which interest conflict between shareholders and managers is more or less attenuated. Charreaux (1997b, p.421) defines corporate governance as "the set of mechanisms that has the effect of delimiting powers and influencing the decisions of managers, in other works, of governing their conduct and defining their discretionary space".

of value (Shleifer and Vishny, 1989). The dispersion of ownership is consequently associated with low levels of R&D investment, since the managers prefer to implement diversification strategies.
In this framework, Hill and Snell (1988, 1989) and Hoskisson et al. (1991) found a positive correlation between the degree of diffusion of capital and diversification strategy of U.S. firms. The argument contends that dispersed ownership structure implies low control on the part of shareholders, which would allow the manager to implement his/her diversification strategy. These authors also show that a strategy of R&D investment is proportionately small in firms where shareholders have little power. Similarly, Francis and Smith (1995) find that private firms with scattered capital are less innovative than those with concentrated capital held by their manager or outside investors.

In Japan, the lack of restrictions on the acquisition of capital encouraged the distribution of permanent capital in the hands of financial institutions and other corporations. The strict regulation of securities markets has facilitated the concentration of ownership. Anderson and Jayaraman (1992), Kaplan (1994) and Kang and Shivdasani (1995, 1999) find that ownership concentration increases the probability of referral of poorly performing managers and recruitment of new managers. The presence of block holders may force managers to maximize the firm's value (Shleifer and Vishny 1997; Striukova 2009). The control by the owners reduces information and agency problems that arise from the separation between ownership and control (Demsetz and Lehn, 1985). The holding of shares by banks and other institutions can encourage increased R&D investment.

In this regard, Hill and Snell (1988), Hansen and Hill (1991), Baysinger et al. (1991) and Wahl and McConnell (2000), Hosono et al (2004) found that the concentration of ownership in the hands of institutions positively affects R&D investment. As these shareholders have inside information on firms, they can reduce the manipulative actions of managers and raise the level of R&D expenditure.

Finally, in the French system, the ownership structure of firms, characterized by the presence of financial and non-financial institutions, is concentrated and belong to Germano-nippon model. The majority shareholders exercise control over the managing team. Charreaux and Pitol-Belin (1990) found that in controlled firms, where capital is concentrated in the hands of a small group of shareholders, they have a stronger control. They encourage managers to avoid strategic decisions that affect the firm's value (Striukova , 2009). Where ownership is concentrated, managers have no incentive to behave opportunistically because shareholders can replace bad managers.

Thus, the manager, who fears his eviction, has an interest in adopting decisions that maximize the firm's value, and reducing diversification strategies. Other empirical studies (Hill and Snell 1988; Denis et al. 1997) also confirmed the idea that the concentration of ownership is associated with lower levels of diversification. With a high concentration of ownership, managers are encouraged to undertake R&D.

In summary, American managers have less incentive to undertake R&D investments than their Japanese and French counterparts. We deduce the following hypothesis:

H1. A dispersed ownership structure (concentrated) in a U.S. firm (Japanese and French) was negatively (positively) associated with the R&D investment.

However, the ownership structure is not the only mechanism of internal governance limiting the discretionary power of managers. The BD is placed at the top of the hierarchy of Corporate Governance Systems (Lorsch and MacIver, 1989). As a statutory authority responsible for ratifying and monitoring managerial decisions (Fama and Jensen 1983a and b)[30], the BD plays an important role in resolving conflicts of interest.

1.2. The structure of the Board of Directors

According to agency theory, Fama (1980) and Fama and Jensen (1983a and b) assign the BD the mission of controlling managers to ensure the maximization of shareholder wealth. The influence of BD on the nature of decisions made by managers depends in part on its composition. The latter is limited to the

[30] Fama and Jensen (1983a and b) distinguish four stages in the decision process and corporate control: Initiative, ratification, implementation and monitoring.

distinction between inside directors (insiders)[31] and outside directors (outsiders)[32]. As the legal representatives of shareholders, outside directors are supposed to be more independent and more competent than inside directors to exercise more effective control over managers.

The respective situation of the directors (internal and external) and the accumulation / separation of decision functions (CEO) and control (Chair), lead to differences in the pattern of BD in different countries. The heterogeneity of directors and the dual or non-dual structure induce different attitudes to the performance of the control task. It seems a priori that the nature of directors, through financial and / or strategic controls[33], as well as the heap of functions – or otherwise - can influence the manager's discretionary latitude to ensure that R&D investment decisions are in the interests of shareholders. This influence varies significantly according to the nature of national governance.

1.2.1. Internal / External Directors and R&D investment

In the United States, the high degree of ownership and control separation in firms is offset by an increased role of BD (Weisbach 1988; Hermalin and Weisbach 1991; Denis and Sarin 1999). This organ, charged with representing the interests of shareholders, is characterized by dominance of outside directors who are likely to be objective and independent. Able to resist the efforts of managers, outside directors play an important role in controlling the decisions of managers to protect the social welfare of the firm (Fama 1980; Fama and Jensen 1983a, b; Zajac and Westphal 1996; Wright et al. 2002). Not being in direct contact with the current management of the firm, outside directors are less capable than inside directors - better informed - to evaluate managers based on subjective methods (Godard, 1997). To make judgments about the quality of management decisions, they exercise a control based on financial indicators.

Assessments based on market values of the performance transfer some risk to managers. The result of a strategy depends on the action of the manager and the hazard associated with the uncertainty of the environment (Desbrières et al. 2000). If the BD decides to evaluate the manager based on stock market performance, it transfers some risk to it, which increases the likelihood of liability and dismissal (Godard, 1996). But the manager is risk averse (the agency theory still holds this hypothesis). Therefore, financial controls based on market values will lead managers to focus on diversification strategies with those of R&D investment.

Similarly, if the outside directors prefer the control of accounting results, they increase the intensity of the manager's effort to maximize diversification strategies, but they remove this effort of investment strategies in R&D preferred by shareholders (who diversify the risk in their investment portfolio). In this context, Hill and Snell (1988), Deutsch (1995) and Xi et al. (2003) found a significant negative relationship between the dominance of outside directors on the board and R&D investment.

In France, the functioning of the Board is contingent on the ownership structure. Charreaux and Pitol-Belin (1990) tested the existence of differences in the composition and role of the board between three types of firm: family, controlled and managerial. In family firms, the shareholders (family members) dominate the board. There are fewer outside directors and the supervisory role is reduced. In controlled firms, controlling shareholders sit on the board and appoint managers and directors. Compared to the family firm BD, there are more outside directors. In the managerial firms, the percentage of outside directors is more important than the other two types of firm. The role of BD is most pronounced. Charreaux and Pitol-Belin (1990) found that the disciplinary role of outside directors is really important only for managerial firms, without dominant shareholder. The degree of control exercised by the board is inversely proportional to the degree of ownership and decision separation.

In firms with diffuse ownership, the BD can discipline the managers through the effects of outside directors on the management decision. The administrators trying to protect the interests of shareholders,

[31] These directors are firm executives or employees that depend hierarchically on the management.
[32] Outside directors serve on the BD but don't exercise any function of management within the firm. For a deeper definition see Kaplan and Minton (1994) and Charreaux (1997a).
[33] Financial controls are based on objective financial criteria, while strategic controls constitute a more open subjective assessment permitting the capture of the finer aspects of the action of the person responsible.

decided to evaluate and reward managers based on financial indicators. Assessments based on stock and / or accounting measurements of the performance transfer some risk to managers (Godard, 1996). The exercise of financial controls led managers to move towards diversification strategy and invest less in R&D activities. This idea is supported by studies by Hoskisson et al. (1989), Baysinger and Hoskisson (1990) and Van den Berghe (2009). The authors found that greater representation of outside directors in BD is associated with greater diversification and a lower concentration of R&D activities.

In Japan, the outside directors are rare (Kang and Shivadasani 1997). Most directors are inside administrators, employees of firms. They have a complementary role to that of managers. If there are outside directors, they are often representatives of the main bank and affiliated firm that have a significant capital. These administrators who maintain business relationships with the company cannot be considered independent directors (Yoshimori, 1998). To exercise effective control and ensure that the actions of managers are in the interest of the firm's partners, directors must be independent and have no relationship with management that could compromise the exercise of their decision freedom.

According to Fukao and Morita (1997), Japanese BD are not only responsible for supervising the CEO, as is the case in the United States, but they are also involved in the management of the company. The relatively large size of BD and the dominant role of inside directors are the characteristics of Japanese Boards. Participating in the decision-making process, administrators have access to internal information richer and more refined based on subjective criteria. To assess the competence and performance of managers and the soundness of their strategic initiatives, internal directors practice strategic controls. Through these controls, they induce subjective and open relations with the managers, and therefore reduce the risk of employment (Godard, 1997). When managers are evaluated on the basis of strategic controls, they are not subject to risk transfer, unlike the case where financial controls are used[34]. Therefore, managers encourage R&D investment. The positive effect of the dominance of inside directors over investment in R & D is confirmed by the results of studies by Hill and Snell (1988, 1989) and Baysinger et al. (1991).

In sum, BD dominated by inside directors incites Japanese managers to invest in R&D through the strategic controls it implements. In contrast, a BD dominated by outside directors, through the financial controls that it develops, provides no incentive for American and French managers to undertake R&D investments. We deduce the following hypothesis:

H2: A structure dominated by inside directors (external) in a Japanese firm (American and French) is positively (negatively) associated with the R&D investment.

1.2.2. The dual functions and R&D investment

In the U.S., the BD is characterized by a dual structure (Daily and Dalton, 1994). The posts of Director General and Chairman of the board are occupied by the same person. The combination of management and control functions by the manager gives him/her a great decision-making power and a great rooting opportunity (Fama and Jensen, 1983a, b). This dual structure does not allow the council to fully play its role because of the confusion of powers and responsibilities (Roe, 1994).

The informational advantage available to the manager, through his experience in business, allows him certain latitude as to the influence he can exert on the selection of investments. He/she can more easily defend the projects they have initiated and implemented, even if they do not create value for shareholders. In this context, it is difficult for the chairman to withdraw as CEO for poor performance. Freed from the control board, American managers are encouraged to pursue their personal interests at the expense of shareholders. They emphasize, in this respect, diversification strategies whose performance is short term. The combination of functions is associated with low levels of R&D investment. This idea is corroborated by the survey of Kor (2006).

In France, the legislator gives firms the opportunity to choose between providing the structure separation or overlapping of functions. This structure is relatively more frequent (Godard and Schatt, 2004). The CEO combines the two functions of decision and control, thus adopting a centralized structure. The combination of the two functions gives him/her greater power of decision and control in the firm. For

[34] A justification of this affirmation is provided in the study of Godard (1996).

French shareholders, the adoption of a dual structure can be risky, since it offers the opportunity for managers to more easily defend the projects initiated and implemented at the expense of their well-being. Recognizing the inefficiency of the BD at performing its control function[35], managers have an incentive to opt for diversification strategies or to reduce R&D investment, according to their interest. This idea reinforces the conclusions of Kor (2006) who found that the BD, having opted for a combination of functions, may lead managers to make opportunistic diversification strategies rejecting R&D investment.

Unlike France and the United States, the Chairman in Japan doesn't normally exercise functions of Director General (Yoshimori, 1998). This implies a clear separation between the functions of decision and control, facilitating the control of the Director General by the Chairman. The Board's role is all the more important as functional separation is more pronounced. The stable control of shareholders, among whom the creditors[36], can reduce agency problems by limiting the powers of managers to expropriate the interests of the firm. It encourages, in this respect, decision making that is oriented to partnership performance (Chen et al. 2007) and directs managers toward undertaking strategies of R&D investment. The findings of the survey achieved by Kor (2006) confirm this idea. The author indicates that the separation of decision and control is positively associated with the intensity of R&D investment.

The distribution of power within firms then plays an important role in shaping the behaviour of U.S., French and Japanese managers concerning R&D investment. The dual structure in which the CEO is also Chairman of the Board increases the intensity of the effort of American and French managers for achieving diversification strategies and a low concentration of activities in R & D. In contrast, an independent structure in which there is separation of the management and control functions allows Japanese managers to encourage R&D investment. We deduce the following hypothesis:

H3: An independent structure (dual) in a Japanese firm (American and French) is positively (negatively) associated with the R&D investment.

As in the foregoing, we consider in the context of this study three variables that determine R&D investment: the concentration of ownership, the dominance of inside directors and the dual structure. The theoretical predictions are presented in the following table.

Table 1. Summary of main explanatory variables of R&D investment and the signs predicted by theories of reference

Hypotheses	Explained variables	Explanatory variables	Expected signs		
			U.S.	JP	FR
H1	R&D Investment	Ownership concentration	+	+	+
H2	R&D Investment	Dominance of inside directors	+	+	+
H3	R&D Investment	Dual structure	-	-	-

II. EMPIRICAL ANALYSIS

This section aims to test the effect of ownership structure and board of directors on R&D investment. Initially, we will present our sample, the explained and explanatory variables and the method of multivariate analysis (canonical analysis). The presentation and interpretation of results of this study will make up a second section.

2.1. Presentation of data and variables measurements

The study data come from two databases (Worldscope and Osiris) and annual reports of publicly traded

[35] Because it possesses a power of influence on the board.

[36] The importance of shareholdings by the largest banks in the country provides them with an important power of control over firms' management.

U.S. (NYSE), Japanese (NIKKEI 225) and French (CAC40) firms over the period 2003-2007. These firms belong to industrial, commercial, tourism, technology and service sectors. The sectional heterogeneity can establish the external validity and generality of results (Lee, 2005). Financial institutions were excluded because of their atypical behaviour in financial policy. Firms whose number of employees was less than 500 were also removed to make the most interesting theoretical plausibility[37]. We selected all firms for which we have data on ownership structure, the composition of BD and the determinants of R&D investment (risk and horizon), that is, 531 firms (178 French, 174 American and 179 Japanese) for comparative statistical analysis.

Measurements of variables of the model are contained in Table No. 2 of the Appendix. One major problem we had in our work is the paucity of empirical studies on the subject. To find the indicators for measuring study variables, we relied on key indicators encountered in the literature to identify the measurements most frequently used and widely available. All variables have led to a purification work done during an iterative process, with the exception of the percentage of inside directors and the dual structure. We will recall here the retained measurements for the explained and explanatory variables.
The indicators often used in literature to measure R&D investment are R&D intensity, amount not communicable by firms. In the setting of our survey, R&D investment is considered like a risky and long term investment. Firms engaged in R&D have a high level of risk and a long-term return.

We use three measurements to assess the risk of R&D investment. Similar to Jensen et al. (1992), Bah and Dumontier (1996, 1998), the first measurement is the standard deviation ratio of return to total assets σ (ROA). The second is the standard deviation ratio of return to sales σ (ROS). The last measurement is the standard deviation ratio of return to equity σ (ROE).

As for the long-horizon R&D investments, Balakrishnan and Fox (1993), Gaver and Gaver (1993) and Bah and Dumontier (1996, 1998) found that firms engaged in R&D activities have a strong growth opportunity. As for these studies, we use three measurements specified by the growth opportunities to assess the investment horizon. The first measurement is the ratio of tangible assets expenditure to profit before interest, depreciation and tax (Balakrishnan and Fox 1993). The second and third are, respectively, the PER and the ratio of the market to book value of equity (MBVE) (Bah and Dumontier 1996; Gaver and Gaver 1993).

These measurements have made for us, alongside the theoretical literature, a framework to create our own measure of R&D investment. We have thus developed a set of 6 items. After iterations made on the basis of Principal Components Analysis (PCA and Varimax rotation)[38] and reliability testing, these 6 items were reduced to 4 items and summarized in 2 factors measuring R&D investment: 1) Risk of R & D investment and 2) Horizon of R&D investment.

For ownership concentration, we used two indicators: the Herfindahl index $HI = \Sigma (OWN_i)^2$ where OWN_i is the property of the i^{th} block holders and i = 1, 2 and 3 (Baysinger and Hoskisson 1989; Baysinger et al. 1991), and the sum of the percentage of shares held by three major shareholders (may be an individual, a family, an institution ...) (Lloyd et al. 1986).

The proportion of inside directors is a quantitative variable measured by the number of inside directors over the total number of directors. Those working in the firm and having family ties with its managers were considered inside directors (Alexander and Paquerot, 2000).

The cumulative function of CEO and Chairman of the Board of Directors is a dichotomous variable taking the value 1 if the two functions are performed by the same person and 0 if otherwise. This measure has been used by several previous researches, we cite as an example Kor (2006), Chen et al. (2007) and Van den Berghe (2009).

To take into account the sectional impact and obtain more reliable results, we introduced a control

[37] According to Scherer (1984), only the large firms can have the motivation and ability to develop new products and engage in projects in R & D. They have the ability to hedge against the inherent risks to the activity in R&D by committing several projects simultaneously.
[38] Results of the PCA are represented in table 4 in Appendix.

variable (binary variable) corresponding to sectional adherence. In this regard, we reduced our sample to two sub-samples, the high-tech firms and low-tech firms, to identify possible differences between U.S., Japanese and French firms, for R&D investment.

The explanatory and control variables influence the realization of R&D investment and verify its multidimensionality. They are also distinct from each other and present, as shown in Tables 3, 3.1 and 3.2 in appendix, a low and/or not significant correlation between them.

To test the model, we use STATISTICA 1994-2000, which is the most common program among the known methods of multivariate analysis. Every relationship has been tested independently by using a canonical analysis (when the relationship is composed of several variables to explain)[39]. This "second generation approach" enables us to determine whether there was a significant relationship between R&D investment and the ownership structure as well as the board of directors.

2.2. Presentation and interpretation of results

This section aims to present the test results of the three assumptions underlying the explanatory model of R&D investment. Initially, the model will make an estimate of the total sample which includes 178 French, 174 American and 179 Japanese firms. In a second step, we will try to focus on two sub-samples that include firms belonging to high/low technology sectors. In this sense, we selected our sample by industry to obtain homogeneous groups (low technology or high technology). This distinction helps to disclose further explanation of the determinants of R&D investment.

2.2.1. Estimation models for heterogeneous groups of firms

The values of Table 5 are indicators of the overall link between R&D investment and independent variables (determinants). Calculations for specific cases in the United States, Japan and France have given only one significant canonical pair at 1%, 5% and 10%.

Table 5. Canonical Correlations for heterogeneous samples (without control variables)

Hypotheses	Pairs of canonical axes	R canonical	R^2	Chi^2	Threshold significance	Index of redundancy
U.S.	1	**0,2503**	**0,0626**	**14,011****	0,0295	**0,0525**
	2	0,1360	0,0185	3,140	0,2079	0,0029
						0,0554
JAPAN	1	**0,3016**	**0,0909**	**18,183*****	0,0057	**0,0333**
	2	0,0951	0,0090	1,583	0,4531	0,0030
						0,0363
FRENCH	1	**0,2981**	**0,1167**	**14,109***	0,0889	**0,0488**
	2	0,1564	0,0579	3,035	0,4538	0,0090
						0,0578

(Thresholds: *** significant at 1 %, ** significant at 5 %, * significant at 10 %)

Information on the correlation coefficients of significant canonical axis pairs appears in Table 5a. This table replicates the factor structure of significant canonical pairs, that is to say, the correlations between synthetic variables from PCA and canonical axes. We indicated in bold weights with a value significantly greater than 0.5 (generally accepted threshold, Evrard et al. 2003), and we highlighted those with a value between 0.2 and 0.5 for further interpretation (see Fahmi 1999; Zouari 2008).

[39] For further study of this statistical method, see Zouari G (2008).

Table 5a - Factor structure of significant canonical pairs for samples mixed

Hypotheses	Variables		Axis 1
U.S.	Explained variables	- Risk of R&D investment	**-0,8788**
		- Horizon of R&D investment	**-0,9511**
	Explanatory variables	- Ownership concentration	**-0,7886**
		- Percentage of inside directors	**-0,5392**
		- Dual structure	0,3505
JAPAN	Explained variables	- Risk of R&D investment	**-0,9978**
		- Horizon of R&D investment	**-0,9890**
	Explanatory variables	- Ownership concentration	**-0,7956**
		- Percentage of inside directors	-0,4724
		- Dual structure	**0,5116**
FRENCH	Explained variables	- Risk of R&D investment	**-0,9032**
		- Horizon of R&D investment	**-0,9280**
	Explanatory variables	- Ownership concentration	**-0,6206**
		- Percentage of inside directors	**-0,5595**
		- Dual structure	0,3053

2.2.1.1. Interpretation of results for U.S. firms

For the relationship between R&D investments and its determinants, the calculations have revealed one canonical pair significant at 5% (see Table 5). The first canonical correlation coefficient (R Canonical) is about 0.25. It expresses the maximum correlation between the two groups of variables (measurements of R&D investment and the internal governance mechanisms) and reflects the existence of a linear relationship between them. This correlation, significantly, expresses by itself more than 6% of common variance (R^2), that is to say of the variance of R&D investment explained by its determinants.

Moreover, the index of total redundancy[40] in all measurements of R&D investment is 5.54%, with the first significant relationship which represents 94.7% (that is, 5.25% over 5.54 %). We can therefore conclude that the two sets of variables share a middle portion of the total variance[41] (Fornell and Larcker, 1980) and therefore our explanation of R&D investment by its determinants is moderately reliable (Thompson, 1990).

The factor structure of the significant canonical axis showed a link between two measurements of R&D investment ("Horizon of R&D" and "Risk of R&D" whose canonical coefficients are **r = -0.95** and **r = -0.87**, respectively) and the variables of internal governance through ownership concentration (**r = -0.78**), dominance of inside directors (**r = -0.53**) and the dual structure (r = 0.35, see Table 5a)

The signs of these correlation coefficients allow us to confirm the three hypotheses tested. Indeed, when managers are investing in long term and risky projects, we are witnessing a governance structure characterized by:
- A high concentration of ownership (hypothesis **H1 is validated**), which joins the research findings of Hill and Snell (1988, 1989) and Francis and Smith (1995);
- BD structure dominated by the inside directors presence (hypothesis **H2 is validated**), according to studies by Hill and Snell (1988) and Xi et al. (2003);
- A separation of decision and control functions (hypothesis **H3 is validated**), this joins the empirical results obtained by Kor (2006).

These results show that the internal structure of American corporate governance, characterized by dispersed ownership, predominantly external directors and a dual structure (a combination of functions) doesn't limit managerial discretion and doesn't encourage R&D investment. Indeed, the lack of internal control systems increases managerial discretion and therefore reduces R&D investment at the expense of

[40] The indicator of redundancy allows us to appreciate the part of the variance of each set of variables explained by canonical axes.
[41] Fornell and Larcker (1980) considers that redundancy is important when it exceeds 10%, average when it is located between 5 and 10%, and weak when its value is less than 5%.

shareholder interests. Thus, there are interrelationships between R&D investment and the variables related to internal governance. The model underlying these relationships is likely to be accepted in U.S. firms.

2.2.1.2. Interpretation of results for Japanese firms

Calculations revealed a single significant canonical pair at 1% (see Table 5). The first canonical correlation coefficient is about 0.30 and reflects the existence of a linear relationship between the two groups of variables. This correlation significantly expressed 9% of common variance, which is to say of the variance of investment in R & D accounted for by the internal governance structure.

Moreover, the index of total redundancy is 3.63%, with the first significant relationship which represents 92%. We can therefore conclude that the two sets of variables share a portion of the total variance described as low (less than 5%, criteria of Fornell and Larcker, 1980), and that the explanatory power of internal governance variable is low (Thompson, 1990).

As summarized in Table 5a, the two variables apprehending R&D investment ("Risk" and "Horizon") are negatively related to the canonical axis (**r = -0.99** and **r = -0.98**, respectively), and those measuring the systems of internal governance ("Ownership Concentration", "Dominance of inside directors" and "Duality") are negatively and positively related (**r = -0.79**, r = -0.47 and **r = 0.51**, respectively, see Table 5a).

Examination of these correlations allows us to **validate hypothesis H1**. Indeed, when the ownership structure is concentrated, the managers of Japanese firms invest more in R&D. Studies led by Hill and Snell (1988), Hansen and Hill (1991), Baysinger et al. (1991) and Wahal and McConnell (2000), Hosono et al (2004) also find that shareholders have inside information on firms, can reduce the manipulative actions of managers, and consequently, increase R&D expenses.

Moreover, when the percentage of inside directors is high and the managers of Japanese firms dissociate the two functions of decision and control, the latter are motivated to invest in R & D (**hypotheses H2 and H3 are validated**). Indeed, an assessment of managers from strategic controls encourages them to promote R&D investment, which joins the studies elaborated by Hill and Snell (1988, 1989), Baysinger and Hoskisson (1990) and Baysinger et al. (1991). Similarly, a separation of decision and control also directs managers toward undertaking strategies of R&D investment, in accordance with studies achieved by Kor (2006).

In conclusion, the canonical results prove the existence of interdependence between R&D investment and internal control variables. It seems, therefore, that the Japanese model cannot be dismissed.

2.2.1.3. Interpretation of the results for French firms

Calculations gave a single significant canonical pair at 10% (see Table 5). The canonical correlation coefficient is about 0.29 and represents nearly 12% of the common variance. And, as the total redundancy index is about 5.8% (between 5 and 10%, criteria of Fornell and Larcker 1980), our explanation of R&D investment by the variables of internal control is fairly reliable (Thompson, 1990).

The analysis of canonical coefficients can retain two significant measurements of R&D investment ("Horizon" and "Risk"). They are negatively related to the canonical axis (**r = -0.92** and **r=-0.90**, respectively). The variables explaining R&D investment ("Ownership Concentration", "Dominance of inside directors" and "Duality") are negatively and positively related (**r = -0.62**, **r = -0.55** and r = 0, 30, respectively, see Table 5a).

The correlation coefficients and their signs allow us to confirm the three hypotheses tested. The central causality that we can deduce is then the following: the more French managers are making R&D investment:

- the more ownership is concentrated (**hypothesis H1 is validated)**. This is consistent with the empirical results obtained by Hill and Snell (1988) and Denis et al. (1997);
- the more inside directors dominate the BD (**hypothesis H2 is validated**). This reinforces studies done by Hoskisson et al. (1989), Baysinger and Hoskisson (1990) and Van den Berghe (2009);

- the less they combined the two functions of decision and control (**hypothesis H3 is validated**), which joins the survey by Kor (2006).

These results show a linear relationship between R&D investment, particularly in terms of horizon and risk, and internal control variables. The model explaining R&D investment through the internal governance structure is likely to be accepted in French firms.

2.2.2. Estimation models for homogeneous groups of firms

We present here the results of models applied to homogeneous firms, according to their technological intensity. We recall that these tests are designed to answer a specific question: Does the internal governance variable have the same effect on R&D investment depending on whether the firm belongs to high-tech or low-tech sectors?

Table 6. Canonical Correlations of the explanatory model of R&D investment for homogeneous samples (low-technology)

Hypotheses	Pairs of canonical axes	R canonical	R^2	Chi^2	Threshold significance	Index of redundancy
U.S.	1	0,2139	0,0457	5,058	0,5363	0,0236
	2	0,1089	0,0118	1,027	0,5983	0,0057
						0,0293
JAPAN	1	0,2177	0,0474	5,828	0,4427	0,0153
	2	0,1491	0,0222	1,843	0,3977	0,0073
						0,0226
FRENCH	1	0,1027	0,0105	1,382	0,9669	0,0040
	2	0,0542	0,0029	0,300	0,8604	0,0018
						0,0058

(Thresholds: *** significant at 1 %, ** significant at 5 %, * significant at 10 %)

Table 6.1: Canonical Correlations of the explanatory model of R&D investment for homogeneous samples (high-technology)

Hypotheses	Pairs of canonical axes	R canonical	R^2	Chi^2	Threshold significance	Index of redundancy
U.S.	1	**0,5333**	**0,2844**	**29,047**	0,0000	**0,2624**
	2	0,2040	0,0416	3,275	0,1944	0,0032
						0,2656
JAPAN	1	**0,4294**	**0,1843**	**18,182**	0,0058	**0,0946**
	2	0,0527	0,0027	0,245	0,8844	0,0185
						0,1131
FRENCH	1	**0,4987**	**0,1634**	**36,672*** **	0,0000	**0,1598**
	2	0,2076	0,0787	7,094	0,1293	0,0045
						0,1643

Table 6.2 - Factor structure of significant canonical pairs of the explanatory model of R&D investment for homogeneous samples (high-tech)

Hypotheses	Variables		Axis 1
U.S.	Explained variables	- Risk of R&D investment	**-0,9477**
		- Horizon of R&D investment	**-0,9733**
	Explanatory variables	- Ownership concentration	**-0,8808**
		- Percentage of inside directors	-0,3756
		- Dual structure	0,3567
JAPAN	Explained variables	- Risk of R&D investment	**-0,9836**
		- Horizon of R&D investment	**-0,9753**
	Explanatory variables	- Ownership concentration	**-0,6741**
		- Percentage of inside directors	**-0,5129**
		- Dual structure	0,4678

FRENCH	Explained variables	- Risk of R&D investment - Horizon of R&D investment	**-0,9682** **-0,9422**
	Explanatory variables	- Ownership concentration - Percentage of inside directors - Dual structure	**-0,6703** -0,3750 **0,6201**

2.2.2.1. Interpretation of results for U.S. firms

Tests of the relationship "R&D Investment / internal controls mechanisms" have revealed one significant canonical pair at 1% for "high technology" U.S. firms (see Tables 6 and 6.1). This correlation expresses more than 28% of the common variance. And as the index of total redundancy is 26.5% (over 10%, criteria of Fornell and Larcker, 1980), we conclude that the explanatory power of the variables related to internal Corporate Governance Systems is strong.

The factor structure of the significantly canonical axis enables us to keep the two measurements of R&D investment ("Risk" **r = -0.94** and "Horizon" **r = -0.97**) and the three variables related to internal controls ("Ownership Concentration" **r = -0.88**, "percentage of inside directors" r = -0.37 and "dual structure" r = 0.35, see Table 6.2). The variability of the second block of variables essentially comes from the first factor.

We then deduce that the choice of R&D (including risky and long term investments) by U.S. managers operating in a "high technology" sector is positively correlated to the concentration of ownership (**hypothesis H1 is validated**), the presence of inside directors in BD (**hypothesis H2 is validated**), and negatively to the overlapping of the two functions of decision and control (**hypothesis H3 is validated**).

Our results support the assumptions of the theory of corporate governance and are in line with those obtained by Hill and Snell (1988, 1989), Francis and Smith (1995) and more recently by Xi et al. (2003) and Kor (2006).

The addition of the control variable "membership sector" can have a better explanatory power[42]. These results then show the existence of significant relationships between R&D investment and internal controls, according to theory, and therefore, the acceptance of the model specific to U.S. firms of high technology.

2.2.2.2. Interpretation of results for Japanese firms

For firms in industries of "low technology", the relationship test "R&D Investment / internal controls mechanisms" yielded no significant canonical pair (see Table 6). There is no linear relationship between the two groups of variables. R&D Investment would not be linked, at least in a linear manner, to the concentration of ownership, overlapping functions of decision and control and dominance of inside directors in the BD of Japanese firms with low technology.

In contrast, the calculations made to test this relationship with Japanese firms of "high technology" gave a single significant canonical pair at 1% (see Table 6.1). The canonical R of about 0.42 reflects the existence of a linear relationship between the two groups of variables. This correlation expresses 18.4% of common variance. Moreover, the total redundancy index is about 11.31% (over 10%, criteria of Fornell and Larcker, 1980). We infer that the relationship between these two sets is strong and that the explanation of R&D investment by variables related to mechanisms of internal controls is highly reliable (Thompson, 1990).

All variables to understand internal controls ("Ownership Concentration" **r =- 0.67,** "Percentage of inside directors" **r = -0.51** and the "dual structure" **r = 0.46**) and those measuring R&D investment ("Risk" and "Horizon" **r = -0.98** and **r = -0.97**, respectively, see Table 6.2) are negatively and positively related to the significant canonical axis. These correlation coefficients indicate that R&D investment in Japanese "high technology" firms depends on a strong concentration of ownership (**hypothesis H1 is validated**), a strong

[42] The R^2 of the initial model (without control variable) rose from 6.26% to 28.44% compared to the model with control variable "high technology" (see Tables 5 and 6.1).

presence of inside directors in BD (**hypothesis H2 is validated**) and a non-dual structure (separation of decision and control) (**hypothesis H3 is validated**).

Thus, these results are on the same lines as those found by Hill and Snell (1988, 1989), Baysinger and Hoskisson (1990), Rechner and Dalton (1991), Pi and Timme (1993), Daily and Dalton (1994) , Baliga et al. (1996) and Core et al. (1999), Wahl and McConnell (2000) and more recently by Hosono et al (2004).

In conclusion, the introduction of the control variable "industry" increases the explanatory power of the model compared to initial results (without control variable)[43]. This shows the importance of this variable in explaining the dependent variable. These results show the existence of significant linear relationship between R&D investment and internal control mechanisms, according to theory, and therefore the acceptance of model specific to Japanese firms of high technology.

2.2.2.3. Interpretation of the results for French firms

Calculations show that the relationship between R&D investment and the mechanisms of internal controls is significant only for firms with "high technology" (see Tables 6 and 6.1). The only canonical axis is significant at 1%. The canonical R is about 0.50 and represents over 16% of the common variance. And as the index of total redundancy is about 17% (superior to 10%, criteria of Fornell and Larcker, 1980), we conclude that the two sets of variables (R&D investment and its determinants) share a large part of the total variance.

In Table 6.2, we note that the two measurements of R&D investment ("Risk" and "Horizon") are negatively related to the canonical axis (**r = -0.96** and **r = -0.94**, respectively). Furthermore, the factors behind the R&D investment ("Concentration of ownership", "percentage of inside directors" and "dual structure") are negatively and positively associated with the canonical axis (**r = -0.67**, r = -0.37 and **r = 0.62**, respectively).

Examination of these correlation coefficients reveals that R&D investment is realized by French firms in high technology, high concentration of ownership (**hypothesis H1 is validated**), dominated by internal administrators in their BD (**hypothesis H2 is validated**) and independent structure (**hypothesis H3 is validated**).

These results confirm the work of Hill and Snell (1988), Baysinger and Hoskisson (1990), Kor (2006), Denis et al. (1997) and Van den Berghe (2009) who argue that ownership concentration, the presence of inside directors and the separation of decision and control motivate managers to undertake risky and long-term investments, including R&D investment in accordance with the interests of shareholders.

Given the canonical results conducted on heterogeneous and homogeneous samples, we note that with the introduction of the control variable membership sector, the R^2 increases from 11.67% (heterogeneous firms) to 1.05% (low technologies firms) and to 16.34% (high technologies firms, see the Tables 5, 6 and 6.1). This indicates the importance of this variable in explaining R&D investment. It is likely that the model with control variable "high technology" cannot be dismissed entirely within French firms.

In summary, the results of tests of theoretical models (with or without control variables) allowed us to explain the behaviour of U.S., Japanese and French managers concerning R&D investment (risky and long-term) through the variables internal controls.

CONCLUSION

The study of R&D investment seems interesting because it allows us to better understand the mechanisms of value creation. Taking into account the characteristics of this investment (i.e. distant horizon and high risk) as well as the agency and transaction costs that result, enables us to explain the behaviour of firms for R&D investment.

[43] The R^2 of the initial model rises from 9.09% to 18.43% compared to the model with control variable "high technology" (see Tables 5 and 6.1).

Overall, we defined our approach to investing in R&D from two complementary angles:
- A conceptual approach to implement national systems of governance, mainly apprehended by the shareholder structure and board of directors, the adoption and efficiency of R&D investment. The relevance of this model has been demonstrated;
- An empirical approach to test three hypotheses at the conceptual phase, with U.S., Japanese and French firms. The canonical analysis conducted proves the existence of a linear and positive association between R&D investments, create value, and the establishment of internal controls appropriate.

If this research provides contributions to the understanding of the determinants of R&D investment, it has, however, and as with all confirmative studies, limits and still leaves many questions open about the issue of investment. In addition to internal mechanisms, which we studied, the model should incorporate external controls mechanisms to represent a more complete reality. These mechanisms include: the financial market, the labour market and the market for goods and services, etc, which have an impact on managerial discretion, and therefore on the choice of R&D investment.

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APPENDIX

Table 2 - Measurements of Explanatory Variables in the Model of R & D Investment

Initial variable	Measurements or Factors extracted
- R&D Investment	Six items; after PCA with Varimax rotation: Two factors: - Risk of R & D Investment - Horizon of R & D Investment
- Ownership concentration	Two items; after PCA with Varimax rotation: Two factors: - Percentage of shares held by three major shareholders - Herfindahl Index
- Dominance of inside directors	One measure: Ratio of the inside directors number over the total number of directors
- Dual structure	One measure: dichotomous variable: 1 if the two functions of CEO and Chairman of the Board Directors are performed by the same person, 0 if otherwise

Table3. Correlations matrix (U.S. Firms)(1)

	Activity sector	Ownership concentration	Duality	Percentage of inside directors
Activity sector	1,00			
Ownership concentration	-,196	1,00		
Duality	,063	-,132	1,00	
Percentage of inside directors	,027	,139	-,172	1,00

Table 3.1 – Correlations matrix (Japanese Firms)(1)

	Activity sector	Ownership concentration	Duality	Percentage of inside directors
Activity sector	1,00			
Ownership concentration	,187	1,00		
Duality	,088	,009	1,00	
Percentage of inside directors	,142	,031	-,112	1,00

Table 3.2 – Correlations matrix (French Firms)(1)

	Activity sector	Ownership concentration	Duality	Percentage of inside directors
Activity sector	1,00			
Ownership concentration	,029	1,00		
Duality	-,023	-,076	1,00	
Percentage of inside directors	,116	-,039	,057	1,00

1) Note that all correlations between variables are significantly smaller than 0.6 (threshold at which we begin to experience serious problems of multi-colinearity). In the Pearson test and the index of conditioning we have found that these variables are distinct from each other and are not significant (correlation thresholds above 10% and the packaging is less than 1000).

Table 4. Summary: Results of PCA

PCA N°	Initial variable	Factors extracted	r	σ^2 (en %)	p value	α	Items deleted
1.1	**R&D investment (USA)**	**Factor 1 : Risk of R&D investment** Item 1 : Standard deviation ROA Item 2 : Standard deviation ROS **Factor 2 : Horizon of R&D investment** Item 1 : Tangible Assets /NOPBT Item 2 : PER **Total**	 0,898 0,894 0,801 0,792	**40,610** **32,322** **72,932**	**1,624** **1,293**	**0,737** **0,631**	- "Standard deviation ROE" (r < 0,5 in factors extracted). - "MBVE" to increase the reliability of the 2nd factor.
1.2	**R&D investment (Japan)**	**Factor 1 : Risk of R&D investment** Item 1 : Standard deviation ROE Item 2 : Standard deviation ROA **Factor 2 : Horizon of R&D investment** Item 1 : Tangible Assets / NOPBT Item 2 : PER **Total**	 0,951 0,938 0,797 0,757	**44,754** **31,064** **75,817**	**1,790** **1,243**	**0,871** **0,555**	- "Standard deviation ROS" (r < 0,5 in factors extracted). - "MBVE" to facilitate the interpretation of Factor 1.
1.3	**R&D investment (French)**	**Factor 1 : Risk of R&D investment** Item 1 : Standard deviation ROE Item 2 : Standard deviation ROA **Factor 2 : Horizon of R&D investment** Item 1 : PER Item 2 : Tangible Assets / NOPBT **Total**	 0,852 0,847 0,856 0,773	**40,354** **26,665** **67,020**	**1,614** **1,067**	**0,695** **0,637**	- "MBVE" (r < 0,5 in factors extracted). - "Standard deviation ROS" to facilitate the interpretation of Factor 2.
2	**Ownership concentration (USA)**	**Factor 1: Ownership concentration** Item 1 : Percentage of shareholders Item 2 : Herfindahl Index	 0,964 0,964	**92,863**	**1,857**	**0,923**	
5	**Ownership concentration (Japan)**	**Factor 1: Ownership concentration** Item 1 : Percentage of shareholders Item 2 : Herfindahl Index	 0,967 0,967	**93,513**	**1,870**	**0,930**	
6	**Ownership concentration (French)**	**Factor 1: Ownership concentration** Item 1 : Herfindahl Index Item 2 : Percentage of shareholders	 0,918 0,918	**84,340**	**1,687**	**0,814**	