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# Firm diversification and equilibrium risk pooling: The Korean financial crisis as a natural experiment

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ABSTRACT

We use the Korean Financial Crisis as a natural laboratory for examining interactions among firm diversification, equilibrium capital structure and tail probability events. When the crisis hit in 1997, several major firms, including a large number of highly leveraged conglomerates (Chaebols), experienced bankruptcies. We show how diversified Chaebols obtain higher equilibrium leverage than non-Chaebols (a "cosigner effect"). In the event of a low probability macro-economic shock, the model predicts a systematic change in relative bankruptcy risks of Chaebol firms. To examine this implication, we introduce an empirical methodology that decomposes equilibrium debt into demand, supply and Chaebol-specific factors, for use in a bankruptcy prediction model. We find that the primary cause of Chaebol firm bankruptcies was not idiosyncratic leverage, but leverage systematically related to greater equilibrium access to debt during normal times.



## 1. Introduction

> "(A)n unprecedented number of highly leveraged conglomerates (Chaebols) have moved into bankruptcy."
>
> IMF Press Release, December 4, 1997

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When the Korean Financial Crisis hit in late 1997, a number of major firms experienced bankruptcies. At the risk of over-simplification, this wave of corporate bankruptcies can be traced to the peculiarities of corporate financial structures in Korea, namely the dominance of Chaebol member firms in the economy and the high dependence on short-term debt.[1] In this paper, we analyze the equilibrium determination of debt for a sample of Korean manufacturing firms for the years 1991–1994 and the subsequent wave of bankruptcies following the 1997 crisis. Our primary goal is to characterize the role of firm diversification in the determination of capital structure and crisis-period bankruptcy.

An important aspect of the wave of Korean bankruptcies was that Chaebol firms were disproportionately affected. This led to a perception that they were responsible for the severity of the crisis. Chaebols are large, family-controlled business groups that consist of diverse, financially affiliated firms. We present a very simple model based on Lewellen (1971) to show how the crisis-period Chaebol bankruptcies may reflect rational market equilibrium outcomes negotiated in normal times. The basic idea of Lewellen's "coinsurance" hypothesis is that when combining operations with imperfectly correlated cashflows, it is possible to reduce firm risk and increase debt capacity. We extend the Lewellen (1971) intuition to consider the impact of a systemic crisis on relative bankruptcy risks of diversified versus undiversified firms. When a systemic shock (or crisis) raises the bankruptcy probability for every firm in an economy, the risk of diversified firms rises relative to non-diversified firms. The factors which make diversified firms better credit risks in normal times can make them worse credit risks during crises. We are the first (to our knowledge) to document a mechanism through which systemic crises may disproportionately impact diversified firms. In particular, we use the Korean Financial Crisis as a natural experiment for examining the impact of diversification on *ex ante* credit provision and *ex post* bankruptcy outcomes when negative tail probability events occur.

The Korean case provides a particularly useful setting for analyzing the impact of diversification on capital structure for several reasons. First, there are a large number of diversified conglomerates (Chaebols) in the economy. Second, both leverage and bankruptcy events are directly observable at the individual Chaebol member firm level. In fact, full financial and accounting statements are available at this level. This is in contrast to U.S. diversified firms which are not required to report detailed segment information. In the U.S., by the Financial Accounting Standards Board's (FASB) Statements of Financial Accounting Standards (SFAS) 131 and SFAS 14, segment-level reporting consists primarily of sales and profit information, making it extremely difficult to capture divisional capital structure. Finally, the severity of the Korean crisis provides identification of a large, unanticipated negative tail probability event.

We introduce a new bankruptcy prediction methodology and use the Korean financial crisis as a laboratory for empirical testing. Since leverage ratios are important predictors of bankruptcy risk, we begin with a first-stage regression to estimate pre-crisis equilibrium debt ratios. This allows us to identify the debt supply, debt demand and Chaebol-specific factors in equilibrium debt ratio determination. Next, we use the parameter estimates from the first stage regression to decompose pre-crisis debt ratios according to Chaebol and non-Chaebol supply and demand factors. For intuition behind the decomposition, we can think of a Chaebol firm's observed debt ratio as the sum of its predicted debt ratio were it a non-Chaebol firm, plus an incremental debt ratio due to Chaebol affiliation (plus an idiosyncratic residual). We then use the decomposed ratios to estimate the incremental crisis period bankruptcy probability due to each of these components. A novel aspect of our decomposition is that we use common debt ratio units. This makes all estimated coefficients directly comparable and allows for an assessment of relative importance of the sources of the observed debt levels. To the best of our knowledge, this methodology is unique and we believe that it provides important insights which would be difficult to obtain from traditional bankruptcy prediction models.

Our primary findings are two-fold: First, Chaebol firms have greater equilibrium access to debt due to diversification. We interpret Chaebol membership as one important measure of diversification. We also exploit cross-sectional variation in the diversification across groups by including the number of member firms in the debt determination regressions. This measure is also positively and significantly related to debt

[1] Historically, due to government policy and imperfect capital markets, Korean firms depended on short term bank debt from government-controlled banks. Korea liberalized banking in the 1990s and in the mid-1990s liberalized short-term foreign borrowing.

provision. Second, although pre-crisis debt level is the most important determinant of bankruptcy, an important cause is leverage that is *systematically* related to Chaebol firms' greater equilibrium access to debt during normal times.

In addition to implications for firm diversification and capital structure, the findings in this paper also have relevance for post-crisis period regulation. The Korea Fair Trade Commission has amended the Monopoly Regulation and Fair Trade Act to, among other things, eliminate cross-subsidiary loan guarantees on new debt. This policy is consistent with the general view in Johnson et al. (2000, p. 22), in which the authors list "troubled firms in a group propped up using loan guarantees by other listed group members" as an example of "looting" by controlling shareholders during the crises of the 1997–1998. In this paper, loan guarantees and crisis period distress of Chaebol member firms are equilibrium outcomes that can exist even without such "looting." Moreover, during periods in which the probability of systemic crisis is low, an implication of the analysis in this paper is that prohibiting such loan guarantees may be inefficient.

This paper organized as follows. The next section provides a brief overview of related literature and a description of the Korean financial crisis. Section 3 presents a simple theoretical model of equilibrium debt determination and derives an empirical specification. Section 4 describes the sample of Korean manufacturing firms. Results of estimation are presented in Section 5. Section 6 concludes.

## 2. Background

### 2.1. Related literature

This paper adds to the literature in three important ways. First, we study changes in the relative bankruptcy risk of diversified (Chaebol member firms) versus stand-alone (non-Chaebol) firms when negative tail probability events occur. This aspect of the value implications of firm diversification has not been previously addressed in depth. A primary observation motivating our analysis is Chaebol firms' relatively high pre-crisis leverage.[2] We argue that this was attainable due to the protective cosigner effect of affiliated firms, as shown in Lewellen (1971) and, more recently, in Leland (2007).[3] The empirical evidence we present is consistent with that view. In the context of mergers of U.S. firms, there is also some empirical evidence in support of Lewellen's "co-insurance" hypothesis. For example, Kim and McConnell (1977) report that leverage increases following diversifying mergers. However the general empirical question of whether diversified firms borrow more is still somewhat open. Stein (2003) reports that the empirical evidence is weak on whether U.S. diversified firms borrow more than their stand-alone peers (e.g., Berger and Ofek (1995) report that U.S. diversified firms borrow approximately 1% more than focused firms).

The econometric approach that we take in this paper allows us to shed further light on this issue since it provides clearer identification of the portion of the debt that comes from firm diversification. In a closely related paper, Dimitrov and Tice (2006) use the business cycle to test whether differences in credit access cause differences between performance in U.S. diversified versus stand-alone firms. They find that focused firms perform worse (i.e., decreases in sales and inventory growth) than diversified firms during recessions. Their use of fluctuations in the macro-economy is similar to the approach that we take in this paper; however, our use of a large (tail probability) shock improves our understanding of the full economic impact of diversified firms' leverage.

Note that the "co-insurance" effect is one of many potentially value-relevant aspects of firm diversification.[4] The more general literature focuses on the "diversification discount," the observation that the stocks of diversified firms trade at a discount relative to the sum of the imputed values of their

[2] Ferris et al. (2003) report that Chaebols have greater debt capacity (industry-adjusted debt-to-asset ratios are 10% higher for Chaebols).

[3] Leland (2007) shows that financial synergies can actually be negative if risks facing operations are different. This is because credit spreads and interest tax deductions may be higher when financial contracts remain separate. A main implication is that financial synergies should be explicitly considered in merger (and divestiture) analyses. An important assumption underlying both Lewellen (1971) and Leland (2007) is firms' greater debt capacities and leverage due to diversification.

[4] Potential costs of diversification include opportunities for cross-subsidizing unprofitable divisions, opportunities for inefficient investment and difficulties aligning incentives of divisional managers. Benefits include productive synergies, economies of scale, efficient allocation of internal resources, increased debt capacity due to decreased cashflow variability and the associated tax savings associated with debt.

individual segments.[5] For example, Lang and Stulz (1994) document a negative relationship between Tobin's *Q* and diversification. Similarly, Berger and Ofek (1995) report a value loss for U.S. firms related to diversification of 13 to 15% during 1986 to1991. Importantly they also find that diversified firms borrow more than single segment firms, which partially offsets reductions in value, due to the debt tax shield.

The second area of the literature to which we contribute is that on optimal capital structure. In Modigliani and Miller (1958), capital structure is irrelevant; however, in the presence of frictions, debt levels may matter. These frictions include: 1) the balancing of the tax benefit of debt against bankruptcy and other leverage-related costs (e.g., Miller, 1977; 2) mitigating conflicts of interest between inside managers (e.g., Jensen and Meckling, 1976; Jensen, 1986) and stockholders and debt holders (e.g., Stulz, 1990; and 3) conveying inside information to capital markets or reducing adverse selection costs (e.g., Myers and Majluf, 1984).[6] Tax-based trade-off theories of capital structure have the closest relationship with our work; however we account for all three of these in our empirical estimation of equilibrium debt levels. If Chaebol firms have higher debt capacities (i.e. lower bankruptcy probabilities, *ceteris paribus*) due to the protective effects of cosigners they will be offered, and will choose, higher levels of borrowing due to the preferential tax treatment of debt.

Finally, the third contribution is the introduction of a new debt decomposition methodology applicable to bankruptcy prediction models. Beginning with Altman (1968), there has been a large body of empirical research using financial and accounting ratios to predict bankruptcy. By decomposing equilibrium debt ratios, we can estimate bankruptcy probabilities, conditional upon demand and supply factors of Chaebol and non-Chaebol firms (rather than the standard accounting ratios). Our methodology allows for economic insights that would be difficult to obtain from the standard approach.

In the next section, we provide a brief description of the Korean financial crisis and implications for Chaebol firms.

### *2.2. The Korean Financial Crisis*

The Korean financial crisis can be explained largely by the chain of events that preceded it. Korean equity markets were not well-developed until the mid-1980s. Bank loans (mainly short-term) have historically been the primary source of corporate investment financing. In 1996, following significant liberalization of the financial sector (to secure OECD membership), the Korean government took steps to liberalize short-term foreign financial borrowing.[7] The large gap in interest rates (approximately 12% domestically, compared to 6.5% in the foreign market during 1995–96) provided strong market incentives for short-term foreign loans. Merchant banks took advantage of the lower rates available outside of Korea.

The Korean banks' reliance on short term foreign debt, combined with the short term nature of corporate leverage, left the economy vulnerable. When Korea subsequently experienced a severe macro fluctuation, the result was devaluation of the Won and a financial crisis (beginning in late 1997), in which both firms and banks had trouble repaying their loan obligations. With the devaluation of the Won, Korean banks became unable to pay their foreign denominated loans and they called in their short term Won-denominated loans without extending new credit. This left many firms without the liquidity necessary to operate at full capacity, even if they were otherwise solvent.

The large number of bankruptcies of Chaebol firms led to a perception that Chaebols were a major part of the “problem” in the Korean crisis. This paper examines this contention and shows how the Chaebol bankruptcies might occur in an equilibrium framework. To understand the arguments, it is useful to discuss what Chaebol firms are. A Chaebol is a group of financially affiliated firms, typically operating in different

[5] The existence of the “discount” in U.S. diversified firms has been the subject of significant recent debate. Mansi and Reeb (2002) find that the observed “discount” reflects a shift in value from equity holders to bondholders, due to decreased cashflow variability. They hold that prior observations of the discount are a result of prior researchers' use of book, rather than market value of debt. Chevalier (2004) and Whited (2001) argue that measurement error explains some of the “discount”. Villalonga (2004) reports evidence of a diversification “premium”. Campa and Kedia (2002) account for possible endogeneity in the relationship between diversification and value.

[6] For a comprehensive survey of the theoretical capital structure literature, see Harris and Raviv (1991). Note that because many new share issues in Korea are rights offerings (i.e., offerings of additional shares to existing shareholders), the pecking order hypothesis of Myers and Majluf (1984) might be expected to be less applicable.

[7] Long-term foreign loans remained restricted.

lines of business. Family control is common, as is a "group headquarters" where certain investment decisions are made. For example, consider Samsung which, prior to the crisis, had more than forty separate firms bearing its name and financial backing. One might own stock in Samsung Electronics (e.g., TVs and computers) and not own stock in the entirely separate Samsung firm, SDI, which manufactures picture tubes and monitors (and mostly sells them to non-Samsung firms). In normal times, if one of Samsung's forty firms were to experience financial difficulty, the remaining firms would act as cosigners on the loans of the division in financial trouble. The "cosigner effect" makes a Chaebol firm less risky, *ceteris paribus* (see Section 3). Hence, in financial equilibrium, the leverage supplied to a Chaebol firm should be greater than its non-Chaebol equivalent.[8] Following a low probability economy-wide shock, cosigners would also have short term loans being called and may have insufficient funds to pay the loans of the insolvent sub-parts of a Chaebol.[9] In this case, the leverage from normal times becomes a liability in crises.

## 3. Equilibrium debt determination

Our main objectives are to identify the factors that determine equilibrium debt ratios (*ex ante*), and then to model the relationship between these factors and the realization of bankruptcy. We focus on the question of whether there was a systematic change in relative bankruptcy risks of conglomerates following the Korean Financial Crisis of late 1997. We start with a heuristic model of a competitive credit market equilibrium during a non-crisis period and use the intuition in Lewellen (1971) to illustrate how diversification can increase debt capacity. We then show how this higher equilibrium access to debt during normal periods can increase the relative bankruptcy risks of diverse firms when negative tail probability events (i.e., crises) occur. This framework guides the decomposition methodology introduced for the empirical implementation.

### *3.1. Hypothesis development and empirical methodology*

#### *3.1.1. Heuristic model of debt determination*

Assume a single bank loan to an individual firm in an amount equal to $L$. Let the probability of bankruptcy equal $\beta$, an increasing function of debt ratio ($D$).[10] The payoff to lenders in the event of bankruptcy is equal to $\alpha L$ where $\alpha < 1$. If a firm does not go bankrupt, lenders receive $(1+\rho)L$, where $\rho$ is the loan contract's equilibrium interest rate spread, an increasing function of debt ratio ($D$) and bankruptcy probability ($\beta(D)$).[11] The expected profit of a lender is:

$$E[\pi] = \beta\alpha L + (1-\beta)[(1+\rho)L] - L. \tag{1}$$

Assuming a competitive equilibrium, the zero (expected) profit condition is:

$$\beta\alpha + (1-\beta)(1+\rho) = 1. \tag{2}$$

Solving for $\rho$ and writing $\rho$ and $\beta$ as functions of the debt to asset ratio ($D$), the model implies a positive interest rate spread:

$$\rho(D) = \frac{1-\beta(D)\alpha}{1-\beta(D)} - 1 > 0. \tag{3}$$

[8] This adds value due to the debt tax shield.

[9] We are not the first to use the Asian financial crisis to examine the role of debt in *ex post* outcomes. While much different in focus from our study, Allayannis et al. (2003) examine crisis-period changes in market values as a function of foreign versus local currency debt. Baek et al. (2004) examine the impact of foreign ownership on crisis-period value changes. They find that firms with more foreign investors had lower decreases in share value while Chaebols experienced larger value decreases.

[10] $L$ denotes total debt amount; $D$ denotes total debt relative to total assets of the firm.

[11] Each individual loan has its own supply and demand, so the endogenously determined $\rho_i$ paid by firm I will generally not equal $\rho_i$ paid by firm $j$.

**Table 1**
Model and methodology: notation

| Parameter/function | Definition |
|---|---|
| $L$ | Loan amount to an individual firm |
| $\beta$ | Probability of bankruptcy |
| $\alpha$ | Fraction of loan recovered in bankruptcy |
| $\rho$ | Loan contract's equilibrium interest rate |
| $D$ | Debt ratio |
| $\Pi$ | Lender's profit |
| $Z$ | Parameters affecting the supply of debt |
| $X$ | Parameters affecting the demand of debt |

An upward sloping supply curve (assumed) implies[12]:

$$\rho'(D) = \frac{\beta'(D)(1-\alpha)}{(1-\beta(D))^2} > 0. \tag{4}$$

Differentiate the equilibrium $\rho$ in Eq. (3) with respect to $\beta$ to describe the relationship between the probability of bankruptcy and the interest rate spread:

$$\frac{\partial\rho}{\partial\beta} = \frac{(1-\alpha)}{(1-\beta)^2} > 0. \tag{5}$$

As one would expect, Eq. (5) implies that lenders charge a higher interest rate as the probability of bankruptcy increases (along with the higher debt ratio). If we consider a zero profit condition and impose highly stylized conditions in which $\alpha$=0 and $\rho$ is very small, then $\beta$ is approximately equal to $\rho$. This implies that a higher exogenous probability of bankruptcy translates into a higher interest rate spread.

Define the supply and demand for debt as:

$$\rho^{s} = s(Z, D) \quad \text{and} \quad \rho^{d} = d(X, D). \tag{6}$$

(where $D$ is debt ratio and $Z$ and $X$ are parameters affecting the supply and demand for debt, respectively). The model's notation is summarized in Table 1. This basic framework allows us to introduce a new debt decomposition methodology, as well as intuition regarding the impact of an unanticipated shock on the bankruptcy probabilities of diversified firms.

*3.1.2. Empirical implementation (debt decomposition methodology)*

Our objective is to establish the predictions of this model and to derive a testable empirical specification. Assume that for the $i$th elements of $Z$ and $X$, represented at by $z_i$ and $x_i$, respectively, $\partial\rho_s/\partial z_i<0$ and $\partial\rho_d/\partial x_i>0$. The first inequality implies that greater $z_i$ shifts the supply curve to the right, indicating lower $\rho$ (lower risk of bankruptcy) and a greater debt ratio for any given demand curve, while the second inequality implies that greater $x_i$ shifts demand to the right, leading to higher $\rho$ (higher risk of bankruptcy) and a greater debt ratio, $D$, for any given supply curve.

For a tractable functional form, let:

$$\rho^{s} = a_0 + a_1 Z + a_2 D \quad \text{and} \quad \rho^{d} = b_0 + b_1 X + b_2 D. \tag{7}$$

Based on our assumptions on supply and demand: $a_1<0$; $a_2>0$: $b_1>0$; $b_2<0$. Equating $\rho_s$ with $\rho_d$, we can write the equilibrium debt ratio and interest rate spread as:

$$D^{*} = \gamma_0 + \gamma_1 X + \gamma_2 Z, \quad \text{where} \quad \gamma_1 = \frac{b_1}{a_2 - b_2} > 0 \quad \text{and} \quad \gamma_2 = -\frac{a_1}{a_2 - b_2} < 0. \tag{8}$$

[12] Also, as $D$ increases, loans become riskier on the margin. Contracting frictions (e.g., information problems) can generate upward sloping supply.

$$\rho^* = \eta_0 + \eta_1 X + \eta_2 Z, \quad \text{where} \quad \eta_1 = \frac{b_1 a_2}{a_2 - b_2} > 0 \quad \text{and} \quad \eta_2 = -\frac{b_2 a_1}{a_2 - b_2} < 0. \tag{9}$$

To implement this in a regression format, suppose there is data on $D$ for each firm $i$ and we consider the regression:

$$D_i = \gamma_0 + \gamma_1 X_i + \gamma_2 Z_i + e_i. \tag{10}$$

To introduce our debt decomposition methodology, we partition the observed $D$ to examine the separate effects of demand and supply factors on the probability of bankruptcy. Let:

$$D_i = \hat{D}\left(\bar{X}, \bar{Z}\right) + \left[\hat{D}\left(X_i, \bar{Z}\right) - \hat{D}\left(\bar{X}, \bar{Z}\right)\right] + \left[\hat{D}(X_i, Z_i) - \hat{D}\left(X_i, \bar{Z}\right)\right] + \varepsilon_i. \tag{11}$$

$D_i$ is the firm's observed debt ratio which is equal to the partitioned predicted debt ratios plus the residual; $X$ is a vector of demand factors and $Z$ is a vector of supply factors; $\bar{X}$ and $\bar{Z}$ are mean levels of demand and supply factors, respectively. The first term in Eq. (11) is the equilibrium debt ratio implied for a firm with mean values for $X$ and $Z$. The second term reflects the equilibrium deviation in the debt ratio of firm $i$ that is due its idiosyncratic demand factors not equaling sample mean demand factors, $\bar{X}$. Note that this term still assumes sample mean supply factors, $\bar{Z}$. The third term then adds the change in equilibrium debt ratio due to Firm $i$'s idiosyncratic supply factors. Finally there is an error term, which reflects Firm $i$'s idiosyncratic deviations from the predicted equilibrium debt ratio for the firm (i.e., the idiosyncratic deviation from Firm $i$'s equilibrium debt-to-asset ratio given the observed demand and supply factors, $X_i$ and $Z_i$).

If we knew the true probability of bankruptcy, $\beta$, we could regress this on the elements of $D$ (predicted and residual values of the debt ratio) from the debt ratio regression (Eq. (11)):

$$\beta = \Gamma_0 \hat{D}\left(\bar{X}, \bar{Z}\right) + \Gamma_1 \left[\hat{D}\left(X, \bar{Z}\right) - \hat{D}\left(\bar{X}, \bar{Z}\right)\right] + \Gamma_2 \left[\hat{D}(X, Z) - \hat{D}\left(X_i, \bar{Z}\right)\right] + \Gamma_3 \varepsilon. \tag{12}$$

Importantly, the constant is scaled to $D(X, Z)$ to facilitate interpretation in common debt ratio units. Eq. (12) is novel (to our knowledge) and is the basis of our empirical model, although the partition is more complex in our actual implementation. As one might expect, Eqs. (7)–(9) imply a positive relationship between $X$ (loan demand) and observed $D$ and a positive relationship between $Z$ and both $\rho$ and $\beta$ (approximately equal under our assumptions), at least during normal times. The model also implies a positive relationship between $Z$ (loan supply) and observed $D$ and a negative relationship between $Z$ and both $\rho$ and $\beta$, during normal times.

### *3.1.3. Application to the Korean Financial Crisis [Lewellen (1971) intuition]*

Given the basic equilibrium models presented above, how might we extend the analysis to provide a better representation of the Korean case? More specifically, how can this framework explain the high levels of debt of Chaebol firms as well as the incidence of post-crisis bankruptcy for Chaebols?

Consider the following simple example of Chaebol bankruptcy: Suppose that the world is composed of many firms that are identical in all respects other than Chaebol affiliation. Assume that all firms carry identical debt levels and that the probability of illiquidity for each firm is drawn from an i.i.d. process and is denoted $\varphi$. All firms are either Chaebol members or independent firms. We define a Chaebol to be simply a loan cosigning agreement.[13] For simplicity, we consider a Chaebol consisting of two member firms. In the original model, the risk that a firm became illiquid at a given level of debt was identical to the bankruptcy probability $\beta(D)$. Clearly, the bankruptcy probability of a Chaebol firm is no longer equal to the probability of individual firm illiquidity since there are some states of the world in which the full loan and interest are repaid, even though the individual borrower is illiquid.

From the perspective of a lender, the probability of illiquidity for each individual firm is $\varphi$. However, a Chaebol firm secures financing based on the fact that it has an affiliated firm which also has a probability of failure equal to $\varphi$ and that these failure probabilities are independent.[14] Suppose $\varphi = 0.01$. Then the relative bankruptcy risk of a non-Chaebol to a Chaebol firm is $\varphi/\varphi^2 = 100$. Now suppose that there is an economy-

[13] In principle, non-Chaebol firms could also enter into cosigning arrangements; however, it is likely that the ties between Chaebol member firms are stronger than they are between unaffiliated firms, making contracting easier for Chaebol members.

[14] We assume independence for purposes of illustration. The intuition holds as long the repayment abilities (i.e., cashflows) of the borrower and the cosigner are not perfectly correlated. Note also that Chaebols are typically groups of unrelated businesses.

wide shock that shifts the probability of bankruptcy by .09 for all firms (note the crisis bankruptcy risk in our sample is more than 15%).[15] Now $\varphi = 0.10$ and the relative bankruptcy risk of the non-Chaebol to Chaebol firm is $\varphi/\varphi^2 = 10$. Thus, not only have bankruptcy risks for individual firms increased, but also the relative risk for the Chaebols relative to the non-Chaebol has increased ten-fold. The "protective effect" of Chaebol membership, which would have been a consideration in the determination of pre-Crisis debt levels, may become a liability when there is a low probability financial crisis.[16]

In this example, we have assumed identical debt levels for Chaebol and non-Chaebol firms in order to illustrate the effect of Chaebol membership on bankruptcy risk. In equilibrium (all else equal), the reduction of bankruptcy risk due to Chaebol membership will allow Chaebol firms to secure higher amounts of debt. With $\beta$ close to $\rho$, banks would be willing to lend larger amounts to Chaebol firms. If they loaned funds to Chaebol firms until the bankruptcy risks, $\beta$, were similar to those for non-Chaebol firms, the relative pre-crisis risk at $\varphi = 0.01$ (probability of individual firm non-Chaebol illiquidity when debt levels were fixed at a constant $D$) will rise. If debt increases value (i.e., via a debt tax shield) then, in equilibrium, Chaebol firms would amass greater debt due to this increased supply.[17] As the Chaebol firm's risk approaches that of an independent firm, its risk in crisis times climbs. One should then expect to see far more Chaebol failures in the event of a crisis when the capital markets are competitive, efficient and have rational expectations (assuming that the perceived probability of a crisis is low).

This simple model and discussion suggest that a lower exogenous risk of Chaebol firms ($\varphi^2$ versus $\varphi$ in the example above) shifts the loan supply curve to the right, so that their interest rates are lower and equilibrium debt ratios are higher. This simple model therefore predicts a negative relationship between extra debt due to Chaebol membership and the probability of bankruptcy. However, in the event of an unlikely economy-wide shock in which $\beta$ increases for all firms, the risk pooling mechanism that leads to a lower bankruptcy probability and greater leverage of Chaebol firms in normal times is precisely what causes them to be riskier in crises.[18]

## 4. Data

Our analysis is based on data from a sample of 385 Korean manufacturing firms listed on the Korea Stock Exchange (KSE) in 1991–1994 and 1997. Accounting data are from the Korea Investment Service and Chaebol membership data are from the Korea Fair Trade Commission. The Korea Investment Service data includes both the financial statements and the income statements of 625 manufacturing firms listed on the KSE in 1994. We require a complete record of the variables for each year included in our analysis, leading to a balanced panel of 385 firms (82 Chaebols and 303 non-Chaebols).

Bankruptcy data for listed manufacturing firms are from the stock price section in the Dong-A Ilbo.[19] The "bankruptcies," influenced by the Korean financial crisis, began to occur in late 1997. For our definition of a bankruptcy, we are interested in identifying a fairly broad measure of a firm's financial failure (e.g., firms that are technically insolvent as well as those that are forced to liquidate). We therefore classify as "bankrupt," all firms on the Korea Stock Exchange that fell into technical insolvency and were downgraded to "firm under price surveillance" by the KSE during the period October 1, 1997 through July 31, 1998.[20]

Table 2 provides summary statistics of our sample of Korean manufacturing firms. The most pronounced characteristic of capital structure of Korean manufacturing firms lies in the high level of corporate borrowing (captured by the debt to total assets variable, DASSET). The sample mean DASSET is 65.9%, of

[15] From the discussion of Table 2 below, 17.4% of firms in the sample are classified as "bankrupt" during the crisis period.

[16] With more firms in a Chaebol, this effect becomes even stronger.

[17] If banks recognize the remote possibility of crisis then the full risk for a Chaebol firm, including the crisis possibilities, will be somewhat higher than its "normal times" risk, which in turn should be lower than that for a non Chaebol.

[18] An alternative involves credit-rationing with a usury constraint. In practice, Korean firms often accessed the curb market. Given this fact and given that the demand and supply factors behave as we suggest in our heuristic theory, we stay with this model.

[19] One of the largest daily national newspapers. Published in Seoul, South Korea.

[20] Insolvent firms fall into the category "firm under price surveillance" under KSE regulations. Firms in this category are permitted to remain listed on the KSE for a limited time period. This bankruptcy definition would include firms that are under price surveillance and then eventually delisted. It would not include firms in some financial distress but still able to meet its debt obligations. Presumably, in ex ante debt provision, creditors care most about whether their claims will be impaired (i.e., technical insolvency), and less about the finances of the firm after obligations are met.

**Table 2**
Descriptive statistics

| | All firms | | Chaebol firms | | Non-Chaebol firms | |
|---|---|---|---|---|---|---|
| | Mean | Std. Dev. | Mean | Std. Dev. | Mean | Std. Dev. |
| DASSET | 65.91 | 16.09 | 74.25 | 10.83 | 63.65 | 16.55 |
| LDASSET | 25.74 | 10.40 | 29.88 | 9.79 | 24.62 | 10.29 |
| ROA | 6.86 | 2.82 | 6.33 | 2.03 | 7.01 | 2.99 |
| TANSET | 35.63 | 13.32 | 41.16 | 12.75 | 34.13 | 13.10 |
| DEPSET | 3.85 | 2.16 | 4.19 | 2.02 | 3.75 | 2.19 |
| LGSALE | 18.41 | 1.25 | 19.75 | 1.23 | 18.04 | 0.98 |
| WC | 9.39 | 16.95 | −2.17 | 12.73 | 12.52 | 16.60 |
| CFDEBT | 8.98 | 10.66 | 6.61 | 4.71 | 9.62 | 11.69 |
| ADSALE | 1.67 | 3.07 | 1.09 | 1.47 | 1.83 | 3.36 |
| GROWTH | 15.87 | 10.81 | 18.85 | 10.70 | 15.07 | 10.72 |
| EXPORT | 27.36 | 27.85 | 26.49 | 24.98 | 27.59 | 28.61 |
| BUSRISK | −1.02 | 0.92 | −0.79 | 0.73 | −1.08 | 0.95 |
| CFIRMS | | | 2.75 | 0.58 | | |
| CSALES | | | 22.13 | 1.39 | | |
| CPROFIT | | | 0.54 | 1.55 | | |
| *N* | 385 | | 82 | | 303 | |

This table presents summary statistics for the sample of 385 Korean Manufacturing Firms, 1991–1994. Variables are defined as follows:
DASSET is the ratio of total debt to total book value of assets (multiplied by 100).
LDASSET is the ratio of long term debt (maturing in more than 1 year) to assets (×100).
ROA is return on assets. Ratio of earnings before interest less tax to total assets (×100).
TANSET is the ratio of tangible assets to total assets (×100).
DEPSET is the ratio of depreciation to total assets (×100).
LGSALE is log of sales.
WC the ratio of working capital (current assets minus current debt) to total assets. CFDEBT is the ratio of cashflow to total debt (×100).
ADSALE is the ratio of advertising expenditure to total sales (×100).
GROWTH is annual growth rate of total assets (×100).
EXPORT is the ratio of exports to sales (×100).
CFIRMS The number of member firms in the Chaebol group (natural log).
CSALES Log of Chaebol group sales, excluding member firm sales.
BUSRISK is time trend controlled business risk (high BUSRISK means low business risk).
CPROFIT Chaebol group profit, defined as total Chaebol profit divided by Chaebol group total.

which most is short term debt. The mean long term debt to asset ratio is 25.7%. Also important is the fact that the firms were highly dependent upon foreign debt (both directly and indirectly though national banks' debt positions). Total foreign debt in Korea amounted to 109.8 billion U.S. dollars in 1996, accounting for 22.6% of gross national product, and short-term foreign debt maturing within 1 year made up 58.8% of total foreign debt as of November 1997, when the Korean government officially requested rescue loans from the IMF. We investigate the question of whether the Korean financial crisis of late 1997 can be attributed to this high dependence on debt and whether any further insight can be gained by a systematic decomposition of debt.

From Table 2, the data also suggest that Chaebol firms had higher levels of borrowing than non-Chaebol firms. The average debt-to-total assets ratios of .74 and .64, respectively are consistent with the observation in Ferris et al. (2003) that Chaebol firms pay less in taxes than non-Chaebol firms due to the tax advantage of leverage. This difference would be expected, given the discussion presented in Section 3. We also note that Chaebol firms have a higher mean value of "collateral value of assets" (TANSET) but a lower mean value for the advertising propensity (ADSALE) compared to non-Chaebol firms. The apparently large difference between Chaebol and non-Chaebol firms in TANSET and ADSALE might be an industry effect since Chaebol firms are more likely to be in the heavy industries and chemicals, which have higher tangible assets and less differentiated products. We use industry fixed effects in our empirical analysis in order to control for this type of variation. Finally, note that we observe lower business risks (i.e., BUSRISK) in Chaebol member firms.[21]

[21] The BUSRISK variable is constructed from OLS regression: $ROA_T = aT + e_T$. ROA is Return on Assets. BUSRISK is the coefficient on independent variable T (time) minus standard error. A Higher value of the BUSRISK variable means lower business risk.

**Table 3**
Bankruptcies

| | Bankrupt firms | Non-bankrupt firms |
|---|---|---|
| Chaebol firms | 16 (19.5%) | 66 (80.5%) |
| Non-Chaebol firms | 51 (16.8%) | 303 (83.2%) |
| All firms | 82 (17.4%) | 303 (82.6%) |

This table reports crisis period (October 1, 1997 to July 31, 1998) bankruptcy events for the sample of 385 Korean manufacturing firms listed on the Korean Stock Exchange.

Table 3 divides our sample of 385 Korean manufacturing firms according to financial failure and Chaebol membership.[22] The table shows that 17.4% of the firms in our sample failed during the sample period. The rate of failure for Chaebol firms is 19.5%, not statistically different from the 16.8% rate for non-Chaebol firms. However, Chaebol and non-Chaebol firms differed substantially in their economic significance. The average size of non-Chaebol firms in our sample is U.S. $91 million in annual sales. Chaebol firms are 5 times larger, with average annual sales at U.S. $451 million.[23]

## 5. Empirical specification and results of estimation

### *5.1. Preliminary model/estimation*

Our main goal is to analyze the relationship between bankruptcy and the contributions of demand, supply and Chaebol related factors to equilibrium debt ratios. As a preliminary step, we examine whether debt levels during the 1991 to 1994 pre-crisis period are, in fact, good predictors of bankruptcy. In order to ensure that *ex ante* levels of debt were obtained during a time in which crisis probability was low (i.e., the crisis was not yet anticipated, consistent with the framework presented in Section 1), we end the analysis of pre-crisis equilibrium debt determination in 1994, 3 years prior to the crisis. For our sample of firms, average pre-crisis debt ratio (debt/book-value-of-assets) was 82.1% for Chaebol firms that went bankrupt, compared to 72.7% for Chaebols that did not. Similarly, for non-Chaebol firms, the debt ratios were 76.9% for firms which became bankrupt and 61.5% for those which did not.

Our model will depend entirely on debt ratios, the factors which lead to them and their influence on bankruptcy. The justification for focusing on the debt to asset ratio can be seen in Table 4a, in which we use a preliminary logit model to evaluate the importance of a set of explanatory variables in the determination of bankruptcy. The response variable in our model equals 1 if a firm became illiquid or bankrupt between October 1, 1997 and July 31, 1998 and zero if it did not. This model employs four independent variables, chosen based on prior bankruptcy studies.[24] The explanatory variables are: size of firm (log of sales, LGSALE); debt to total assets ratio (DASSET); liquid assets (the ratio of working capital to total assets WC); and debt coverage (the ratio of cashflow to total debt CFDEBT). These variables capture the importance of the firm in the economy, long-term solvency, short-term ability to pay down debt, and the financial performance of the firm relative to its debt level, respectively. We estimate the model separately for each year, 1991–1994 (3 to 6 years prior to bankruptcy). The results of estimation are presented in Table 4a. The debt ratio (DASSET) is the only significant predictor of bankruptcy for all of the years of estimation (the estimated coefficient is positive, as one would expect).

Given the heavy reliance on short term debt prior to the crisis, debt maturity might play a role in bankruptcy outcomes. To examine this possibility, we rerun the model presented in Table 4a, but decompose debt ratios into short- and long-term components. The results are presented in Table 4b. As

[22] The Korean Fair Trade Commission lists the 30 largest "groups" of two or more firms in total assets for each year, which we use to define firms as "Chaebols." There is little turnover in these top 30, but we include any firm which made the top 30 list.

[23] Chaebols are defined by sales of two or more affiliated firms. In principle, a large Chaebol could be made up of several very small firms, but on average the Chaebol firms in our sample are large. There is a substantial sample overlap between the firm sizes, 10.7% of our Chaebol firm annual sales observations are smaller than the mean for the non-Chaebols.

[24] We also replicated the basic logit using the variables in Altman (1968). Altman's five variables are ratios: working capital to total assets; retained earnings to total assets; earnings before interest and taxes to total assets; sales to total assets; market value of equity to book value of debt. We found that only the retained earnings to total assets ratio was protective against bankruptcy.

**Table 4a**
Logit regression results: crisis period bankruptcies

| Years prior to crisis | Variable name | Intercept | LGSALE | DASSET | WC | CFDEBT |
|---|---|---|---|---|---|---|
| *Dependent variable: bankrupt=(0,1)* | | | | | | |
| 6 (1991) | Coefficient | 1.35 | 0.359[a] | 0.056[a] | 0.01 | −0.04 |
| | Std. Error | 2.50 | 0.14 | 0.02 | 0.02 | 0.01 |
| | Chi-square | 0.29 | 6.69 | 10.87 | 0.64 | 2.23 |
| 5 (1992) | Coefficient | −0.03 | 0.317[b] | 0.062[a] | 0.01 | −0.03 |
| | Std. Error | 2.60 | 0.14 | 0.02 | 0.02 | 0.01 |
| | Chi-square | 0.00 | 5.46 | 15.75 | 0.38 | 1.46 |
| 4 (1993) | Coefficient | −1.73 | −0.21 | 0.058[a] | 0.01 | −0.04 |
| | Std. Error | 2.53 | 0.13 | 0.02 | 0.03 | 0.01 |
| | Chi-square | 0.47 | 2.48 | 13.39 | 1.28 | 1.90 |
| 3 (1994) | Coefficient | −2.58 | −0.13 | 0.050[a] | 0.019[b] | −0.062[b] |
| | Std. Error | 2.51 | 0.13 | 0.01 | 0.03 | 0.01 |
| | Chi-square | 1.06 | 0.96 | 11.86 | 4.09 | 4.86 |

This table presents results of a logit model where the dependent variable is an indicator equal to 1 if the firm experiences a bankruptcy event during the period October 1, 1997 to July 31, 1998. The sample consists of 385 Korean manufacturing firms. The explanatory variables are defined as follows:
LGSALE: the log of sales.
DASSET: ratio of total debt to total book value of assets.
WC: ratio of working capital (current assets-current debt) to total assets.
CFDEBT: total debt coverage, defined as the ratio of cashflow to total debt.
[a]Significant at the 1% level; [b]significant at the 5% level.

shown in the table, both components have similar impacts on *ex post* bankruptcy. In fact, long and short term debt are substitutes (they are negatively and significantly correlated, with a correlation coefficient of −.17). The data suggest that it is total debt, regardless of type, that matters. This would be expected if, for example, firms were refinancing some of their long term debt with new short term debt. Given the results in Tables 4a and 4b, we focus on total debt ratios in all subsequent analysis.

Having established that pre-crisis debt levels are an important indicator of bankruptcy, we proceed to the main focus our analysis, in which we generate estimates of predicted debt and then decompose these

**Table 4b**
Logit regression results: crisis period bankruptcies with long/short debt decomposition

| Years prior to crisis | Variable name | Intercept | LGSALE | LDASSET | SDASSET | WC | CFDEBT |
|---|---|---|---|---|---|---|---|
| *Dependent variable: bankrupt=(0,1)* | | | | | | | |
| 6 (1991) | Coefficient | 1.545 | −0.367[a] | 0.060[a] | 0.053[a] | 0.008 | −0.0372 |
| | Std. Error | 2.548 | 0.140 | 0.019 | 0.019 | 0.012 | 0.025 |
| | Chi-square | 0.544 | 0.009 | 0.001 | 0.005 | 0.527 | 0.134 |
| 5 (1992) | Coefficient | −0.193 | −0.313b | 0.060[a] | 0.067[a] | 0.009 | −0.0258 |
| | Std. Error | 2.626 | 0.136 | 0.018 | 0.018 | 0.012 | 0.022 |
| | Chi-square | 0.941 | 0.022 | 0.001 | 0.000 | 0.461 | 0.231 |
| 4 (1993) | Coefficient | −2.342 | −0.185 | 0.052[a] | 0.067[a] | 0.016 | −0.0388 |
| | Std. Error | 2.623 | 0.132 | 0.017 | 0.018 | 0.011 | 0.028 |
| | Chi-square | 0.372 | 0.161 | 0.002 | 0.000 | 0.154 | 0.163 |
| 3 (1994) | Coefficient | −1.849 | −0.152 | 0.056[a] | 0.041[b] | 0.014 | −0.063[b] |
| | Std. Error | 2.638 | 0.133 | 0.017 | 0.018 | 0.011 | 0.028 |
| | Chi-square | 0.484 | 0.253 | 0.001 | 0.021 | 0.186 | 0.027 |

This table presents results of a logit model where the dependent variable is an indicator equal to 1 if the firm experiences a bankruptcy event during the period October 1, 1997 to July 31, 1998. The sample consists of 385 Korean manufacturing firms. The explanatory variables are defined as follows:
LGSALE: the log of sales.
LDASSET: ratio of long term debt to total book value of assets.
SDASSET: ratio of short-term debt to total book value of assets.
WC: ratio of working capital (current assets-current debt) to total assets.
CFDEBT: total debt coverage, defined as the ratio of cashflow to total debt.
[a]Significant at the 1% level; [b]significant at the 5% level.

debt ratios based on Chaebol and non-Chaebol demand and supply factors. We then estimate a logit model of bankruptcy using the predicted/residual value approach described in Section 3. This enables identification of any systematic effects of Chaebol membership, debt demand and supply on the probability of bankruptcy.

### 5.2. Equilibrium debt ratios

In this step, we generate predicted values for pre-crisis equilibrium debt levels using two-stage least squares. The dependent variable in our model is pre-crisis debt-to-assets and the independent variables are the supply and demand variables for the years 1991 to 1994, defined in Table 5 and discussed in more detail below.

Variables in Table 5 that affect the demand side of the debt ratio are profitability (ROA), growth rate of assets (GROWTH), depreciation (DEPSET), and the collateral value of assets (TANSET). ROA is a potentially important demand variable; however the predicted sign is ambiguous according to agency explanations for capital structure and the "pecking order" hypothesis. Jensen (1986) presents the free cashflow hypothesis that debt can mitigate the ability for managers to consume perquisites when cashflows are high. Under this theory, we expect a positive relationship between ROA and debt demanded. If, on the other hand, internal funds are cheaper than external funds (i.e., the pecking order hypothesis in Myers and Majluf (1984)) this would imply a negative relationship between ROA and debt demanded. We use DEPSET (depreciation/total assets) to examine the tax tradeoff theory. To the extent that alternative tax shields exist (i.e., depreciation), we expect to observe less debt demanded when depreciation is greater. The GROWTH variable allows us to estimate the role of under-investment ("debt overhang") problems. Firms with high growth opportunities will demand less debt in order to avoid value loss due to under-investment when debt levels are too high (i.e., when positive net present value projects from the perspective of the firm are unattractive to equity holders because the benefits of these projects are enjoyed by debtholders). Because the measured growth rate of total assets might be correlated with the residual in the debt determination equation, we use an instrument to measure growth. Finally, TANSET (tangible assets/total assets) allows us to examine the role of risk-shifting. When firms have higher tangible assets, costs due to potential risk-shifting when firms are near distress are reduced. Therefore these firms will, all else equal, demand higher levels of debt (see e.g., Rajan and Zingales (1995) for international evidence of the positive relationship between tangible assets and debt levels).

**Table 5**
Variable definitions for decomposition analysis (variables are for firm *i* in year *t*)

| | |
|---|---|
| *Dependent variable* | |
| DASSET | Debt level, defined as total debt divided by book value of assets. |
| *Explanatory variables* | |
| Demand factors | |
| ROA | Return on assets: profit (earnings before interest, less taxes) divided by book value of assets. |
| DEPSET | Depreciation divided by book value of assets. |
| GROWTH | Annual growth rate of assets. |
| TANSET | Tangible assets divided by book value of assets. |
| Common supply factors | |
| LGSALE | Firm size variable. (Log) Total sales |
| ADSALE | Total advertising expenditure divided by total sales. |
| EXPORT | Total exports divided by total sales. |
| BUSRISK | Business risk. Variable constructed from OLS regression: $ROA_T = aT + e_T$. BUSRISK is the coefficient on independent variable T (time) minus standard error. A higher value of the BUSRISK variable means lower business risk. |
| Chaebol-specific supply factors | |
| CHAEBOL | Dummy variable equal to 1 if firm is a Chaebol firm, 0 otherwise. |
| CHLGSALE | Chaebol firm size, defined as the log of total sales*Chaebol dummy (CHAEBOL). |
| CFIRMS | Number of member firms in the Chaebol group (natural log). |
| CPROFIT | Chaebol group profit, defined as total Chaebol profit divided by Chaebol group total assets (in year *t*). |
| CSALES | Log of Chaebol group sales, excluding member firm. |
| Industry | 21 industry dummy variables. |

Supply variables are assumed to be driven by asymmetric information, the ability of the firm to repay (business risk) and the coinsurance effect. We expect to observe greater debt ratios when asymmetric information is low.[25] That is, when firm size (LGSALE) and advertising propensity (ADSALE) are large. We also expect greater debt when business risk is low (i.e., "BUSRISK" value is high; and firm size, "LGSALE" is high) and when the coinsurance effect is strong.[26] To the extent that advertising propensity reflects the degree of product differentiation, the earnings volatility of high advertising firms would also be lower due to higher barriers to entry and mobility, which withstand the shocks coming from new competition. A lower probability of bankruptcy stemming from the reduced earnings volatility for high advertising firms would increase the supply of debt. We expect supply of debt to be negatively related to export proportion (EXPORT). To the extent that the export proportion reflects the risk of exchange rate fluctuations, the debt capacity of high export firms would tend to be lower and this would have the effect of decreasing the supply of debt. Business risk is a measure of earnings volatility over time and affects the supply of debt. Because of the potential endogeneity of both growth (GROWTH) and business risk (BUSRISK), these variables are instrumented in a first stage regression with industry dummies as the instruments.[27] The first stage regressions are highly significant (at the .01% level), with *F*-values of 9.89 for the GROWTH regression and 36.60 for the BUSRISK regression. We are able to capture 17 and 45% of the variation in these variables, respectively.

As we described in Section 3, Chaebol membership reduces the bankruptcy risk (and increases debt supply) of a Chaebol member firm through risk pooling among Chaebol members. This is because, while individual member firms tend to operate in focused industries, Chaebol groups are diverse. Therefore we include a Chaebol membership dummy variable (CHAEBOL) as a supply factor capturing diversification. In order to shed further light on the underlying mechanism driving this increased debt of diversified firms, we also include a Chaebol group diversification measure (CFIRMS, one plus the log number of member firms). This variable is included to capture cross-sectional variation in the effects of diversification. When the number of cosigners (CFIRMS) increases, we would expect debt supply to increase as well.[28] Profitability of the entire Chaebol group might also matter. One would expect that lenders are more willing to provide capital to member firms of Chaebols that are more profitable (captured by CPROFIT, Chaebol profitability multiplied by the Chaebol dummy) since the perceived risk of failure of a member of a high profitability Chaebol group is low. Size (CSALES, the log size of the Chaebol group, excluding the member firm) may also indicate higher risk protection. Because size is expected to have a protective effect then, all else equal, we would expect a positive relationship between Chaebol group size and member firm debt provision.

Before moving to the results, the interpretation of the impact of Chaebol membership deserves discussion. Chaebols are diversified groups of (mainly single-industry) member firms; however, one potential concern is that the CHAEBOL dummy is capturing something unrelated to group diversification. For example, this variable might be related to political power of controlling families or the Korean government's export-oriented policy. Note that the firm size, Chaebol group size, and export controls should capture these potential factors. In addition, the CFIRMS variable, which captures cross-sectional variation in the number of cosigners across Chaebol firms, allows identification of a diversification effect beyond Chaebol group membership.

The first step in the analysis requires a decomposition of equilibrium debt ratios based on the supply and demand variables presented in Table 5. Results of estimation of the 2SLS model of equilibrium debt on these variables are presented in Table 6.[29] Of the demand side variables, the results suggest that

[25] When we discuss supply and demand, we generally think of downward sloping demand and upward sloping supply curves. That is, negative coefficients on demand variables and positive coefficients on supply variables; however, in this framework, the business risk variable is actually "reverse," so the expected signs are flipped (value of this variable means less business risk.).

[26] Large firms are perceived to have lower exogenous risk compared to small firms in that they tend to be more diversified and may also have easier access to rescue loans when they face liquidity constraints or fail.

[27] Industry dummies are based on Korean Stock Exchange industry codes (similar to 3-digit SIC codes). The dummies, as well as all other exogenous variables in the system are used in the first stage regressions.

[28] Choi and Cowing (2002) report that the number of affiliate firms also important in explaining Chaebol performance.

[29] As noted above, growth (GROWTH) and business risk (BUSRISK) are endogenous and are instrumented in a first stage regression with industry dummies as the instruments. These instrumented variables are used in the second stage regression of equilibrium debt ratios on supply and demand factors.

**Table 6**
Does diversification matter?

| Dependent variable = debt to total assets (DASSET) | | |
|---|---|---|
| *Explanatory variables* | Coefficient | *t*-Value |
| Intercept | 48.601[a] | 3.59 |
| | | |
| *Demand factors* | | |
| ROA (profit/total assets) | −2.516[a] | −6.41 |
| DEPSET (depreciation/total assests) | −1.381[a] | −3.47 |
| GROWTH (growth rate of total assets, instrumented) | −0.268[c] | −1.89 |
| TANSET (tangible assets/total assets) | 0.011 | 0.21 |
| | | |
| *Supply factors* | | |
| LGSALE (log of sales) | 2.903[a] | 4.45 |
| ADSALE (advertising/total sales) | −0.074 | −0.45 |
| EXPORT (exports/total sales) | −0.055[a] | −2.85 |
| BUSRISK (risk around time trend, higher means less risk) | 8.236[a] | 4.02 |
| | | |
| *Chaebol-specific supply factors* | | |
| CHAEBOL (Chaebol membership dummy) | 139.617[a] | 5.08 |
| CHLGSALE (log of sales times Chaebol dummy) | −2.423[b] | −2.48 |
| CFIRMS (number of Chaebol group firms) | 6.433[b] | 2.07 |
| CPROFIT (profits/assets for the entire Chaebol) | −0.148 | −0.23 |
| CSALES (log of Chaebol group sales, excluding member firm) | −4.80[a] | −3.51 |
| | | |
| Adj. *R*-squared | 0.167 | |
| N | 1540 | |

Equilibrium debt ratios.
[a]Significant at 1% level (two-tailed); [b]significant at the 5% level; [c]significant at the 10% level. Time fixed effects are included, but not reported.

profitability, depreciation and growth all significantly impact debt ratios. The results indicate that greater ROA is associated with lower equilibrium debt (statistically significant, coefficient estimate of −2.516), presumably because this enables use of greater internal funds for investment (consistent with the pecking order theory of capital structure). In addition, consistent with tax-based explanations, the negative and significant coefficient estimate on DEPSET of −1.381 suggests that firms with higher depreciation demand less debt. Finally, consistent with underinvestment/debt over-hang explanations, we find a negative relationship between GROWTH and the debt-to-assets ratios of the firms in our sample. The only insignificant demand side variable is on tangible assets (TANSET), although the sign is positive, as predicted. Of the supply factors, as expected, we find that a large firm size (LGSALE) and low business risk (BUSRISK) are both significantly related to higher debt ratios. Advertising, our measure for visibility, does not appear to play a significant role in debt provision. The coefficient on exports is negative, as expected.

A primary purpose of this step in our analysis is to generate partitioned predicted debt ratios; however, results in Table 6 are also important because they shed light on the impact of diversification on *ex ante* determination of debt. In particular, we find a significant (at the 1% level) positive effect of Chaebol membership (CHAEBOL) on debt. This is consistent with diversified firms having higher equilibrium access to debt. Moreover, in the cross-section, debt provision varies positively with the extent of Chaebol group diversification, proxied by the number of cosigners (CFIRMS). The statistically significant (at the 5% level) estimated coefficient of 6.433 implies that, all else constant, at the sample mean debt to asset ratio, increasing the (log) number of member firms in a Chaebol by one standard deviation from its mean of 2.75 (from Table 2, the standard deviation is .58) increases the debt to asset ratio by 5.03%. The latter finding rules out many alternative explanations for the observation that Chaebol firms are able to obtain higher levels of debt (e.g., simply because of political connectedness of controlling families). We also find differences in debt determinants between Chaebol and non-Chaebol firms, with a significantly negative coefficient on the Chaebol dummy/sales interaction variable (CHLGSALE). For non-Chaebols the log sales effect is strongly positive and significant, whereas for Chaebols the effect is positive, but very small. Although size matters in debt determination, it matters much less for Chaebols, which is consistent with

the co-insurance effect.[30] Chaebol group profitability (CPROFIT) is insignificant and the coefficient on Chaebol group size (CSALES) is negative and significant. The latter finding is somewhat puzzling; however it is possible that the size of cosigners is related to an internal capital market, which would substitute for external debt. It may also be that simply being a Chaebol member firm (CHAEBOL) and having a large number of cosigners (CFIRMS) are the most important measures of diversification.[31]

Taken together, these findings motivate further investigation into the widely held contention that Chaebols were responsible for a major part of the financial crisis. Based on the partitioning methodology presented in Section 3, we use the results from this 2SLS estimation to regress the probability of bankruptcy on partitioned predicted debt ratios and the residual value.

### 5.3. Bankruptcy prediction based on the predicted/residual value approach

We introduce a unique methodology in our bankruptcy prediction model to gain insight into the mechanisms driving the widespread bankruptcies in Korea. To estimate our main model, we decompose debt ratios according to Chaebol and non-Chaebol supply and demand factors. The approach that we introduce involves using the parameter values obtained in the previous section to "partition" observed debt ratios. We partition "predicted debt ratios" according to sources of bankruptcy risk (Chaebol membership, demand factors, supply factors and Chaebol-specific supply factors). To this we add the residual from the debt ratio equation for each firm in the data set as well. *Hence, the sum of our partitioned predicted debt ratios and our residuals is identically equal to the actual debt ratio for each firm.* In our final model, this decomposition allows us to identify which sources of increased debt increased the probability of bankruptcy and therefore identify any systematic sources of *ex post* inefficiency. We estimate a logit model where the response variable is BANKRUPT, equal to 1 if a firm went into bankruptcy between October 1, 1997 and July 31, 1998 and zero otherwise. The explanatory variable is the debt-to-assets ratio, which we partitioned into nine components.

For our logit we replace the traditional constant term with the predicted debt ratio of a non-Chaebol firm with all demand and supply variables at their mean levels. This is simply substituting one constant for another. By convention, the constant term is a column of 1's in the $\boldsymbol{X}$ matrix of explanatory variables. One could in principle use any other non-zero constant in place of this column and obtain results identical in all respects but one: the coefficient on this column will differ from the coefficient on the column of 1's by the inverse of the new constant. Our transformation leads the parameter estimate on the constant term to have the same derivative with respect to an increase in the debt ratio as the other terms and assures that the sum of our independent variables is identically equal to the debt ratio, $D/A$. This eases interpretation of the intercept and allows for direct comparison with the magnitudes of the other parameter estimates.

Let $y_{it}=1$ if a firm falls into bankruptcy and 0 otherwise. We estimate the probability of bankruptcy $E[y_{it}/X_{it}]\equiv\beta=\frac{e}{1+e^{\gamma X_{it}}}$, where

$$\begin{aligned}\gamma X_{it}\equiv{} & a_0\mathrm{DhatNC}+a_1\mathrm{DiffSuppNC}+a_2\mathrm{DiffSNC}+a_3\mathrm{DiffDNC}+a_4\mathrm{DiffCNC}\\ & +a_5\mathrm{DiffSuppC}+a_6\mathrm{DiffSC}+a_7\mathrm{DiffDC}+a_8\mathrm{ResidNC}+a_9\mathrm{ResidC}.\end{aligned} \tag{13}$$

Our explanatory variables in Eq. (13) are defined below.

#### 5.3.1. Average non-Chaebol debt ratio

$$\mathrm{DhatNC}\equiv\hat{D}_i\left(\bar{X}^{nc},\ \bar{Z}^{a,nc},\ \bar{S}^{nc}\right). \tag{14}$$

The coefficient on this, $a_0$, is simply the increase in the bankruptcy probability if the mean non-Chaebol firm had an increase in its debt ratio by one percentage point. This is the "constant term."

[30] Importantly, the net marginal effect of Chaebol membership on equilibrium debt levels is positive. The sum of the coefficients on CHAEBOL and CHLGSALE is positive and significant, at the 1% level. This suggests that accounting for Chaebol membership in the basic specification is important. The same is true for the sum of all of the coefficients on the Chaebol interaction variables (CHAEBOL, CHLGSALE, CFIRMS, CSALES, CPROFIT).

[31] Note that CFIRMS is defined as the log of one plus the number of member .rms. This value is zero for non-Chaebol firms.

*5.3.2. Extra non-Chaebol supply (excluding size) effect*

$$\text{DiffSuppNC} \equiv \left[\hat{D}_i\left(\bar{X}^{nc}, Z^a, \bar{S}^{nc}\right) - \hat{D}_i\left(\bar{X}^{nc}, \bar{Z}^{a,nc}, \bar{S}^{nc}\right)\right](1-DC_i). \tag{15}$$

This is the deviation in predicted debt from the value in Eq. (14) which takes into account a non-Chaebol firm's actual supply factors (excluding size) in determining the debt level. The supply factors are captured in the $Z$ terms and the difference in predicted debt levels due to these factors is multiplied by one minus the Chaebol dummy. The $(1-DC_i)$ dummy means that the value is non-zero only for non-Chaebol firms. The coefficient on this, $a_1$, is the increase in the probability of bankruptcy if debt is increased due to greater willingness to supply debt. *During normal times* one would expect that this coefficient would be negative, as the supply curve moves to the right, the equilibrium interest rate spread, $\rho$, decreases and our model suggests that hence, so would the bankruptcy probability, $\beta$.

*5.3.3. Extra non-Chaebol size effect*

$$\text{DiffSNC} \equiv \left[\hat{D}_i\left(\bar{X}^{nc}, Z^a, S\right) - \hat{D}_i\left(\bar{X}^{nc}, Z^a, \bar{S}^{nc}\right)\right](1-DC_i). \tag{16}$$

This difference deducts the first term in Eq. (15) from the predicted value of a non-Chaebol firm with mean level demand factors but with its own firm supply factors, where size, S, is the supply factor. The coefficient on this, $a_2$, is the increase in bankruptcy probability if the debt ratio rose by one percentage point due to greater willingness to supply debt because of non-Chaebol firm size. Again, in normal times, since firm size is a willingness to supply term, one would expect $a^2 < 0$.

*5.3.4. Non-Chaebol extra demand effect*

$$\text{DiffDNC} \equiv \left[\hat{D}_i(X, Z^a, S) - \hat{D}_i\left(\bar{X}^{nc}, Z^a, S\right)\right](1-DC_i). \tag{17}$$

Following the same routine, we now find the deviation attributable to demand factors for a non-Chaebol firm. As debt goes up due to greater demand, our simple model of normal times tells us that both interest rate and the probability of bankruptcy should increase, or $a_3 > 0$.

*5.3.5. Chaebol membership effect*

$$\text{DiffCnonC} \equiv \left[\hat{D}_i\left(\bar{X}^c, \bar{Z}^{a,c}, Z^{j,c}, \bar{S}^c\right) - \hat{D}_i\left(\bar{X}^{nc}, \bar{Z}^{a,nc}, \bar{S}^{nc}\right)\right] * DC_i. \tag{18}$$

This is the Chaebol effect and a primary focus of our analysis. Note that the second expression is again the "constant" term from Eq. (14). $Z^{j,c}$ are Chaebol-specific characteristics (e.g., CFIRMS, the log number of member firms in the Chaebol, plus one). What this vector of variables captures is the predicted debt ratio of a Chaebol with mean demand and supply factors for the Chaebol sample net of the predicted debt ratio of a non-Chaebol firm with mean demand and supply factors for the non-Chaebol sample. This captures both the impact of simply being a Chaebol as well as the average differences due to the mean supply and demand factor differences between Chaebols and non-Chaebol firms.[32] The $DC_i$ dummy means that the value is zero for all non-Chaebol member firms.

In normal times one would expect that, as a supply factor, being a member of a Chaebol would lower $\rho$ and $\beta$, so that $a_4$ would be negative. Our equilibrium model suggests that if the probability of bankruptcy rises generally, that the relative probability of Chaebol bankruptcies would also rise. Hence, despite the fact that this is a supply factor, we expect $a_4 > 0$ (*ex post*, due to the crisis).

*5.3.6. Chaebol extra supply effect*

$$\text{DiffSuppC} \equiv \left[\hat{D}_i\left(\bar{X}^c, Z^{a,c}, Z^{j,c}, \bar{S}^c\right) - \hat{D}_i\left(\bar{X}^c, \bar{Z}^{a,c}, Z^{j,c}, \bar{S}^c\right)\right] * DC_i. \tag{19}$$

[32] We have also run the model decomposing the elements of the Chaebol effect. The results are similar to those reported in Table 7 below.

This is simply the Chaebol analogue to Eq. (15) above (which was for non-Chaebols), its coefficient is $a_5$ which we would expect to be negative in normal times.

*5.3.7. Chaebol extra size effect*

$$\text{DiffSC} \equiv \left[\hat{D}_i\left(\bar{X}^c, Z^{a,c}, Z^{j,c}, S^c\right) - \hat{D}_i\left(\bar{X}^c, Z^{a,c}, Z^{j,c}, \bar{S}^c\right)\right] * DC_i. \tag{20}$$

This is the Chaebol analogue of Eq. (16) above, so we expect $a_6 < 0$ in normal times.

*5.3.8. Chaebol extra demand effect*

$$\text{DiffDC} \equiv \left[\hat{D}_i\left(X^c, Z^{a,c}, Z^{j,c}, S^c\right) - \hat{D}_i\left(\bar{X}^c, Z^{a,c}, Z^{j,c}, S^c\right)\right] * DC_i. \tag{21}$$

This is the analogue to Eq. (17) above with expected $a_7 > 0$ in normal times.

*5.3.9. Residuals*

$$\text{ResidNC} \equiv \varepsilon_i(1 - DC_i) \quad \text{and} \quad \text{ResidC} \equiv \varepsilon_i * DC_i. \tag{22}$$

Recall that $\hat{D}$ is the partitioned predicted debt ratio; $\boldsymbol{X}$ is a vector of demand factors; $S$ is firm size (log sales); $Z^a$ is a vector of supply factors common to all firms, both Chaebols and non-Chaebols, and $Z^j$ are Chaebol-specific supply factors. Superscripts nc and $c$ represent non-Chaebol and Chaebol firms, respectively. If one were to take the sum of Eqs. (14)–(17) one would have, for each non-Chaebol firm, the predicted debt ratio, $\hat{D}_i(X, Z^a, S)$. For each firm this would be its predicted debt ratio given its actual values of demand and supply factors. Add its residual and one has the non-Chaebol firm's observed debt level. Similarly if one were to sum Eqs. (14), (18), (19), (20) and (21), one arrives at a Chaebol firm's predicted debt ratio. Adding the residual in Eq. (22) gives the Chaebol firm's observed debt ratio. The non-Chaebol and Chaebol residuals defined in Eq. (22) are debt residuals multiplied by non-Chaebol and Chaebol dummy variables, respectively. Deviations from predicted values may be thought of as either equilibrium (due to some unmeasured supply or demand factor) or unplanned deviations. Whether idiosyncratic extra debt raises or lowers bankruptcy probabilities, then, is an empirical question. If the extra debt is due to unmeasured demand or to unplanned deviations from equilibrium values then idiosyncratic extra debt should raise bankruptcy probabilities, or $a_8 > 0$. On the other hand, if the extra debt is due to unmeasured supply, then the estimated coefficient on $a_8$ will be less than 0. The interpretation of the coefficient on the Chaebol firm residual, $a_9$, is similar.

Note the key property of these variables. Each of these is in identical units. So, if one regresses Y on these variables, each coefficient is interpreted as the derivative of Y with respect to one more percentage point added to the debt ratio due to the factor being captured by the variable in question. The magnitudes of the coefficients are directly comparable in terms of importance of the magnitude of the effect associated with the different factors leading to more debt.

Based on the competitive equilibrium model, which is assumed to represent the model generating pre-crisis financial structures, we expect that during normal times supply variables such as firm size will shift the supply curve to the right, leading to a higher debt ratio and a lower interest rate (lower probability of bankruptcy), i.e., the effect of firm size on the pre-crisis probability of bankruptcy should be negative, holding all else equal. Similarly, the model predicts a negative relationship between extra debt due to Chaebol membership and the probability of bankruptcy during normal times. The model also predicts that partitioned debt demand will be positively related to the probability of bankruptcy.

What happens when a crisis hits? If there were no risk pooling benefits to diversification in normal times and all firm level probabilities of bankruptcy simply rose by a uniform scalar, then one would expect the same sign predictions as in normal times. However, the simple model in Section 3 demonstrated that the risk-pooling mechanisms lead Chaebols to be more credit worthy in normal times and hence carry more debt. The protective effect of diversification reverses itself in crisis times. Therefore, we expect the Chaebol effect on the probability of bankruptcy in our partition to be positive, given pre-crisis equilibrium debt.

**Table 7**
Does diversification play a role in bankruptcy outcomes?

| Variable name | Coefficient | Estimate | Std. Error | Chi-square |
|---|---|---|---|---|
| DhatNC | $a_0$ | −0.031[a] | 0.009 | 261.92 |
| DiffSupNC | $a_1$ | 0.077[a] | 0.013 | 37.61 |
| DiffSNC | $a_2$ | −0.149[a] | 0.034 | 19.42 |
| DiffDNC | $a_3$ | 0.054[a] | 0.010 | 31.46 |
| DiffCnonC | $a_4$ | 0.064[a] | 0.014 | 20.28 |
| DiffSupC | $a_5$ | 0.059[c] | 0.019 | 9.97 |
| DiffSC | $a_6$ | −0.315 | 0.242 | 1.70 |
| DiffDC | $a_7$ | 0.066[a] | 0.020 | 11.21 |
| ResidNC | $a_8$ | 0.062[a] | 0.006 | 100.22 |
| ResidC | $a_9$ | 0.037[a] | 0.014 | 6.73 |

Predicted/residual value approach.
This table presents results of a logit model where the dependent variable is an indicator equal to 1 if the firm experiences a bankruptcy event during the period October 1, 1997 to July 31, 1998. The sample consists of 385 Korean manufacturing firms. The explanatory variables are decomposed debt ratios which are defined as follows:
Variable definitions:
DhatNC: Average non-Chaebol predicted demand.
DiffSupNC: Non-Chaebol supply effect.
DiffSNC: Non-Chaebol size effect.
DiffDNC: Non-Chaebol extra demand effect.
DiffCnonC: Chaebol effect.
DiffSupC: Chaebol supply effect.
DiffSC: Chaebol size effect.
DiffDC: Chaebol extra demand effect.
ResidNC: Non-Chaebol residual debt effect.
ResidC: Chaebol residual debt level effect.
[a]Significant at 1% level (two-tailed); [b]significant at the 5% level; [c]significant at the 10% level.
Decomposition of the debt ratios (total debt/book value of assets) by demand level, firm size, and Chaebol membership. All firms, all years are included in the regression. Dependent variable = bankrupt (0,1).

### 5.4. Estimation results

The main results of our decomposition analysis are in Table 7.[33] The positive signs and significance of the Chaebol and non-Chaebol demand factors ($a_7$ and $a_3$, respectively) are consistent with our competitive equilibrium model. For supply factors, the extra debt due to firm size is significant and negatively related to the probability of post-crisis bankruptcy for non-Chaebols ($a_2$). Again, this would be expected if the normal time probabilities were simply increased in a relatively uniform fashion in the crisis. *Note the significance of this finding*: Debt is not "harmful" per se. If debt is added due to equilibrium conditions that imply more safety, then extra debt obtained due to these factors would not be expected to increase bankruptcy probabilities. This suggests that size is of protective value in both normal times and crisis times. That we can trace this effect through the higher debt ratio associated with being large is an important confirmation of the validity and value of our debt decomposition approach. Similarly, we can look at the size effect for Chaebol firm debt. The estimated coefficient ($a_6$) on this is insignificant although the sign is negative, as predicted. But there are reasons why one would expect this size effect to be less important for Chaebols. For example, Chaebol firm size plays little role in the predicted debt ratios in Table 6 (i.e., the sum of the coefficients on LGSALE and CHLGSALE is small), presumably because the cosigners are the debt guarantee, not the individual firm's liquidity. Again, looking back to Table 6 provides evidence of this link in the positive and significant coefficients on CHAEBOL and CFIRMS (Chaebol membership and number of Chaebol member firms, respectively).

The empirical findings for the other supply factors in Table 7 (exports, advertising and the business risk variable) for both Chaebol ($a_5$) and non-Chaebol firms ($a_1$) should also have negative effects on bankruptcy

[33] We ran separate regressions for individual years (6, 5, 4, and 3 years prior to bankruptcy). Results from separate regressions are not substantially different from pooled results and are not reported.

**Table 8**
Logit regression using demand, supply and Chaebol membership variables

| Dependent variable = bankrupt (0,1) | | |
|---|---|---|
| *Explanatory variables* | Coefficient | Chi-square |
| Intercept | 5.399[a] | 11.31 |
| *Demand factors* | | |
| ROA (profit/total assets) | −0.056[b] | 5.78 |
| DEPSET (depreciation/total assets) | −0.344[a] | 40.57 |
| GROWTH (growth rate of total assets) | −0.002 | 0.33 |
| TANSET (tangible assets/total assets) | −0.002 | 0.13 |
| *Supply factors* | | |
| LGSALE (log of sales) | −0.268[a] | 9.13 |
| ADSALE (advertising/total sales) | −0.073[a] | 7.70 |
| EXPORT (exports/total sales) | −0.006[c] | 3.55 |
| BUSRISK (risk around time trend, higher means less risk) | 0.130 | 2.55 |
| *Chaebol-specific supply factors* | | |
| CHAEBOL (Chaebol membership dummy) | 4.930 | 0.80 |
| CHLGSALE (log of sales times Chaebol dummy) | 0.405 | 3.75 |
| CFIRMS (number of Chaebol group firms) | −4.455[a] | 39.30 |
| CPROFIT (profits/assets for the entire Chaebol) | −0.694[a] | 26.85 |
| CSALES (Chaebol group sales, excluding member firm sales) | −0.061 | 0.06 |

[a]Significant at 1% level (two-tailed); [b]significant at the 5% level; [c]significant at the 10% level.

probabilities if the effects of these variables on firm liquidity are the same in crisis times as in normal times. In our estimates, these are positive, not negative. While puzzling, there could be systematic crisis related reasons for this. To examine this we ran a bankruptcy logit model based on all of our supply and demand factors, rather than on decomposed debt ratios (Table 8, discussed below).

We can now turn to our primary focus: the impact of systematic factors in equilibrium debt determination (in particular, Chaebol-specific factors) on bankruptcy outcomes. We observe a significant, positive Chaebol effect on the probability of bankruptcy, $a_4$. The estimated coefficient on the Chaebol membership effect variable, DiffCnonC, of 0.064 is significant at the 1% level and is inconsistent with our simple model of Chaebol debt determination in normal times. However, if there were an increase in bankruptcy risk associated with the crisis, as our model in Section 3 predicts, we would observe a large increase in the relative bankruptcy risk of Chaebols. The risk sharing that leads to more safety in normal times leads to a higher debt ratio and a lower probability of bankruptcy in normal times (again, the rightward shift of the supply curve decreases both $\rho$ and $\beta$). But, as we demonstrated, the cosigner effect turns around in crisis times, an entire Chaebol may become illiquid because of its greater debt ratio, meaning that each of its firms would be illiquid. This is the effect shown in Table 7.

It is worth noting that we use a scaled intercept, a vector of constants equal to predicted debt of the average non-Chaebol firm. The estimated coefficient on this constant (DhatNC) is negative. One might expect this to be zero in equilibrium, at least *ex ante*, but the effect is smaller than every other estimated coefficient estimate.

The last variables in the table are the non-Chaebol and Chaebol residuals ($a_8$ and $a_9$, respectively). The estimated coefficients on both $a_8$ and $a_9$, are positive and significant. The point estimate of the coefficient on the Chaebol residual is smaller than the non-Chaebol residual, and they are statistically different from one another (at the 10% level). Except for the constant term, the estimated coefficient on the Chaebol residual is the smallest effect (in absolute value). This suggests that, "excess debt," (i.e., debt above equilibrium values) for Chaebol firms is not what drove the widespread bankruptcies. This may be because individual member firm effects are less important than the overall Chaebol at the onset of the crisis. That is, idiosyncratic debt levels do matter for Chaebol firms (not surprising, given the institutional factors contributing to the crisis such as banks calling in short term loans), but the systematic factors that we

**Table 9**
Predicted effects and empirical findings

| | Demand level | Supply: firm size | Supply: Chaebol membership and diversification | Other Chaebol supply factors |
|---|---|---|---|---|
| Predicted | (+) | (−) | (+) *ex post*<br>[(−) *ex ante*] | (−) |
| Empirical findings | Significant (+) for non-Chaebol<br>Significant (+) for Chaebol | Significant (−) for non-Chaebol<br>Significant (−) for Chaebol | Significant (+) | Significant (+) |

This table maps the empirical findings to the hypothesized relationships between debt supply/demand factors and *ex post* bankruptcies (when an unanticipated, systemic shock occurs).

identified in the main analysis explain more than this variable. By contrast, note that for non-Chaebol firms, the estimated coefficient on the residual is almost as high as the coefficient on debt due to supply factors.

Table 8 presents a simple logit specification in which we estimate bankruptcy probabilities in the multivariate context, using the supply and demand factors instead of the decomposed debt ratios. Perhaps the most striking observation is that while Chaebol membership impacts debt ratios, Chaebol membership alone is not related to *ex post* bankruptcy probabilities. Moreover, Chaebol group profitability and diversification do, on average, have protective effects. These findings, along with the results in Table 7, suggest that it was increased borrowing capacity resulting from diversification that caused Chaebol bankruptcies, not Chaebol membership alone.[34] The results in Table 8 also shed light on the finding of a positive relationship between bankruptcy and debt due to supply factors (estimated coefficients on $a_1$ and $a_5$). It appears that firms with the lowest business risk (greater BUSRISK) were afforded more debt during normal times and were also more likely to go bankrupt post-crisis. Our debt decomposition results suggest that these firms, which had stronger positive profit trends (and/or fewer deviations around their trends), were afforded greater debt, and that their reversals with the economy may have been as strong as for other firms, leaving them more vulnerable.

A comparison of the theoretical predictions and empirical results are in Table 9. Taken together, our main results indicate that systematic effects, including those related to greater equilibrium access to credit of diversified firms during normal times, contributed to the widespread insolvencies. While the ability to observe subsidiary-level borrowing makes the Korean case ideal for analysis, it is important to note that the implications of this study are also relevant to firms operating outside of Korea. U.S. conglomerates are one example. In the event of a large, negative macroeconomic shock, we would expect to observed higher bankruptcies of conglomerates with subsidiaries that, during normal times, have obtained credit based on cosigning roles played by same-firm divisions (these debt levels are efficient, *ex ante*).

## 6. Conclusions

In this paper we use the Korean Financial crisis as a natural experiment for examining the impact of diversification on *ex ante* credit provision and *ex post* bankruptcy outcomes when negative tail probability events occur. The Korean setting is ideal for analyzing these questions, as the availability of detailed financial data on Chaebol member firms is much greater than segment-level information on U.S. diversified firms.

We first develop a simple model of equilibrium leverage based on the probability of bankruptcy in the event of firm insolvency. Cosigners reduce the bankruptcy risk in such cases. We show how members of diversified Chaebols can act as cosigners for other members. This can reduce the probability of bankruptcy and hence increase debt capacity of individual member firms in equilibrium. We then show that the benefits of having diversified cosigners relative to no cosigners can fall when the underlying probability of insolvency rises. If this underlying probability rises sufficiently, as in a crisis, the factors which made for

[34] Note that while one can easily compare statistical significance of the coefficients directly from the results in Table 8, the magnitudes are not directly comparable, as they are in Table 7.

relative safety of cosigning firms in normal times will create vulnerability for such firms in crisis times due to their endogenous selection of higher leverage during normal times.

To test these implications, we introduce a new empirical methodology in which we estimate a model of equilibrium debt determination for firms during the pre-crisis period and then partition equilibrium debt ratios into demand, supply and Chaebol-specific factors. These decomposed debt ratios are used in a second-stage bankruptcy prediction model to estimate the relationship between these sources of pre-crisis leverage and bankruptcy. To our knowledge, this approach is unique.

Viewing a Chaebol as a cosigning arrangement means that in normal times a Chaebol firm is less likely to go bankrupt, and is likely to carry more debt than its non-Chaebol counterpart. We empirically document these predicted higher pre-crisis debt ratios for Chaebols. Most importantly, we also show that the protective effects of cosigners allow for additional debt that becomes a liability in crises. Our empirical analysis supports this hypothesis. Results suggest that an extra percentage point in the debt ratio *because the firm is part of a Chaebol* has approximately 70% greater impact on bankruptcy than an extra percent of idiosyncratic debt relative to the equilibrium debt. The risk-pooling mechanism which makes Chaebol's efficient under normal conditions makes them vulnerable in crises.

Taken together, the findings in this paper provide perspective on some of the Korean government's post-crisis policies. One example is the prohibition of loan cosigning arrangements between Chaebol member firms. In 1999, the Korea Fair Trade Commission amended the Monopoly Regulation and Fair Trade Act to, among other things, eliminate cross-subsidiary loan guarantees on new debt. Debt ratios of Chaebols have subsequently decreased. Given the findings in this paper, one might ask whether prohibiting cosigning is a good policy. Our results suggest that as long as firms have debt positions with maturities that are close to their capital lives and the probabilities of systemic crises are low, then cosigning can increase debt capacities and reduce bankruptcy risk. The negative and significant estimated coefficient on CFIRMS in Table 8 supports this view. In fact, it suggests that a policy that bans all cosigning by member firms reduces efficiency during normal times.

If the goal is to limit widespread bankruptcies, a more effective policy would be to encourage less reliance on short term debt to finance long term assets. This would decrease the likelihood that, in the event of crisis, member firms' loans would be called in at same time and would also limit refinancing risk. Moreover, our finding that the number of cosigners within Chaebol firms has a protective effect on bankruptcy should cause regulators encouraging firms to spin off non-core businesses to also consider the potential costs of such actions.

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