The Thai Currency Crisis: Financing Constraints, High Fixed Costs and Corporate Governance

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1. Introduction.

Currency crises can have devastating effects on economic growth and welfare. In the worst year of the Asian Currency Crisis--1998--real output *fell* by 6.9 percent in Korea, 10.8 percent in Thailand, 7.7 percent in Malaysia, and 14.1 percent in Indonesia. At the same time, the currencies of Korea, Thailand, Malaysia, and Indonesia depreciated sharply, in most cases by over 100 percent. Many papers have analyzed why output fell so dramatically during the Asian currency crisis, despite the sharp currency depreciations (see the papers in Edwards and Frankel, 2002). Perhaps the most prominent explanation for the fall in output is the crisis-induced tightening of financing constraints facing domestic firms. The tightening of financing constraints made the purchase of intermediate parts, capital equipment, and the payment of wages expensive, leading to a fall in production and output.

According to the "financing constraints" view, the crisis started when international lenders refused to roll-over their loans, resulting in a sudden drop in capital inflows to emerging markets. The domestic currency depreciated, leading to a sharp rise in foreign debt, given that most of the debt was in foreign currency. Other firm financial characteristics such as total assets and profits deteriorated. Because of moral hazard, some lenders, particularly banks, based their lending decisions on observable firm financial characteristics, such as debt and profits. When these characteristics deteriorated, banks cut back their lending--firms could not produce and output fell. This "financing constraints" view of the Asian currency crisis is stressed in the models of Chang and Velasco (1999), Cole and Kehoe (1997), Radelet and Sachs (1998), Furman and Stiglitz (1998), and Aghion, Bacchetta, and Banerjee (2000).

Despite the plethora of theoretical models, previous testing of the "financing constraints" view are scarce. Most of the previous work examined the impact of tightening financing constraints on physical capital investment. The results are mixed. While Osangthammanont (2002) found that the deterioration in financial characteristics indeed lowered investment rates, Luengnaruemitchai (2003) did not find any relationship. Bleakley and Cowan (2003) examine whether the deterioration in firm financial characteristics caused, in particular, by the exchange rate depreciation had a negative effect on investment. Surprisingly, they find that the exchange rate depreciation had a positive effect on investment. Although the exchange rate depreciation resulted in an increase in foreign debt, and an overall deterioration in financial characteristics, the expenditure switching and thus the stimulative effect of the depreciation on investment was larger.

In this paper, we add to the empirical literature by examining the relationship between financing constraints and output during crisis, using Thai firm level data. We find that tightening financing constraints had a moderately large effect on lowering output, accounting for about half the output decline in 1998. The effect of tightening financing constraints on the fall in output is quite large, because of high scale economies and high fixed costs in Thai industries. With high fixed costs, the crisis induced increase in unit costs and financing costs required a large output decline for variable costs to decrease sufficiently, to enable the firm to survive. In other words, with high fixed costs, output had to be sufficiently large for the firm’s revenues to cover its costs, and to avoid bankruptcy.

Our finding of the important role of financing constraints and high fixed costs in worsening the Asian economic crisis supports the work of McKinnon and Pill (1997), Corsetti, Pesenti, and Roubini (1998), and Dekle and Kletzer (2002), and others that suggest that overborrowing and overinvestment prior to the crisis contributed to the severity of the crisis. According to this view, implicit government guarantees of bank borrowing by firms led to labor hoarding and excessive investment in physical capital, land, and other forms of fixed capital before the crisis, requiring a high output level for the firm to avoid bankruptcy.

We also examine the role of Thai corporate governance institutions in propagating the Thai crisis. We find that if a firm had a close relationship with a financial institution before the crisis (in 1996), the decline in output was much more severe for the firm, although financing constraints are loosened. A close banking relationship prior to the crisis allowed the firm to overborrow and overinvest, leading to very high fixed costs, and vulnerability to slight changes in input and financing costs.

This paper is organized as follows. In Section 2, we show how the pattern of sales in our data of Thai listed firms is consistent with aggregate GDP fluctuations during the Thai crisis. In Section 3, we model financing constraints and show how tightening financing constraints and declining ratios of prices to unit costs can depress output. In Sections 4 and 5, we show the importance of high fixed costs in magnifying the effect of tightening financing constraints; and how these high fixed costs can raise the minimum level of output for the firm to avoid bankruptcy. Sections 6 and 7 discuss the estimation framework and the data. Section 8 reports estimates of scale returns; scale returns in Thai industries are estimated to be very high.

Section 9 depicts estimates of the impact of tightening financing constraints and depreciating exchange rates on firm output. The estimated effects of tightening financing constraints on firm bankruptcy probabilities are shown in Section 10. Using our accounting framework, Section 11 calculates how much of the decline in output during the financial crisis can be explained by the rise in financing costs, and the depreciation of exchange rates. In Section 12, we show how Thai corporate governance institutions--especially the close relationships among firms and banks--contributed to the crisis. Section 13 concludes.

2. Thai Output Losses During the Crisis.

The Thai economic crisis started in July 1997; GDP declined slightly in 1997, but sharply (-11 percent) in 1998 (Table 1). There was recovery in 1999 and 2000, but GDP growth was still lower than the 6-7 percent growth before the crisis. Particularly, GDP in the financial sector (banks and financing companies) dropped by over 10 percent in 1997, and over 30 percent each in 1998 and 1999, as many banks and financing companies failed. If financial markets are imperfect, the failures of these financial institutions no doubt contributed to the increase in financing costs; and the output slowdown of non-financial companies.

In our micro data of Thai listed firms, we only examine firms in the non-financial sector. The GDP of Thai private firms, excluding those in finance declined by 1.2 percent in 1997 and -12 percent in 1998, while increasing by 7 percent in 1999. In our sample of listed firms, the average output of firms actually increased by 6.3 percent in 1997, while decreasing at 5.4 percent in 1998, and 3.2 percent in 1999. Thus, the average growth of the firms in our sample differ considerably from the growth in the GDP of Thai non-financial firms.

The output of firms in our sample comprise about 25 percent of the GDP of Thai non-financial firms.[1] The rest of GDP is comprised of the output of non-listed private firms, including

[1]Strictly speaking, GDP is a value added measure, while firm sales is a gross output measure. Thus, the two measures cannot be compared directly. However, in practice, changes in GDP and in gross output are very highly correlated, so fluctuations in gross output (firm sales)

output by the self-employed. We can calculate the implied growth rate of non-listed firms from the GDP growth rate and the growth rate of listed firms (Table 1). Since non-listed firms are mostly small, it is not surprising that output of non-listed firms is much more volatile than the output of larger, listed firms. Thus, once we account for non-listed firms, the growth of listed firms appear consistent with the growth in aggregate GDP.

An Accounting Framework for Output Fluctuations of Thai Listed Firms

The total output of Thai listed firms can be expressed as:

$$Y_t = \Pr(nbk) * y_{t,nbk} + \Pr(1 - nbk) * y_{t,bk}$$

where $\Pr(nbk)$ is the percentage (fraction) of non-bankrupt firms, $y_{t,nbk}$ is the output of non-bankrupt firms, and $y_{t,bk}$ is the output of bankrupt firms.

Since $y_{t,bk} = 0$,

$$\Delta \ln Y_t = \Delta \ln \Pr(nbk_t) + \Delta \ln(y_{t,nbk}) .$$

The changes in the output of non-bankrupt firms, $\Delta \ln(y_{t,nbk})$ are also depicted in Table 1. The difference in growth rates between all the listed firms in the sample, and only the non-bankrupt firms is the change in the percentage of firms that went bankrupt. This difference is especially large in 1999, when 15 percent of firms in the sample went bankrupt. The large contribution of bankruptcy to output and GDP fluctuations during the crisis, means that it is important to analyze the determinants of bankruptcy

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can be compared to fluctuations in GDP.

3. Financing Constraints and Borrowing Costs.

Our analysis rests on two assumptions regarding the typical firm in an emerging market like Thailand. First, we assume that the firm is financing constrained, that the borrowing costs of firm i depend on the financial characteristics of the firm:

$$\tilde{R}_{it} = \tilde{R}(f_{it}) . \qquad (1)$$

$\tilde{R}_{it}$ are real borrowing costs, the ratio of nominal borrowing costs of firm i, R_{it}, and the risk-free nominal interest rate, R_t, $\tilde{\mathrm{R}}_{\mathrm{it}} = \mathrm{R}_{\mathrm{it}} / \mathrm{R}_{\mathrm{t}}$. f_{it} is a vector of financial characteristics of the firm that may affect the firm's ability to borrow, such as cash flow, asset size, and the ratio of debt to assets. Our specification of credit constraints follows Aguiar (2001) and others, and assumes that banks and other lenders differentiate between good- and poor credit risk borrowers by charging the poor risk borrowers, higher interest rates.

An alternative to model credit market imperfections is to follow Stiglitz and Weiss (1981) and assume that lenders cannot differentiate among borrowers–all borrowers are charged the same common interest rate, and accept a common fixed loan size. In the Stiglitz and Weiss model, there is an induced tendency for firms with poor financial characteristics to borrow more, since these firms have higher default rates and lower expected interest costs (because of their higher bankruptcy probabilities). Given that the supply of all bank loans is fixed, credit is rationed to firms with poor financial characteristics, with the amount of rationing increasing with the deterioration in f_{it}. An implication of the Stiglitz and Weiss model is that rationed firms cannot increase their borrowing no matter what $\tilde{R}_{it}$ they are willing to pay; $\tilde{R}_{it}$ is effectively infinite at the rationed loan level.

Our assumption that borrowing costs $\tilde{R}_{it}$ are related to f_{it} can be made consistent with the Stiglitz and Weiss (1981) model. Anecdotal evidence says that during the Thai and Korean crises, firms that were rationed from banks went to finance companies to borrow at higher interest rates; and those that were rationed from finance companies went to the curb market to borrow at even higher interest rates (Phongpaichit and Baker, 2000, p. 49-57; IMF, 1998). There appears to be a hierarchy of lenders in Thailand and Korea (and in many other developing countries, with segmented financial markets). As their financial conditions f_{it} deteriorated, firms moved down the hierarchy of lenders (from banks to curb market money lenders), in turn, paying higher premia over the risk-free rate, R_{it}. Of course, there may be firms with financial characteristics so poor than no one will lend to them. These firms effectively go bankrupt, and drop out from the sample. Later, we empirically examine how financial characteristics, f_{it} are related to bankruptcies.

The second set of assumptions relate to the technology of the firm. We assume that firm i belongs to industry j, such as nontradeables or construction, and that production is Cobb-Douglas; with factor inputs labor, intermediate goods, and capital; having factor prices W_{jt}, F_{jt}, R_{it}, respectively. The cost function is then standard (Berndt, 1991, p. 69):

$$C_{it} = A_{it}^{-\varepsilon} * W_{jt}^{\delta} F_{jt}^{\theta} R_{it}^{1-\delta-\theta} * y_{it}^{\varepsilon} \tag{2}$$

where A_{it} is a productivity term, y_{it} is firm output, and ε describes how average and marginal costs change when output changes. Average costs *decrease, are constant, or increase* with increasing output, as $\varepsilon < 1, \varepsilon = 1, \varepsilon > 1$, respectively.[2] Marginal costs are proportional to average costs, with ε the constant of proportionality. The typical interpretation of *decreasing* average costs ($\varepsilon \prec 1$) at least in the short-run is the presence of high fixed costs, such as the fixed portion of the wage bill, or the rental costs of land, structures, and machinery that are incurred every year regardless of the output level.

4. Exchange Rate Depreciation, Financing Constraints, and Firm Output.

Let firm i be a competitive firm, a price-taker of domestic or international prices prevailing in the industry, p_{jt}. All the firms in industry j produce the same homogeneous output.

We can then express the profits of firm i in industry j at the beginning of any period t, namely,

$$\pi_{it} = p_{jt} * y_{it} - A_{it}^{-\varepsilon} * W_{jt}^{\delta} F_{jt}^{\theta} R_{it}^{1-\delta-\theta} * y_{it}^{\varepsilon}. \tag{3}$$

Maximizing (3) with respect to y_{it} and simplifying, we obtain:

$$y_{it} = \left(\frac{p_{jt}}{A_{it}^{-\varepsilon} * W_{jt}^{\delta} F_{jt}^{\theta} R_{it}^{1-\delta-\theta} * \varepsilon}\right)^{\frac{1}{\varepsilon-1}}. \tag{4}$$

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[2] Also, it is well-known that for the cost-function to be well-behaved, the cost-function has to be homogeneous of degree one in input prices, so the exponents on the input prices sum to one (Berndt, p. 170).

Note that in this simple example of a competitive, price-taking firm, ε must be greater than one for the firm to be maximizing profits. Thus, we consider only cases of increasing average and marginal costs ($\varepsilon > 1$). Let $c_{jt} = W_{jt}^{\delta} F_{jt}^{\theta} R_t^{1-\delta-\theta}$ represent the unit cost index for industry j.[3] Then (4) can be re-written as:

$$y_{it} = \left(\frac{p_{jt}}{c_{jt} * A_{it}^{-\varepsilon} * \tilde{R}_{it} (f_{it})^{1-\delta-\theta} * \varepsilon}\right)^{\frac{1}{\varepsilon-1}} \tag{5}$$

That is, firm output *rises* with increasing industry prices, p_{jt}; and *falls* with increasing industry unit costs, c_{jt}, and firm borrowing costs, $\tilde{R}_{it}$.

Currency crises are typically accompanied by dramatic changes in macroeconomic variables. In a typical currency crisis, there is a sharp depreciation of the domestic currency, and a large drop in net capital inflows (Edwards and Frankel, 2002). In Thailand during the first year of the currency crisis, the Baht depreciated by about 34 percent against the U.S. dollar; and net capital inflows dropped from plus 4 billion dollars in 1997 to minus 15 billion in 1998.

These changes in macroeconomic variables affect firm output through (5), by raising industry unit costs and prices, and c_{jt} and p_{jt}. Whether firm supply declines depends on the

[3]This represents the minimum cost to produce a unit of output in industry j.

relative increases in c_{jt} and p_{jt}. Industry unit costs, c_{jt}, will increase, since the currency depreciation will raise most imported input prices. The currency depreciation will raise the prices of imported or internationally traded intermediate inputs (F_{it}) such as petroleum, raw materials, and machinery.

How much industry prices, p_{jt} increase after a currency depreciation depends on whether the industry produces tradeable goods that are highly integrated in international markets. The more integrated the good in international markets, the higher the price in domestic currency increases, because the law of one price is more likely to hold. However, even prices for so-called "non-tradeable" goods may increase somewhat, since most nontradeables contain some tradeables components. For example, during the first year of the crisis, tradeables goods prices rose by 8.2 percent, 12.5 percent, and 6.0 percent in Korea, Thailand, and Malaysia. Nontradeables prices rose by 5.1 percent, 9.3 percent, and 5.4 percent in Korea, Thailand, and Malaysia. Thus, while the ratio of prices to unit costs $\frac{p_{jt}}{c_{jt}}$ may increase for some highly tradeables industries, that ratio is likely to fall for nontradeables and industries that are less integrated in international markets.

Borrowing costs increase when the firm's balance sheets (f_{it}) deteriorate (through (1)).

Alternatively, when a crisis strikes, borrowing costs can tighten for all firms, resulting in an upward shift in the excess borrowing function, $\tilde{R}'(f_{it}) \succ \tilde{R}(f_{it})$. As an example of the former increase in borrowing costs, a currency collapse can damage a particular firm's balance sheets by raising foreign debt levels in domestic currency terms. In Thailand and in other countries, the collapse of the domestic currency sharply raised foreign debt levels. Just prior to the crisis at the end of the second quarter 1997, the Thai private sector foreign debt-GDP ratio stood at about 60 percent (Bank of Thailand, 2003). A year after the depreciation of the Thai baht, the same foreign debt-GDP ratio increased to 93 percent.

As an example of the latter tightening of borrowing costs, more generally, lending to all firms may decline in times of financial panic, resulting in an upward shift in borrowing costs (1). As mentioned, the Thai financial sector collapsed during the financial crisis, probably impacting their ability to lend. Roll-overs of foreign lending collapsed. In Korea, while 99 percent of foreign short-term loans were renewed in December 1996, by December, 1997, only 15 percent of foreign short-term loans were renewed (IMF, 1998). To explain these declines in roll-overs, Chang and Velasco (1999) and Cole and Kehoe (1997) emphasize coordination problems among lenders in the presence of short term debt. In these models, lenders refuse to roll-over their loans, because they fear others may also refuse to do so, resulting in a sudden drop in capital inflows. Relatedly, Radelet and Sachs (1998) and Furman and Stiglitz (1998) emphasize that currency crisis push highly leveraged borrowers to financial insolvency, creating a general financial panic, and discouraging foreign and domestic lenders from rolling over their loans.

From (5), real output falls when the ratio of industry prices to industry costs, $\left(\dfrac{p_{jt}}{c_{jt} * A_{it}^{-\varepsilon} * \widetilde{R}_{it}(f_{it})^{1-\delta-\theta} * \varepsilon}\right)$, declines. As shown above, for non-tradeable goods such as construction and real estate, this is highly plausible, since the ratio of industry prices to unit costs will be falling. However, if the deterioration in f_{it} , or the upward shift in $\widetilde{R}_{it}$ are sharp, output can decline even for highly tradeable industries, such as automobiles and electronics.

5. Changes in Returns to Scale and Firm Shutdown.

From (5), we can see that as ε decreases (increases), the impact of changes in p_{jt}, c_{jt}, and $\widetilde{R}_{it}$ on y_{it} rises (falls). As ε decreases, marginal and average costs increase more slowly. Since in a competitive setting, profit maximizing output is determined where price equals marginal costs, small changes in p_{jt} , c_{jt} , and $\widetilde{R}_{it}$ will lead to large changes in output. That is, with high scale economies (low ε), small changes in $\dfrac{p_{jt}}{c_{jt}}$ and $\widetilde{R}_{it}$ will require large adjustments in output, to reduce variable costs sufficiently for the firm to avoid bankruptcy. Thus, high scale returns or high fixed costs can <u>magnify</u> the impact of an exchange rate depreciation; or of a tightening of financing constraints, on output.

This magnification effect can be dramatic. Suppose that $\varepsilon = 3$, which implies low returns to scale. A 10 percent decrease in $\frac{p_{jt}}{c_{jt}}$ will lower y_{it} by only 5 percent. Now suppose that

ε =1.2. A 10 percent decrease in $\frac{p_{jt}}{c_{jt}}$ will now lower y_{it} by 50 percent.

Figure 1 depicts the relationship between firm output, and the price-unit cost ratio. Decreases in the price-unit cost ratio, shift the *horizontal* ('PC' line) downwards. The *upward sloping* curve ('FC' curve) has the slope, $\left(\frac{1}{A_{it}^{-\varepsilon}\varepsilon\tilde{R}_{it}(f_{it})}\right)^{\frac{-1}{\varepsilon-1}}$. Decreases in ε make the 'FC' curve flatter. Equilibrium y_{it} is determined where the PC line intersects the FC curve.

Suppose that the currency crisis lowers the price-unit cost ratio, and shifts the PC line downwards, from PC0 to PC1. Figure 1 shows that output declines from y_o to y_1. The figure also shows that the flatter the FC curve (the closer ε approaches unity), the larger is the change in output. Thus, the higher the fixed costs, the larger is the decline in output.

It can also be shown that tightening financing constraints (an increase in $\tilde{R}_{it}$) will shift the FC curve upwards. Again, the flatter the FC curve, the larger is the decline in output. Thus, whether the currency crisis induces a decline in $\frac{p_{jt}}{c_{jt}}$, or an increase in $\tilde{R}_{it}$, the effect on output (the magnification effect) is larger, the smaller the ε , or the larger the fixed costs.

Returns to scale also affects the minimum level of output, below which the firm will shutdown or go into bankruptcy. The shutdown or minimum level of output (y_i^{Min}) necessary for the firm to survive is:

$$y_i^{Min} = \left(\frac{p_j^{Min}}{c_j^{Min} * A_i^{-\varepsilon} * \tilde{R}_i^{Min}}\right)^{\frac{1}{\varepsilon-1}}, \tag{6}$$

where p_j^{Min}, c_j^{Min}, $\tilde{R}_i^{Min}$ are the minimum prices, unit costs, and borrowing costs of the firm. From (6), we can see that as ε falls, the minimum survivable scale of the firm rises. If a firm or a firm's lenders suspect that the firm will be facing prices lower than p_j^{Min}, and unit and financing costs higher than c_j^{Min} and $\tilde{R}_i^{Min}$ for the long-run, then the firm should shutdown; the firm's revenues will not cover its costs.[4]

The model developed above is a static, or long-run model. Thus, shifts in p_{jt} , c_{jt} , and

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[4]This shutdown condition is from the Kuhn-Tucker condition from maximizing (3) with respect to the budget constraint.

$\tilde{R}_{it}$ are viewed as long-run or permanent by firms and lenders. For shifts in p_{jt} and c_{jt}, the permanent shift assumption may be justified, since it is well known that exchange rate changes, which primarily drive the price-unit cost ratio are permanent; nominal exchange rates are a random walk process. If, as Radelet and Sachs (1998) and Furman and Stiglitz (1998) argue, changes in $\tilde{R}_{it}$ are also exchange rate driven, then shifts in financing constraints may also be viewed as permanent.

6. Estimation of the Relationship Between Firm Output, Financing Constraints, and Price and Unit Cost Shifts.

To examine these interacting effects of financing constraints, price and unit cost shifts, and returns to scale in depressing output during economic crisis, we estimate the supply function of the firm (4) using data from the Thai economic crisis of 1996-2000.

We assume that borrowing costs for firm i at time t depend linearly on firm financial characteristics, firm fixed effects, and the macroeconomic conditions prevailing at time t:

$$\ln \tilde{R}_{it} = a + w_j + d' f_{it} + k' w_i + MacroCon + e_{it} . \qquad (7)$$

where f_{it} is a vector of firm financial characteristics; *MacroCon* are a group of macroeconomic controls; w_i are firm-specific dummy variables, *a* is a constant, *d* and *k* are coefficient vectors, and e_{it} is an idiosyncratic shock. Depending on the specification, we include a combination of exchange rates, the exchange rate interacted with industry dummy variables, and time dummies to control for macroeconomic effects.

The firm financial characteristics that are believed to affect borrowing costs are: the *coverage ratio* (profits/interest expenses), *log asset size*, and the *leverage ratio* (the ratio of debt to assets) (Hubbard, 1998; James and Houston, 2001; Aguiar, 2001). Decreases in the coverage ratio, and in the log asset size; and increases in the leverage ratio should all raise borrowing costs. Many papers (see Hubbard, 1998 for a review) have shown that if external finance is costly, capital investment by the firm is positively correlated with firm profit, since profit is one of the internal funds available to the firm. Surveys of bank credit officers in Thailand and elsewhere note that the officers pay much attention to coverage and leverage ratios, and asset size (Samphantharak, 2003). The coverage and leverage ratios capture the firm's past borrowing, and reflect the firm's ability to survive under adverse shocks. Large firms–firms with high assets–should also be able to withstand bankruptcy; and banks should be more willing to lend to them.

We take the logarithm of the supply function (5):

$$\ln(y_{it}) = (-\frac{1}{\varepsilon-1}\ln(\varepsilon)) + \frac{1}{\varepsilon-1}\ln\frac{p_{jt}}{c_{jt}} + \frac{\varepsilon}{\varepsilon-1}\ln A_{it} - \frac{1}{\varepsilon-1}(1-\delta-\theta)\ln\tilde{R}_{it}(f_{it}) \quad (8)$$

and assume that log productivity can be expressed as a function of firm-specific effects, and time dummy variables:

$$\ln A_{it} = b + z' w_i + n' w_t + w_{it}\,, \quad (9)$$

where b is a constant, z and n are coefficient vectors; w_i are firm-specific dummy variables,

w_t are a time dummy variables, and w_{it} is an idiosyncratic error. Our econometric strategy is to estimate (7) (first-stage), and (8) (after substituting in (9)) by panel two-stage least squares, in which we treat w_i as a firm fixed effect.

Because of the lack of data on unit costs by industry, we cannot use data on $\frac{p_{jt}}{c_{jt}}$ to estimate (8). Since during crisis, most of the variation in $\frac{p_{jt}}{c_{jt}}$ arises from fluctuations in exchange rates, we proxy $\frac{p_{jt}}{c_{jt}}$ by a set of j industry dummy interacted with the log nominal exchange rate.[5] This allows the effect of $\frac{p_{jt}}{c_{jt}}$ on output to vary by industry, and over time, depending on the log exchange rate. In another specification, instead of the full set of industry-log exchange rate dummies, we include the log exchange rate interacted with only a tradeables industry dummy variable. In the equations with time dummies, the exchange rate cannot be included, because of multicollinearity. The baseline year of the time dummies is 1996. The time dummy variables capture the effects of all the macroeconomic shocks, including shocks to

[5]There are 17 industries in our sample.

productivity, the exchange rate, the aggregate market interest rate, and other variables.

Thus, the wage rate, the price of intermediate goods, and the aggregate interest rate, are not included in the estimation of the supply function. This should not result in omitted variable biases, since the effects of these variables, which vary only across industries and over time, should be captured by the industry time variables interacted with the exchange rates.

By estimating (7) and (8) jointly, important hypotheses of our model, and of the Thai currency crisis will be tested. The first hypotheses is whether the firms with deteriorating financial characteristics experienced tightening financing constraints. Using Thai firm level data, we examine whether the ratios of cash flow to firm capital, debt to assets, and other financial characteristics deteriorated during the crisis; and whether changes in these characteristics raised borrowing costs.

The second hypothesis is whether after holding these individual financial characteristics constant, borrowing costs increased for all firms during the crisis. For instance, in Thailand, economic conditions were worst in 1997 and 1998 (Pongpaichit and Baker, 2000; Osangthammanont, 2002). As noted above, the output of the financial sector declined severely between 1996-2000, impairing the ability of the financial sector to make loans. If during the worst years of the crisis, there was a fall-off in lending by banks and foreigners, then controlling for financial characteristics, borrowing costs should increase for all firms. The general tightening of monetary policy in 1997 and 1998 should have also contributed to the higher borrowing costs in those years. We examine whether there was a level shift up in borrowing costs for all firms in the worst years of the crisis, by testing whether the time dummy variables in 1997 and 1998 in (7), are significantly positive. We also examine whether fluctuations in the exchange rate affected the cost of borrowing. An exchange rate depreciation may raise the cost of borrowing for all firms, if general panic spreads among domestic and international lenders.

The third hypothesis is whether an increase in borrowing costs actually contributed to the decline in firm output. Even if borrowing costs increased, the effect of these increases on firm output may be small. We estimate the coefficient $(\frac{1}{\varepsilon-1})*(1-\delta-\theta)$ on $\ln\tilde{R}_{it}$ in (8). If this coefficient is large, then the increase in borrowing costs will have a large impact on output. From this coefficient estimate, we can also determine how fixed costs and scale returns can magnify the impact on output of a rise in interest rates, and price and input cost increases.

7. Data and Descriptive Statistics.

The data to estimate (7) and (8) are from a CD-ROM obtained from the Thai Stock Exchange.[6] The CD-ROM contains balance sheet and income statement data between 1996-2000

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[6]We are aware of at least two other panel data set of Thai firms. The World Bank randomly selected 652 Thai firms in 1998, with retrospective questions for 1997 and 1996. The data set is described in Hallward-Driemeir (2000). The World Bank sample includes both listed and the smaller, unlisted firms, and contains balance sheet and income statement information. Hallward-Driemeir (2000) mentions some caveats in using the World Bank data set. Among her caveats is first that response rates were quite low. Second, the unit of observation is the plant or the enterprise, and not the firm. It is unclear how informative balance sheet and income statements are at the enterprise or firm level. The record keeping at the firm level is probably much better, since it is the firm that pays taxes, not the enterprise or plant. Finally, the data are not in accord with any standard accounting rule–each survey respondent answers each question subjectively. The accounting statements of our firms were audited by internationally accredited accountants.

Several researchers (Osangthammanont, 2002; Samphantharak, 2003) used data provided by Thailand's Ministry of Commerce. That data set is broader than the sample of listed firms used in this paper, and includes all registered firms, but do not include small, informal household businesses. All told, there are about 910 firms in their sample, compared to about 210 for 220 firms listed on the Exchange. Industry-specific GDP deflators were obtained from the Bank of Thailand. Table 2 depicts some descriptive statistics of the Thai firms in our sample. Real Sales (y_{it}) are nominal sales divided by the industry-specific GDP deflator.[7] Surprisingly, the real sales of the tradeables sector contracted just as sharply as the real sales of the entire listed firm sector, despite the Baht depreciation. Real Costs are nominal total costs divided by the industry-specific GDP deflator, and include the cost of sales, and selling and administrative expenses. Average Costs are Real Costs divided by Real Sales. The Interest Rate ($\tilde{R}_{it}$) is equal to the total interest paid by the firm divided by the firm's liabilities.[8] Liabilities include all firm financial liabilities, including trade credits. The Leverage Ratio is the ratio of the firm's liabilities divided by the firm's assets. The Coverage Ratio is the ratio of the firm's profits to total interest payments.

In general, almost all firm financial characteristics deteriorated between 1996-2000, with the deterioration most severe in 1997 and 1998. The average interest rate paid by firms increased from 5.7 percent in 1996 to 8.2 percent in 1998, and declined thereafter. Note that these rates are lower than the nominal (call) interest rates that banks use to obtain internal funds (Table 1). Firm level interest rates are an average of contracted rates, and if contracts are long, firm level interest

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firms in our sample.

[7]The value of production would be more appropriate as an output measure, but no production or inventory data are available in our database.

[8]That we would like is the marginal interest (borrowing) rate, but that is not easily available. The marginal rate would be higher than the average rate in times of crisis, especially during periods of high non-performing loans, as banks raise rates to compensate for the greater risk.

rates may lag the market interest rates. Firm level interest rates in Thailand may also be subsidized by the government and banks (Wiwattanakantang, Kali, and Carumilind, 2003).

The rise in average firm level interest rates in 1998 reflect both a tightening of monetary policy, and an overall deterioration in the financial conditions of Thai firms. The leverage ratio also surged in the midst of the crisis in 1997 and 1998, while declining slowly as the economy recovered. Part of the surge in the leverage ratio is related to the depreciation of the Thai Baht, which raised foreign debt levels in Baht terms, although we lack data on foreign currency borrowing.

Real total costs went up sharply between 1996-2000. Although we have tried to control for the rise in the price of inputs (by dividing by the industry GDP deflator); the GDP deflator is only an imperfect measure of input prices. Thus, the rise in total costs may reflect the exchange rate depreciation-induced rise in input prices. The measure of average costs, however, is relatively flat between 1996-2000, implying that the behavior of total costs is probably more related to firm scale (y_{it}), rather than to higher input prices, including higher borrowing costs. However, without controlling for firm-specific variables, we cannot conclude from our observed flat average costs that average costs are indeed nearly constant $(\varepsilon = 1)$.

Table 2 also depicts three corporate governance dummy variables, suggested by previous researchers to affect firm performance, especially during times of crisis. Details on the construction of the corporate governance variables are given in the Appendix. These characteristics are as of 1996 (just before the crisis) and correspond to whether: 1) the CEO of the firm is from the Founding Family; 2) the firm has close ties with a bank or financing company; and 3) the firm is a Joint Venture with a foreign firm. The use of these variables is underscored by the economic theory of business groups.

The basic idea of business groups is that although the firms are legally distinct, capital is transferred among firms within a group; that is, there are internal capital markets within business groups. When external finance is costly, these internal capital markets can serve a beneficial role. When external finance is costly, the marginal costs across firms within a group are not equalized. If marginal costs are not equal, aggregate profits of the group firms can be maximized by transferring funds from the firms with lower marginal costs to the firms with higher marginal costs. Researchers (Khanna and Rivkin, 2001) have found that group firms have higher profitability than non-group firms in many countries.

Recently, however, studies have been focusing more on the negative side of business groups. The idea is that business groups are associated with minority shareholder expropriation (Johnson, La Porta, *et. al.)* The majority or controlling shareholder, say the founding family, will expropriate group funds for inefficient investment projects, for example, in diversification into unprofitable but glamorous sectors, and elaborate corporate headquarters. Wiwattanakantang, Kali, and Carumilind (2002) show that listed Thai firms belonging to business groups had greater access to long-term debt before the crisis; and engaged in inefficient investment projects.

If the CEO is from the founding family, the firm may have easier access to the internal funds from other companies belonging to the founding family. This ability to share risk may allow the firm to better withstand the crisis, and maintain its output. On the other hand, if the easier access to capital before the crisis lead to inefficient investment, the “shutdown” level of output of the firm may be too high. As costs sharply increase during the crisis, the firm may have to close. The effects should be similar, if the firm has close ties to a bank or financing company. Overall, it is an empirical question whether group affiliation enables a firm to better withstand the crisis.

A quarter of the Thai firms in our sample were joint ventures with foreign firms. Since all of the joint venture partners were from industrialized countries, presumably the partners were better financed. The infusion of new funds from the joint venture partner may allow the Thai firm to better withstand the crisis. On the other hand, the joint venture partner may be less loyal to the Thai firm; and may be apt to cut of funds at the first signs of trouble. It is an empirical question how Thai joint ventures performed during the crisis.

Finally, the number of firms in our sample drops from 219 in 1996 to 189 in 1999, because of bankruptcies. We later estimate the determinants of bankruptcies during the crisis, using the shutdown equation (6).

8. Estimates of Returns to Scale.

In the estimation of the supply function (8), the effect of returns to scale $\frac{1}{\varepsilon - 1}$ cannot be separately identified from the interest share of output, $(1-\delta-\theta)$. In Dekle, Karnchanasai, and Hoontrakul (DKH, 2003), we carefully estimated the average cost function (from (2)), to determine the returns to scale parameter, ε.[9]

Table 3 depicts some of the results from DKH (2003). In the average cost function, the

[9]In DKH (2003), we estimated the following form of the average cost function, $\ln \frac{C_{it}}{y_{it}(W_{jt}^{\delta} F_{jt}^{\theta} R_t^{1-\delta-\theta})} = -\varepsilon \ln(A_{it}) + (\varepsilon - 1)\ln y_{it}$, where $W_{jt}^{\delta} F_{jt}^{\theta} R_t^{1-\delta-\theta}$ is the industry GDP deflator. Thus, although the average cost equation only include Ln(Sales) and Ln(Interest) as explanatory variables, the effects of other input prices are implicitly controlled through the GDP deflator.

coefficient on Log(Sales) is equal to $(\varepsilon - 1)$.[10] In specifications (1) and (2), the coefficient on Log(Sales) is negative, implying ε to be less than unity, or that average costs are decreasing. This result is robust for all the specifications in DKH (2003), implying that fixed costs are large. Decreasing average costs, however, are inconsistent with profit maximization in our simple model of the price-taking firm.

We therefore restrict ε to be greater than one, and re-estimate the average cost function (Specification (3)). We showed in Section 5 that even with $\varepsilon > 1$, we can observe the magnification effect, and that as ε approaches 1, the magnification effect becomes larger. With this restriction, the coefficient on $(\varepsilon - 1)$ is now estimated to be 0.10, implying that ε_t = 1.1. Thus, ε is quite close to unity, and the magnification effect should be large.

A ε of 1.1 implies that a 5 percent increase in $\frac{p_{jt}}{c_{jt}}$ will lower output by 50 percent.

Relatively small changes in the price-unit cost ratio, or in firm level interest rates can lead to very large changes in output.

9. The Estimation of the Impact of Financing Constraints, and Exchange Rate Fluctuations on Firm Supply.

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[10] A discussant mentioned that since we are using sales instead of output in the estimation of the average cost function, the estimates are subject to measurement error. In DKH (2003), we instrumented for the Log(Sales) variable, and the results were unaffected. Instrumental variables estimation is the most common way of correcting for measurement error.

The estimates of firm supply (8), are depicted in Tables 4 and 5.[11] As mentioned in Section 6, we cannot include the Log Price-Cost ratio in our estimation because of the lack of data. Since the Log Price-Cost ratio only varies over time and across industries, we can capture most, if not all of the variation in the Log Price-Cost ratio by the Log(Exchange Rate) interacted with the full set of industry dummy variables.

In Table 4, Log(Interest) is not instrumented. Although small, the coefficient on Log(Interest) is significant and negative; a rise in interest rates lowers Log(Sales). A depreciation of the nominal exchange rate sharply lowers Log (Sales) for the nontradeables sector. For the tradeables sector, the exchange rate depreciation slightly (0.78-0.76=0.02) *expands* Log (Sales). That the nontradeables sector responds negatively, and that the tradeables sector responds positively to the exchange rate depreciation, is consistent with our model.

In Table 5, Log(Interest) is instrumented by firm level financial characteristics, the variables appearing in the first-stage regressions (7). In general, in the first stage regressions, the firm level financial characteristics are highly significant and have the correct signs. Log (Leverage) is significantly *positive* in the specifications without time dummies; that is, highly indebted firms pay higher interest rates. A 10 percent increase in the Leverage-Asset ratio increases interest rates by 2.1 percent. Log (Assets) is highly significantly *negative*; the larger the firm, the lower the interest rate. A 10 percent increase in Log (Assets) decreases interest rates by

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[11]Since surviving firms may have a lower response of output to changes in explanatory variables, there may be survivorship bias in estimating (8) on only the sample of surviving firms. To correct for this survivorship bias, we followed the method of Wooldridge (2002, p. 586) and included the inverse Mills ratios obtained from the t=1997,...,2000 cross-section probits in (8). Wooldridge shows that if the inverse Mills ratios are insignificant, then there is no survivorship bias. None of the inverse Mills ratios turned out to be statistically significant implying that there is no survivorship bias in estimating (8) on only the sample of surviving firms.

6.2 percent. Finally, the higher the profits relative to the interest rate paid (the coverage ratio), the lower is the interest rate charged. The significance of these financial characteristics, imply that during the crisis, firms with deteriorating financial characteristics paid higher interest rates.

The Log (Exchange Rate) is positive, implying that the exchange rate depreciation raised interest rates during the crisis. Note that the impact of higher aggregate interest rates on firm level interest rates during the crisis is captured by the time dummies, explaining in part, why the time dummies are positive during the worst years of the crisis 1997-1998. The positive sign on the time dummies, especially in 1998, suggests that borrowing costs increased for all firms. This means that even if a particular firm's financial characteristics remained constant, the firm faced higher borrowing costs because of aggregate shocks--general banking failure, panic by domestic and international lenders, or tight monetary policy.

In the estimates of firm supply (second stage), the coefficient on Log (Interest) is again significantly negative, but now its magnitude is much higher. A 10 percent increase in firm interest rates, say from 5 percent to 5.5 percent results in a 2.2 percent decrease in firm supply. The log exchange rate now exerts a strongly negative effect on nontradeables output, and even a slightly negative effect on tradeables output. A 10 percent depreciation of the exchange rate lowers nontradeables output by 6.5 percent, and tradeables output by 0.4 percent.

Comparing specifications (3) and (4) in the second stage, the signs of the time dummy variables are negative when the exchange rate interacted with the tradeables dummy is included, but positive when the exchange rate interaction term is dropped. This arises because the interaction term captures the expansionary effect of an exchange rate depreciation on tradeables output. When the interaction term is dropped, the time dummies are positive and capture the expansionary effects.

10. The Estimation of the Impact of Financing Constraints, and Exchange Rate Fluctuations on Firm Shutdown (Bankruptcy) Probabilities.

Substituting (1) into (6), and then taking a first-order Taylor expansion, we obtain:

$$y_i^{*Min} = A + B\frac{p_j^{Min}}{c_j^{Min}} + DA_i + Ff_i^{Min} + \varepsilon_i \tag{10}$$

where y_i^{*Min} is the unobserved, shutdown output level or the minimum scale of the firm. A, B, and D, and F are coefficients, and ε_i is an approximation error term. The firm will shut down if its actual output level as dictated by (5), falls below y_i^{Min}.

In the data, what we observe is whether or not at each period t, a firm has exited from the sample, presumably because of bankruptcy.

$$y_{it} = 1 \quad \text{if} \quad y_{it}^* > 0 \quad \text{(not bankrupt)}$$

$$y_{it} = 0 \quad \text{if} \quad y_{it}^* <= 0 \quad \text{(if bankrupt)} \tag{11}$$

We apply panel probit analysis to (11) to examine whether exchange rates and firm financial conditions affected the probability of bankruptcy. We assume that lagged exchange rates and lagged firm financial conditions proxy for the minimum price-unit cost ratio, and minimum firm financial conditions. We assume that firms and their lenders form forecasts of long-run prices, unit costs, and financial conditions using the lagged actual values of these variables.

The results are depicted in Table 6. Panel fixed-effects estimates failed to yield reasonable results (not depicted); the panel random-effects estimates were more successful, and are depicted in column (1).[12] The only financial characteristic that was statistically significant in affecting bankruptcy probabilities was the level of assets. The implied elasticity of 0.26 means that a 10 percent increase in assets resulted in a 2.6 percent increase in the probability of survival (non-bankruptcy).[13] An exchange rate depreciation significantly raises the probability of firm survival (non-bankruptcy).[14] A 10 percent exchange rate depreciation raises the probability of survival of a firm in the nontradeables sector by 18.2 percent; and a firm in the tradeables sector by 20.6 percent.[15]

The results when we apply the standard probit estimator, without random or fixed effects, that is, neglecting the panel structure of the data, are depicted in column (2). The exchange rate is

[12]In our sample, the number of bankrupt firms is small. Only 5 and 25 firms went bankrupt in 1998 and 1999, respectively, which are smaller bankruptcy rates than in the entire population of Thai firms. The population of Thai firms include smaller, unlisted firms, of which the probabilities of bankruptcies are higher. As Maddala (1983) suggests, probit estimates are likely to yield poor results when the fraction of one of the dichotomous (0,1) variables–in our case, “bankrupt” firms–is low. (I thank Bhanupong for this insight).

[13]We also included firm financial characteristics interacted with the corporate governance variables, but none of the interacted variables were significant.

[14]Although the exchange rate depreciation tightens financing constraints, the cheaper Thai Baht expands exports, and reduces imports, allowing bankrupt firms to increase their output.

[15]Note that we cannot include time dummies when the exchange rate is included in the estimation.

now significant and positive for only the tradeables industries. None of the firm financial characteristics are now significant. In general, both specifications (columns (1) and (2)) yield large standard errors and poor fits, suggesting that alternative specifications for the determinants of bankruptcy may yield better results.

11. Accounting for the Impact of Changes in Financing Constraints on Thai Listed Firm Output.

The total impact of a change in variable X_{it} , say, a firm's interest rate on the change in output is:

$$\frac{\partial \ln Y_t}{\partial \ln X_{it}} = \frac{\partial \ln \Pr(nbk)}{\partial \ln X_{it}} + \frac{\partial \ln y_{t,nbk}}{\partial \ln X_{it}} \qquad (12).$$

Given the rather poor performance of the panel probit estimates of the probability of bankruptcy, here we focus on only the non-bankrupt firms. In performing our output accounting, we use specification (2) in Table 5, since that specification most cleanly captures the impact of exchange rate changes on output.[16]

Using (12), Table 7 depicts the accounting for the real output changes of Thai non-bankrupt listed firms. The contributions of the changes in firm interest rates to the changes in output , $\left(\frac{\partial \ln y_{t,nbk}}{\partial \ln(\mathrm{int}\,erest_{it})} * d\log(\mathrm{int}\,erest_{it})\right)$ are quite large in 1998, implying that the

[16]The other specifications include the industry variables interacted with the exchange rate, so changes in exchange rates impact output in complicated, industry-specific ways.

tightening of firm financing constraints played a major role in the fall in output in that year. In 1998, the increase in firm interest rates contributed to nearly half the decline in output. The contributions of the changes in firm financial characteristics to the changes in output, $(\frac{\partial \ln y_{t,nbk}}{\partial \ln(\text{int}\,erest_{it})} * \frac{\partial \ln(\text{int}\,erest_{it})}{\partial \ln(f_{it})} * \partial \log(f_{it}))$ are rather modest. For example, the contribution of the change in Log (Assets) is only -0.3 percent in 1998. Thus, it seems that the worsening of firm-specific financial characteristics was not important in aggravating the crisis. Rather, the general tightening of financing constraints, say, caused by the crash in the financial sector, was more important in accounting for the output decline.

The exchange rate contributes to the changes in output by the direct effect, through changes in $\frac{p_{jt}}{c_{jt}}$, and by the indirect effect, through changes in firm interest rates. For *non-tradeable* firms, the exchange rate depreciation had quite a large direct negative effect on output, as unit costs increased more than prices ($\frac{p_{jt}}{c_{jt}}$ fell). For tradeable firms, the depreciation had a positive direct effect on output. On average for Thai listed firms, the Baht depreciation raised output, since in our sample there are more tradeable firms than non-tradeable firms. In 1998, the exchange rate depreciation contributed to raising output by 0.7 percent, with the direct effect of the depreciating exchange rate contributing 0.3 percent, and the indirect effect (through interest rates) contributing 0.4 percent.

Thus, the changes in aggregate exchange rates, and firm interest rates cannot account for the entirety of the output changes. Idiosyncratic firm specific effects account for the remainder of the output changes.

12. The Impact of Corporate Governance on Financing Constraints and Output.

Finally, we examine the effects of our three corporate governance dummy variables: 1) whether the CEO is from the founding family (CEOFAM); 2) the firm has close times with a bank (BANK); 3) or is a joint venture with a foreign company (JV). We interact these dummy variables with firm financial characteristics, f_{it}, and include these interacted variables in the financing constraint equation (7), to examine their sign and significance. If, for example, the coefficient on $BANK * Log(Leverage)$ is positive and significant, then for firms with close bank ties, leverage has a smaller effect on increasing firm interest rates.

We also interact these dummy variables with the log firm level interest rate, $\ln \tilde{R}_{it}(f_{it})$, in the supply function (8), to examine whether the relationship between tightening financing constraints and output is influenced by corporate governance. For example, if the coefficient on $BANK * \ln \tilde{R}_{it}(f_{it})$ is significantly negative, then for firms with close bank ties, an interest rate increase will have a larger negative effect on output.[17]

[17]A discussant suggested that the variables CEOFAM, JV, and BANK are variables related to a firm’s ownership structure, rather than capturing a firm’s corporate governance characteristics, such as transparency and fairness. However, it is well known that ownership structure affects the incentives of the management, and therefore the corporate governance

Table 8 depicts the two-stage least squares estimates of equations (7) and (8), with the interaction variables included. We only depict the results in which f_{it} and $\tilde{R}_{it}$ are interacted with BANK. None of the variables interacted with CEOFAM or JV are significant, meaning that whether the CEO is from the founding family, or the firm is a joint venture, does not affect the cost of financing, or the impact of the cost of financing on output.

BANK interacted with Log(Leverage) is significantly negative in specifications (3) and (4). In fact, for firms with close bank ties, Log(Leverage) has no effect on financing costs. A heavily leveraged firm with close bank ties pays no higher interest than a lightly leveraged firm. If a firm has close bank ties, BANK interacted with the Coverage Ratio is significantly positive in all specifications, implying that a fall in the Coverage Ratio has a smaller effect in raising financing costs. This is consistent with a large corporate finance literature, suggesting that group affiliation, especially if that group includes a bank, almost completely eliminates financing frictions (Hubbard, 1998; James and Houston, 2001). Overall, these results imply that a close banking relationship moderates the effect of worsening financial characteristics on firm interest rates.

BANK interacted with Log(Interest) is highly significantly negative in all specifications. For firms without banking relationships, the effects of an interest rate increase on output are rather small. For firms with close banking relationships, the effects of an interest rate increase on output are large. In fact, comparing the results of Table 8 with the results in Table 5, the sums of the coefficients on Log(Interest) and BANK*Log(Interest) in Table 8 are always higher than the coefficients on Log(Interest) in Table 5. That is, the output of firms with close banking

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characteristics of the firm.

relationships respond more strongly to interest rate changes, compared to the output of the average firm.

These results suggest that for firms with close bank ties, there is a large impact of tightening financing constraints on firm output. Thai firms with close banking relationships have large scale economies. These Thai firms were able to obtain funds cheaply just before the crisis, enabling them to become intensive in fixed-assets, such as capital. This intensity in fixed assets, however, made the firms more vulnerable to rising unit costs and financing costs. Although the increases in financing costs were moderated by the firms' close relationships with banks, these close banking relationships also sharply raised scale returns, and the minimum output levels necessary for the firm to avoid bankruptcy.

13. Conclusion.

In this paper, we examined the role of financing constraints in depressing output during the crisis, using Thai firm level data. Out of a total 1998 output decline of 3.7 percent in our sample, we find that tightening financing constraints contributed to lowering output by 1.7 percent. However, most of this output decline was caused not by the deterioration in individual firm characteristics, but by the general tightening of financing constraints, say, by banking sector distress, or the tightening of monetary policy.

We also found evidence of high scale economies or high fixed costs in Thai industries. With high scale economies or fixed costs, small changes in unit costs or financing costs can lead to large changes in output. We interpret the high fixed costs as evidence of overinvestment prior to the crisis.

The exchange rate depreciation generally raised output. The depreciation lowered the output of non-tradeable firms, as unit costs increased by more than prices, but raised the output of tradeable firms. Output overall increased, since in our sample, tradeable firms outnumber non-tradeable firms.

Finally, we find that firms with close relationships with banks experienced a larger decline in output. Although the effects of deteriorating firm financial characteristics on financing constraints are moderated for firms with close banking ties, these same firms appear to have very high fixed costs. Thai firms with close banking ties were able to obtain funds cheaply from banks before the crisis; allowing the firms to become intensive in fixed assets, but making them vulnerable to rising unit and financing costs.

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Appendix: Construction of Corporate Governance Variables.

For all firms in our sample, the top 10 owners of each firm in 1996 were looked up from the Annual Reports of the Security Exchange of Thailand. The firms were classified into two types: 1) those with most of the large shareholders sharing the same last name; and 2) those with multiple large shareholders. Firms in group 1) invariably had CEO's with the same last name as the majority shareholder or the "founding" family. Firms in group 2) always had a professional CEO, although some members of the Board of Directors often shared the same last name.

We classified a firm as having a close relationship with a bank or financing company if the firm had a large shareholder who also owned a bank or financing company. For example, there were 39 firms with Sophonpanich as a large shareholder. These firms were classified as having a close relationship with Bangkok Bank, which is majority owned by Sophonpanich.

Whether a firm is a joint venture can also be uncovered from the Annual Reports. Many (26) joint ventures were with Japanese firms in the tradeables industries–automobiles, textiles, and appliances.

Figure 1: Determination of Firm Output and the Magnification Effect

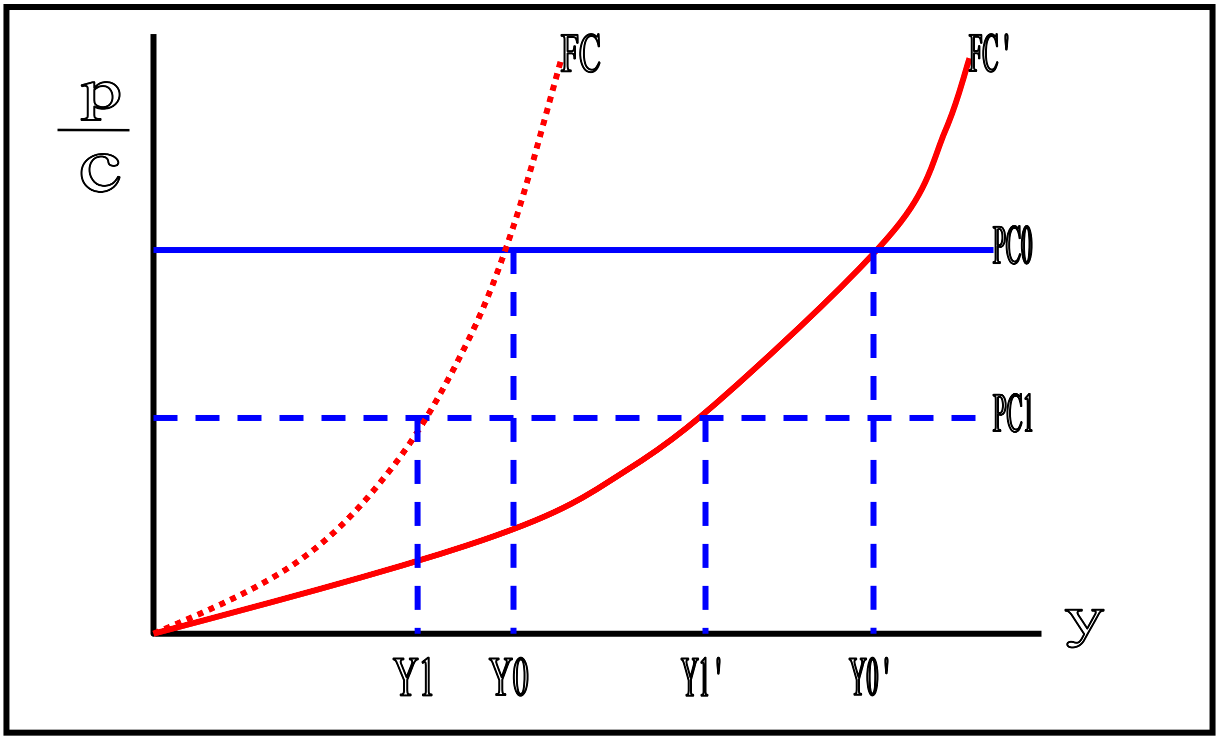

Table 1
Thailand: Macroeconomic Characteristics

Average	1996	1997	1998	1999	2000
GDP 1/	3115	3073	2758	2872	3009
(% Change)	…..	-1.4	-11	4.4	4.8
Finance GDP 1/	220	196	138	91	84
(% Change)	…..	-11	-30	-34	-8
GDP, Excluding Finance Public Sector, Agriculture	2374	2345	2071	2223	2337
(% Change) 1/	…..	-1.2	-12	7	5
Output Growth of Thai 2/ Firms in Sample (% Change)					
All Firms in Sample	…..	6.3	-5.4	-3.2	11.3
Only Non-bankrupt Firms	…..	6.8	-3.7	9.5	11.3
Implied Growth Rate of 3/ Nonlisted Firms	…..	-4.3	-14.5	11.5	2.5
Baht/$ Exchange Rate	25.25	31.15	41.03	37.61	39.95
(% Change)	…..	23	32	-8	6
Nominal Interest Rate	10.5	12.5	12.5	4	4
(% Change)	…..	19	0	-68	0

1/ In Billions of 1988 Baht.
2/ Of Listed Firms exclusive of those in Finance.
3/ Given that the output of listed firms comprise about 31 percent of the total output of Thai firms.

Table 2
Characteristics of Thai Listed Firms

Average	All years	1996	1997	1998	1999	2000
Interest Rate 1/	0.064	0.057	0.059	0.084	0.066	0.052
Leverage Ratio 2/	0.59	0.54	0.67	0.61	0.58	0.58
Coverage Ratio 3/	181	62	93	201	289	291
of Tradeables	240	6	94	341	488	299
Real Sales 4/	3216	2949	3150	3035	3324	3700
of Tradeables	3053	2645	2953	2834	3231	3679
Real Assets 4/	7153	6446	7931	7189	7367	6824
Real Costs	2216	2027	2140	2119	2245	2604
Average Costs	0.49	0.51	0.49	0.47	0.49	0.48
CEO from Founding Family 5/	0.42					
Close Bank Ties 6/	0.65					
Joint Venture 7/	0.25					
Number of Firms	-----	219 115	218 115	214 115	189 104	189 104

1/ Total Interest Payments/Liabilities.
2/ Total Liabilities/Total Assets
3/ Profits/Total Interest Payments
4/ Total Sales/Prices and Total Assets/Prices (in millions of 1995 Baht).
5/ Firm (in 1996) has CEO from founding family (proportion of all firms).
6/ Firm (in 1996) has close ties with bank or financing company (proportion of all firms).
7/ Firm (in 1996) is a joint venture with foreign firm (proportion of all firms)

Table 3

Estimates of Returns to Scale
(From Dekle, Karnchanasai, and Hoontrakul, 2003)

Specification	(1) 1/	(2) 2/	(3) 3/
	Dependent Variable: Log(Average Costs)		
Log (Interest)	-0.001 (-0.83)	-0.011 (-1.13)	0.005 (0.80)
Log (Sales)	-0.19 (-6.05)	-0.10 (-4.57)	0.10 (32.0)
Implied Returns to Scale	0.81	0.82	1.10
R-squared	0.86	0.033	0.86
Observations	1029	810	1029

(T-statistics are in parentheses.)

1/ Firm fixed effects, time dummies, and industry dummy variables interacted with the exchange rate are not depicted.
2/ All variables are first differenced. Time dummies and dummy variables interacted with the exchange rate are not depicted.
3/ Coefficient on log(sales) restricted to be positive.

Table 4

Estimate of Firm Supply

Specification	(1) 1/	(2) 2/	(3) 3/	(4) 4/
	Dependent Variable: Log Sales			
Log(Interest)	-0.048	-0.039	-0.029	-0.12
	(-3.51)	(-2.59)	(-1.79)	(-0.83)
Log (Exchange Rate)	-0.068	-0.76	.....	.....
	(-0.87)	(-9.16)		
Log (Exchange Rate* Tradeables)	.....	0.78	0.79	.....
		(6.95)	(7.07)	
Year 2	-----	.....	-0.11	0.16
			(-3.22)	(3.71)
Year 3	-----	.....	-0.38	0.22
			(-8.75)	(2.81)
Year 4	-----	.....	-0.31	0.19
			(-7.71)	(2.71)
Year 5			-0.29	0.29
			(-6.76)	(3.71)
R-squared	0.96	0.96	0.96	0.96
Observations	1029			

T-statistics in parentheses.

1/ Firm fixed effects, and industry dummy variables interacted with the exchange rate are not depicted.

2/ Firm fixed effects, and industry dummy variables interacted with the exchange rate are not depicted.

3/ Firm fixed effects are not depicted.

4/ Firm fixed effects, and industry dummy variables interacted with the exchange rate are not depicted.

Table 5
Effect of Financial Variables on Firm-Level Interest Rates and Estimates of Firm Supply

	First Stage				Second Stage 5/			
Specification	(1) 1/	(2) 2/	(3) 3/	(4) 4/	(1) 1/	(2) 2/	(3) 3/	(4) 4/
	Dependent Variable: Log (Interest Rate)				Dependent Variable: Log(Sales)			
Log (Interest Rate)	-----	-----	-----	.....	-0.16	-0.19	-0.22	-0.22
					(-3.14)	(-3.39)	(-3.36)	(-3.36)
Log (Sales)	.....	......	.....	.....	.....	.....	.....	.....
Log (Leverage)	0.21	0.26	0.14	0.82	.....	.....	.....	.....
	(1.61)	(1.94)	(0.99)	(0.61)				
Log (Real Assets)	-0.62	-0.65	-0.69	-0.67	-----	-----	.....	-----
	(-5.06)	(-5.71)	(-6.44)	(-5.91)				
Coverage Ratio	-0.0021	-0.0021	-0.0021	-0.0021	-----	-----	.....	-----
	(-2.94)	(-2.94)	(-2.89)	(-2.88)				
Log (Exchange Rate)	-0.039	0.37	.....	.....	0.37	-0.65	.....	-----
	(-0.13)	(2.33)			(2.65)	"(-6.17)		
Log (Exchange Rate* Tradeables)	.....	-0.072	-0.79	.....	.....	0.61	0.59	.....
		(-3.49)	(-3.71)			(4.67)	(4.38)	
Year 2	-----	.....	0.31	0.12	-----	.....	-0.81	0.13
			(0.37)	(1.72)			(-2.34)	(3.32)
Year 3	-----	.....	0.27	0.51	-----	.....	-2.61	0.21
			(1.95)	(6.57)			(-3.96)	(2.89)
Year 4	-----	.....	-1.25	0.64	-----	.....	-2.84	0.11
			(-1.03)	(0.77)			(-6.29)	(1.78)
Year 5	-----	.....	-0.44	-0.22	-----	.....	-0.31	0.16
			(-3.23)	(-2.62)			(-6.03)	(2.09)
R-squared	0.76	0.74	0.77	0.79	0.95	0.95	0.95	0.96
Observations	1029							

T-statistics are in parentheses.

1/ Firm fixed effects, and industry dummy variables interacted with the exchange rate are not depicted.
2/ Firm fixed effects are not depicted.
3/ Firm fixed effects, and industry dummy variables interacted with the exchange rate are not depicted.
4/ Firm fixed effects, and industry dummy variables interacted with the exchange rate are not depicted.
5/ Variables in the corresponding columns in the first stage are instruments for the log (interest rate).

Table 6

Panel Probit on No Bankruptcy
(Dependent Variable=1 if Firm not Bankrupt)

	(1) 1/	Implied Elasticity	(2) 2/	Implied Elasticity
Lagged (Leverage Ratio)	0.065	…..	0.0046	**…..**
	(0.27)		(0.81)	
Lagged (Real Assets)	0.0003	**0.26**	0.00015	**…..**
	(1.73)		(1.16)	
Lagged (Coverage Ratio)	0.0012	**…..**	0.00091	**…..**
	(0.93)		(0.67)	
Exchange Rate	0.04	**1.82**	-0.023	**…..**
	(6.22)		(-0.98)	
Exchange Rate* Tradeables	0.01	**0.24**	0.0093	**0.21**
	(2.17)		(2.14)	
Restricted Log-Likelihood	-151.7		-125.4	
Number of Observations	876		876	

Sample: All Firms, 1997-2000.
1/ Random Effects Panel Probit Estimator.
2/ Standard Probit Estimator.

Table 7

Accounting for the Real Output Change of Thai Non-Bankrupt Listed Firms
(in Percent Change, Unless Otherwise Noted)

Average	1997	1998	1999	2000
Output Change (All Firms)	6.3	-5.4	-3.2	11.3
(Non-Bankrupt Firms)	6.8	-3.7	9.5	11.3
From Change in Interest Rates 1/	-0.2	-1.7	1.2	1.2
Of Which:				
Change in Real Assets 2/	0.7	-0.3	0	-0.2
Change in Leverage Ratio 3/	-0.3	0.1	0	0
From Change in Exchange Rates	0.4	0.7	0.1	0
Of Which:				
Direct Effect 4/	0.2	0.3	0	0
Indirect Effect Through Interest Rates 5/	0.2	0.4	0.1	0

1/ The coefficient on the interest rate (in Table 5) times the percentage change in the interest rate.
2/ The coefficient on real assets (in Table 5) times the change in real assets times the value in 1/.
3/ The coefficient on leverage (in Table 5) times the change in leverage times the value in 1/.
4/ The coefficient on the exchange rate (in second stage, Table 5) times the change in the exchange rate.
5/ The coefficient on the exchange rate (in the first stage, Table 5) times the change in the exchange rate times the coefficient on the interest rate (in Table 5).

Table 8

Effects on Bank Affliation on Firm Interest Rates and Output

(Two-Stage Least Squares)

	First Stage				Second Stage 5/			
Specification	(1) 1/	(2) 2/	(3) 3/	(4) 4/	(1) 1/	(2) 2/	(3) 3/	(4) 4/
	Dependent Variable: Log (Interest)				Dependent Variable: Log(Sales)			
Log (Interest)	-----	-----	-----	.....	-0.081	-0.08	-0.09	-0.09
					(-2.16)	(-2.05)	(-2.11)	(-2.21)
Bank*Log (Interest)	.....	.....	.....	.....	-0.19	-0.29	-0.31	-0.21
					(-1.92)	(-2.34)	(-2.35)	(-1.94)
Log (Sales)	.....	......	.....	.....	.....	.....	.....	.....
Log (Leverage)	0.41	0.49	0.45	0.37	.....	.....	.....	.....
	(2.11)	(2.33)	(2.28)	(2.07)				
Bank*Log(Leverage)	-0.31	-0.39	-0.46	-0.43				
	(-1.29)	(-1.33)	(-1.89)	(-1.93)				
Log (Real Assets)	-0.54	-0.55	-0.61	-0.61	-----	-----	.....	-----
	(-4.39)	(-4.65)	(-5.33)	(-5.01)				
Bank*Log(Real Assets)	-0.092	-0.13	-0.11	-0.0058				
	(-1.13)	(-1.57)	(-1.16)	(-0.62)				
Coverage Ratio	-0.0032	-0.0033	-0.0032	-0.0031	-----	-----	.....	-----
	(-5.55)	(-5.34)	(-6.25)	(-6.56)				
Bank*Coverage Ratio	0.0019	0.0021	0.0019	0.0018				
	"(1.89)	(2.03)	(2.02)	(1.89)				
Log (Exchange Rate)	-0.23	0.42	.....	.....	0.29	-0.56	.....	-----
	(-0.07)	(2.67)			(1.97)	"(-4.68)		
Log (Exchange Rate* Tradeables)	.....	-0.83	-0.83	.....	.....	0.49	0.47	.....
		(-3.75)	(-3.95)			(3.42)	(3.16)	
Year 2 (1997)	-----	.....	0.13	-0.17	-----	.....	-0.07	0.11
			(1.81)	(-0.19)			(-1.83)	(2.59)
Year 3 (1998)	-----	.....	0.53	0.18	-----	.....	-0.19	0.18
			(7.01)	(1.22)			(-2.41)	(2.22)
Year 4 (1999)	-----	.....	0.07	-0.21	-----	.....	-0.25	0.079
			(0.85)	(-1.61)			(-4.86)	(1.19)
Year 5 (2000)	-----	.....	-0.19	-0.52	-----	.....	-2.93	0.11
			(-2.42)	(-3.49)			(-5.71)	(1.31)
R-squared	0.76	0.74	0.77	0.79	0.96	0.97	0.98	0.97
Observations	1029							

T-statistics are in parentheses.

1/ Firm fixed effects, and industry dummy variables interacted with the exchange rate are not depicted.
2/ Firm fixed effects are not depicted.
3/ Firm fixed effects, and industry dummy variables interacted with the exchange rate are not depicted.
4/ Firm fixed effects, and industry dummy variables interacted with the exchange rate are not depicted.
5/ Variables in the corresponding columns in the first stage are instruments for the log (interest rate).