Beyond cash flow and voting rights: Valuation and performance of firms in complex ownership structures*

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Abstract

We propose new measures to describe the ownership structure of family business groups that go beyond the standard measures of cash flow and voting rights. Our measures include the degree of pyramiding in the ownership structure of a group firm, and the centrality of a firm for the group structure (e.g., whether a given firm is used by the family to control other group firms). The theoretical arguments in Almeida and Wolfenzon (2006) suggest that group firms that are owned through pyramids should have lower profitability and should be more capital intensive than group firms that are owned directly by the family. The theory also suggests that central firms should have lower market valuations than public group firms that are not used by the family to set up and acquire new firms. Finally, the theory suggests that group firms that are closer to the family (e.g., at the top of the group) should be older than firms that are farther away from the family (e.g., at the bottom of the group). We use a unique dataset of Korean family business groups (*chaebols*) to provide evidence that is largely consistent with these implications. Our results suggest that cash flow and voting rights are not the only ownership variables that are associated with the performance and valuation of group firms.

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Groups of firms under common ownership are very prevalent around the world. These so called business groups account for a large fraction of the economic activity of many countries.[1] Most of these groups are controlled by families, which hold not only direct stakes in group firms, but also indirect stakes through other firms in the group. For example, one typical ownership structure is referred to as a pyramid. In this structure, the family achieves control of the constituent firms by a chain of ownership relations: the family directly controls a firm, which in turn controls another firm.[2]

Despite the widespread presence of family business groups in many countries around the world, the causes and consequences of the ownership structures of groups are not well understood. In particular, previous literature has focused mostly on the effects of the group structure on the cash flow and voting rights that the controlling shareholder holds in each group firm (see, e.g., La Porta et al., 1999, Bebchuk, Kraakman and Triantis, 2000, Claessens et al., 2000, Bertrand et al., 2002, and Faccio and Lang, 2002). However, it is not clear that these standard ownership variables are sufficient statistics to describe group ownership structure. For example, Almeida and Wolfenzon (2006) argue theoretically that pyramids are not equivalent to a direct ownership structure with the same cash flow and voting rights (and thus, with the same degree of separation between ownership and control).

In this paper, we propose new measures to describe the ownership structure of business groups that go beyond the standard measures of cash flow and voting rights. These measures include a measure of the *position* of any group firm relative to the controlling shareholder (a measure of the degree of pyramiding in the ownership structure of that firm), and a measure of the *centrality* of a firm for the group structure (e.g., whether a given firm is used by the family to control other group firms). The theoretical arguments in Almeida and Wolfenzon (2006) suggest that position and centrality should be related to firm performance and valuation in systematic ways. First, the theoretical arguments (reviewed below in Section 2) suggest that group firms that are owned through pyramids should have lower profitability and should be more capital intensive than group firms that are owned directly by the family. Second, central firms should have lower market valuations than public group firms that are not used by the family to set up and acquire new group firms. The theory also suggests that group firms that are closer to the family (e.g., at the top of the group) should be older than firms that are farther away from the family (e.g., at the bottom of the group).

We use a unique dataset of Korean business groups (*chaebols*) to test these implications. *Chaebols* are an ideal object for our tests, given the complexity of their ownership structures. In addition, the political and regulatory context of *chaebols* in Korea allows us to obtain extremely detailed ownership data on chaebol firms. Since the mid-1990s the top Korean chaebols have had to report their complete ownership information to the Korean Fair Trade Commission (KFTC). These reports also include detailed ownership and accounting data on *private* firms in each *chaebol*, which offers us a window into data that are not generally

[1] Claessens, Fan, and Lang (2002) find that, in eight out of the nine Asian countries they study, the top 15 family groups control more that 20% of the listed corporate assets. In a sample of 13 Western European countries, Faccio and Lang (2002) find that in nine countries the top 15 family groups control more than 20% of the listed corporate assets.

[2] Pyramids are very common throughout the world. See, among others, Claessens, Djankov, and Lang (2000), for the evidence on East Asia, Faccio and Lang (2002) and Barca and Becht (2001) for Western Europe, Khanna (2000) for emerging markets, and Morck, Stangeland and Yeung (2000) for Canada.

available in the literature.

Nevertheless, the complex ownership structure of chaebols also present some measurement challenges. The typical chaebol has dozens of firms with several ownership links among them. This level of complexity makes it difficult for the researcher to manually compute the ownership variables of interest, including the standard measures of cash flow and voting rights (which are important controls in the empirical specifications that we use). Therefore, we provide algorithms that can generate the ownership variables for group structures of any degree of complexity. Some of our calculations borrow from previous literature, in particular the formula to compute cash flow rights derived by Brioschi et al. (1989), and Flath (1992). Other formulas that we propose are novel, including the measure of position and an algorithm that can identify the presence of cross-shareholdings involving any number of firms.[3]

We also develop a new measure of the controlling shareholder's voting rights in group firms, which we call "critical control threshold". As we argue in Section 2, the most common method used in the literature to compute voting rights (the *weakest link* measure) does not work well for ownership structures that have either multiple ownership links leading to the same firm or substantial cross-shareholdings. Both of these issues are common in Korea.[4] The critical control threshold is a modification of the weakest link that is well defined and easy to compute for any possible group structure. In addition, to show that our results are robust to the definition of voting rights, we also compute an alternative measure of voting rights used in the literature, which we call "consistent voting rights".[5]

We use these ownership variables to provide a description of the ownership structure of Korean chaebols in the period of 1998 to 2004. Both pyramids and cross-shareholdings are very common in Korean chaebols. The median firm in a Korean chaebol is controlled through another firm (median position equal to 2), and 25% of the firm-years involve firms in cross-shareholding loops, typically with 3 firms. In contrast, only a few group firms are classified as being central to the control of the group. We also show that older, larger and public firms are more likely to be central to the group structure, suggesting that the largest, most important group firms tend to be those that are used by the family to control other firms. The results also confirm the prediction of Almeida and Wolfenzon's (2006) theory regarding the historical evolution of business groups. Firms with high positions (those owned through pyramids) are younger than firms that are at the top of the group. Overall, the snapshot of chaebol structure that we provide is largely consistent with the idea that Chaebols grow as the family uses successful (e.g., large, public) group firms to set up and acquire new group firms that are placed at the bottom of the group.[6]

We test the additional implications of the theory by relating group structure to firm profitability and valuation. First, we provide evidence that firms that are owned through

[3]The measure of centrality that we derive is similar (but not identical) to that proposed by Kim and Sung (2006).

[4]The weakest link measure is used, among others, by Barontini and Caprio (2004), Claessens et al (2000, 2002), and Faccio and Lang (2002). Faccio and Lang show that multiple links and cross-shareholdings are not common in Europe. In such cases, the weakest link measure can be easily computed.

[5]This is also the measure of voting rights used by Korean regulators. This measure of voting rights is similar to those used by La Porta et al. (1999), Lins (2003) and Aganin and Volpin, (2005).

[6]Aganin and Volpin (2005) also report similar evidence for one particular Italian business groups (the Pesenti group).

pyramids (those in the bottom layer of the group) have lower profitability than firms that are controlled directly by the family, but which are not central for the control of the group. We exclude the central firms from this comparison, because Almeida and Wolfenzon's (2006) theory has no predictions about the relative profitability of these firms. These results also hold after controlling for the degree of separation between ownership and control induced by pyramids, suggesting that the relationship between pyramids and profitability that we uncover is not due to the degree of separation. Second, we provide some evidence that firms owned through pyramids are more capital intensive than firms owned directly by the family (again, this comparison excludes the central firms). These results confirm the predictions of Almeida and Wolfenzon (2006), which suggest that firms with high investment requirements and/or low profitability are more likely to be set up in pyramids (a selection effect).

We also test the prediction that central firms should have lower market valuations than other public group firms. In Almeida and Wolfenzon's theory, this valuation discount is caused by the anticipation of future pyramidal investments by central firms. We find a robust negative correlation between centrality and market-to-book ratios (Tobin's Q), which holds after controlling for standard variables and also for the measures of separation between ownership and control. Overall, the results show that the separation between ownership and control is not the only dimension of ownership structure that is relevant for understanding the valuation and profitability of firms in business groups.

The outline of the paper is as follows. Section 1 provides a brief review of the literature on the financial performance of family group firms. Section 2 develop the empirical implications that we seek to test in the paper. Section 3 introduces our methodology to compute ownership variables for group firms. In Sections 4 and 5 we describe the legal and regulatory framework of Korean Chaebols, and the data that we use. In Section 6 we present the results that describe the ownership structure of Korean chaebols, and in Section 7 we relate the ownership variables to performance and valuation.

1 Literature review

There is a vast literature on family business groups.[7] In this section, we discuss briefly the part of the literature that links ownership structure to financial performance.

The existing literature recognizes that business group's ownership structure is a potentially important determinant of firm performance and valuation.[8] Nevertheless, the focus is mostly on cash flow and voting rights. For example, Bertrand et al (2002) use a sample of Indian business groups to show that group membership is harmful to performance because it provides incentives for the family to tunnel resources from firms in which the controlling shareholder has low cash flow rights, to those in which the shareholder's cash flow rights are high. In the context of Korean chaebols, Baek, Kang and Lee (2007) argue that discounted

[7] For a detailed review, see Morck et al. (2005).

[8] This does not mean that ownership is the only dimension of group structure that is interesting. Khanna and Thomas (2005), for example, show that stock price comovement in Chilean firms is greater when directors overlap than when firms belong to the same pyramid. Bertrand et al. (2004) link group structure to the history of the familes of controlling shareholders. See also Khanna (2000), and the survey by Khanna and Yafek (2007).

equity issues are more likely when the controlling shareholder has higher ultimate ownership in the acquirer than in the issuer. Bae, Kang and Kim (2002) argue that intra-*chaebol* acquisitions transfer wealth from firms in which the family has low cash flow rights (typically the acquirer) to those in which the family has higher cash flow rights. Claessens et al. (2002) show that firm value is negatively related to separation between ownership and control in East Asia, and Lins (2003) finds similar results for a sample of emerging markets' firms. Joh (2003) finds that separation between ownership and control is negatively related to profitability in Korea.[9] The latter three papers use samples that also include non-business group firms. However, as discussed by Morck et al. (2005), pyramiding is likely to be the primary reason for cash flows to diverge from control rights in these samples, suggesting that these findings are largely driven by separation between ownership and control in business groups.

Some papers have also related financial performance to variables that indicate whether a firm has some indirect (e.g., pyramidal) ownership. In particular, Claessens et al. (2002) and Volpin (2002) provide evidence that firms with indirect ownership have lower Tobin's Q than other firms. Holmen and Hogfeldt (2004) suggest that this undervaluation is greater if the controlling shareholder has lower ultimate ownership in the pyramidal firm. In addition, the literature has examined the relationship between valuation and firm membership in business groups, without taking the group's ownership structure into account (Khanna and Rivkin (2001), Khanna and Palepu (2000), Fisman and Khanna (2000), and Claessens, Fan and Lang (2002)). Khanna and Palepu (2000), for example, find a positive effect of group membership in their sample from India. However, their effect is limited to the largest business groups. Baek et al. (2004) focus on the effects of Asian crisis on Korean firms, and show evidence for a stronger impact of the crisis on Chaebol firms.

Finally, the literature has provided some evidence on the correlation between ownership variables and firm characteristics. In particular, there is some evidence that firms that are owned through pyramids are smaller and younger than firms at the top of the group (those that own shares in other firms). Aganin and Volpin (2005) describe the evolution of the Pesenti group in Italy, and show that it was created by adding new subsidiaries to the firms the Pesenti family already owned. One of their conclusions is that in Italy, business groups expand through acquisitions when they are large and have significant cash resources. Claessens, Fan and Lang (2002) find that firms with the highest separation of votes and ownership (i.e., those most likely to be owned through pyramids) are younger than those with less separation. Pyramidal firms also seem to be associated with larger scales of capital investment. Attig, Fischer, and Gadhoum (2003) find evidence consistent with this implication, using Canadian data. Claessens, Fan and Lang (2002) also find that in East Asia, group firms tend to be larger than unaffiliated firms. Bianchi, Bianco, and Enriques (2001) find similar evidence for Italy.

[9] Bennedsen and Nielsen (2006) find that valuation is negatively related to separation between ownership and control in Continental Europe, but also that profitability is unrelated to measures of separation in the same region.

2 Hypotheses regarding family groups

As discussed in Section 1, previous empirical literature takes the group ownership structure as given, and focuses on its effect on firm performance and valuation. According to the literature, group structure affects performance through its effect on the cash flow and voting rights held by the controlling shareholder. For example, because a pyramid generally induces separation between ownership and control, firms that are owned through pyramids are predicted to have lower performance than other similar firms. There has been less focus in trying to understand the group structure itself. For example, why is it that pyramids exist? The traditional informal explanation for pyramids argues that pyramids are formed to allow the controlling shareholder (the family) to achieve control of a firm using only a small cash flow stake. For instance, a family that directly owns 50% of a firm that in turn owns 50% of a different firm achieves control of the latter firm with an *ultimate* cash flow stake of only 25%. Notice that these existing arguments are explicitly or implicitly based on the effects of group structure on ownership concentration and separation between ownership and control.

In contrast, Almeida and Wolfenzon (2006) present a model that provides a rationale for the existence of pyramids that does not rely on the separation of cash flow from voting rights. The model is based on the assumption that the family can extract private benefits from the firms it controls at the expense of minority shareholders. In the model, the family has the choice of setting up a new firm (call it firm B) either through a pyramid (that is, using an existing group firm to buy a controlling equity stake in the new firm) or directly (that is, buying the equity stake directly with the family's personal wealth). Under the pyramidal structure, firm B is owned by all the shareholders of the original firm (call it firm A). As a result, although the family shares the security benefits of firm B with nonfamily shareholders of firm A, it has access to all of the retained earnings (cash) of firm A. Under the alternative, non-pyramidal ownership structure, nonfamily shareholders of firm A have no rights to the cash flows of firm B, and thus the family captures all of its security benefits. However, in this case, the family has access to only its share of the retained earnings of the original firm (for example, through dividend payments).

Because in a pyramidal structure the family shares the security benefits of firm B with nonfamily shareholders of firm A, while in the non-pyramidal structure it keeps all the security benefits, low security benefits (e.g., high private benefits) increase the family's payoff under the pyramidal structure relative to that under the horizontal structure (*payoff advantage*). Second, because outside investors take into account the extraction of private benefits, external financing becomes more expensive for the family when private benefits are high. This effect makes the family's ability to use all the retained earnings of firm A in a pyramid structure more valuable (*financing advantage*).

This argument generates predictions for the relationship between the characteristics of firm B and the ownership structure that is chosen by the family. In particular, firms with high investment requirements and/or low profitability are more likely to be set up in pyramids. Because these types of firms generate lower security benefits for investors, if the family uses a pyramid to set these firms up, they find it easier to finance them and they also achieve a higher payoff than if they use a non-pyramidal structure.

Almeida and Wolfenzon also argue that these relationships hold irrespective of the degree of separation between family ownership and control in firm B. While we would expect firms

owned through pyramids to show higher separation between ownership and control than firms owned directly by the family (an argument that is almost mechanical), the payoff and financing advantages identified by Almeida and Wolfenzon are not directly related to the deviation between cash flow and voting rights in firm B.

The model also generates implications about the valuation of pyramidal investments by the shareholders of firm A. Because the family selects low profitability, capital intensive, high private benefit firms into pyramids, minority shareholders of firm A should not expect high returns from pyramidal investments. For example, an unanticipated announcement of a pyramidal investment of significant size should generate a negative return for the shareholders of firm A. In addition, if shareholders anticipate significant future pyramidal investments by firm A, then they should discount the shares of A to compensate for the future low returns.

Finally, Almeida and Wolfenzon's model also generates implications about the timing of pyramid creation. In the model, the pyramid allows the family to use firm A's financial capacity to reduce the financing costs of setting up firm B. This argument implies that pyramids tend be created over time, following good performance of existing family firms. In other words, we expect to the firms at the top of the pyramid (those that are like firm A in the model) to be older than the firms at the bottom of the pyramid (those that are like firm B). In addition, we expect the firms at the top of the pyramid to have been successful in the past, in order to allow the family to use their financial resources to acquire and set up new firms in the bottom of the group.

To summarize this discussion, Almeida and Wolfenzon's model suggests the following implications about the structure of business groups, which can be tested with our data on Korean chaebols:

Implication 1 Group firms that are owned through pyramids have lower profitability than group firms that are owned directly by the family.

Implication 2 Group firms that are owned through pyramids are more capital intensive than group firms that are owned directly by the family.

Implication 3 Public group firms that are used by the family to set up and acquire new group firms should have lower valuations than public group firms that are not used to set up and acquire new group firms.

Implication 4 Group firms that are at the top of the pyramid are older than firms at the bottom of the group.

Some observations are in order. Regarding implication 1, previous literature has shown that the separation between ownership and control induced by pyramids is negatively related to firm profitability (see Section 1). However, the arguments in Almeida and Wolfenzon suggest that implication 1 should hold *controlling for* measures of separation between ownership and control. In addition, while previous literature has interpreted this negative association as evidence that pyramids reduce profitability, implication 1 is driven by the opposite direction of causality - lower profitability firms are selected into pyramids. Regarding implication 2, there has been some suggestion in the literature that pyramids are associated with larger scales of investment, but most of the evidence pertains to comparisons between group and

non-group firms. In contrast, implication 2 pertains to a comparison between group firms that are placed at different positions in the group. As discussed in Section 1, Aganin and Volpin (2005) present some anecdotal evidence for implication 4 using Italian corporate history.

We believe implication 3 is new to the literature. The arguments in previous literature focus mostly on the relation between a given group firm's valuation and *its own ownership structure*. That is, previous literature has related the family's ownership concentration and separation between ownership and control in firm i to the valuation of firm i. In contrast, implication 3 has nothing to do with the ownership structure of firm i, but rather it is driven by whether firm i is used by the family to acquire equity stakes in other group firms or not. Naturally, when testing implication 3 it is important to control for variations in ownership concentration that could be correlated with a firm's status in the group.

As we will see in the Korean data, there are basically two types of inter-company equity holdings in Korean chaebols. The first is a pure pyramidal equity stake that mirrors the stake that firm A holds in firm B in Almeida and Wolfenzon's model. However, cross-shareholdings among group firms are also common (firm A holds shares in firm C, which holds shares in firm A). Unfortunately, we are not aware of any theoretical arguments that pertain directly to cross-shareholdings (with the exception of the standard argument that cross-shareholdings can be used to separate ownership and control). In the empirical analysis, we will document whether cross-shareholdings are associated with performance and valuation while controlling for separation between ownership and control.

3 Metrics of group ownership structure

In order to test the empirical implications described in Section 2, we need to provide empirical counterparts for the variables suggested by the theory. In particular, we need to identify those firms that are used by the family to control other group firms, and to measure the ownership structure of a group firm (pyramidal versus direct ownership). In addition, we need to compute the standard metrics of cash flow and voting rights in order to show that the new measures of ownership structure contain information that is not captured by the separation between cash flow and voting rights.

As discussed above, most of the previous literature on group ownership structure focuses on measuring cash flow and voting rights. We base our discussion in the existing literature. However, we also show how the standard formula that is used to calculate cash flow rights can also be used to measure the position of a firm in the group structure (that is, whether a group firm is owned through a pyramid). In addition, we argue that the standard measure of voting rights (the weakest link) is difficult to apply to groups with complex ownership structures such as the Korean chaebols. We propose an alternative measure that captures a similar intuition to that behind the weakest link, and use this measure to compute a variable that allows us to identify the firms that are used by the family to control other group firms.

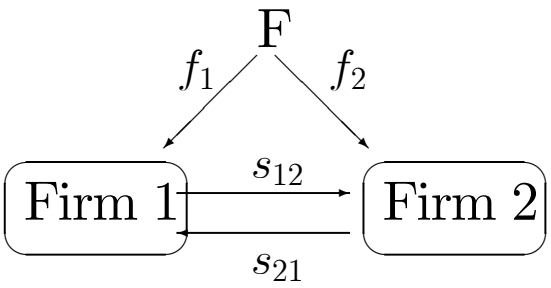

Figure 1: Cross-shareholdings

3.1 Computing ultimate cash flow rights

The definition of *ultimate* cash flow rights of the family in a particular firm is the fraction of the dividends paid by that firm that is (eventually) received by the family.[10] Because the ownership structures of business groups are usually quite complex, typically involving a fair number of inter-company holdings (e.g., pyramids and cross-shareholdings), only part of the dividends that the controlling family receives are due to its direct stake. To incorporate the effect of indirect holdings on the ultimate cash flow stake we use the formula originally proposed by Brioschi et al. (1989) and Flath (1992). This formula is general enough to accommodate *any* number of firms and *any* possible ownership structures (i.e., any possible configuration of inter-company holdings). In addition, we show how the same formula can be used to generate two measures of group ownership structure that have not been previously discussed in the literature.

We illustrate the computation of cash flow rights with a simple example (Figure 1). The family has a direct stake of f_1 and f_2 in firms 1 and 2, respectively. Also, firm 1 holds a stake of s_{12} of firm 2, and firm 2, in turn, holds a stake of s_{21} in firm 1. Thus, firms 1 and 2 have cross-shareholdings with each other. Let us compute the ultimate cash flow stake of the family in firm 2.

Suppose firm 2 pays one dollar in dividends. The family receives f_2 and firm 1 receives s_{12}. Out of the s_{12} dollars received by firm 1, the family owns $f_1 s_{12}$, and firm 2 owns $s_{21}s_{12}$. Out of the $s_{21}s_{12}$ dollars owned by firm 2, the family owns $f_2(s_{21}s_{12})$, and firm 1 owns $s_{12}(s_{21}s_{12})$. As it is clear, the ownership chain will continue indefinitely. From the pattern that emerges, we can compute the fraction of the dividend that is owned by the family as:

$$\begin{aligned} u_2 &= f_2 + f_1 s_{12} + f_2(s_{21}s_{12}) + f_1 s_{12}(s_{12}s_{21}) + f_2(s_{21}s_{12})^2 + f_1 s_{12}(s_{12}s_{21})^2 + ... \qquad (1) \\ &= \frac{f_2}{1 - s_{21}s_{12}} + \frac{f_1 s_{12}}{1 - s_{21}s_{12}} \end{aligned}$$

The computation of cash flow rights can be generalized using the formula proposed by Brioschi et al., 1989, and Flath, 1992.

[10] For brevity, we refer to the controlling shareholder as the "family" in the ensuing discussion.

3.1.1 A general formula

Consider a business groups with N firms. We define the matrix of inter-corporate holdings A as follows:

$$A = \begin{bmatrix} 0 & s_{12} & ... & s_{1N} \\ s_{21} & 0 & ... & s_{2N} \\ \vdots & \vdots & \vdots & \vdots \\ s_{N1} & ... & s_{N\,N-1} & 0 \end{bmatrix} \tag{2}$$

where s_{ij} is the stake of firm i in firm j. In other words, column j contains the stakes of the corporate direct owners of firm j. We also define a vector with the direct stakes of the family in each of the N firms:

$$\mathbf{f} = \begin{bmatrix} f_1 \\ f_2 \\ \vdots \\ f_N \end{bmatrix} \tag{3}$$

Proposition 1 *The ultimate ownership of the family in each of the n firms is given by* $\mathbf{u} = [u_1\ u_2\ ...\ u_N]'$*:*

$$\mathbf{u}' = \mathbf{f}'(I_N - A)^{-1} \tag{4}$$

where I_N *is the* $N \times N$ *identity matrix.*

Despite the fact that this formula is known, we would like to illustrate its derivation to clarify the derivation of the two new metrics that we propose below (*position* and *loop*). Take for example the group in Figure 1. In this case the matrix of intercompany holdings is:

$$A = \begin{bmatrix} 0 & s_{12} \\ s_{21} & 0 \end{bmatrix}, \tag{5}$$

and $f = [f_1\ f_2]'$. Suppose we want to compute the ultimate ownership of the family in firm 2. The idea is to follow the path that a dollar of dividends paid by firm 2 through the group structure. In vector form the initial dividend is given by:

$$\mathbf{d}_2 = \begin{bmatrix} 0 \\ 1 \end{bmatrix}. \tag{6}$$

In the rest of the paper, we let $\mathbf{d}_i$ be the vector of zeroes with a 1 in the i^{th} position.

We can now rewrite the computations above in matrix form. First, the family receives $\mathbf{f}'\mathbf{d}_2 = f_2$ and corporate owners receive $A\mathbf{d}_2 = [s_{12}\ 0]'$ due to their direct stakes (that is, firm 1 receives s_{12} dollars). It is useful to think of this as *stage 1* of the computation. While this is irrelevant for the calculation, it is also useful to assume that all group firms pay out any dividends that they receive from other group firms. That is, suppose that firm 2 pays out the s_{12} dollars that it received in stage 1. The family will then receive $\mathbf{f}'A\mathbf{d}_2 = f_1 s_{12}$ and corporate owners will receive $A(A\mathbf{d}_2) = A^2\mathbf{d}_2 = [0\ s_{21}s_{12}]'$. This is *stage 2* of the computation. We can then continue the process indefinitely. In stage 3, the dividend is $A^2\mathbf{d}_2$. The family receives $\mathbf{f}'A^2\mathbf{d}_2$ and corporate owners receive $A^3\mathbf{d}_2$, and so forth.

A pattern emerges: starting from dividend $\mathbf{d}_2$ and after n stages, the fraction of the original dollar held by corporate owners is $A^n\mathbf{d}_2$ and the dividend received by the family in this stage $\mathbf{f}'A^{n-1}\mathbf{d}_2$. The same algorithm can be repeated for any firm i. Thus, we obtain:

$$u_i = \sum_{n=1}^{\infty} \mathbf{f}'A^{n-1}\mathbf{d}_i = \mathbf{f}' \left(\sum_{n=1}^{\infty} A^{n-1} \right) \mathbf{d}_i = \mathbf{f}'(I_N - A)^{-1}\mathbf{d}_i. \tag{7}$$

This shows how formula 4 is derived. We will now use the objects in this formula to define two new measures of group structure. Both of these measures involve only matrix computations, and do not require the researcher to manually examine the flow chart with cross-ownership links.

3.2 Firm's position in a group

A potentially important characteristic of the ownership structure of a business group is the position of a firm in the group, as explained in Section 2. We can think of a firm's position as the distance between the family and a given firm in the group. For example, in the case of a simple pyramid with two firms the firm in the bottom of the pyramid is farther away from the family than the firm in the top of the pyramid.

In order to operationalize this notion of position, it is useful to consider the *stages* of the computation above. Recall that $\mathbf{f}'A^{n-1}\mathbf{d}_i$ is the dividend that the family gets in stage n from a dollar that originates in firm i. If a family owns a direct stake in firm i, it will receive a dividend in the first stage. Thus, $\mathbf{f}'A^{n-1}\mathbf{d}_i$ is strictly positive for $n = 1$. Nevertheless, this does not show that the firm's position is equal to 1, because dividends can also reach the family from paths other than the direct one. For example, if the family holds a stake in another firm j, which holds a stake in firm i, then $\mathbf{f}'A^{n-1}\mathbf{d}_i$ is also positive for $n = 2$.

In order to compute a measure of position that takes all such paths into account, we define the position of a firm i as a weighted average of all the stages in which the family receives dividends from firm i. We use as weights the fraction of the ultimate cash flow rights contributed by the particular path/stage. This measure can be formally defined as follows:

Definition 1 *The position of firm i in the group is defined as:*

$$pos_i = \sum_{n=1}^{\infty} n \frac{\mathbf{f}'A^{n-1}\mathbf{d}_i}{u_i} \tag{8}$$

In order to illustrate the computation of position, take the group in Figure 1 with the assumption that $s_{21} = 0$ (no cross-shareholdings). In this case, firm 2 is owned both directly (through the stake f_2), and indirectly, through the stake s_{12}. So we have:

$$pos_2 = 1\frac{f_2}{f_2 + f_1 s_{12}} + 2\frac{f_1 s_{12}}{f_2 + f_1 s_{12}}, \tag{9}$$

which is simply a weighted average of the direct path, and the indirect one through firm 1. If f_2 is very small, for example, then the position of firm 2 will be close to 2, meaning that

the ownership of firm 2 is approximately pyramidal. In contrast, if the direct stake f_2 is large and the indirect stake s_{12} is small, then pos_2 is close to one.

Notice that this definition of position is also applicable to the case of cross-shareholdings ($s_{21} > 0$). In this case, equation 8 will contain a sum of infinite paths, each one weighted by the ownership contributed by that path:

$$pos_2 = 1\frac{f_2}{u_2} + 2\frac{f_1 s_{12}}{u_2} + 3\frac{f_2(s_{21}s_{12})}{u_2} + 4\frac{f_1 s_{12}(s_{12}s_{21})}{u_2} + ... \tag{10}$$

It is easy to see that, consistent with intuition, the position of firm 2 will be higher as the size of the cross-shareholdings increase and the direct ownership stake f_2 decreases.

3.3 Identifying general cross-shareholdings

We can also use the objects involved in formula 4 to check whether a given firm is part of a cross-ownership pattern, and to compute the number of firms involved in this cross-ownership loop. The idea behind the calculation is the following. If firm i pays a dividend and after n stages the dividend reappears firm i, then it must be that the firm is part of a loop. Also, the number of stages needed for the money to reappear for the first time in firm i measures the number of firms in the shortest loop.

Definition 2 *Let*

$$loop_i = \min\{n \mid n \geq 1 \text{ and } \mathbf{d}_i' A^n \mathbf{d}_i > 0\}, \tag{11}$$

then firm i is in a loop if and only if $loop_i < \infty$. The number of firms in the shortest loop firm i is involved is given by $loop_i$.

Recall that $A^n \mathbf{d}_i$ is a vector with the dividends received by each group firm after n stages, following a dollar that originated in firm i. Because we are interested in the dividends received by firm i itself, we pre-multiply by $\mathbf{d}_i'$ to get the i^{th} element.

3.4 Computing Control Rights

The computation of control rights in a complex group is challenging because it is not clear what fraction of the votes held by intermediate firms is controlled by the family. We start by discussing the weakest link idea that is frequently used in the literature. As we will show, this methodology is not readily implementable in groups with extensive cross-shareholdings. Because of this problem, we propose an alternative to the minimum link method which captures the same intuition as the minimum link and is easily implementable for any possible group structure (the critical control threshold, CC).

3.4.1 The weakest link

Consider the following example of a simple pyramid in Figure 2. Clearly, the family controls 21% of the votes of firm 1 through its direct stake. But what about firm 2? The *weakest link* method assigns the minimum voting stake in the chain of control. That is, the family is assumed to hold 21% of the votes of firm 2 as well. For simple pyramids, this measure is

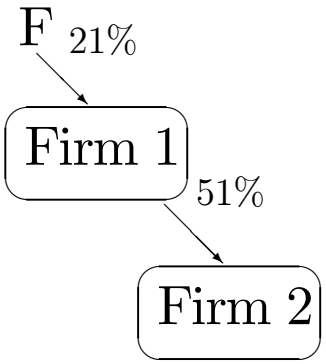

Figure 2: A simple pyramid

intuitive: Because control of firm 2 is obtained through firm 1, it cannot be the case that the family's degree of control is firm 2 is higher than that in firm 1. Another way to think about this measure is to consider the minimum equity stake that an outsider would need to acquire to challenge the family's control of firm 2. If an outsider acquires 21% of firm 1, it would have as much control of firm 2 as the family has. Thus, it makes intuitive sense to define the family's voting rights in firm 2 as being equal to 21%.

However, it is not clear how to extend this calculation to groups with complex ownership structures. The first problem arises when there are multiple chains leading to the same firm. The weakest link rule calls for computing the minimum votes along each chain and then adding these values. In Figure 3, for example, this procedure would lead to voting rights greater than 100% for firm 3, suggesting that there might be some *double-counting* of family votes arising from the presence of multiple links. This double-counting problem arises from the fact that there are two chains of control that go through firm 2 and end up in firm 3, and the minimum link procedure adds up all of them. Does it make sense to say that the family has full control of firm 3 in this case? We believe this is not reasonable, because the family's control of firm 3 depends on the family's control of firm 1, which holds 60% of the shares of firm 3. However, the family holds only 40% of the shares of firm 1. In principle, an outsider could acquire control of firm 3 through an acquisition of more than 40% of the shares of firm 1.

XXX ADD EXAMPLE HERE (FIGURE 3). Family holds 40% of firm 1, 50% of firm 2, and 5% of firm 3. firm 1 holds 30% of firm 2, and 60% of firm 3. Firm 2 holds 30% of firm 3XXX

The existence of cross-shareholdings also poses problems for the calculation of the weakest link. For example, in Figure 1, what would be the weakest control link between the family and firm 2? To answer that question, one needs to know what is the degree of control that the family has over firm 1. According to the weakest link idea, the degree of control over firm 1 should be equal to the weakest link between the family and firm 1. However, because firm 2 holds shares in firm 1, in order to calculate the weakest link between the family and firm

1 we also need to know the weakest link between the family and firm 2. The weakest link formula as discussed in the literature does not tell us how to solve this *circularity* problem that arises from the presence of cross-shareholdings.

Because multiple links and cross-shareholdings are very common in our data, it is difficult to directly apply the minimum link idea to the Korean data.[11] We turn to an alternative measure that can accommodate these issues.

3.4.2 An alternative measure: the critical control threshold (CC)

The idea behind the CC measure of control is again to calculate the weakest link in the control chain leading up from the family to any firm in the group. This measure is equivalent to the weakest link when cross-shareholdings and multiple links are absent (that is, for straight pyramids). This measure is derived from two simple assumptions about control.

The set of firms controlled by the family To compute the set of firms controlled by the family, we make two assumptions:

Assumption 1 *A family controls a firm if and only if it holds more than T votes in it.*

Assumption 2 *The votes that a family hold in a firm are the sum of its direct votes plus all the direct votes of firms under family control, where control is defined in Assumption 1.*

This definition of control is a combination of the idea of a control treshold (Assumption 1), plus the assumption that, if a family controls a firm, it controls the votes that this firm holds on other firms.

The following proposition establishes the formal condition that the set of firms controlled by the family must satisfy (for a given control threshold T). Suppose we start the analysis with a set N, which contains all candidate firms that could be controlled by the family. This set can represent all firms in a country, or a pre-identified subset of those firms.

Proposition 2 *For a given treshold T, the set of firms controlled by the family is given by:*

$$C(T) = \{i \in N : f_i + \sum_{j \in C(T),\ j \neq i} s_{ji} \geq T\}. \tag{12}$$

In other words, the set $C(T)$ is the solution to a fixed point problem.[12]

There is a simple algorithm that can be used to find $C(T)$ in any situation. We first provide a formal definition of the algorithm and then we explain how it works.

[11] Naturally, the empirical relevance of the double-counting and the circularity problems depends on the extent to which cross-shareholdings and multiple links are important. For example, Faccio and Lang (2002) show that neither problem is very prevalent in their European sample. In such a case it is straightforward to compute the minimum link by ignoring the effect of cross-shareholdings. For example, in Figure 1 one can define the minimum link between the family and firm 2 as $\min(f_2, f_1 s_{12})$.

[12] Let $F(X) = \{i \in N : f_i + \sum_{j \in X,\ j \neq i} s_{ji} \geq T\}$. Then $C(T)$ then satisfies $F(C(T)) = C(T)$.

Definition 3 *(Algorithm) Let the sequence of sets* $S(0) \supseteq S(1) \supseteq S(2)...$ *be defined by* $S(0) = N$, *and* $S(n+1) = \{i \in S(n) : f_i + \sum_{j \in S(n),\, j \neq i} s_{ji} \geq T\}$.

The idea of this algorithm is to start with all the firms, $S(0) = N$. In the first stage, we assume that the family controls all the firms and we drop the firms in which the direct and indirect stake of the family is below T. This procedure generates $S(1)$. Next, we assume that the family controls only the firms in $S(1)$ and again drop from $S(1)$ the firms in which the direct and indirect stake of the family is below T (of course, we only consider indirect stakes of firms that are in $S(1)$). This generates $S(2)$. We can repeat this algorithm a number $\sharp N$ of times to arrive at $S(\sharp N)$. This last set is important in light of the following Proposition.

Proposition 3 $S(\sharp N)$ *satisfies condition 12.*

The proof of this proposition in the Appendix. A property that simplifies the algorithm is that if $S(n) = S(n+1)$ for $n < \sharp N$ then $S(\sharp N) = S(n)$. This means that we can stop the algorithm the first time we do not drop a firm.[13]

The critical control threshold: definition We can now define our new measure of control rights:

Definition 4 *For any firm* $i \in N$, *the* critical control threshold *is given by*

$$CC_i = \max\{T \mid i \in C(T)\} \tag{13}$$

The critical control threshold is the *highest control threshold that is consistent with family control of firm* i. In other words, if the control treshold were higher than CC_i, then firm i would not be part of the set of firms controlled by the family.

Let us now illustrate the calculation of CC using the examples in Figures 2 and 3. In Figure 2 (a simple pyramid), notice that as long as $T \leq 21\%$ the family controls firm 1, and therefore controls firm 2 as well. Thus, $C(T) = \{1, 2\}$ for any $T \leq 21\%$. As T increases beyond 21%, firm 1 is dropped from the control set. This also causes firm 2 to be dropped because the family no longer controls firm 1's votes in firm 2. Thus, we conclude that the critical control thresholds are 21% for both firms (coinciding with the weakest link solution).

Consider now Figure 3. While we could not compute the voting rights of the family in firm 3 using the weakest link, it is easy to see that $CC_3 = 40\%$. Once T reaches 40% the family no longer controls firm 1 with its direct stake. Without firm 1, the family controls only 35% of the shares of firm 3, so firm 3 is dropped from the control set as well. The intuition is that while an outsider can only buy 5% of the shares of firm 3 directly in the market, it can contest the control of firm 3 by purchasing a 40% stake in firm 1.

For simple pyramids, it is clear that CC and the weakest link will coincide. In more general ownership structures, CC corresponds to the minimum equity stake that an outsider needs to acquire in any group firm, to contest the control of a given group firm. We believe this definition captures the same idea as the weakest link with the advantage that it is not subject to the double-counting and circularity problems explained above.

[13] As we discuss in the Appendix, with cross-shareholdings there might be multiple sets that satify condition 12. We show that set $S(\sharp N)$ is the unique set that contains the maximum number of firms.

3.5 Measuring the centrality of a firm for the control of the group

We can use the CC measure to easily calculate a statistic that summarizes how important a given firm is for the control of the overall group (*centrality*). In terms of the empirical implications developed in Section 2, we use the centrality variable to identify which firms are used by the family to control other group firms.

For example, take the group in Figure 3. In this example, firm 1 is likely to be a central firm for the control of the group, because firm 1 holds significant stakes in firms 2 and 3. Firm 3, in turn, is not (because it does not hold shares in other firms). An easy way to capture this difference is to drop all firms (one by one) from the group's ownership matrix, and then calculate the decrease in CC for the other group firms. For example, if firm 3 is dropped from Figure 4, CC_1 and CC_2 are unchanged. In contrast, if firm 1 is dropped, CC_3 goes down from 40% to 35%. Notice, in contrast, that CC_2 does not change since the firm controls 50% of firm 2 directly. Even though firm 1 holds shares in firm 2, this stake is not important for the control of firm 2 given the large direct stake.

These calculations suggest the following definition for a firm's centrality in the group control structure:[14]

Definition 5 *We define the* centrality *of a firm i as:*

$$central_i = \frac{\sum_{j \neq i} CC_j - \sum_{j \neq i} CC_j^{-i}}{\sharp N - 1}, \tag{14}$$

where CC_j^{-i} is the critical control threshold of firm j, computed as if firm i held no shares in the other group firms.

In words, we compute the centrality of firm i as the average decrease in CC across all group firms other than firm i, after we exclude firm i from the group. This formula, as the previous ones, can be implemented for any group structure.

3.6 Consistent voting rights

Besides the weakest link, previous literature has also used an alternative measure of voting rights, namely the sum of direct stakes held by the controlling shareholder, and direct stakes held by firms controlled by this shareholder (LaPorta et al., 1999, Aganin and Volpin, 2003, and Lins, 2003). We use the set of firms controlled by the family to implement this measure of control rights:

Definition 6 *Given a threshold T, the* consistent voting rights *of the family in firm $i \in C(T)$ are defined as:*

$$VR_i(T) = f_i + \sum_{j \in C(T),\ j \neq i} s_{ji} \tag{15}$$

[14] Kim and Sung (2006) compute a similar variable for Korea, using cash flow rights instead of voting rights. They show that their measure of centrality is inversely related to the probability that the firm goes public. In contrast, we show below that central firms are much more likely to be public in our sample.

In words, to find the family's sum of votes in firm i we simply sum the direct votes held by the family in firm i with all the indirect votes held by other firms that belong to $C(T)$. The resulting distribution of voting rights,$\{VR_1(T), VR_2(T)...\}$ is *consistent* with the control threshold T, in the sense that $VR_i(T) \geq T$ for all i. For example, in the group of Figure 4 we would have $\{VR_1(T), VR_2(T), VR_3(T)\} = \{40\%, 80\%, 95\%\}$, for $T \leq 40\%$.

4 Korean Chaebols: Definition and Regulatory Framework

A "Chaebol" is a South Korean's business group consisting of many firms in diverse business areas that are owned and controlled by family members. The chaebols exert significant economic influence in Korea. For example, as of 2004 the chaebols accounted for 14% of the value added of the entire manufacturing sector, 2.95% of the nation's employment, and more than half (52.3%) of the total market value of all listed companies.

4.1 Regulatory Framework for Chaebols

Chaebols are mainly regulated by laws pertaining to competition policies. This contrasts with legal regimes addressing regulation of corporate groups in other countries: laws relating to holding companies in the US, a specialized law of corporate groups, Konzernecht, in Germany, and special provisions addressing group-related issues in European company laws.[15] Although the main purpose of regulating business groups in other countries is to protect creditors and minority shareholders against the opportunism of controlling shareholders, its main purpose in Korea is to deter excessive concentration of economic power into a small number of large companies. Lacking a legal regime to address concentration of economic power, Korea has relied on the Monopoly Regulation and Fair Trade Act (hereafter just Fair Trade Act or FTA). The government agency to oversee the FTA is the Fair Trade Commission (FTC) that was established in 1981 along with the law.

The legal expression for chaebol is 'Large Business Group,' which is precisely defined in the FTA. The business group is legally designated based on the size, the size being the combined total asset of affiliated companies in the group. From 1987 to 2001, the FTC designated annually the 30 largest chaebols. The firms in the designated 30 chaebols were prohibited from cross shareholdings and also subject to limitations on equity investment in the domestic firms. From 1998, immediately after the outbreak of the financial crisis, these firms were also prohibited from cross debt guarantees among affiliated companies. From 2002, the FTC changed its scheme of designating chaebols. The FTC first designates a group of chaebols that are prohibited from cross shareholding and cross debt guarantees.[16] Legally, these chaebols are termed 'business groups subject to limitation on cross shareholding and

[15] For different legal regimes addressing business groups in different countries, see Kraakman et. al. (2004),

[16] Non-financial affiliates cannot provide other affiliated companies with financial guarantees for credits supplied by domestic financial institutions. Cross shareholding among chaebol's affiliates is prohibited by the FTA. Financial institutions of chaebols are exempt from this regulation, if they invest other people's money in affiliated company shares. These finance companies of chaebols, however, may not exercise voting rights of shares of domestic companies in the same chaebol.

cross debt guarantees.' Currently, these are business groups with the combined assets greater than two trillion won.[17] Among these business groups, very large ones are further 'subject to ceiling on total equity investment in other domestic companies.'[18] In this paper, chaebol hereafter refers to those family-controlled business groups subject to legal limitations on cross shareholding and cross debt guarantees.

4.1.1 Who are the legal members of chaebols (Inclusion requirements)

A chaebol in the FTA is defined as a business group where "an 'identical person' de facto controls member firms' businesses." An identical person is rather broadly defined to include a controlling shareholder and his or her 'related persons' which in turn includes relatives and affiliated companies. There are two criteria for a de facto control of a company called 'affiliated company': de facto ownership of more than 30 per cent, excluding preferred shares, of a company and de facto exercise of controlling influence on a company. The latter criterion, de facto exercise of controlling influence, in turn is further detailed to include cases of an exchange of directors and managers and also substantial business transactions between a firm directly controlled by an identical person and the company in question. Because this criterion of 'controlling influence' is very broadly interpreted, some companies legally belong to a group even though neither families nor other affiliated companies own shares of those companies.

5 Data Description

This section describes the sources for the ownership, accounting and financial data that we use in this study.

5.1 Ownership Data

The ownership data of our study are from Korean Fair Trade Commission (hereafter KFTC). These data contain the stock ownership information for the largest 30 business groups from 1998 to 2001 and the large business groups subject to regulations on cross-shareholding and debt guarantee of affiliates of the same group from 2002 to 2004, which are designated by KFTC. As explained above, KFTC has assigned and supervised the largest 30 business groups from 1987 to 2001 and the large business groups subject to prohibitions on cross-shareholding and debt guarantee from 2002 to now based on the Monopoly Regulation and Fair Trade Act(hereafter Fair Trade Act) and its enforcement ordinance.

The largest 30 business groups until 2001 and the business groups under cross-shareholding and debt guarantee prohibition after 2002 should report the status of affiliate shareholders and persons with special interest and the main financial status on April 1 to KFTC until the end of April each year, following Fair Trade Act and its enforcement ordinance. Among the

[17] Based on the won/dollar exchange rate of 946 on March 9th, 2007, two trillion won amounts to 2.1 billion US dollars.

[18] The threshold asset size of 'very large business groups' used to be five trillion won until 2005 but increased to six trillion won in 2006.

ownership data and financial data which KFTC has kept, we obtained the data for the period 1998-2004. However, we study only business groups with the ownership of a natural man (i.e., family business groups), exclude other business groups such as government-controlled business groups. The ownership structures of 800 companies of 30 groups in 1998, 681 companies of 30 groups in 1999, 518 companies of 25 groups in 2000, 590 companies of 25 groups in 2001, 638 companies of 31 groups in 2002, 739 companies of 35 groups in 2003, and 776 companies of 36 groups in 2004 are available. The total size of firm-years is 4742.

The ownership status of the affiliates and the person with special interest of each firm in the above ownership data of KFTC is recorded relatively in detail. In our ownership data, the shareholders are categorized into 7 types; family owner, the relatives of family owner, nonprofit affiliate, , group officer, treasury stock, and others. In addition, the name, the holding quantity, and the ratio of common stocks and preferred stocks of each individual shareholder are recorded. For example, take the ownership information of Samsung Corporation in Samsung group. In 2004, the family owner held 1.42%, the relatives of the family owner 0.01%, two nonprofit corporations 0.23%, four affiliates 9.64%, thirty seven group officers 0.15%, Samsung Corporation itself 2.20% (treasury stock), and others 86.52% of its common stock.

5.2 Financial data

We take advantage of two databases developed by Korea Listed Companies Association (KLCA) and Korea Investors Service (KIS). KLCA and KIS's databases contain information not only of listed companies, but also some private firms which are subject to external audit. As it stands, KLCA turned out to cover 860 firms and 2994 year-firms that are also included in the ownership sample above, and KIS covers 790 firms and 2780 year-firms. In sum, financial data of 3741 firm-years (which amounts to 73.25% of the firm-years in the ownership data) are available. Our sample contains 3,548 firm-years of ownership data from 1998 to 2004. Out of these firm-years, the accounting data is available for 3,445 of them.

6 Ownership Structure of Korean Chaebols

In this section we provide a detailed description of the ownership structure of Korean chaebols in the period of 1998 to 2004. As we will argue, understanding the typical chaebol structure allows us to sharpen the implementation of the empirical implications described in Section 2. In addition, in this Section we relate the ownership variables to firm characteristics other than accounting variables and valuation measures (which are analyzed in Section 7), and present a test of Section 2's implication 4.

6.1 An example - Hyundai Motor

Figure 4 shows a summarized picture of the 2004 ownership structure of the Hyundai Motor Chaebol. The total number of firms in the group is 27, but the figure only depicts the ownership relations among 11 of them. This example is fairly typical of a Korean Chaebol. The individual at the top (Jung Mong Koo in the case of Hyundai Motor) controls some

firms directly, with no cross-shareholdings (e.g., Changwon and Glovis), and also several firms that own equity stakes in each other.

Table 1 shows some variables of interest for the firms depicted in Figure 4. Hyundai Motor, Hyundai Mobis and Kia Motors are the most important firms for the control of the Hyundai Motor Chaebol, given that these are the firms with the highest values for the *centrality* variable. These firms are also among the largest firms in the Chaebol in terms of the number of employees, and they tend to be older as well. In addition, these firms (central, larger, older) are also the ones that are publicly traded (in addition to BNG Steel and INI Steel). The figure shows that these firms indeed hold stakes in several other Chaebol firms. Though it is a bit hard to follow the ownership links with the naked eye, our variable loop show that these central firms are also part of a cross-ownership loop, with 3 firms in it (variable "steps"). For example, notice that Kia owns 18% of the shares of Mobis, which owns 14% of the shares of Motor, which owns 37% of the shares of Kia.

6.2 Summary statistics

Table 2 shows the average values for the ownership variables across all firm-years in our sample (Panel A), and the cross-correlation matrix (Panel B). There are a total of 47 groups that were present at any point in the sample between 1998 and 2004, and 1085 firms. The controlling family holds 13% of the cash flows of the median firm, but it holds substantial more votes according to the two alternative measures of voting power. The VR (consistent voting rights) measure gives the largest voting power. The family and the affiliate firms hold 68% of the votes of the median firm in the sample. In contrast, the critical control threshold of the median firm is 30%. Thus, the separation between ownership and control is substantially larger if one uses VR to measure voting power (the separation variables are computed as voting rights minus cash flow rights for the two measures of control).

The data also indicate a substantial degree of pyramiding in Korean chaebol firms (the median position of a firm is 2.06), but with substantial variation. Some firms are owned directly (25% of firms show average position lower than 1.40), with few ownership links from other group firms. Finally, only a few firms have positive values for the centrality variable (the 75th percentile is zero), indicating that only a small fraction of group firms are central for group control. The summary statistics also show that 26% of the firm-years involve listed firms, while 74% involve private firms, and that 25% of the firm-years involve firms in cross-shareholding loops.

The fraction of firms participating in cross-shareholding loops may seem surprising given the Korean regulation restricting direct cross-shareholdings. However, Panel B shows that the overall majority of cross-shareholding loops has 3 firms in it (72% of all loops). The high incidence of cross-shareholdings also underscores the importance of using measures of cash flow and voting rights that can handle the impact of cross-shareholdings.

Finally, we present in Panel C the simple correlations among the ownership variables. Consistent with the Hyundai Motor example, the correlations show that public firms, central firms and firms in loops tend to be higher up in the group structure (negative correlation with position). These variables are also correlated among themselves, that is, central firms are more likely to be public and to belong to loops.

We have also calculated the ownership variables separately for each one of the 47 groups

in our sample. The related tables are omitted for brevity, but are available from the authors. Each group has on average 16 affiliated firms. Out of these firms, an average of 4 firms are public, and an average of 2.93 firms belong to cross-shareholding loops. Also, on average 3 firms have a centrality measure greater than 0.01. Finally, if we define direct ownership as a position lower than 1.2, then an average of 3.12 firms are owned directly by the family.

6.3 Ownership structure and firm characteristics

As explained in Section 2, Almeida and Wolfenzon's (2006) model predicts that pyramidal business groups are created as the controlling family uses existing and successful group firms to set up and acquire new firms. One specific implication of this framework is that firms at the bottom of the group should be younger than firms at the top of the group (implication 4). We test this implication by relating firm age to the position measure described above. In addition, we examine the correlations between our other two new ownership variables (centrality and loop) and basic firm characteristics including size, age, and public status. The regressions include group and year dummies, and the standard errors are clustered by firm. The regressions with group dummies provide evidence on the relationship between ownership variables and firm characteristics within groups. The results are similar if we do not use the group dummies.

The results on Table 3 (columns I and II) how very clearly that older, larger and public firms are more likely to belong to cross-shareholding loops and to be central to the group structure. These results confirm the pattern suggested by the Hyundai Motor example, in that the largest, most important group firms tend to be those that are used by the family to control other firms. The results are also confirm implication 4, in that firms with high positions (those owned through pyramids) are clearly younger than firms that are at the top of the group. These results also hold when we control for the measures of ownership concentration and separation between ownership and control, suggesting that the correlation between age and position is not simply due the standard ownership variables.

Overall, this snapshot of chaebol structure is largely consistent with a historical evolution of chaebols. Cheabols grow as the family uses successful (e.g., large, public) group firms to set up and acquire new group firms that are placed at the bottom of the group.[19]

6.4 Summary: the average structure of a Korean Chaebol

Figure 5 summarizes the analysis above by charting the ownership structure of the average Korean Chaebol. There are roughly three layers in the Chaebol ownership structure. Some firms (firms 1, 2 in the Figure) are owned directly at the very top of the group (position close to 1), without ownership links to the other firms (like Changwon in the Hyundai Motor example above). The middle layer contains the firms that belong to cross-shareholding loops such as Kia Motors in the example above. The typical loop contains three firms, given the prohibition of direct cross-shareholding links. The firms in this middle layer are more likely to be public, and they are larger and older than other Chaebol firms. The firms in this layer

[19] Aganin and Volpin (2005) also report similar evidence for one particular Italian business groups (the Pesenti group).

are also the firms that are likely to be central for the group control structure (i.e., they own substantial stakes in other firms in the bottom layer). In this bottom layer, we have firms that are more likely to be private, smaller and younger (i.e., Ajumetal in the Hyundai Motor example). They are also less likely to own substantial stakes in other firms (less central, less cross-shareholdings). The number of firms in this layer of private/non-central/no loop firms is much higher than those in the upper layers (roughly 10 out of the 16 firms).[20]

The picture depicted in Figure 5 allows us to sharpen the tests of implications 1 to 3 of Section 2. Implications 1 and 2 compare firms that the family chooses to control through other firms (e.g., through pyramids) with those that the family chooses to control directly. Importantly, this comparison does *not* refer to the firms that the family uses to control other firms (e.g., the central firms). In terms of Figure 5, these implications refer to a comparison between firms like firms 1 and 2 with the firms owned through pyramids (such as firms 6 to 16). Accordingly, the empirical tests that we perform below will relate the profitability and capital intensity of group firms to their position in the group, excluding the central firms from the regressions. Implication 3, in contrast, is specifically about the valuation of firms that are used by the family to control other firms. Figure 5 suggests that Korean chaebols have a well defined group of firms that the family uses to set up and acquire new firms (firms 3, 4 and 5 in the Figure). The empirical tests below will compare the valuation of these central firms with the valuations of other publicly traded firms in the group.

7 Profitability, valuation and ownership structure

In this section we present the empirical tests of implications 1 to 3 of Section 2, which relate the profitability, capital intensity and valuation of group firms to measures of group structure.

7.1 Measures of profitability and valuation

To correctly measure the profitability of each chaebol firm, we need to ensure that reported profits are not affected by equity stakes that a chaebol firm holds in other firms. Starting in 1999, the financial statements of Korean chaebol firms became subject to the *equity method* reporting rule. The basic idea behind this accounting rule is to record firm A's share of firm B's equity as an asset for firm A, and firm A's share of firm B's profits as a source of non-operating income for firm A. Fortunately, the financial statements contain enough information to allow us to back out the exact amount by which accounting figures have been adjusted because of equity stakes. We use this information to calculate our measures of assets and profits for Chaebol firms, which we denote "Operating Assets" and "Operating Profits". The details are in the appendix.

There are similar issues involved in computing a measure of valuation for chaebol firms. The market value of a publicly listed chaebol firm includes the value of the equity stakes that this firm holds in other chaebol firms, both public and also private. However, unlike

[20] Nevertheless, we stress that this average picture hides substantial variation. For example, some public firms (such as BNG Steel in the Hyundai Motor example) do not own shares in other firms. This particular source of variation will be important in the valuation results that we present below.

the adjustment to the accounting items there is no way to calculate the market value of each chaebol firm's operating assets without incurring some measurement error. First, we need to make some assumption about the valuation of the private firms in the chaebol, in order to deduct the value of equity stakes held in private firms. Second, in order to calculate a measure such as a market-to-book ratio we need both the ownership (to compute the value of equity stakes) and the accounting data (to compute the book value of operating assets). However, in general the accounting and the ownership data refer to different months of the year. Most of the accounting data is from December (the fiscal month for a majority of firms), while the ownership data refers to April of a given year.

Because of these measurement problems, we use in our benchmark regressions a measure of Q that is not adjusted for the market and book value of equity stakes held in other chaebol firms (unadjusted Q, Q_{una}):

$$Q_{una} = \frac{EV + \text{Book Liabilities}}{\text{Book Assets}}. \tag{16}$$

The observed equity value of a chaebol firm EV incorporates the value of the equity stakes held in other firms. Also, the firm's total book assets includes an accounting adjustment for book equity held in other firms, as explained above. As far as we know all of the previous literature on business groups used a similar valuation measure.

Nevertheless, we also check whether the results are sensitive to correcting Q for equity stakes. In order to do this we derive implied operating asset values from market prices, and divide by the book value of operating assets. We use the book value of equity to value the private firms in the chaebol (if book equity is positive), and use the ownership matrix to deduct the value of equity stakes that each chaebol firm holds in other firms. The resulting Q measure can be interpreted (conditional on measurement issues) as the Q that a group firm would have if it were valued as a stand-alone entity (Q_{sa}):

$$Q_{sa} = \frac{EV + \text{Book Liabilities - Value of equity stakes}}{\text{Operating assets}}. \tag{17}$$

While we use Q_{una} in our regressions below, the results are qualitatively identical if we use Q_{sa}, suggesting that the standard practice of using an unadjusted measure of valuation does not introduce much of an error.

Table 4 reports the summary statistics for the accounting and valuation variables. Our benchmark measure of profitability is operating ROA, defined as operating profits divided by operating assets (see the appendix for the definitions). For comparison, we also report a measure of profitability unadjusted for the equity stakes (total profits/total assets). The average unadjusted measure overstates average profitability by a small amount. Naturally, operating assets are lower than total assets because of the adjustment for equity stakes (approximately a 10% decrease). Next, we present statistics on the two measures of Q (which have very similar properties), and the equity values that we use to compute them. There are a total of 886 firm-years available for public firms between 1998 and 2004. Q_{una} is based on the total market value of equity, while Q_{sa} is calculated using the stand-alone value of equity (which is lower than the market value due to the adjustment for equity stakes). We use capital expenditures divided by operating assets to measure capital intensity, and

non-current liabilities divided by operating assets to measure leverage.[21]

7.2 Pyramids, profitability and capital intensity

As explained above, some of the predictions that we want to test are based on a comparison of firms that are owned through pyramids with firms that are owned directly by the family. In addition, the comparison does not refer to the firms that the family uses to control other firms (e.g., the central firms). Almeida and Wolfenzon's (2006) predicts that firms that the family chooses to control through the central firms should have lower profitability and higher capital intensity than the firms that the family chooses to control directly (that is, without any ownership by the central firms). These are implications 1 and 2 described in Section 2.

In order to implement a test of implications 1 and 2, we construct the following empirical test. First, we construct a variable called *pyramid*, which is equal to one if the average position of a group firm is bigger than 2, and equal to zero if average position is in the 25th percentile or lower (the 25th percentile of position is equal to 1.4). Then, we restrict the sample to firms that have the centrality variable lower or equal to 0.015.[22] This filter restricts the empirical test to non-central firms. We end up with a sample of 2,499 firm-years, 77% of each with a pyramidal ownership structure ($pyramid = 1$).

To test implications 1 and 2, we use the following regression:

$$\begin{aligned} Pyramid_{i,t} &= \alpha_1 OperROA_{i,t} + \alpha_2 Capex_{i,t} + \beta Controls_{it} + \\ &\quad + \sum_j industry_j + \sum_t year_t + \varepsilon_{i,t,} \end{aligned} \tag{18}$$

where the controls include firm size (measured by the log of operating assets), age and public status, and in some specifications the measures of separation between ownership and control. This specification also controls for industry and year fixed effects. The industry classification corresponds roughly to a 2-digit SIC classification in the US (there are 45 different industries in the sample). In some specifications, we also include group fixed effects to measure within group effects. The standard errors are clustered at the level of the firm. Implication 1 suggests that the coefficient α_1 should be negative, and implication 2 suggests that the coefficient α_2 should be positive.

The results are reported in Table 5. Column (1) suggests that firms owned through pyramids are indeed less profitable and more capital intensive than those that the family chooses to own directly. Since the pyramid variable is likely to be highly correlated with the proxies for separation between ownership and control (which can also affect firm profitability according to traditional stories about pyramids), in the next regressions (columns (2) and (3)) we include our two proxies for separation between ownership and control ($separVR$ and

[21] This is consistent with results in Bohren and Michalsen (1994), who compute distortions due to double counting of value of firms with cross stakes in Norway. Valuation metrics such as price-earnings ratio are relatively unaffected by cross-shareholdings, since there is double counting in both the numerator and the denominator. However, French and Poterba (1991) report a substantial effect on cross-shareholdings on price-earning ratios in Japan.

[22] The results below are not sensitive to small variations in the cutoffs used to compute the *pyramid* variable and to define non-central firms.

separCC). As expected, these variables are highly correlated with *pyramid*. Nevertheless, profitability remains highly correlated with the pyramid variable.

These results suggest that the relation between profitability and pyramidal ownership that we uncover is *not* due to the separation between ownership and control induced by pyramids. The inclusion of the ownership variables does reduce the significance of the capital intensity variable, which is still significant in column (2) but not in column (3). Finally, in columns (4) to (6) we introduce group fixed effects. The results suggest that *within each group* firms owned through pyramids are less profitable and more capital intensive than those owned directly (though the latter relation is not always significant). These results are broadly consistent with implications 1 and 2 of Section 2.

7.2.1 Profitability and the other ownership variables

For the purpose of illustration, we also document the relationship between firm profitability and our two other new ownership variables in Table 6 (centrality and loop). We regress operating ROA on centrality and loop, controlling for basic firm characteristics (age, size and public status), industry and year dummies. In addition, because our measure of profitability is computed after interest payments, we control for leverage (which is expected to have a negative correlation with profitability).

The results in Table 6 suggest that centrality is negative correlated with profitability. The results hold after controlling for the measures of separation between ownership and control, and are actually stronger when we include group dummies in the regressions, indicating that within each group central firms have lower profitability than other firms. There is no evidence of a relation between profitability and the loop variable.

7.3 Valuation and ownership structure

We now examine the valuation of group firms, and we test implication 4 which says that central firms in the group should trade at a discount relative to non-central firms in the group. According to the arguments in Almeida and Wolfenzon (2006), this valuation discount is due to minority shareholder's anticipation of future pyramidal investments by the central firm. To test implication 3 we use the following regression:

$$\begin{aligned} Q_{i,t} &= \alpha_1 central_{i,t} + \alpha_2 Capex_{i,t} + \beta Controls_{it} + \\ &\quad + \sum_j industry_j + \sum_t year_t + \varepsilon_{i,t,} \end{aligned} \tag{19}$$

where the controls include firm size (measured by the market value of total assets), age and public status, leverage, capital expenditures (to control for growth opportunities), operating ROA (to control for current profitability) and in some specifications measures of ownership concentration and separation between ownership and control. As explained above, we use the unadjusted measure of Q in these regressions (Q_{una}), but the results are similar if we use Q_{sa}. We also include the loop variable among the controls to check whether there is any relationship between loop and valuation. We control for industry and year fixed effects, and the standard errors are clustered at the level of the firm. Implication 4 suggests that the coefficient α_1 should be negative.

Table 8 presents the results. Column (1) suggests that centrality is indeed negatively related to valuation. The other variables have the expected signs. Large and younger firms have higher Q, as do firms with high growth opportunities. These results remain after controlling for the proxies for separation between ownership and control (columns (2) and (3)). Interestingly, only the measure based on the critical control threshold is significant in these regressions, showing the standard negative sign. In addition, there is some evidence that firms in cross-shareholding loops have lower valuations as well (though the correlation is weaker than that for centrality). The negative relation between centrality and valuation is also robust to the inclusion of group dummies in the regression, suggesting that within each group central firms are valued at a discount relative to other firms. These results are consistent with implication 3.

7.3.1 Anecdotal evidence: the SK example

There is also some anecdotal evidence of low valuation of central Chaebol firms. A well known case is that of SK Corporation.In December 2003, the market capitalization of SK Corporation (the largest oil refinery in Korea) was approximately 2.9 billion dollars. Besides several stakes in private group firms, SK Corporation had a stake of 20% on SK Telecom (the largest mobile telecom company in Korea), which was worth 13.6 billion dollars, and a 39% stake in SK Networks, which was worth 4.3 billion dollars.[23] As a result of these equity stakes, SK corporation was the most central firm in the ownership structure of the SK group (centrality = 0.09, which is in the 92% percentile of our entire sample).

The value of these equity stakes alone (i.e., assuming a zero value for the stakes in private firms) was 4.4 billion dollars.[24] Thus, the implied equity value of SK corporation's operating assets was -1.5 billion dollars. One possible explanation for SK corporation's negative equity value is that the firm had a large amount of liabilities (book value equal to 8.1 billion dollars). If we add the entire amount of the book liabilities to SK corporation's operating equity value, we obtain a market value of 6.6 billion dollars for the operating assets of SK corporation (i.e., the value of the assets not including the equity stakes in other group firms). For comparison, the book value of the operating assets in December 2003 was 9.75 billion dollars. Thus, SK corporation's market-to-book ratio of operating assets (Q_{sa}) was 0.68 in December 2003.

This relatively low valuation for SK corporation attracted the interest of an activist investment fund that specializes in emerging market stocks (the Sovereign Fund), which amassed 15% of SK Corp. shares in the market during 2003 and started issuing takeover threats. Sovereign's attack subsequently raised SK Corporation's equity value. As a result, in December 2004 SK corporation's Q had increased to 0.92.[25]

[23] The ownership data are as of April, 2003.

[24] SK Telecom and SK Networks also own shares in a private firm that owns shares in SK corporation, that is, they belong to a cross-shareholding loop.

[25] SK corp's equity value went up to 6 billion dollars, while the value of the equity stakes went up to 4.7 billion. Liabilities were 6.8 billion, and the book value of operating assets was 8.1 billion.

7.3.2 Other explanations for the relation between centrality and valuation: discussion

We note that the Almeida and Wolfenzon argument is not the only possible explanation for the valuation discount on central firms. One important characteristic of these firms (and also of firms in cross-shareholding loops) is that they hold substantial stakes in other firms. Furthermore, these stakes might be *non-marketable* for the parent company, in the sense analyzed by Longstaff (1995). If the stakes are necessary to retain control of subsidiary firms, then the parent company might be restricted from selling them. In Longstaff's model, this restriction introduces a discount on the valuation of the security for the investor who holds it but is restricted from selling it, relative to the market value of the security for other investors (such as the minority shareholders of the subsidiary).[26] Thus, the value of the equity stakes held by the parent company could be be lower than the value of an identical stake held by other investors in the subsidiary company.

The finding that central firms have low valuations bear some resemblance to the closed end fund puzzle (see, i.e, Shleifer (2000)). Closed end mutual funds tend to trade at substantial discounts relative to the NAV (net asset value) of the securities in their portfolios.[27] In particular, some of the explanations developed to explain the closed end fund puzzle bear some resemblance to the agency and marketability stories above. It is possible that shareholders of the closed end fund expect poor portfolio management in the future (agency story), or that the closed end fund might hold shares that have trading restrictions such as privately placed stock (marketability story). Nevertheless, not all arguments regarding the closed end fund puzzle seem equally relevant. For example, the investor sentiment story explained in Shleifer (2000) would require individual investors to be more likely to trade shares of the parent company relative to the subsidiaries. There is no reason to expect that condition to hold in the Korean data.

Cornell and Liu (2001), Mitchell, Pulvino and Stafford (2002) and Lamont and Thaler (2003) provide some evidence that parent company discounts have also been observed in the US market. For example, in the period of 1985-2000, Mitchell, Pulvino and Stafford (2002) identify 70 firms in which the market value of the equity stake that the parent holds in the subsidiary is higher than the market value of the parent (similarly to the SK example above). Lamont and Thaler (2003) show some extreme examples of potential misvaluations (such as the Palm and 3Com example), in which a commitment by the parent to spin-off the shares of the subsidiary at a fixed rate in a future date creates an apparently clear arbitrage opportunity.[28] The standard explanation for this phenomenon in the US is that it is due to noise trading bidding up the prices of the subsidiary stocks,[29] and arbitrage costs that make a price correction difficult.

It is possible that this inefficient markets story is also behind the low valuations of central

[26] In Longstaff's model, the discount comes from the fact that investors have market timing ability, which they cannot be taken advantage of if there is a binding restriction to sell.

[27] See Buysschaert, Deloof and Jegers (2004), for related evidence using data from Belgian holding companies.

[28] The spin-off fixed a ratio of shares of Palm that each 3Com shareholder would receive (1.5) in one year, subject to SEC approval. However, 3Com traded at a price that was substantially lower than 1.5 times the price of Palm.

[29] A large fraction of the firms analyzed in these studies are in the internet sector.

firms in Korea. However, we believe this story on its own is less likely to explain the Korean parent company discount. First, the Korean phenomenon seems to be more general than the internet bubble-related discounts in the US. It is linked to the characteristics of the ownership structures of business groups, rather than stemming from particular industry characteristics of the subsidiary firms. For example, if we use the same criteria used by Mitchell, Pulvino and Stafford (2002) to identify potential cases of misvaluation, we find 90 firm-years out of a total of 815 in which the market value of equity stakes are larger than the market value of the parent company, 11% of the entire sample.[30] In contrast, all the papers cited above suggest that this phenomenon is rather rare in the US market, partly because it is less common to observe a structure in which both the parent and the subsidiary are publicly traded. In addition, the subsidiaries of central Korean firms are not concentrated in any particular industry. Second, the alternative explanations discussed above (agency and control-related marketability issues) are more likely to hold in Korea than in the US, given the particular governance and ownership characteristics of Korean corporate finance.[31]

[30] This calculation assumes that private group firms have a market-to-book ratio of one, as in the calculation of Q_{sa} above. The number of cases is even higher is we use the alternative method used by Mitchell et al., which assumes that the operating equity of the parent should be valued at book levels. We can show that this criteria is equivalent to requiring that $Q_{sa} < 1$, which is true of more than 50% of the sample including firms that do not own stakes in other firms.

[31] Cornell and Liu (2001) discuss agency and liquidity explanations of US parent company discounts, and reject both possibilities in favor of the market inefficiency story above.

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Appendix

Proof of Proposition 3

We need to show $S(\sharp N) = \{i \in N : f_i + \sum_{j \in S(\sharp N),\, j \neq i} s_{ji} \geq T\}$. The proof is divided into a number of steps.

Step 1: $S(\sharp N) = S(\sharp N + 1)$.

Consider two cases: 1) $S(\sharp N) = \varnothing$ and 2) $S(\sharp N) \neq \varnothing$. In case 1), the lemma follows directly from the definition of $S(\sharp N + 1)$. In case 2), we have that, after $\sharp N$ stages, there are firms that are not yet eliminated. Because we started with $\sharp N$ firms, this means that there was a stage $n \leq \sharp N$ such that no firm was dropped. In other words, we have that $S(n) = S(n-1)$. We can now compute $S(n+1) = \{i \in S(n) : f_i + \sum_{j \in S(n),\, j \neq i} s_{ji} \geq T\} = \{i \in S(n-1) : f_i + \sum_{j \in S(n-1),\, j \neq i} s_{ji} \geq T\} = S(n)$, where the first equality follows from $S(n) = S(n-1)$ and the second from the definition of $S(n)$. Analogously, we can show that $S(n) = S(n+1) = S(n+2) = \ldots = S(\sharp N) = S(\sharp N + 1)$. The last equality proves step 1.

Step 2: $S(\sharp N) \subseteq \{i \in N : f_i + \sum_{j \in S(\sharp N),\, j \neq i} s_{ji} \geq T\}$

Note that $S(\sharp N) = S(\sharp N + 1) = \{i \in S(\sharp N) : f_i + \sum_{j \in S(\sharp N),\, j \neq i} s_{ji} \geq T\}$, where the first equality follows from step 1 and the second is simply the definition of $S(\sharp N + 1)$. Because $S(\sharp N) \subseteq N$, it is clear that $i \in S(\sharp N) \Rightarrow i \in \{i \in N : f_i + \sum_{j \in S(\sharp N),\, j \neq i} s_{ji} \geq T\}$.

Step 3: $S(\sharp N) \supseteq \{i \in N : f_i + \sum_{j \in S(\sharp N),\, j \neq i} s_{ji} \geq T\}$

Towards a contradiction, we suppose that $k \in \{\, i \in N : f_i + \sum_{j \in S(\sharp N),\, j \neq i} s_{ji} \geq T\}$ and $k \notin S(\sharp N)$. The first condition implies that

$$f_k + \sum_{j \in S(\sharp N),\, j \neq i} s_{jk} \geq T. \tag{20}$$

The last condition implies that firm k was eliminated in some earlier stage in the algorithm, say stage n. Thus $k \in S(n-1)$ but $k \notin S(n)$. We now have

$$T > f_k + \sum_{j \in S(n-1),\, j \neq k} s_{jk} \geq f_k + \sum_{j \in S(\sharp N),\, j \neq k} s_{jk}, \tag{21}$$

where the first inequality follows from the fact that firm k was eliminated in round n and the second inequality follows from $S(n-1) \supseteq S(\sharp N)$ and the fact that $s_{ij} \geq 0$. This is a contradiction because Equations 20 and 21 cannot hold at the same time. Putting together steps 2 and 3 leads to the statement of the Proposition.■

Multiple control sets

Consider the example in Figure A1, and assume that $T = 25\%$. Clearly, we have that $C(25\%) = \{1, 2, 3\}$ because the set $\{1, 2, 3\}$ satisfies condition 3. However, the null set

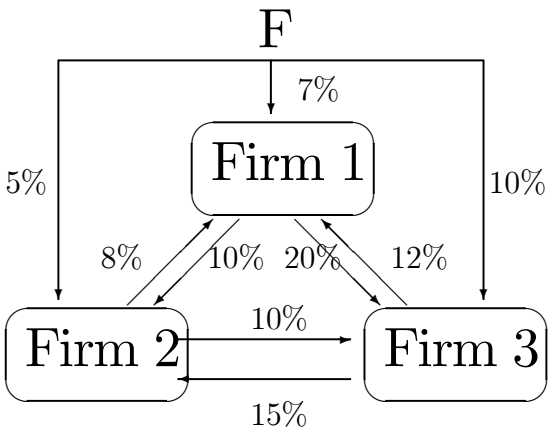


Figure A1: A complex group with many cross-shareholdings

also satisfies condition 3 for the same control threshold. To see this, suppose that the family controls no firms, then its voting rights in firms 1, 2 and 3 are 5%, 7%, and 10%, respectively. Note that all of them are below the threshold of 25%, confirming that the family does not control any of these firms.

Because in the case of Korea the firms with which we start (the set N) have already been pre-classified as members of the chaebol, we would like to choose the set that satisfies condition 12 and at the same time has the maximum number of firms. We can prove the following Proposition.

Proposition 4 *Consider all possible sets of firms that satisfy condition 12 for a given control threshold T: $C_1, C_2, \ldots, C_M$. The following holds: $S(\sharp N) = \bigcup_{i=1}^{M} C_i$.*

This Proposition of important for two reasons. First, it tells us that there is a unique set that has the maximum number of firms over all the sets that satisfy condition 12. This is important since it removes the arbitrariness of picking a set among many. Second, the proposition tells us that the outcome of the algorithm is precisely the set we are looking for.

The proof of this result is divided into two steps.

Step 1: $S(\sharp N) \subseteq \bigcup_{i=1}^{M} C_i$

By Proposition 3, we know that $S(\sharp N)$ satisfy condition 12, thus there is a m such that $S(\sharp N) = C_m$. The result follows.

Step 2: $S(\sharp N) \supseteq \bigcup_{i=1}^{M} C_i$

We show that $C_m \subseteq S(\sharp N)$ for all $m = 1 \ldots M$. Step 2 follows directly from this. Take a set C_m. Because C_m satisfies condition 12 the following is true:

$$\text{For all } k \in C_m, \ f_k + \sum_{j \in C_m,\, j \neq k} s_{jk} \geq T \tag{22}$$

Towards a contradiction, suppose that some of the firms in C_m are not in $S(\sharp N)$. That is, there must be a stage in the algorithm in which the first firm of C_m is eliminated. Let that stage be n. We then have that $C_m \subseteq S(n-1)$ but there is at least one $k \in C_m$ such that $k \notin S(n)$. We now have that

$$T > f_k + \sum_{j \in S(n-1),\, j \neq k} s_{jk} \geq f_k + \sum_{j \in C_m,\, j \neq k} s_{jk}, \tag{23}$$

where the first inequality follows from the fact that k is eliminated in round n and the second follows from $C_m \subseteq S(n-1)$ and the fact that $s_{jk} \geq 0$. This is a contradiction because Equations 22 and 23 cannot hold at the same time. This proves step 2. Finally, putting together steps 1 and 2 leads to the statement of the Proposition.■

Accounting measures of operating assets and operating profits

After January 1st, 2003, the item 'stocks accounted in equity method' (code number KLCA 123560) reports the aggregate book value of the shares subject to the equity method. Before 2003, however, 'stocks accounted in equity method' was not separately recorded but pooled into all investment securities. The data are available from the footnotes to financial statements, which we examined to calculate this item for the remaining years. Regarding profits, the profits coming from affiliate companies (call it "equity method profits") are recorded in two items in the non-operating portion of the income statement of parent companies. If equity method profits are positive, they are called "Gain on valuation of Equity Method" (KLCA # 242100). If they are negative, they are called "Loss on valuation of Equity Method" (KLCA # 252600).

With this knowledge, it is easy to adjust the financial statements to back out the values of the accounting figures that refer to each individual Chaebol firm. Specifically, we have:

$$\text{Operating Assets} = \text{Total Assets - Equity Method Stock}, \tag{24}$$

and:

$$\text{Operating Profits} = \text{Total Profits - Gains from Equity Method + Losses from Equity Method}, \tag{25}$$

where we define Operating Assets/Profits as the asset/profit values that the Chaebol firm would have in the absence of the equity method adjustment. These asset/profit figures reflect the individual assets and profitability of each Chaebol firm.

One issue with the calculation of operating profits is that one cannot easily back out the tax implications of the equity method adjustments. For example, if affiliate companies provide profits to a parent, the parent's taxes will be higher. However, we do not know exactly how much higher. Thus, in the calculations below, we use a pre-tax measure of profitability to measure each firm's Total Profits that we input in equation 25 (specifically, we use *ordinary income* to measure total profits).

We also check the data for basic consistency requirements. In particular, if the balance sheet shows a number for the equity method stock (i.e., if item KLCA#123560 is non-missing), then there should also be an item in the income statement for gains and losses from equity method (i.e., KLCA#242100 and KLCA#252600 cannot both be missing). The

reverse should also hold. In addition, it should not be the case that *both* items KLCA#242100 and KLCA#252600 are positive, since affiliates will either generate a profit or a loss. We eliminate all firm-years that do not satisfy this consistency requirement.

Table 1. Hyundai Motor's ownership structure.

Firm	Ult. Own	VR	CC	Position	Loop	Steps
Glovis	100.0%	100.0%	100.0%	1.0	0	0
Changwon	58.2%	67.6%	57.0%	1.0	0	0
INI Steel	10.4%	32.6%	25.0%	1.3	1	3
Hyundai Mobis	9.8%	35.2%	25.0%	1.3	1	3
Hyundai Motor	7.1%	25.0%	25.0%	1.4	1	3
Hyundai Capital	14.9%	93.1%	25.0%	1.6	1	3
BNG Steel	9.1%	60.7%	25.0%	1.9	0	0
Kia Motors	4.2%	47.6%	25.0%	2.4	1	3
World Industries	5.1%	90.5%	25.0%	2.8	0	0
Dymos	5.5%	97.8%	25.0%	2.8	0	0
Ajumetal	3.8%	72.7%	25.0%	3.8	0	0

Firm	Centrality	Type	Employ	Age	Industry
Glovis	4	private	196	3	Other Transport
Changwon	0	private	195	30	Fabr. Metals
INI Steel	4	listed	4329	50	Basic metals
Hyundai Mobis	12	listed	3924	27	Motor Vehicles
Hyundai Motor	13	listed	52542	37	Motor Vehicles
Hyundai Capital	0	private	1059	11	Fin. Institution
BNG Steel	0	listed	544	38	Basic metals
Kia Motors	9	listed	31432	60	Motor Vehicles
World Industries	0	private	1624	28	Motor Vehicles
Dymos	0	private	875	5	Motor Vehicles
Ajumetal	0	private	204	31	Basic metals

Table 2. Summary statistics, ownership structure

Panel A. Basic statistics

All firms	Mean	StDev	Median	25%	75%	Firm-years
Ultimate ownership	0.21	0.22	0.13	0.05	0.28	3548
VR	0.68	0.28	0.68	0.47	1.00	3548
CC	0.33	0.19	0.30	0.19	0.43	3548
Separation VR	0.47	0.29	0.44	0.23	0.73	3548
Separation CC	0.12	0.11	0.12	0.03	0.19	3548
Average Position	2.11	0.82	2.06	1.40	2.56	3548
Centrality	0.02	0.05	0.00	0.00	0.00	3524
Loop	0.25	0.43	0.00	0.00	1.00	3548
Public	0.26	0.44	0.00	0.00	1.00	3548
					No.Firms	1085
					No.Groups	47

Panel B: Correlation table

	Ult Own	Votes (VR)	Votes (CC)	Av Pos	Public	Centrality
Votes (VR)	0.36					
Votes (CC)	0.86	0.35				
Av Pos	-0.52	0.20	-0.28			
Public	-0.16	-0.57	-0.15	-0.23		
Centrality	0.11	-0.17	0.16	-0.26	0.37	
Loop	-0.06	-0.25	-0.09	-0.18	0.42	0.21

Panel C. Number of firms in loop

Firms in loop	Frequency	Percent
2	87	9.74
3	641	71.78
4	118	13.21
5	34	3.81
6	11	1.23
7	1	0.11
8	1	0.11
Total	893	

Table 3. Ownership variables and firm characteristics

	Dependent variable				
	Loop	Centrality	Position	Position	Position
	(1)	(2)	(3)	(4)	(5)
Firm age	9.074***	0.824***	-12.867***	-8.081***	-7.833***
	(8.40)	(5.21)	(-6.00)	(-5.43)	(-5.02)
No employees	0.165***	0.016***	-0.162***	-0.129***	-0.162***
	(5.49)	(3.21)	(-3.23)	(-3.38)	(-4.35)
Public	0.182***	0.024***	-0.152***	-0.083	-0.388***
	(4.91)	(4.66)	(-2.20)	(-1.47)	(-7.16)
Ult. Own				-1.750***	-1.627***
				(-16.84)	(-15.36)
Separ VR				0.934***	
				(13.12)	
Separ CC					2.182***
					(12.66)
Group FE	Yes	Yes	Yes	Yes	Yes
Observations	3548	3524	3548	3548	3548
R-squared	0.36	0.28	0.31	0.63	0.62

Standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4. Summary statistics of accounting and financial variables

	Mean	StDev	Median	25%	75%	Firm-years
Op return on assets	0.02	0.11	0.03	-0.01	0.08	2976
Return on assets	0.02	0.11	-0.01	0.03	0.09	2976
Op assets (million USD)	708	2544	72	16	400	3445
Assets (million USD)	772	2735	75	17	434	3445
Firm age	16.8	14.3	13.0	4.0	26.0	3445
No employees	1202.7	3768.9	198.0	44.0	845.0	3445
Quna	0.92	0.32	0.85	0.74	1.00	886
Qsa	0.91	0.36	0.84	0.72	1.01	870
Mkt value of equity (million USD)	2077	5044	737	235	1997	886
Stand alone mkt value of equity (million USD)	1901	4693	694	226	1878	870
Capital expenditures/operating assets	0.05621	0.14849	0.02884	0.00762	0.07237	2592
Leverage	0.21084	0.27919	0.14505	0.04234	0.30094	2636

Note: The variables are defined in the text.

Table 5. Determinants of pyramidal versus direct ownership

	Dependent variable: Pyramids					
	(1)	(2)	(3)	(4)	(5)	(6)
Capital Exp.	0.098*	.085*	.054	.093*	0.094*	0.031
	(1.8)	1.7	1.24	1.7	1.88	0.75
Op. Roa	-0.379***	-.294***	-.281***	-.379***	-0.313***	-0.309***
	(-3.3)	-2.83	-3.21	-3.07	-2.8	-3.6
Firm age	-8.307***	-6.512***	-6.639***	-8.415***	-6.821***	-6.143***
	(-3.82)	-3.53	-4.02	-3.79	-3.71	-3.66
Ln Assets	0.013	-.003	.007	.002	0.003	0.004
	(1.03)	-0.26	0.71	0.16	0.24	0.45
Public	0.011	.224***	-.018	.016	0.231***	-0.045
	(0.17)	4.05	-0.4	0.28	4.48	-1.12
Separation (VR)		.804***			.840***	
		15.76			15.79	
Separation (CC)			2.153***			2.395***
			17.17			16.29
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Group FE	No	No	No	Yes	Yes	Yes
Observations	1773	1773	1773	1773	1773	1773
R-squared	0.18	0.39	0.47	0.29	0.47	0.55

Std. errors clustered at firm level. * signif. at 10%; ** signif. at 5%; *** signif. at 1%

Table 6. Profitability and the other ownership variables

Dependent variable: Operating return on assets

	(1)	(2)	(3)	(4)	(5)	(6)
Firm age	-0.087	-0.123	-0.120	.037	0.016	0.013
	-0.33	-0.46	-0.45	0.13	0.06	0.05
Ln(assets)	0.004	0.005*	0.004	0.005	0.005	0.005
	1.57	1.69	1.6	1.57	1.55	1.55
No employees	0.023**	0.022**	0.022**	0.019*	0.019*	0.019*
	2.27	2.19	2.22	1.83	1.79	1.83
Public	-0.005	-0.009	-0.003	-0.003	-0.006	-0.002
	-0.59	-1.12	-0.43	-0.4	-0.74	-0.25
Leverage	-0.094***	-0.094	-0.094***	-0.092***	-0.092***	-0.092***
	-5.55	-5.46	-5.53	-4.94	-4.89	-4.93
Centrality	-0.079*	-0.087*	-0.076*	-0.112**	-0.115**	-0.112**
	-1.76	-1.95	-1.72	-2.14	-2.19	-2.15
Loop	-0.006	-0.006	-0.007	0.001	0.001	0.001
	-0.97	-1	-1.06	0.11	0.06	0.03
Separation (VR)		-0.020*			-0.014	
		-1.68			-1.1	
Separation (CC)			-0.039			-0.030
			-1.51			-1.01
Group FE	No	No	No	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2611	2611	2611	2611	2611	2611
R-squared	0.15	0.15	0.15	0.24	0.25	0.25

Standard errors clustered at firm level. * significant at 10%; ** significant at 5%; *** significant at 1%

Table 7. Valuation and centrality

Dependent variable: Tobin's Q

	(1)	(2)	(3)	(4)	(5)	(6)
Centrality	-0.536***	-0.552***	-0.508***	-0.385**	-0.377**	-.385**
	-3.63	-3.68	-3.36	-2.33	-2.37	-2.31
Loop	-0.050	-0.050	-0.049	-0.043	-0.042	-.043
	-1.55	-1.55	-1.51	-1.04	-1.01	-1.04
Firm age	-4.240***	-4.280***	-4.287***	-4.421***	-4.380***	-4.420***
	-3.66	-3.63	-3.68	-3.27	-3.16	-3.27
Ln assets	0.088***	0.088***	0.088***	0.088***	0.089***	.0886***
	6.49	6.5	6.49	5.4	5.37	5.36
op roa	0.228	0.227	0.228	0.351	0.349	.351
	1	0.99	1.01	1.5	1.5	1.5
Capex	0.422*	0.419*	0.410*	0.337	0.337	.337
	1.93	1.92	1.88	1.62	1.62	1.62
Leverage	0.081	0.086	0.087	0.028	0.026	.028
	0.62	0.66	0.67	0.22	0.21	0.22
Separation (VR)		-0.057			.028	
		-0.68			0.32	
Separation (CC)			-0.200*			0.003
			-1.79			0.03
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Group FE	No	No	No	Yes	Yes	Yes
Observations	808	808	808	808	808	808
R-squared	0.43	0.43	0.43	0.53	0.53	0.53

Standard errors clustered at firm level. * significant at 10%; ** significant at 5%; *** significant at 1%

Figure 4. Ownership Structure of Hyundai Motor in 2004

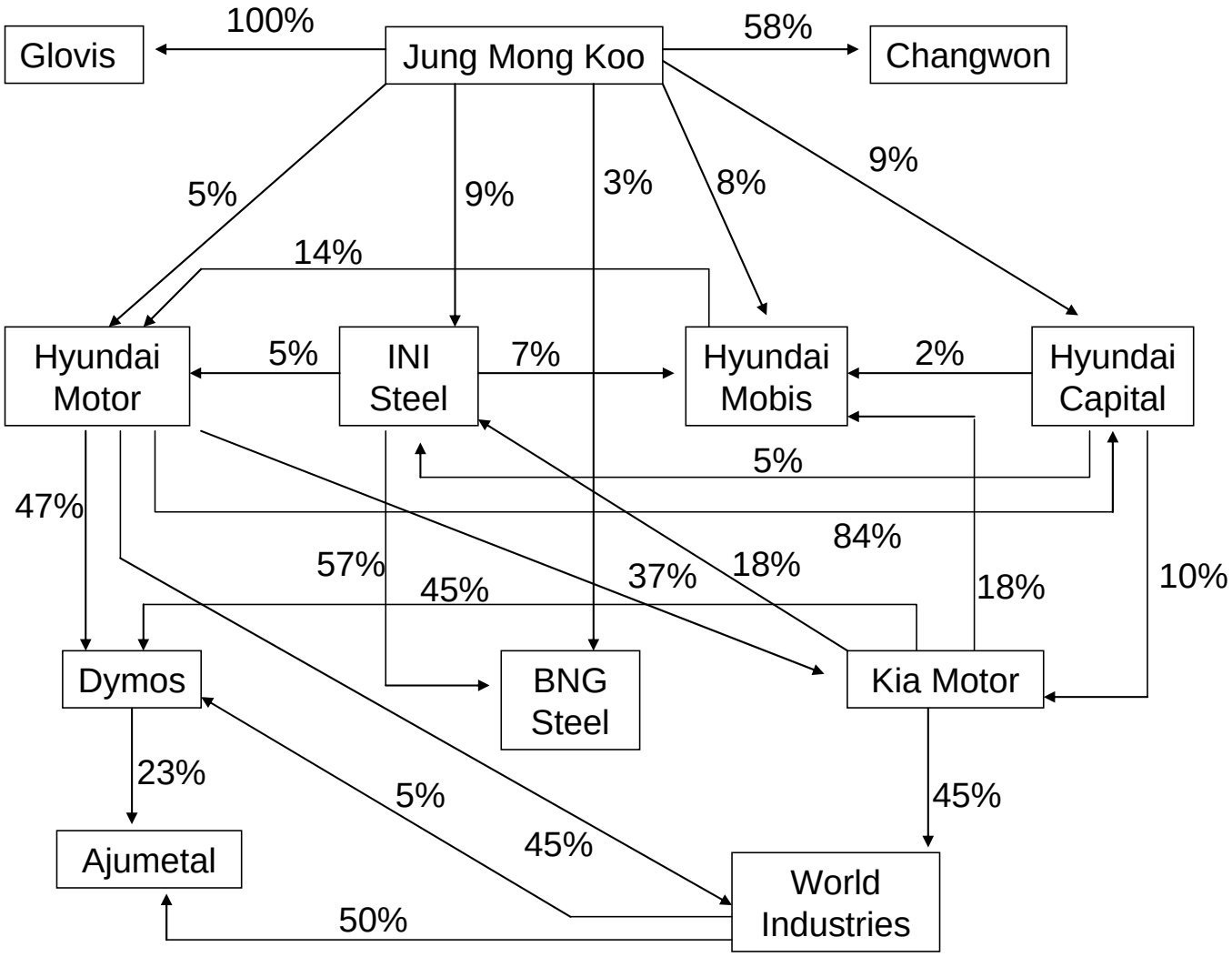
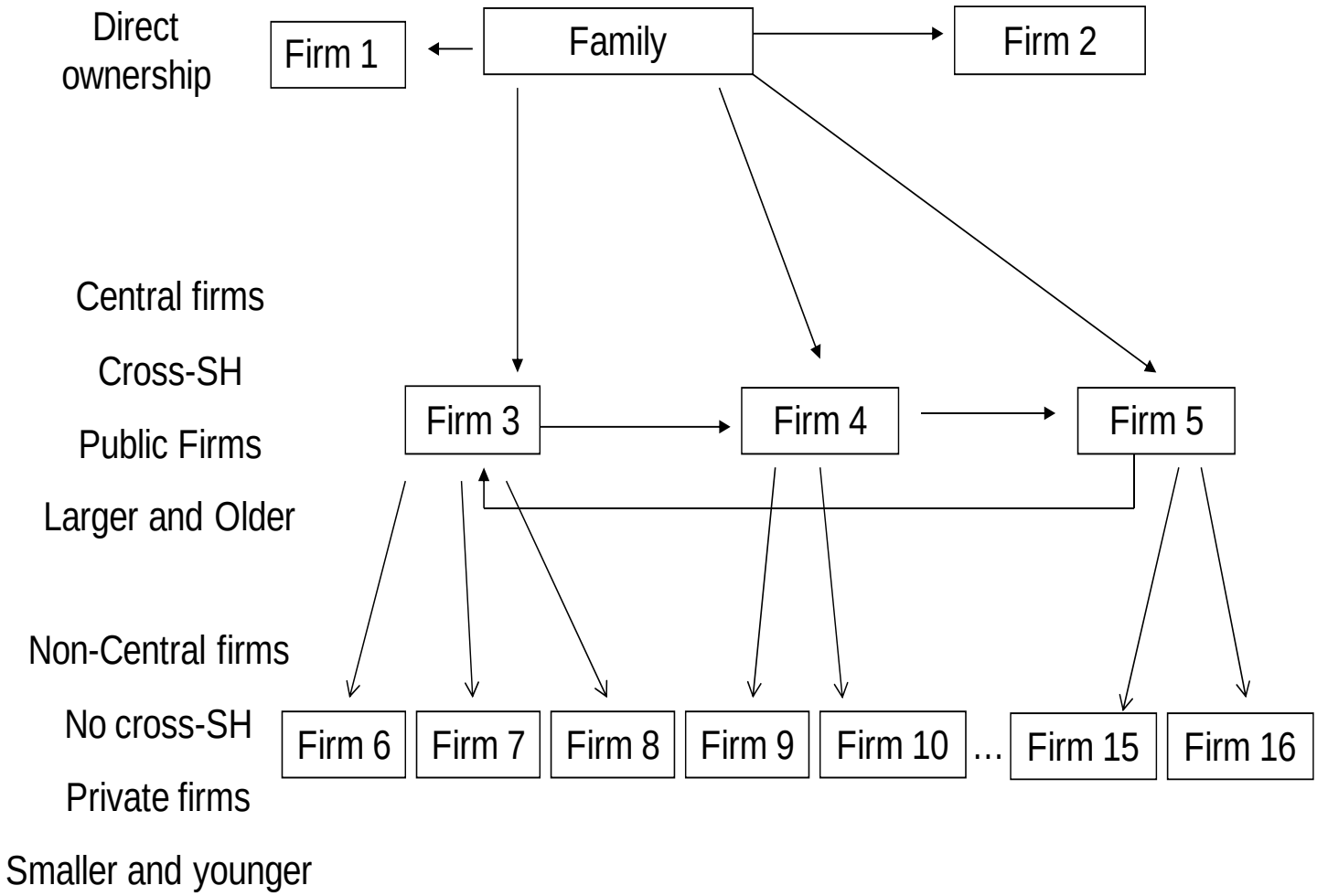


Figure 5. Average Ownership Structure of a Korean Chaebol, 1998-2004



Average group: 16 firms, 3 central firms, 3 firms with direct ownership, 4 public firms, 3 firms in loops