Internal Capital Markets in Business Groups

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Abstract

Business groups are important in many countries. Several studies have looked at the performance and behavior of firms that are members of a business group. This paper looks at the issue in more detail and tries to answer some related questions. First, do business groups really have internal capital markets and do they provide efficient resource allocation (in a view of the controlling shareholders)? Also, what are the characteristics that determine the tendency to have efficient resource allocation in business groups? Using an investment model with costly external finance, I derive an empirical regression counterpart and use it to test the existence of internal capital markets in business groups. I also test various characteristics of groups that tend to affect the groups' resource allocation. Firm-level data from Thailand's Ministry of Commerce is used as a sample in the empirical sections. The results show that corporate control, group size, and within-group intermediaries tend to facilitate the efficient resource allocation. Corporate laws and regulations deliver the opposite results while industry diversification shows no effect on within-group resource allocation. In sum, the paper provides evidence from micro data that the structure of business groups and corporate governance are related to the investment decision of firms.

1 Introduction

"Business groups" are common in many countries, especially in emerging economies. In those economies, the role of collections of legally distinct firms tied together and coordinating on their actions is important. Linkage between member firms is complex. It could be formal or informal, and direct or indirect – ranging from pyramidal holding company structure to cross ownership and to common directorates. This feature can be traced at least back to the Japanese pre-war *zaibutsu* and its post-war *keiretsu*. Many economists have been studying the performance and behavior of firms in business groups extensively. Several results of those studies refer to the existence of internal capital markets within business groups. In this paper, I look at the issue in more detail and try to answer related questions: First, do business groups have internal capital markets? Are the internal capital markets deliver the efficient resource allocation within the group? Finally, if some groups tend to have more efficient allocation than others, what are the characteristics that determine this tendency? Using the firm-level data from Thailand's Ministry of Commerce, this study shows that the degree of efficiency of resource allocation varies across business groups. Groups

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whose controllers have higher control, groups with more number of member firms, and groups with winthin-group intermediaries tend to have more efficient resource allocation. Groups with larger fraction of listed firms deliver the opposite results while industry diversification seems not to affect the efficiency of resource allocation of the groups.

In this paper, I define "business group" as a collection of legally independent firms that are wholly or partly owned and managed by the same person (or a group of person such as family)[1]. What makes business groups different from a collection of firms interacting through the external markets; and what makes business groups different from a collection of segments in a diversified firm? These questions are not new. They are just a variant of what Ronald Coase (1937) posed more than 60 years ago on the nature of firms and markets. Business groups stand between the two of them. I take as a building block Grossman and Hart's (1986) view of a firm as a nexus of assets, and use their definition of ownership to distinguish activities within business groups from the ones that occur within firms or in the external markets. Grossman and Hart define ownership as residual control rights over the use of assets of the firms. Therefore, an owner of a firm has a right to transfer assets across segments of the firms in order to maximize the value of her firm. In effect, this is just an establishment of internal capital markets within the firm[2]. Similarly, I define a business group as a collection of legally independent firms that are controlled by a person (or a group of persons) that has a right over the use of assets of the member firms. This person has a right to transfer assets across the member firms, hence establishing internal capital markets[3] within a group. What makes a business group different from a firm is that the right over the use of assets is limited because each member firm in a group is independent by law. Since the composition of shareholders of each member firms of a group could be different, the optimal resource allocation in a view of the controller is possibly not the optimal one in other shareholders' prospect. This conflict of interest between inside (controlling) and outside (non-controlling) shareholders makes the within-group capital markets imperfect, even when there is no agency problem between the owner and the managers of the member firms. The degree of imperfection is lower when the controller has higher ability to control the group. This ability in turn depends on the structure of the group and corporate laws in the economy.

I assume that external capital market is imperfect so external fund is more costly than internal finance. This assumption is natural in emerging economies because their capital markets are not fully developed and firms tend to have credit constraints. As presented in Gilchrist and Himmelberg (1998), the marginal cost of fund determines the firm's discount factor that is used in discounting the stream of marginal future benefits of the current investment. As a result, the firm's investment will depend on its financial determinants as well as its profitability. Since a group with absolute control can freely transfer resources across its member firms, the efficient allocation implies that the marginal costs of fund are equalized across firms within the group; therefore, a group firm's investment should depend only on its group's financial factor and the firm's own profitability– but

[1] With this definition, I will use the terms "manager" and "controller" interchangeably throughout the paper.

[2] However, the fact that the owner has a full right in asset relocation within her firm does not imply that the internal capital market is perfect in a sense that it equates marginal product across projects within the firm. Imperfection can arise, for instance, in the presence of agency problem between the owner and the managers of different segments. See Stein (1997) and Rajan, Servaes and Zingales (2000).

[3] Here I use the term "internal capital market" in a very broad meaning. It includes within-group transfers, within-group credit markets, and within-group equity market, among others.

not the firm's financial determinants.

In this paper, I will study the issue addressed above in two steps. First, I derive two structural models of investment in the presence of costly external finance– one for a non-group firm and the other for firms in a group with absolute control. I derive an empirical counterpart of the model and use it to test whether there is internal capital markets in groups or not, and also whether they deliver an efficient resource allocation outcome. Then, I test which characteristic of groups that affect the efficiency of resource allocation. The potential characteristics include corporate ownership and control of the groups, group size, corporate law and regulation, within-group intermediaries, and industry diversification. The results show that (1) corporate control, (2) group size, and (3) within-group intermediaries tend to facilitate the efficient resource allocation in a view of the controlling shareholders. Corporate laws and regulations deliver the opposite results while industry diversification shows no effect on within-group resource allocation. In sum, the paper provides evidence from micro data that the structure of business groups and corporate governance are related to the investment decision of firms.

Before going to the next sections, it is important to address three issues explicitly. First, the main purpose of this paper is not to propose a theory explaining the formation of business groups and I will take the existence of business groups as well as groups' characteristics as given. However, the results from this paper should suggest some ideas on the nature of business groups that motivate a future research on endogenous group formation and endogenous group structure. Second, modeling the costly external finance is beyond the scope of this paper. Cost of external finance is assume to be increasing and convex *a priori*. Lastly, with the existence of costly external finance, I define efficient resource allocation as the allocation of fund that equalizes the marginal cost of external finance across firms in a group. If the marginal costs are not equal, the controller can get higher aggregate profit from transfering fund from the firms with low marginal costs to the firms with higher marginal costs. Therefore, the term "efficiency" in this paper is defined in a view of the controller.

The rest of the paper goes as follows. Section 2 reviews related literature regarding capital markets and corporate investment, as well as existing studies on business groups. Section 3 presents the structural model of corporate investment of non-group and group firms when external fund is costly. Section 4 presents an empirical strategy of this study. Section 5 describes Thailand's firm-level data and reasons why this data set is good for this study. The empirical results are in section 6. The paper ends with conclusion and appendix.

2 Related Literature

How to allocate funds across projects is a fundamental question in corporate finance. The existing literature looks at two similar but different questions on this issue. The first question is how to allocate funds across firms in the economy, and the second one is how to allocate funds across projects within a particular firm. In other words, the first question concerns with external capital market while the second question looks at the internal market. Stein (2001) offers a more extensive survey of the literature in this field.

External Capital Market and Investment

I start with the literature on external capital markets. In their seminal paper, Modigliani and Miller (1958) show that, in a world with frictionless perfect capital markets, capital is allocated efficiently in such a way that the marginal product of capital is equated across all projects in the economy. The Q-theory approach, proposed by Tobin (1969) and extended by Hayashi (1982), reformulates the neoclassical theory of investment with the implication that, under perfect capital market, a firm's investment should depend only on its profitability, as measured by the Q value. Firm's financial characteristics such as capital structure or liquidity should not affect the firm's investment behavior.

However, in a world with frictions such as information asymmetry, internal and external finance are not perfect substitutes. Using funds from external sources is possibly more costly than using internal funds such as cash flow. For example, Myers and Majluf (1984) and Greenwald, Stiglitz and Weiss (1984) suggest that issuing new equities could be costly to the firm; Stiglitz and Weiss (1981) show that some firms with good investment opportunity cannot get loans to finance their projects.

Studies of the effects of financing constraints on corporate investment can be traced back at least to Meyer and Kuh (1957) and have been growing since the work by Fazzari, Hubbard and Peterson (1988). The empirical strategy goes as follows. First, sample firms are divided into groups *a priori* according to their degree of credit constraint. The criteria range from dividend payouts (Fazzari, Hubbard and Peterson (1988)) to membership in large industrial groups (Hoshi, Kashyap and Scharfstein (1991) for Japanese *keiretsu*, Perotti and Gelfer (1998) for Russian Financial-Industrial Groups, among others). Running a regression of a firm's investment on its cash flow and some measures of its future profitability, these studies then compare the regression coefficients of the cash flow from different groups of firms. The common finding is that the investment of the firms that are *a priori* group as credit-constrained firms is more sensitive to cash flow than the one of unconstrained firms. The argument from this investment-cash flow regression is that a credit-constrained firm has to rely more on its own internal fund; therefore, its investment is more sensitive to the movement of its cash flow[4]. However, this investment-cash flow approach is criticized by Kaplan and Zingales (1997, 2000) that the firms with higher sensitivity of investment to cash flow empirically are not necessary the firms with higher degree of credit constraint[5].

Although most of the empirical research in this field mainly focus on testing the implication of the theory, there are also some studies that try to estimate the structural model of corporate investment and financial policy. Bond and Meghir (1994) investigate the relationship between investment and cash flow by estimating the Euler equation for optimal capital accumulation in the presence of convex adjustment costs. Gilchrist and Himmelberg (1998) post and try to answer a slightly different question: How much does investment respond to its "fundamental" *versus* "financial" determinants? In sum, their study shows that, in addition to a firm's fundamental profitability, financial factors help explain the firm's investment.

Internal Capital Market and Investment

Theoretical ideas about capital markets within a firm date back to at least Alchian (1969)

[4] Hubbard (1998) offers a survey of the literature in this direction.

[5] Kaplan and Zingales (1997) re-categorize low-dividend firms in Fazzari, Hubbard and Peterson's sample according to each firm's annual report and management discussion of liquidity. They find that firms that appear financially less constrained have higher investment sensitivity to cash flow than the firms that appear more constrained.

and Williamson (1975). Alchian's argument on the advantage of internal capital market is that corporate headquarters have ability in monitoring and information production. However, Gertner, Scharfstein and Stein (1994) argue that Alchian does not give a clear reason why headquarters are better than a bank in a delegated monitoring model of Diamond (1984). Instead, in their opinion, the main distinction between a bank and corporate headquarters are that the headquarters own the business units while the bank does not. Their definition of ownership follows Grossman and Hart (1986) in a sense that it means a residual control rights over the use of assets of the firms.

Examples of empirical studies in this line of research are Lamont (1997) and Shin and Stulz (1998) for conglomerates; and Houston, James and Marcus (1997) for bank holding companies. They find that loan growth at a subsidiary bank is more sensitive to the holding company's cash flow and capital position than the bank's own. Their results suggest that there is an internal capital market within a firm, but the market is not perfect.

Business Groups

An intermediate case of capital allocation applies to business groups[6]. Most of economics literature on business groups focuses on the characteristics and roles of Japanese *keiretsu*[7]. The traditional findings are that the *keiretsu* firms tend to have lower operating profitability but also lower variance. The results support the idea that there is insurance within the group, but this insurance comes with a cost in terms of lower average profits. Recently, there are studies that challenge the traditional idea of insurance provided by *keiretsu*. See Beason (1998) and Kang and Stulz (2000) for examples.

Khanna and Rivkin (2001) studies the performance of group firms in emerging markets. Their results on profitability, as measured by the rate of returns to asset, of the firms are diverse: Affiliated firms have higher profitability than non-affiliated firms in some countries, while lower or indifferent in other countries. However, profit rates of group firms are closer to one another than they are to the profit rate of other firms in almost all countries in their sample. Khanna and Yafeh (2000) look closer on three channels of risk sharing among business groups. First, they find that there is profit sharing through intra-group trade in some countries, but the magnitude is quite small. Second, they find no evidence supporting that dividend plays a role as shock absorbers. Finally, they find that within-group loans are associated with substantial liquidity smoothing in India.

Lastly, following a series of recent economic crises, many studies have been focusing more on the dark side of business groups. One of the main ideas is that business groups are associated with (legal or illegal) minority shareholder expropriation. The insight stems from Akerlof and Romer's (1993) looting and Johnson, La Porta, Lopez-de-Silanes and Shleifer's (2000) tunneling. Claessens, Djankov, Fan and Lang (1999) take this idea and look at East Asian crisis, while Bertrand, Mehta and Mullainathan (2003) focus on Indian groups.

Differences between this Study and Existing Literature

Most of the literatures on business groups focus on the groups performance as measured by profit rates. However, profit rate is not a good variable used to analyze the problem of resource allocation within a group. In production theory, the first-best capital allocation is the allocation

[6] Business group is a topic studied not only in economics but in sociology as well.

[7] Hoshi and Kashyap (2001) offer extensive survay of this literature.

that equalizes net[8] marginal product of capital across firms in the group. In principle, marginal product of capital is observable so we can test the theory of efficient resource allocation directly by comparing the marginal product across firms. However, capital is a durable good, so the profit rate (or the rate of return to assets) is just a part of a stream of marginal product of capital over the lifetime of that capital good. As a result, equal profit rates at a given date do not imply efficient capital allocation. Looking jointly at investment and its profitability (such as Q in the neoclassical theory, for instance) is preferable. Efficient allocation of capital implies higher investment in a project that has higher profitability.

Although a lot of work on investment and business groups has been done already, very few of them really look at the internal capital market within business groups. The closest study is Hoshi, Kashyap and Scharfstein (1991). However, their study is mainly on the relationship between a firm's liquidity and its investment, where the existence of internal capital markets within *keiretsu* are implicitly assumed *a priori*. Therefore, they focus more on comparing the effect of being in (any) business groups and not being in (any) groups rather than the efficient resource allocation of firms when they are in the same group. The study of interdependence of resource allocation across investment units is more prominent in Lamont (1997), and Shin and Stulz (1998), but their studies look at the allocation of capital within a firm – not across firms within a group as what I study here. Looking at internal capital markets across firms within a business group has an advantage over looking at the market within a firm in a sense that data on assets, investment, and so on are better defined and measured at the firm level than at the segment level, especially when assets such as buildings or machines are commonly used by more than one segments. On the other hand, one would argue that transfers across segments of a firm have less friction than transfers across firms within a group, in particular when the ownership composition of the firms are different. However, the benefit of this imperfection is that it can then be used to test the implication of corporate control and corporate governance on investment later. Moreover, this paper also look at various characteristics of the groups that tend to efficient resource allocation and empirically test them jointly.

3 Model

The model used in this paper is a corporate investment model with costly external borrowing. This type of model has been extensively used in many studies[9]. For simplicity, the financial friction is not endogenously modeled in this study. Instead, we assume that if firm i borrows by issuing a one-period corporate bond B_t in period t, it has to repay $R_i(B_t)$ in period $t+1$, where $R_i(\cdot)$ is a monotonically increasing in B and is continuously differentiable with respect to B.

We study investment behavior of two extreme types of firms in this section. The first type is the firms that do not belong to any business group. The problem of this type of firms is the same as what was presented by other existing literature. In this case, each firm solves its optimization problem individually. The second type of firms is the group firms over which the controller has a full control. Since we define a business group as a collection of firms that are controlled by the same

[8] Net of marginal cost of capital.

[9] Examples are Whited (1992), Hubbard and Kashyap (1992), Jaramillo, Schiantarelli and Weiss (1996), and Gilchrist and Himmelberg (1998).

controller who also owns shares of the group's member firms, the controller of a group maximizes *her own* total dividend streams from all firms in the group. Since the controller controls the group's decision completely, she can make any internal transfers of fund between the firms in her group. This frictionless transfer within group is not likely to occur if the controller does not have a full control over all firms in the group. We will discuss the sources of this friction, and empirically test them later in this paper.

3.1 Non-group Firm

The problem of the controller of a non-group firm is to choose the paths of capital stock and debt so as to maximize her expected discounted dividend stream, subject to constraints on nonnegativity of dividends.

$$\max_{\{K_{\tau+1},B_\tau\}_{\tau=t}^{\infty}} D_t + E_t \sum_{s=1}^{\infty} \beta^s D_{t+s}$$

subject to

$$\begin{aligned} D_\tau &= \Pi(K_\tau) - I_\tau - C(I_\tau, K_\tau) + B_\tau - R(B_{\tau-1}) \\ K_{\tau+1} &= (1-\delta) K_\tau + I_\tau \\ D_\tau &\geq 0, \end{aligned}$$

for all $\tau \geq t$, where $\Pi(\cdot)$ and $C(\cdot)$ are the firm's production function, and adjustment cost function, respectively; β is a constant discount factor; and δ is a constant depreciation rate of capital stock.

Let λ_τ be a Lagrange multiplier for non-negative dividend constraint in period τ.

Substituting $I_\tau = K_{\tau+1} - (1-\delta) K_\tau$ into D_τ,

$$D_\tau = \Pi(K_\tau) - (K_{\tau+1} - (1-\delta) K_\tau) - C(K_{\tau+1} - (1-\delta) K_\tau, K_\tau) + B_\tau - R(B_{\tau-1}).$$

The first-order condition with respect to K_{t+1} is

$$-(1+\lambda_t)\left[1 + \frac{\partial C(K_t, I_t)}{\partial I_t}\right] + E_t\left\{\beta(1+\lambda_{t+1})\left[\frac{\partial D_{t+1}}{\partial K_{t+1}} + (1-\delta)\left(1 + \frac{\partial C(K_{t+1}, I_{t+1})}{\partial I_{t+1}}\right)\right]\right\} = 0.$$

The Euler equation for investment is

$$1 + \frac{\partial C(K_t, I_t)}{\partial I_t} = E_t\left\{\beta \cdot \frac{1+\lambda_{t+1}}{1+\lambda_t} \cdot \left[\frac{\partial D_{t+1}}{\partial K_{t+1}} + (1-\delta)\left(1 + \frac{\partial C(K_{t+1}, I_{t+1})}{\partial I_{t+1}}\right)\right]\right\}. \tag{1}$$

Note that λ_t is the shadow price of the firm's internal funds.

The first-order conditions for borrowing imply

$$E_t\left[\frac{1+\lambda_{t+1}}{1+\lambda_t}\right] \cdot \beta \cdot R^{/}(B_{i,t}) = 1, \tag{2}$$

where $R^{/}(B_{i,t}) \equiv \frac{dR(B_{i,t})}{dB_{i,t}}$. Equation (2) can be viewed as an asset pricing equation, where $\beta\frac{1+\lambda_{t+1}}{1+\lambda_t}$ is the effective stochastic discount factor faced by the firm. The equation implies that the variables that raise the marginal cost of borrowing tend to reduce the adjustment coefficient of the expected discount factor , $E_t\left[\frac{1+\lambda_{t+1}}{1+\lambda_t}\right]$.

3.2 Group with Full Control

Suppose that a firm belongs to a business group. We assume that this firm has (at least) two sources of external finance, namely from outside its group and from other firms within the group. We want to characterize the efficient allocation of fund within a group. By "efficient allocation", I mean the allocation that maximize the total value of the shares owned by the group's controller[10]. As we shall see later, this efficient allocation may not be the efficient one in a view of outside shareholders or the economy as a whole.

Since the controller of group firms has a full control over the whole within-group transfer contracts, we can think that in each period τ she can just choose a net group's transfer $t_{i,\tau}$ to each member firm i. Note that transfers could be positive or negative. Indeed, it is possible that they are positive or negative for a particular firm in all periods.

Because a membership of a group and the ability of a group controller to transfer funds within her group are common knowledge, we assume that if firm i borrows by issuing a one-period corporate bond $B_{i,t}$ in period t, it has to repay $R_i(B_{i,t}, \mathbf{B}_{I,t})$ in period $t+1$, where $R_i(\cdot)$ is a monotonically increasing in $B_{i,t}$ and each element of $\mathbf{B}_{I,t}$ and is continuously differentiable with respect to $B_{i,t}$ and $\mathbf{B}_{I,t}$. Note that $\mathbf{B}_{I,t}$ is a vector of borrowing of each firm in group I, $i \in I$.

The controller's problem is

$$\max_{\{K_{i,\tau+1}, B_{i,\tau}, t_{i,\tau}\}_{\tau=t}^{\infty}} \sum_{i=1}^{N_I} \theta_i \left[D_{i,t} + E_t \sum_{s=1}^{\infty} \beta_i^s D_{i,t+s} \right]$$

subject to

$$\begin{aligned} D_{i,\tau} &= \Pi_i(K_{i,\tau}) - I_{i,\tau} - C_i(I_{i,\tau}, K_{i,\tau}) + t_{i,\tau} + B_{i,\tau+1} - R_i(B_{i,\tau}, \mathbf{B}_{I,\tau}) \\ K_{i,\tau+1} &= (1-\delta_i) K_{i,\tau} + I_{i,\tau} \\ \theta_i D_{i,\tau} &\geq 0 \\ \sum_{i=1}^{N_I} t_{i,\tau} &= 0, \end{aligned}$$

for all $\tau \geq t$, where θ_i is the controller's share in firm i.

Let $\lambda_{i,t}$ denote the Lagrange multipliers of the dividend nonnegativity constraint of firm i, and μ_t be the multiplier for the break-even condition of the group's transfers in period t, respectively. The Euler equation for investment is the same as equation (1).

The first-order conditions for external borrowing imply

$$E_t \left[\frac{1+\lambda_{i,t+1}}{1+\lambda_{i,t}} \right] \cdot \beta_i \cdot \frac{dR(B_{i,t}, \mathbf{B}_{I,\tau})}{dB_{i,t}} = 1, \quad \text{for all } i, \tag{3}$$

[10] In this paper, a composition of a group is exogenously given in two ways. First, whether a firm belong to any group is given. Also, the number of shares of group firms held by the manager is also exogenous. Endogenizing group formation is an interesting research, but it is beyond the scope of this paper. However, I will later discuss how selection and endogenous share-holding affect the empirical findings.

where $\frac{dR\left(B_{i,t},\mathbf{B}_{I,\tau}\right)}{dB_{i,t}}$ is the *total* derivative of $R\left(B_{i,t},\mathbf{B}_{I,\tau}\right)$ with respect to $B_{i,t}$. Again, the effective stochastic discount factor is $\frac{1+\lambda_{i,t+1}}{1+\lambda_{i,t}}\beta_i$. Finally, the first-order conditions for internal transfers imply

$$E_t\left[\frac{1+\lambda_{i,t+1}}{1+\lambda_{i,t}}\right]\cdot\beta_i = E_t\left[\frac{\mu_{t+1}}{\mu_t}\right], \quad \text{for all } i. \tag{4}$$

Since all firms in the group are facing the same shadow price of within-group transfers μ, equation (4) implies that $E_t\left[\frac{1+\lambda_{i,t+1}}{1+\lambda_{i,t}}\right]\beta_i$ is the same for all firms in the group. This is intuitive because this condition further implies that the marginal cost of external borrowing is equalized across firms within the same group, i.e. $\frac{dR\left(B_{i,t},\mathbf{B}_{I,\tau}\right)}{dB_{i,t}} = \frac{1}{E_t\left[\frac{\mu_{t+1}}{\mu_t}\right]}$. Since the controller can transfer fund frictionlessly within the group, the optimal borrowing pattern is that all firms in the group borrow until their marginal costs are equal, which is also equal to the group's shadow internal interest rate.

This case illustrates at least two effects of a group on a member firm's behavior. First, there is insurance across firms within a group. Idiosyncratic shocks to a firm's internal sources of fund such as cash flows are absorbed by the whole group through within-group transfers. Therefore, in this extreme case, we would expect to see no effect of firm's financial idiosyncratic shocks on its investment. The second effect is a tunneling effect. The firms with lower costs of external borrowing behave like a credit supplier to the firms with higher costs. The "donor" firms cannot use that fund to invest in its own projects. This effect could lead to a conflict of interest between controlling and non-controlling shareholders. The conflict is minimal when the compositions of shareholders are identical for all members of the group. In such case, the group itself is equivalent to a diversified firm, where each member firm is considered as its segment.

It is not so obvious to say that being in a group hurts the monority shareholders. First, as described above, being in business group could serve as an insurance device for member firms, which may benefit the controlling shareholder as well as the minority shareholders. Second, being a member in business groups is a common knowledge so the minority shareholders are likely to take this information into their consideration when they made their decision to purchase the share of the firm. One implication is that the stock price has incorporated this information already. Also, if we observe that there are minority shareholders holding shares of the firms, it must be that doing so benefits them in some ways. In other words, even though the non-controlling shareholders know that the controller may transfer funds out of the firm, holding some shares of the group firm could be the optimal portfolio choice of the non-controlling shareholders. To perform welfare analysis, we need to know the preference of both controlling and non-controlling shareholders. This is beyond the scope of this paper.

As a final remark, although the ownership parameter θ_i does not *directly* affect either investment decision or financing decision of a particular firm, it does *indirectly* affect investment and financing

decision of the firm through the value of μ_t and μ_{t+1},

$$\mu_t = \frac{\sum_{i=1}^{N_I}\theta_i\left(1+\lambda_{i,t}\right)}{N_I} = \frac{\sum_{i=1}^{N_I}\theta_i\left(1+\lambda_{i,t}\right)}{\sum_{i=1}^{N_I}\theta_i}\cdot\frac{\sum_{i=1}^{N_I}\theta_i}{N_I},$$

$$\mu_{t+1} = \frac{\sum_{i=1}^{N_I}E_t\left[\theta_i\left(1+\lambda_{i,t+1}\right)\beta_i\right]}{N_I} = \frac{\sum_{i=1}^{N_I}E_t\left[\theta_i\left(1+\lambda_{i,t+1}\right)\beta_i\right]}{\sum_{i=1}^{N_I}\theta_i}\cdot\frac{\sum_{i=1}^{N_I}\theta_i}{N_I}.$$

In other words, the group's shadow price of internal fund is a product of a weighted average of the member firms' shadow price of internal fund and an average of the shares owned by the controller.

3.3 Frictions within Group

In the real world, a controller of a group rarely have full control over the member firms. I consider some frictions that affect the likelihood that a group will have efficient allocation (in a perspective of a controller) in this section.

3.3.1 Controlling Ability of the Controller

As discussed above, although a business group provides some insurance across firms within the group, it could have tunneling effect as well. Since this tunneling has negative impacts on outside shareholders of the donors while it has positive effects on outside shareholder of the recipient firms, there is a tension between inside (controlling) and outside (non-controlling) shareholders. We would expect that a group over which its controller has more "control", such as measured by ownership or voting rights, is more likely to have efficient allocation. It is important to note that not only control over a particular firm matters for the firm's investment, the control over the other firms in the group also determines the existence of internal capital markets. In other words, the fact that a controller has absolute control over a particular firm does not guarantee perfect internal capital market outcomes. To have such outcomes, the controller needs to have absolute control over other firms in the group as well.

3.3.2 Corporate Law and Regulation

Usually minority shareholders' interest is protected by corporate laws, although the degree of protection varies by countries and legal systems[11]. Within a country level, different types of firms could be governed by different laws, which have different restrictions and requirements on transfers and loans among firms within a group[12]. A group consisting of many strictly-regulated firms is less likely to have efficient resource allocation since their resource transfers are more difficult.

[11] La Porta, Lopez-de-Silanes, Shleifer and Vishny (1998) have a cross-country survey on this issue.

[12] See example for Thailand in the empirical sections.

3.3.3 Within-Group Intermediaries

As a knowledge in banking theory, intermediaries facilitate flows of funds across economic units. In the context of business groups, intermediaries include financial intermediaries (commercial banks, finance companies, and insurance companies, among others), as well as firms that act as the vertex of the pyramidal structure of the groups such as holding companies. Therefore, groups with financial intermediaries are more likely to have efficient resource allocation.

3.3.4 Industry Diversification

Traditional wisdon suggests that industry diversification provides insurance against a group's *aggregate* shocks, i.e. the more diversified the group, the less volatile the group's cash flow. However, this argument does not imply how resources are allocated across member firms, *given the aggregate shocks* to the group. In practice, both industry homogeneity and diversity could facilitate flows of resource across firms. For example, two member firms could trade between themselves on credit, in addition to direct lending or borrowing in cash[13]. This creates one kind of internal credit market. Within-group trade could be both intra-industry or inter-industry, depending on the nature of the group itself. For example, a frozen chicken firm could buy raw chicken from a chicken farm owned by the same controlling shareholders. On the other hand, trading within group could be inter-industry. For instance, a department store could buy canned food or clothes from it's affiliated firms.

3.3.5 Size of Group

In principle, size of the groups can have either positive and negative effect on the group's likelihood of having efficient resource allocation. On one hand, bigger groups are more likely to have more severe within-group information and coordination problems, hence less likely to deliver perfect internal capital market outcome. On the other hand, groups with more members are more likely to have alternative ways to transfer resources among themselves[14], thereby tending to have efficient resource allocation.

4 Empirical Strategy

To derive the regression specification, we follow the method used by Gilchrist and Himmelberg (1998). First, we recursively substitute the investment Euler equation (1) to get

$$1 + c\left(I_{i,t}, K_{i,t}\right) = \beta_i E_t \sum_{s=1}^{\infty} \beta_i^{s-1} \left(1 - \delta_i\right)^{s-1} \left(\prod_{k=1}^{s} \left(\frac{1 + \lambda_{i,t+k}}{1 + \lambda_{i,t+k-1}} \right) \right) MPK_{i,t+s}, \tag{5}$$

[13] Other related examples along this line include (1) transfer of physical capital such as machine between firms that produce similar goods (hence using similar type of machines); (2) transfer pricing by setting the price of product sold to affiliated firms lower than the market price.

[14] For example, suppose that a group has two firms (firm A and firm B), and the controller is prevented to transfer resources explicitly across these firms. It is unlikely that the group will have efficient resource allocation. However, if this group has firm A, firm B, and firm C, where firm C does a business with both firm A and firm B. It is possible for the group to transfer resources indirectly between firm A and firm B – through the channel provided by transactions with firm C.

where $c(I_{i,t}, K_{i,t})$ is the marginal adjustment cost and $MPK_{i,t}$ is the marginal profit net of adjustment costs, i.e. $MPK_{i,t} = \frac{\partial D(K_t)}{\partial K_t} = \frac{\partial \Pi(K_t)}{\partial K_t} - \frac{\partial C(I_t, K_t)}{\partial K_t}$.

With assumptions (i) that $\frac{1+\lambda_{i,t+k}}{1+\lambda_{i,t+k-1}}$ linearly depends on firm's financial characteristics $FIN_{i,t+k}$ if firm i is a non-group firm, and depends on a group-time financial determinant FIN^J_{t+k}, where J is a group index, if firm i is in group J; (ii) that the adjustment cost is quadratic in $\frac{I_{i,t}}{K_{i,t}}$, i.e. its marginal cost is linear in $\frac{I_{i,t}}{K_{i,t}}$. Derivation in the appendix shows that we can linearly approximate equation (5) as

$$\frac{I_{i,t}}{K_{i,t}} = \begin{cases} \alpha_0 + f_i + \alpha_1 Q^{FIN}_{i,t} + \alpha_3 Q^{MPK}_{i,t} + \varepsilon_{i,t}, \text{ if firm } i \text{ is non-group firm} \\ \\ \alpha_0 + f_i + \alpha^J_2 Q^{FIN,J}_t + \alpha_3 Q^{MPK}_{i,t} + \varepsilon_{i,t}, \text{ if firm } i \text{ is in group } J \ , \end{cases} \tag{6}$$

where $Q^{FIN}_{i,t}$ is the present value of financial characteristic that determine the marginal cost of external finance of firm i; $Q^{FIN,J}_t$ is the present value of financial characteristic that determine the marginal cost of external finance of member firms in group J; and $Q^{MPK}_{i,t}$ is the present value of the marginal profitability of investment of firm i in period t. This equation shows that, in a presence of imperfect capital market, a firm's investment depends on its cost of financing ($Q^{FIN}_{i,t}$ and/or $Q^{FIN,J}_t$), in addition to its investment profitability and the firm's fixed effect.

To get an implementable regression equation, I rewrite equation (6) as

$$\frac{I_{i,t}}{K_{i,t}} = \alpha_0 + f_i + \alpha_1 Q^{FIN}_{i,t} + \sum_{J=1}^{N} \left(\gamma^J_{0,t} d^J_{i,t} + \gamma^J_{1,t} d^J_{i,t} Q^{FIN}_{i,t} \right) + \alpha_3 Q^{MPK}_{i,t} + \varepsilon_{i,t}; \ E\left[\varepsilon_{i,t}\right] = 0. \tag{7}$$

where $d^J_{i,t}$ is a dummy variable indicating that the firm is in group J in period t. For a non-group firm, $d^J_{i,t} = 0$ for all J; therefore, its investment depends on its own financial situation captured by $Q^{FIN}_{i,t}$ and its investment profitability measured by $Q^{MPK}_{i,t}$, in addition to the firm characteristic effect f_i. For a firm in group I, $d^J_{i,t} = 0$ for all $J \neq I$. If the group is fully controlled and capital is allocated efficiently across firms within the group, then we expect to see $\alpha_1 + \gamma^J_{1,t} = 0$. Equation (7) is the regression specification counterpart of the model that we will use in the empirical part of this study.

If $Q^{MPK}_{i,t}$ is a true state variable and is correctly measured, then the existence of perfect internal capital markets[15] implies that a group firm's investment decision should be independent of the firm's financial characteristics, after being controlled for its group effect. Therefore the null hypothesis of having perfect internal capital markets is that

$$H_0 : \alpha_1 + \gamma^I_1 = 0.$$

However, there are several frictions that make internal capital markets imperfect. To test the extent that each factor affects the within-group resource allocation, I modify equation (7) to get a following regression specification:

$$\frac{I_{i,t}}{K_{i,t}} = \alpha_0 + f_i + \alpha_1 Q^{FIN}_{i,t} + \sum_{J=1}^{N} \gamma^J_{0,t} d^J_{i,t} + Q^{FIN}_{i,t} \ \mathbf{X}_i \boldsymbol{\eta} + \alpha_3 Q^{MPK}_{i,t} + \varepsilon_{i,t}; \ E\left[\varepsilon_{i,t}\right] = 0, \tag{8}$$

[15] In a sence that fund is allocated efficiently.

where $\mathbf{X}_i$ is a matrix of characteristics of firm i or group I to which firm i belongs, $i \in I$, and $\boldsymbol{\eta}$ is a corresponding vector of coefficients. If an element of $\boldsymbol{\eta}$ has a negative coefficient, the characteristic makes investment less sensitive to the firm's own financial characteristics. On the other hand, if an element of $\boldsymbol{\eta}$ has positive, the characteristic makes investment more sensitive to the firm's own financial characteristics. Note that the dummies $d^J_{i,t}$ capture the common group's financial characteristics. We expect that the characteristics facilitating the operation of internal capital markets should have negative coefficients, and opposite result for the characteristics that prohibiting the internal capital market.

5 Data

5.1 Data Source

The sample used in this study are some listed and some non-listed firms in Thailand during 1993-1996. There are several reasons why the data for Thailand over that period is a good sample in this study. First, it was an emerging economy that capital markets were not fully developed. Second, business groups were in essentially every sectors. Moreover, we can extend the period of the data set to study the response of groups to shocks during the 1997 economic crisis. Finally, the data is available for both listed and non-listed firms. Therefore, we can test the effect of corporate law and regulation on the investment decision of firms as well.

I exclude all firms in financial and real estate sectors from the sample because the interpretation of their financial balance sheets is different from firms in other sectors. The sample consists of a balanced panel of 907 firms from 1993 to 1996. All firms in the sample are relatively big firms in Thailand during the period covered in the data. For every year during 1993-1996, either (1) they had annual turnover more than 200 million Baht[16]; (2) they were one of the leading companies in its industry; or (3) they were listed in the Stock Exchange of Thailand. Totally, there are 2,721 firm-years in the full sample. Some observations are dropped out later due to missing values of some variables.

5.1.1 Financial and Ownership Data

All registered firms[17] in Thailand have to submit annual financial statements to the Ministry of Commerce. The documents submitted must be audited by authorized accounting auditors. The data are publicly available upon paying some fee. Moreover, all listed firms are also required to submit the same as well as additional data to the Security and Exchange Commission.

5.1.2 Data on Groups

Groups are defined on ownership and control basis – Firms are in the same group if they are (wholly or partly) owned and managed by the same family. To identify groups, I firstly use the information from a book called *Thai Business Groups 2001: A Unique Guide to Who Owns What*. There are

[16] Approximately 8 million US Dollar using 1996 exchange rate, or 4.44 million US Dollar using 2002 exchange rate.

[17] By "registered firms", I do not consider all small informal household business, such as a noodle shop or a street vendor because they are not juristic person under Thailand's Civil and Commercial Code.

150 families covered in the book. Although the book provides a lot of information about family backgrounds, its list of companies affiliated to each family cannot serve the purpose of this study well. For example, some particular firms were considered as an affiliation to several groups. Some companies were assigned to a family even though the family did not hold so many shares in the companies when I check with the corresponding ownership data from the Ministry of Commerce. Also, some families are so tied together that we cannot consider them separately. Finally, there were a lot of groups that were not included in the book due to their small number of member firms, even though each member firm was considered large and important in its industry. Therefore, I focus mainly on the ownership data from the Ministry of Commerce and identify group firms by myself, with some helps from the book as sometimes family members do not share the same lastname. In sum, 117 groups are included in the current sample – 27 of them are additional to the ones listed in the book. Figures 1 to 3 present some examples of groups.

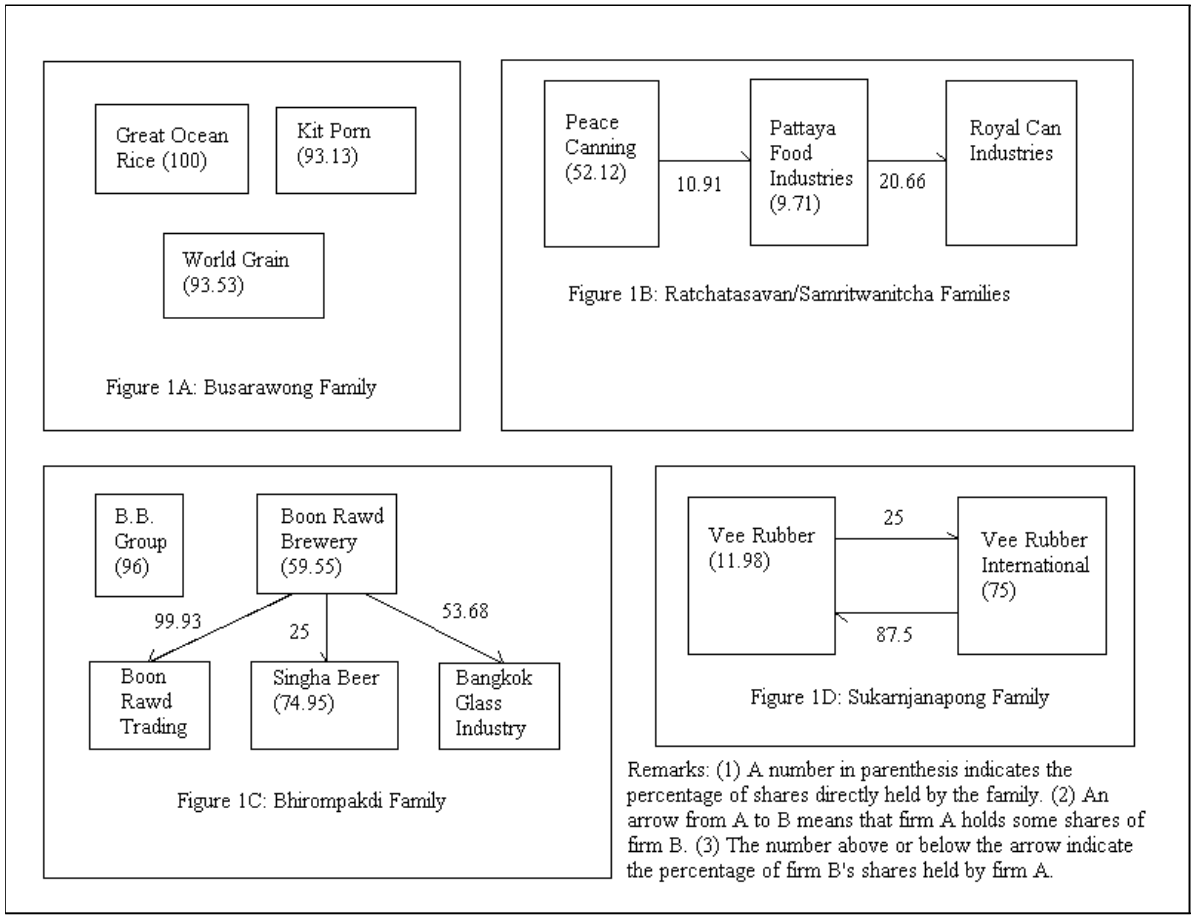

Figure 1 Examples of Simple Group Structures

Figure 1 shows example of simple group structures. Figure 1A presents a group that consists of many firms owned by the same family. There is no direct connection between the firms themselves. Alternatively, figure 1B shows a group formed by a chain shareholding. Figure 1C is an example of a pyramidal structure of business group. Finally, figure 1D presents a group with cross shareholding.

Business groups may have a more complex structure than the ones shown in figure 1. A group may consist of many chain shareholdings or many firms serving as a vertex of a pyramidal structure. Cross shareholding could also be more complex. Figures 2 and 3 show examples of more complicated group structures. To avoid confusion, all numbers indicating shareholding are not included.

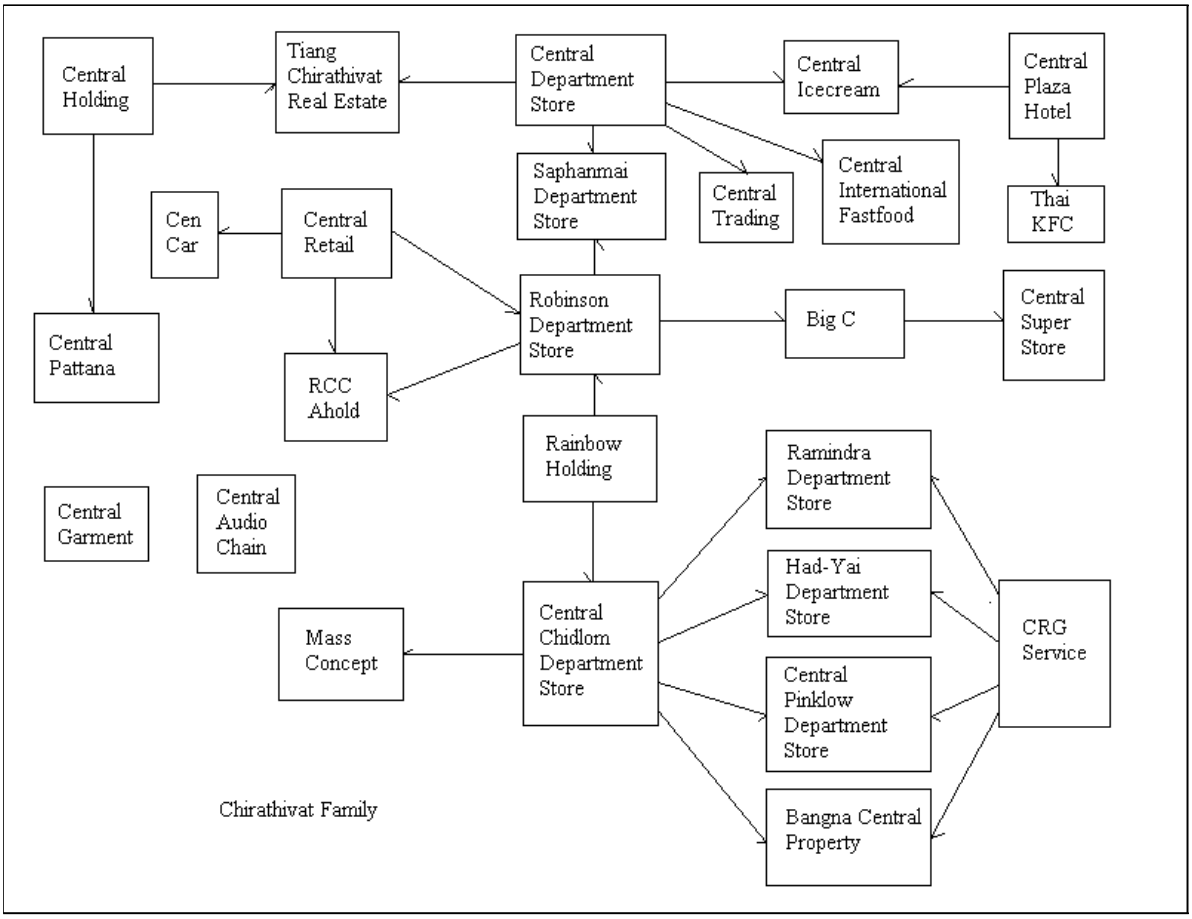

Figure 2 Example of Groups with Many Chain Shareholding and Many Pyramids

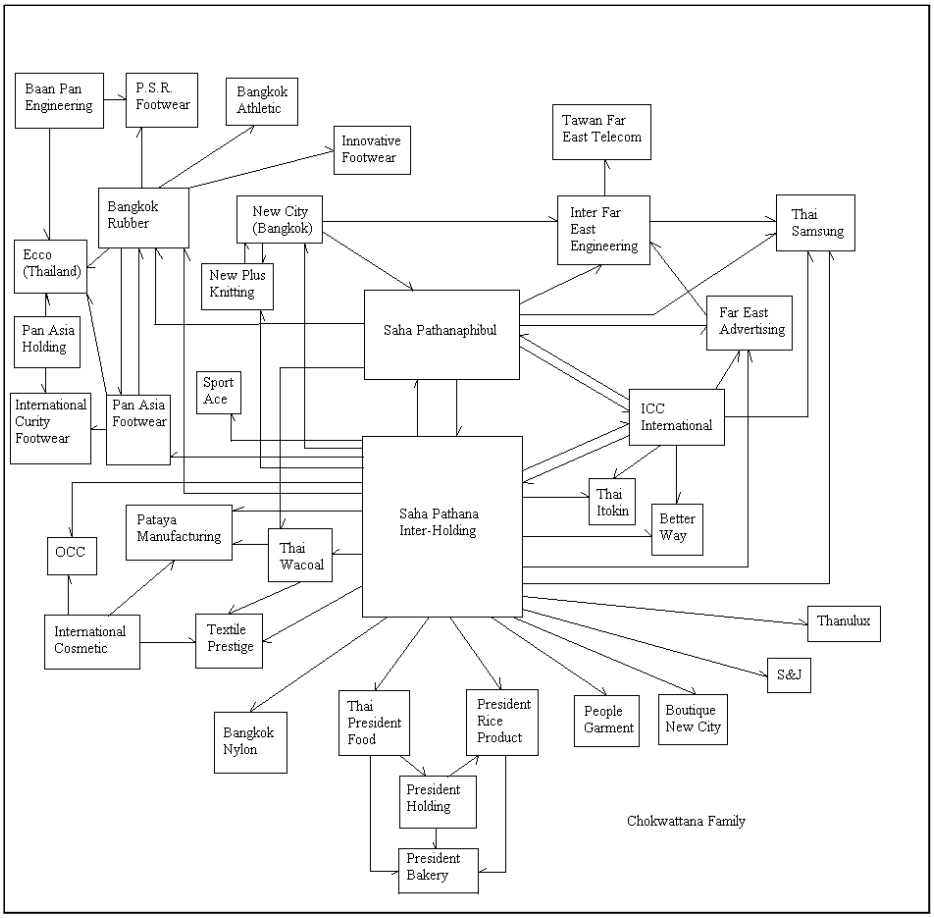

Figure 3 Example of Groups with Many Chain Shareholdings, Many Cross Shareholdings and Many Pyramids

5.2 Data Description and Summary Statistics

5.2.1 Firm Characteristics

Tables 1 and 2 present summary statistics of the firms in the sample. In this paper, industry is classified in 2 levels. The broad classification consists of 8 industries while the detailed classification has 41 industries. After excluding financial and real estate sectors from the sample, there are 34 industries in 7 broad categories. The summary statistics for each industry are shown in table 1. Table 2 provides summary statistics of financial characteristics of firms in the sample.

Table 1 Summary Statistics for Industries in the Sample

Industry	Number of Firms				Age in 1996 (Year)				
	Total	Listed Firms	Public Firms	Group Firms	Mean	Min	Max	Med	Std. Dev.
Agriculture	**130**	**27**	**27**	**84**	**18.5**	**4**	**54**	**17**	**10.0**
Farming, Livestock, Fishery & Aquaculture	11	1	1	11	18.1	8	23	18	5.5
Animal Feeds	19	7	7	17	15.8	6	29	17	7.4
Agriculture Product from Crops	60	7	7	34	22.3	5	54	22	11.9
Agriculture Product from Animals	24	10	10	10	13.1	4	24	12.5	5.1
Agriculture Related Business	16	2	2	12	16.0	5	31	16	7.9
Consumer Products	**158**	**27**	**27**	**80**	**26.4**	**3**	**114**	**24**	**17.3**
Foods	50	14	14	20	22.7	6	46	21.5	9.9
Beverages	22	3	3	20	22.3	7	63	13.5	14.7
Pharmaceuticals & Cosmetics	34	3	3	10	27.7	4	105	26	15.9
Consumer Items	15	2	2	5	34.1	8	114	29	26.8
Department & Grocery Stores	12	1	1	10	15.8	3	28	17	7.6
General Trading	25	4	4	15	35.8	11	112	28	23.3
Financial Institutions	**107**	**59**	**71**	**37**	**31.5**	**4**	**90**	**26**	**16.8**
Banking*	18	13	16	8	48.6	9	90	50	16.3
Securities & Trusts*	41	26	34	9	24.4	4	44	24	6.2
Insurance*	22	14	14	8	47.6	18	67	48	11.1
Financial Services*	14	3	4	2	20.1	11	60	16	13.2
Venture Capitalist*	12	3	3	10	13.2	10	24	12.5	3.7
Services	**90**	**27**	**29**	**36**	**20.3**	**4**	**120**	**18**	**15.7**
Transportation & Delivery Services	29	4	4	6	23.4	5	65	23.5	16.4
Hotels, Restaurants & Tours	33	13	14	17	20.5	7	120	13	20.0
Hospitals & Clinics	10	6	6	1	17.7	10	25	18.5	4.2
Other Services	18	4	5	12	16.8	4	29	16.5	8.1
Light Industry	**258**	**86**	**86**	**114**	**17.9**	**3**	**50**	**16**	**9.8**
Textiles, Garments, Accessories & Leather Products	59	25	25	30	21.6	6	43	22	8.6
Jewelry & Ornament	13	5	5	2	12.6	3	24	11	7.7
Footwear, Sport Goods & Toys	13	3	3	10	16.5	8	46	12	12.9
Paper, Paper Products, Books & Stationery	29	5	5	10	16.5	6	28	15	7.0
Glass & Glassware	13	3	3	9	18.9	5	45	17	11.0
Electrical & Electronic Products	46	15	15	13	18.7	5	44	16	9.7
Wood Products & Furniture	10	3	3	3	16.0	9	24	15	5.1
Rubber Products	13	5	5	7	19.7	6	48	19	12.9
Printing & Publishing	12	8	8	4	23.3	6	50	22.5	12.6
Computers, Telecommunications & Office Equipment	39	13	13	24	13.4	3	43	10	8.7
Other Light Industry	11	1	1	2	15.2	4	29	9	10.5

Table 1 (Continued) Summary Statistics for Industries in the Sample

	Number of Firms				Age in 1996 (Year)				
Industry	Total	Listed	Public	Group	Mean	Min	Max	Med	Std Dev
Heavy Industry	**138**	**23**	**24**	**58**	**20.2**	**3**	**50**	**19**	**10.8**
Mining, Quarrying, Iron, Steel & Non-Ferrous	32	8	8	15	20.0	3	38	18.5	10.6
Petroleum, Gas & Exploration Services	18	6	7	7	21.8	7	50	20	13.6
Machinery & Equipment	19	2	2	10	19.9	5	49	20	13.0
Other Metal Fabricated Products	15	5	5	3	21.9	6	38	23.5	9.1
Automobiles, Motorcycles, Trucks, Tractors, Spare Parts	54	2	2	23	19.4	4	46	18	10.0
Chemical & Petrochemical Products	**75**	**16**	**17**	**35**	**17.3**	**3**	**37**	**16**	**9.0**
Chemicals & Paints	51	5	6	21	17.6	3	37	16	9.4
Plastics	24	11	11	14	16.7	6	33	13.5	8.3
Construction and Real Estate	**84**	**47**	**51**	**50**	**22.3**	**3**	**83**	**21.5**	**13.9**
Construction Contractors & Consultants	29	9	10	11	23.2	8	66	22	12.4
Real Estate Developers*	26	22	25	16	11.5	7	16	11.5	6.4
Construction Material	29	16	16	23	22.1	3	83	21	15.5
All	**1040**	**312**	**332**	**494**	**21.5**	**3**	**120**	**18.5**	**13.7**
Sample*	907	231	236	441	20.3	3	120	18	12.8

* Sample excludes Real Estate Developers and Financial Institutions.

Table 2 Summary Statistics for Financial Characteristics

	Sample		
	All Firms	**Group Firms**	**Non-Group Firms**
Total Assets (Million Baht)			
Mean	3,491	5,731	1,333
Min	7	22	7
Max	2,420,000	2,420,000	39,000
Median	846	1,076	684
Standard Deviation	60,800	86,800	2,269
Total Fixed Capital (Million Baht) [(1)]			
Mean	687	915	467
Min	0.06	0.06	0.10
Max	45,200	45,200	9,964
Median	207	240	179
Standard Deviation	2,218	3,029	854
Age (Year)			
Mean	19.54	19.35	19.72
Min	0	0	0
Max	120	105	120
Median	18	17	18
Standard Deviation	12.31	11.85	12.73
Investment Rate [(2)]			
Mean	0.122	0.113	0.132
Min	-0.989	-0.973	-0.989
Max	1.937	1.937	1.888
Median	0.020	0.006	0.036
Standard Deviation	0.386	0.405	0.366
Cash Flow to Capital Ratio [(3)]			
Mean	0.206	0.191	0.220
Min	-0.213	-0.206	-0.213
Max	0.934	0.934	0.923
Median	0.161	0.149	0.173
Standard Deviation	0.178	0.170	0.184
Profit Rate [(4)]			
Mean	0.041	0.042	0.040
Min	-0.472	-0.352	-0.472
Max	0.541	0.525	0.541
Median	0.027	0.027	0.027
Standard Deviation	0.086	0.086	0.086

Remarks: (1) Total fixed capital includes land and machinery and excludes all financial assets such as cash, loans or investment in securities. (2) Investment rate is the rate of change in total fixed investment. (3) Cash flow to fixed capital. (4) Profit rate is total net profit to total asset ratio.

There are various legal types of business organizations in Thailand. I do not consider sole proprietor[18] and non-registered partnership[19] in this study since they are not juristic person under Thai laws. Thai corporate laws allow Thai company be registered in only two types: private limited company[20] and public limited company. Shareholders of private limited company enjoy limited rights or protections under the Civil and Commercial Code. On the other hand, public limited company is governed by the specific law called Public Limited Company Act B.E. 2535 (A.D. 1992). The law was drafted with a view to revamp the old Public Limited Company Act B.E. 2521 (A.D. 1978) which was obsolete and impractical. The features in the current law that give more protection to minority shareholders are that[21]:

- (80) A director that benefits from purchases of sales of the company's assets cannot vote for or against the transactions.

- (86) A director is prohibited from operating the same business that competes with the company, unless she announces that she is doing such a business during the shareholder meeting before appointed.

- (87) A director cannot purchase assets from or sell assets to the company, unless the board of directors approves the transaction.

- (88) A director must inform the company whenever she benefits from any contracts made by the company.

- (89) A public limited company cannot lend to (or put a collateral for) its directors or employees (or any businesses owned more than 50% by its directors or employees), except that the lending is classified as a welfare compensation or it is a business as usual for commercial banks.

Additionally, under the Stock Exchange of Thailand (SET) rule, all listed companies must be public limited company. Therefore, they must comply with disclosure requirement of Stock Exchange in addition to the Public Limited Company Act itself. SET's regulations on transactions with related companies are that:

- For low-value transactions, the company must declare the detail of the transaction to public.

- For high-value transactions, the company must consult with an independent financial consultant and must get an approval from shareholder meeting.

5.2.2 Group Characteristics

There are 117 groups in the sample. The average number of firms in a group is 5.68 and the median is 3. A firm is considered being in a group if a controller of the group controls more than 10% of the voting rights of the firm[22]. The mean and median group age are approximately 30 and 28 years, respectively.

[18] Sole proprietor is an individual running his or her own business.

[19] Non-registered partnership is two or more people forming a venture without registration with the Ministry of Commerce.

[20] For the purpose of this study, private limited company also includes registered partnership (i.e. partnership registered as a juristic person) as well as liability limited partnership (i.e. a partnership comprising two types of partners – limited liability partner and unlimited liability partner) because all of them are governed by the Civil and Commercial Code. A reader should be careful that there are also some legal difference among these firms.

[21] The number in the parenthesis in front of each item indicates the section number.

[22] In practice, it is difficult to know exactly how many firms are in each group. In this paper, I scope my analysis on relatively large firms only. Precisely, the number of firms in each group considered here is the number of large

Definition and calculation of ultimate ownership and control follow La Porta, Lopez-de-Silanes and Shleifer (1999) and Claessens, Djankov and Lang (2000). In case that there is a chain shareholding, I initially compute the ownership along the chain by calculating the product of share along the chain. The calculation is more complicated if there are more than one chain for each firm. In such case, the ultimate ownership is the sum of the ownership over all chains that can be traced back to the controlling family[23]. Corporate control is based on the voting right the family has. Due to a "one share, one vote" rule, control is just the share the family holds. However, in case of a chain shareholding, control over the voting right of a firm is the minimum share along each chain. The ultimate control is the sum of the controls over all chains[24]. The calculation gets more complex when there is a cross shareholding, where I have to calculate ownership (and control) of multiple firms simultaneously[25]. Finally, the group's average ownership (or control) the average of the ownership (or control) over all firms in the group. It is obvious that chain shareholdings create a discrepancy between ownership and control. In this sample, the mean and median of group's average ownership are 54% and 53%, respectively. They are 58% and 57% for group's average control.

Not every groups have member firms registered as public limited company or listed company in the stock market. On average, 29% of firms in a group are listed and 31% are public company.

Some groups also have intermediaries as member firms. In this paper, intermediaries include commercial bank, finance and security company, insurance company, company offering financial services (such as credit cards), holding company, and venture capitalist. However, more than half of groups do not have these kinds of firm as a member.

To measure industry homogeneity, I compute two indices: one for a broad classification of industry, and the other one for a detailed classification. The indices are in the range of zero and one, where one represents a perfect homogeneity and zero implies perfect diversity[26]. The higher the index, the more homogenous is the group in terms of industry classification. Industry homogeneity index I is based on a broad classification of industry while index II is on a more detailed classification. The mean and median index across groups are 0.68 and 0.58, respectively, for the broad classification. They are 0.41 and 0.35, respectively, for the detailed classification. Table 3 presents summary statistics of the group characteristics.

firms in the group. See Samphantharak (2002) for more detail.

[23] Consider figure 1B as an example. In this case, the families own 51.12% of *Peace Canning (1958) Co. Ltd.*; $9.71 + (0.1091 * 51.12) = 15.40\%$ of *Pattaya Food Industries Co. Ltd.*; and $0.2066 * 15.40 = 3.18\%$ of *Royal Can Industries Co. Ltd.*

[24] Consider figure 1B again. The families control 52.12% of voting rights in *Peace Canning (1958) Co. Ltd.*; $9.71 + \min\{52.12, 10.91\} = 20.62\%$ in *Pattaya Food Industries Co. Ltd.*; and $\min\{20.62, 20.66\} = 20.62\%$ in *Royal Can Industries Co. Ltd.*

[25] Consider figure 1D. Suppose that the family owns $x\%$ of *Vee Rubber Co. Ltd.* and $y\%$ of *Vee Rubber International Co. Ltd.* We must have that $x = 11.98 + 0.875 * y$ and that $y = 75 + 0.25 * x$. Solving these equations simultanously gives us $x = 99.33$ and $y = 99.83$. In general, this is a fixed-point problem with discount factors less than one. Therefore, the solutions always exist.

[26] The index for group I is $\left[\sum_{m=1}^{M_I}\left(\frac{n_{m,I}}{N_I}\right)^2\right]^{\frac{1}{2}}$, where N_I is the number of firms in group I, $n_{m,I}$ is the number of firms in group I that are in industry m, and M_I is the number of industries in group I.

Table 3 Summary Statistics for Group Characteristics

	No. of Groups	Mean	Median	Min	Max	Std. Dev.
Number of Firms	117	5.68	3	2	51	7.71
Age (1996)	117	30.05	28	7	114	16.51
Average Ownership	117	0.54	0.53	0.06	1	25.77
Average Control	117	0.58	0.57	0.15	1	23.40
Number of Listed Firms	117	1.54	1	0	18	2.62
Fraction of Listed Firms	117	0.29	0.25	0	1	0.31
Number of Public Firms	117	1.63	1	0	19	2.68
Fraction of Public Firms	117	0.31	0.25	0	1	0.32
Number of Financial Intermediaries	117	0.41	0	0	15	1.74
Fraction of Financial Intermediaries	117	0.04	0	0	0.57	0.12
Number of (Broad) Industry	117	2.09	2	1	6	1.31
Index of Industry Homogeneity I	117	0.68	0.58	0.18	1	0.29
Number of (Detailed) Industry	117	2.87	2	1	19	2.72
Index of Industry Homogeneity II	117	0.41	0.35	0.01	1	0.35

6 Empirical Results

The main problem of estimating equation (8) is that it is very unlikely that $Q_{i,t}^{MPK}$ is correctly measured, especially for non-listed firms that we do not have "market" variables such as stock prices. Also, it is unclear what the empirical counterpart for $Q_{i,t}^{FIN}$ is[27]. In this paper, I use the average Tobin's Q as proxied by a ratio of market to book values as a measure of firm's fundamental profitability, $Q_{i,t}^{MPK}$, and firm's cash flow as a proxy fort $Q_{i,t}^{FIN}$. The reasons for this choice of variables are as follows: First, there are a lot of studies on investment-cash flow sensitivity in the literature. By using the same variables, I can compare my results to theirs. Second, there is no obvious evidence that other measure of $Q_{i,t}^{MPK}$ is significantly better. Third, as Kaplan and Zingales (1997) show, if external finance is costly, then investment is positively correlated with cash flow – which is one kind of internal funds of the firm. Finally, from personal conversations with credit officers in commercial banks in Thailand, I learn that banks pay a lot of attention to cash flow and interest coverage when they evaluate loan applications[28].

One of the main problems to get a market to book value as a proxy of $Q_{i,t}^{MPK}$ is that the sample consists of both listed and non-listed firms. Since non-listed firms are not traded in the stock market, we do not observe the price variables of the firms and therefore cannot compute the market to book values as usual. To overcome this problem, I compute the industry average book to market value and use it as a proxy for firm's fundamental profitability for all firms in the

[27] To deal with this problem, Gilchrist and Himmelberg (1998) estimate $Q_{i,t}^{MPK}$ and $Q_{i,t}^{FIN}$ from vector autoregression method introduced by Abel-Blanchard (1988).

[28] Other factors are three-year profits, irregular change in income and cost of production, and credit score. Credit score is computed from 5-year performance, interest coverage, debt-to-equity ratio, ratio of net worth to paid-up capital, and qualitative criteria (such as previous records at the bank, parent company, industry situation, and whether the firm is in the top of its industry).

industry. As some listed firms are in business group and their stock price could incorporate this fact in addition to the profitability information, I use only data on non-group listed firms when I compute the industry average market to book values[29].

To distinguish the result from this paper to the method commonly used in business group studies, I compare the results with Hoshi, Kashyap, Scharfstein (1991) approach. In their approach, group firms are less financially constrained so their investment should be less sensitive to their cash flow. The sample in this paper delivers a similar result, as shown in table 4.

Table 4 Regressions of Investment on Cash Flow and Q for Non-Group Firms and Group Firms

Dependent Variable: Investment/Capital	(1)	(2)
Cash Flow/Capital	0.124***	0.412***
	(0.015)	(0.033)
Group vs. Non-Group Dummy * (Cash Flow/Capital)		-0.350***
		(0.037)
Group vs. Non-Group Dummy	Not Included	Included
Industry Average Q	0.012	0.012*
	(0.078)	(0.007)
Adjusted R^2	0.022	0.115

Remarks: All regressions include firm fixed effects, firm size, and year effects. Standard errors are in parentheses. ***, **, and * indicate that the estimate is significant at 1%, 5%, and 10%, respectively.

Table 4 shows that, on average, group firms' investment is less sensitive to cash flow as compared to non-group firm. This result is consistent to what many studies have found in other samples. However, this approach is criticized by Kaplan and Zingales (1997) as I described in the related literature section.

Instead, the model in this paper suggests that a firm's investment should be less sensitive to the firm's own cash flow, once controlled for the *individual group-year* effects. Table 5 presents the result from this regression.

[29] There is an exception when all listed firms in the industry are group firms. In this case, the industry average is the average over all firms in the industry.

Table 5 Regressions of Investment on Cash Flow and Q for Non-Group Firms and Group Firms (Controlled for Each Individual Group-Year Effects)

Dependent Variable: Investment/Capital	Full Sample (1)
Cash Flow/Capital	0.410***
	(0.036)
Group vs. Non-Group Dummy * (Cash Flow/Capital)	-0.344**
	(0.040)
Individual Group-Year Dummies	Included
Industry Average Q	0.024***
	(0.098)
R^2	0.021

Remarks: All regressions include firm fixed effects, firm size, and year effects. Standard errors are in parentheses. ***, **, and * indicate that the estimate is significant at 1%, 5%, and 10%, respectively.

The result shows that, once group-year effects are controlled, being a group firm decreases the investment-cash flow sensitivity from 0.41 by 0.34 on average. The net effect of cash flow on investment for group firms is 0.066 and is significantly different from zero at 1% level. This result implies either that cash flow may contain some information about firm's profitability that is not captured by industry average Q, firm fixed effects, and year effects; or that there are imperfect internal capital markets.

If the internal capital markets are not perfect and do not deliver an efficient resource allocation outcome, it is natural to look next at the factors that facilitate or prohibit the operation of internal capital markets. I consider five factors in this paper: corporate ownership and control, corporate law and regulation, within-group intermediaries, industry diversification, and group size.

6.1 The Effects of Group Characteristics

6.1.1 Corporate Ownership and Control

If the controlling shareholder of a group has more control over the group, it is easier for her to transfer funds across member firms or manage the terms of contract of the loans between the firms within the group. Therefore, the group is more likely to have efficient resource allocation outcome. The effect of ownership and control on investment's response to cash flow is presented in table 6. The sample includes only group firms.

Table 6 Effects of Ownership and Control of Group Controlling Shareholders on Investment - Cash Flow Sensitivity of Group Firms

Dependent Variable: Investment/Capital	(1)	(2)
Cash Flow/Capital	0.120***	0.131***
	(0.035)	(0.042)
Group's Average Ownership * (Cash Flow/Capital)	-0.106*	
	(0.061)	
Group's Average Control * (Cash Flow/Capital)		-0.115*
		(0.069)
Industry Average Q	0.053***	0.053***
	(0.015)	(0.015)
Individual Group-Year Dummies	Included	Included
R^2	0.167	0.166

Remarks: All regressions include firm fixed effects, firm size, and year effects. Standard errors are in parentheses. ***, **, and * indicate that the estimate is significant at 1%, 5%, and 10%, respectively. Average ownership and control are in scale of 0 to 1.

The coefficient of the interaction term between cash flow and group's average control is negative. This suggests that the more the control the group controlling shareholder has, the more efficient resource allocation within group[30]. Back-of-envelope calculation implies that a 10% increase in a group's average control reduces the sensitivity of firm's investment to its own cash flow from 0.131 to 0.1195, or approximately 8.78%. The result is similar when I use group's average ownership instead of control.

6.1.2 Corporate Law and Regulation

Table 7 shows the effects of the Public Limited Company Act B.E.2535 and the Stock Market of Thailand's regulations on the sensitivity of investment to cash flow. The sample includes only group firms. Since the Public Limited Company Act and the Stock Market of Thailand's regulations impose restrictions on transfers and lending to affiliated firms as well as directors and employees, it is less likely that a group with a big fraction of firms being registered as public company or being listed in the stock market will have an efficient resource allocation.

[30] Recall that efficient resource allocation is defined as efficiency in a view of the controlling shareholders.

Table 7 Effects of Corporate Law and Regulation on Investment - Cash Flow Sensitivity of Group Firms

Dependent Variable: Investment/Capital	(1)	(2)	(3)
Cash Flow/Capital	0.031	0.031	0.030
	(0.030)	(0.031)	(0.030)
Group's Fraction of Listed Firms * (Cash Flow/Capital)	0.235*		0.242*
	(0.144)		(0.157)
Group's Fraction of Public Firms * (Cash Flow/Capital)		0.230*	
		(0.142)	
Group's Fraction of Non-Listed Public Firms * (Cash Flow/Capital)			-0.493
			(3.945)
Individual Group-Year Dummies	Included	Included	Included
Industry Average Q	0.053***	0.053***	0.053***
	(0.015)	(0.015)	(0.015)
R^2	0.166	0.166	0.166

Remarks: All regressions include firm fixed effects, firm size, and year effects. Standard errors are in parentheses. ***, **, and * indicate that the estimate is significant at 1%, 5%, and 10%, respectively.

Regression (1) shows that if all firms in a group are listed, then the sensitivity of investment to cash flow of a firm in the group will be approximately 0.23 higher than that of a group with no firms listed. More dramatically, the investment-cash flow sensitivity for a firm in a group that has no firm listed is basically not significantly different from zero. The effect of the Public Company Act is similar and is shown in regression (2).

Since all listed firms must be registered as public company, we can test whether the results described above come from being listed or being public company. This can be done by putting the interaction term of cash flow and group's fraction of listed firms together with the interaction term of cash flow and group's fraction of non-listed public firms. The predictions are that (a.) if being public company matters, the coefficient of the latter interaction term should be positively significant; (b.) if being public company does not matter, the coefficient of the second interaction term should not be significant; and (c.) if being listed is different from only being public company, the coefficient of the first interaction term should be significantly more than the coefficient of the second interaction term. Regression (3) suggests that being public company does not seem to prevent the existence of internal capital markets. Therefore, the result delivered by regression (2) just comes from the fact that all listed firms must be registered as public company, and many public company are listed in the stock market. This results shed some light on the effectiveness of the

Public Company Act B.E.2535[31].

6.1.3 Within-Group Intermediaries

If intermediaries help facilitate flow of funds across group firms, then groups with intermediaries should have more efficient resource allocation. Table 8 shows the effects of within-group intermediaries on firm's investment-cash flow sensitivity[32]. The sample includes only group firms.

Table 8 Effects of Within-Group Financial Intermediaries on Investment - Cash Flow Sensitivity of Group Firms

Dependent Variable: Investment/Capital	(1)	(2)
Cash Flow/Capital	0.073***	0.075***
	(0.020)	(0.021)
Group's Fraction of Intermediaries * (Cash Flow/Capital)	-0.077***	
	(0.031)	
Dummy of Having Within-Group Intermediaries * (Cash Flow/Capital)		-0.041
		(0.054)
Industry Average Q	0.052***	0.053***
	(0.015)	(0.015)
Individual Group-Year Dummies	Included	Included
R^2	0.176	0.160

Remarks: All regressions include firm fixed effects, firm size, and year effects. Standard errors are in parentheses. ***, **, and * indicate that the estimate is significant at 1%, 5%, and 10%, respectively.

Regression (1) shows that the higher the fraction of within-group intermediaries, the lower the sensitivity of investment to firm's own cash flow. Roughly speaking, a 10% increase in the fraction of intermediaries reduces the sensitivity from 0.073 to 0.0653, or approximately 10%. However, the result is not robust when I use dummy of having within-group intermediaries instead of the fraction of intermediaries in the interaction term.

[31] There are few amendments to the Public Company Act B.E.2535 (A.D.1992) after the 1997 economic crisis. One of the interesting features is that it allows minority share holders to sell their shares back to the company if they think that they are treated unfairly. This amendment is designed in order to give more protection to minority shareholders. Other features include the debt-to-equity swap, which facilitates the debt restructuring process. The amendments became effective in 2001.

[32] In this paper, intermediaries include financial intermediaries (commercial banks, finance companies, insurance companies, companies offering financial services such as credit cards), firms that act as the vertex of the pyramidal structure of the groups such as holding companies, as well as venture capitalist.

6.1.4 Industry Diversification

Table 9 shows the effects of industry diversification on the investment-cash flow sensitivity of group firms. The sample includes only group firms. Industry homogeneity indices are in the range of 0 and 1. The lower the index, the more diverse is the group in terms of industry. Industry homogeneity index I is based on a broad classification of industry while index II is on a more detailed classification.

Table 9 Effects of Group's Industry Diversification on Investment - Cash Flow Sensitivity of Group Firms

Dependent Variable: Investment/Capital	(1)	(2)
Cash Flow/Capital	0.101**	0.089***
	(0.043)	(0.027)
Group's Industry Homogeneity Index I * (Cash Flow/Capital)	-0.055	
	(0.066)	
Group's Industry Homogeneity Index II * (Cash Flow/Capital)		-0.103
		(0.099)
Industry Average Q	0.052***	0.052***
	(0.015)	(0.015)
Individual Group-Year Dummies	Included	Included
R^2	0.155	0.156

Remarks: All regressions include firm fixed effects, firm size, and year effects. Standard errors are in parentheses. ***, **, and * indicate that the estimate is significant at 1%, 5%, and 10%, respectively. Industry homogeneity indices are in the range of 0 and 1. The lower the index, the more diverse is the group in terms of industry. Industry homogeneity index I is based on a broad classification of industry while index II is on a more detailed classification. The broad classification consists of 8 industries. The detailed classification has 41 industries.

The results show that industry diversification does not affect the investment-cash flow sensitivity of group firms. In other words, the more diversified groups do not tend to have either more or less efficient resource allocation.

6.1.5 Group Size and Scale Effect

So far we consider only the characteristics that are scale free. All of them are normalized by the size of the groups. Table 10 shows the effects of group size, as measured by the number of member firms, on the sensitivity of the firm's investment to its own cash flow. The sample in this table includes both group and non-group firms.

Table 10 Effects of Group Size and Composition on Investment - Cash Flow Sensitivity of Group Firms

Dependent Variable: Investment/Capital	(1)	(2)	(3)	(4)
Cash Flow/Capital	0.176***	0.222***	0.309***	0.341***
	(0.023)	(0.026)	(0.034)	0.038
Group's Number of Firms * (Cash Flow/Capital)	-0.004**	-0.055***	-0.035***	-0.041***
	(0.002)	(0.015)	(0.010)	(0.011)
Group's Number of Industries * (Cash Flow/Capital)		0.003	-0.023	-0.016
		(0.003)	(0.017)	(0.017)
Group's Number of Listed Firms * (Cash Flow/Capital)			0.092***	0.081***
			(0.024)	(0.025)
Group's Number of Within-Group Intermediaries * (Cash Flow/Capital)				-0.047*
				(0.026)
Individual Group-Year Dummies	Included	Included	Included	Included
Industry Average Q	0.024**	0.025**	0.026***	0.025**
	(0.010)	(0.010)	(0.010)	(0.010)
R^2	0.138	0.155	0.171	0.175

Remarks: All regressions include firm fixed effects, firm size, and year effects. Standard errors are in parentheses. ***, **, and * indicate that the estimate is significant at 1%, 5%, and 10%, respectively.

The effect of the number of member firms on the investment-cash flow sensitivity if negatively significant. This result suggests that the larger the group, the more efficient resource allocation. In other words, the result supports the idea that the larger network create more channels of resource transfers. This effect overcome the coordination problem that might increase as the group grows bigger.

The effect of group size is robust when I add the number of industries, the number of listed firms, and the number of within-group intermediaries into the regressions. The effects of industry diversification, law and regulation, and intermediaries are consistent with the results previously described. However, the effect of intermediaries seems weaker. The interaction coefficient is no longer significant at 5%, although it is still significant at 10%.

6.2 Channels of Resource Allocation

[To Be Added]

7 Conclusion

This paper tries to answer some questions about business groups: Do business groups really have internal capital markets? Do they provide efficient resource allocation (in a view of the controlling shareholders)? What are the characteristics that determine the tendency to have efficient resource allocation in business groups? This study consider an economy that external capital market is imperfect and external fund is more costly than internal finance, with is natural in emerging economies, where capital market is not fully developed and firms tend to have credit constraints. In this environment, the marginal cost of external fund determines the firm's discount factor that is used in discounting the stream of marginal future benefits of the current investment. As a result, the firm's investment will depend on its financial determinants as well as its fundamental profitability. Since a group with absolute control can freely transfer resources across its member firms, the efficient allocation in a view of a controller implies that the marginal costs of fund are equalized across firms within the group; therefore, a group firm's investment should depend only on its group's financial factor and the firm's own profitability– but not the firm's financial determinants.

Using this model, I derive an empirical regression counterpart and use it to test the existence of internal capital markets in business groups. I also test various characteristics of groups that tend to affect the groups' resource allocation. Firm-level data from Thailand's Ministry of Commerce is used as a sample in the empirical sections. The results show that corporate control, group size, and within-group intermediaries tend to facilitate the efficient resource allocation. Corporate laws and regulations deliver the opposite results while industry diversification shows no effect on within-group resource allocation.

There are some issues that are not considered in detail in this paper. First, group formation and group characteristics are exogenously given in this paper. Second, the paper is also abstract from welfare analysis of the non-controlling shareholders. These issues are important and are waiting for further research. However, the results from this paper should shed some light on the nature of business groups and their structure, which could serve as a starting point to explain why and how business groups are formed.

The main contributions of this paper come in two folds. First, it presents a structural model with an empirical counterpart that can be used to study investment behavior of firms in business groups. Second, the paper provides empirical evidence from micro data that the structure of business groups and corporate governance are indeed related to the investment decision of firms.

8 Appendix: Derivation of Equation (6)

I follow the method used by Gilchrist and Himmelberg (1998). Denote $\rho_i = \beta_i (1 - \delta_i)$ and $\Lambda_{i,t,t+s} = \prod_{k=1}^{s} \left(\frac{1+\lambda_{i,t+k}}{1+\lambda_{i,t+k-1}} \right)$, we have

$$1 + c\left(I_{i,t}, K_{i,t}\right) = \beta_i \sum_{s=1}^{\infty} \rho_i^{s-1} E_t \left[\Lambda_{i,t,t+s} MPK_{i,t+s} \right].$$

Using a first-order Taylor approximation around $E_t \left[\Lambda_{i,t,t+s}\right] \simeq \kappa_1$ and $E_t \left[MPK_{i,t+s}\right] \simeq \kappa_2$,

$$\Lambda_{i,t,t+s} MPK_{i,t+s} \simeq \kappa_0 + \kappa_1 \Lambda_{i,t,t+s} + \kappa_2 MPK_{i,t,t+s}. \tag{9}$$

Next, we approximate

$$\begin{aligned}
\Lambda_{i,t,t+s} &= \prod_{k=1}^{s}\left(\frac{1+\lambda_{i,t+k}}{1+\lambda_{i,t+k-1}}\right) \\
\Lambda_{i,t,t+s} &= \prod_{k=1}^{s}\left(1+\frac{(1+\lambda_{i,t+k})-(1+\lambda_{i,t+k-1})}{1+\lambda_{i,t+k-1}}\right) \\
\Lambda_{i,t,t+s} &\simeq 1+\sum_{k=1}^{s}\frac{\lambda_{i,t+k}-\lambda_{i,t+k-1}}{1+\lambda_{i,t+k-1}} \\
\Lambda_{i,t,t+s} &\simeq \begin{cases} \phi_0+\phi_1 FIN_{i,t+k}, \text{ if firm } i \text{ is non-group firm} \\ \phi_0+\phi_2^J FIN_{t+k}^J, \text{ if firm } i \text{ is in group } J\ , \end{cases} \qquad (10)
\end{aligned}$$

where we assume that $\frac{\lambda_{i,t+k}-\lambda_{i,t+k-1}}{1+\lambda_{i,t+k-1}}$ of firm i linearly depends on firm's financial characteristics[33] $FIN_{i,t+k}$ and a group-time financial determinant FIN_{t+k}^J, where J is a group index. The two extreme cases presented in the previous section can be viewed as special cases to this approximation. For non-group firms, $\Lambda_{i,t,t+s}$ depends only on individual firm's characteristics. On the other hand, $\Lambda_{i,t,t+s}$ for a firm in a fully controlled group I should depend only on its group-time effect.

Finally, substituting equation (9) into (5), we have

$$\begin{aligned}
1+c\left(I_{i,t},K_{i,t}\right) &= \beta_i\sum_{s=1}^{\infty}\rho_i^{s-1}E_t\left[\Lambda_{i,t,t+s}MPK_{i,t+s}\right] \\
1+c\left(I_{i,t},K_{i,t}\right) &= \beta_i\sum_{s=1}^{\infty}\rho_i^{s-1}E_t\left[\kappa_0+\kappa_1\Lambda_{i,t,t+s}+\kappa_2 MPK_{i,t,t+s}\right] \\
1+c\left(I_{i,t},K_{i,t}\right) &= \kappa_0\beta_i\sum_{s=1}^{\infty}\rho_i^{s-1}+\kappa_1\beta_i E_t\left[\sum_{s=1}^{\infty}\rho_i^{s-1}\Lambda_{i,t,t+s}\right]+\kappa_2\beta_i E_t\left[\sum_{s=1}^{\infty}\rho_i^{s-1}MPK_{i,t,t+s}\right] \qquad (11)
\end{aligned}$$

[33] In theory, this term could depend on any characteristics that determine the cost of external funds. However, financial situation of a firm is one of the most important factors since the data in the firm's balance sheet and income statement, to a big extent, provide information about the default risk of the firm.

Then, substitute (10) into (11)

$$
\begin{aligned}
1+c\left(I_{i,t},K_{i,t}\right) &= \kappa_0\beta_i\sum_{s=1}^{\infty}\rho_i^{s-1}+\kappa_1\beta_i E_t\left[\sum_{s=1}^{\infty}\rho_i^{s-1}\Lambda_{i,t,t+s}\right]+\kappa_2\beta_i E_t\left[\sum_{s=1}^{\infty}\rho_i^{s-1}MPK_{i,t,t+s}\right] \\
1+c\left(I_{i,t},K_{i,t}\right) &= \begin{cases} \kappa_0\beta_i\sum_{s=1}^{\infty}\rho_i^{s-1}+\kappa_1\beta_i E_t\left[\sum_{s=1}^{\infty}\rho_i^{s-1}\left(\phi_0+\phi_1 FIN_{i,t+k}\right)\right]+\kappa_2\beta_i E_t\left[\sum_{s=1}^{\infty}\rho_i^{s-1}MPK_{i,t,t+s}\right] \\ \text{if firm } i \text{ is non-group firm} \\ \kappa_0\beta_i\sum_{s=1}^{\infty}\rho_i^{s-1}+\kappa_1\beta_i E_t\left[\sum_{s=1}^{\infty}\rho_i^{s-1}\left(\phi_0+\phi_2^J FIN_{t+k}^J\right)\right]+\kappa_2\beta_i E_t\left[\sum_{s=1}^{\infty}\rho_i^{s-1}MPK_{i,t,t+s}\right] \\ \text{if firm } i \text{ is in group } J \end{cases} \\
1+c\left(I_{i,t},K_{i,t}\right) &= \begin{cases} \left(\kappa_0+\kappa_1\phi_0\right)\beta_i\sum_{s=1}^{\infty}\rho_i^{s-1}+\kappa_1\phi_1\beta_i E_t\left[\sum_{s=1}^{\infty}\sum_{k=1}^{s}\rho_i^{s-1}FIN_{i,t+k}\right]+\kappa_2\beta_i E_t\left[\sum_{s=1}^{\infty}\rho_i^{s-1}MPK_{i,t,t+s}\right] \\ \text{if firm } i \text{ is non-group firm} \\ \left(\kappa_0+\kappa_1\phi_0\right)\beta_i\sum_{s=1}^{\infty}\rho_i^{s-1}+\kappa_1\phi_2^J\beta_i E_t\left[\sum_{s=1}^{\infty}\sum_{k=1}^{s}\rho_i^{s-1}FIN_{t+k}^J\right]+\kappa_2\beta_i E_t\left[\sum_{s=1}^{\infty}\rho_i^{s-1}MPK_{i,t,t+s}\right] \\ \text{if firm } i \text{ is in group } J \end{cases} \\
1+c\left(I_{i,t},K_{i,t}\right) &= \begin{cases} \tilde{f}_i+\tilde{\alpha}_1 Q_{i,t}^{FIN}+\tilde{\alpha}_3 Q_{i,t}^{MPK}, \text{ if firm } i \text{ is non-group firm} \\ \tilde{f}_i+\tilde{\alpha}_2^J Q_t^{FIN,J}+\tilde{\alpha}_3 Q_{i,t}^{MPK}, \text{ if firm } i \text{ is in group } J\ . \end{cases}
\end{aligned} \tag{12}
$$

If the adjustment cost is quadratic in $\frac{I_{i,t}}{K_{i,t}}$, then its marginal cost is linear in $\frac{I_{i,t}}{K_{i,t}}$. Equation (12) can be rewritten as

$$
\frac{I_{i,t}}{K_{i,t}} = \begin{cases} \alpha_0+f_i+\alpha_1 Q_{i,t}^{FIN}+\alpha_3 Q_{i,t}^{MPK}+\varepsilon_{i,t}, \text{ if firm } i \text{ is non-group firm} \\ \alpha_0+f_i+\alpha_2^J Q_t^{FIN,J}+\alpha_3 Q_{i,t}^{MPK}+\varepsilon_{i,t}, \text{ if firm } i \text{ is in group } J\ , \end{cases} \tag{13}
$$

where $Q_{i,t}^{FIN}$ is the present value of financial characteristic that determine the marginal cost of external finance of firm i; $Q_t^{FIN,J}$ is the present value of financial characteristic that determine the marginal cost of external finance of member firms in group J; and $Q_{i,t}^{MPK}$ is the present value of the marginal profitability of investment of firm i in period t. Finally, $\varepsilon_{i,t}$ is the stochastic component of the adjustment costs and other stochastic factors that are not captured by $Q_{i,t}^{FIN}$, $Q_t^{FIN,J}$, and $Q_{i,t}^{MPK}$.

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