The Role of Firm Size in Controlling Output Volatility during the Asian Financial Crisis

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We thank Carlos Vegh, Amartya Lahiri and Luisa Lambertini for their comments and suggestions. Any errors are our responsibility.

ABSTRACT

This study sets out to develop a simplified risk premium model to explain output volatility within the economies of Asia in the immediate aftermath of the Asian financial crisis. Firms are allowed to borrow from both domestic and foreign banks, with the firms' debts being loosely constrained (at high levels) prior to the crisis (lending boom) but becoming tightly constrained (at low levels) on the outbreak of the crisis (lending bust).

The lending rate is a function of the debt-capital ratio; thus if firms have only limited access to the credit market, then they will accumulate less capital and become small firms. Given their lower collateral, small firms face higher risk premiums which will ultimately lead to a much greater reduction in output when a credit crunch suddenly hits. Our model predicts that small firm size will accelerate unanticipated shocks; therefore, output volatility will be greater in countries with small firms than in those with large firms.

Keywords: Asian financial crisis; Firm size; Credit constraints; Risk premiums.

JEL Classification: E5, F3, F4.

INTRODUCTION

For most of the Asian economies, the eruption of the Asian financial crisis in 1997 was nothing short of a nightmare, and despite the extensive research into the causes and effects of the crisis, some of the worst affected countries have yet to fully recover. Indeed, an examination of these worst affected countries reveals that there is considerable variation in the real-side response to the shock, from around -10 per cent to -20 per cent.[1] It therefore seems crucial to determine the underlying differences between these countries that could possibly lead to such variations in their response to the crisis.

The Asian financial crisis was preceded by a significant lending boom that subsequently came to a very abrupt end; the availability of bank loans dried up almost instantaneously, leading to a reduction in the level of capital available for production, and therefore, a general fall in production output. Following the initial breakout of the crisis in Thailand, the contagion had spread rapidly across the whole of Asia resulting in unprecedented economic depression; with stock prices falling dramatically between 1997 and 1998, there was considerable shrinkage in firms' overall asset values. An illustration of the stock price index for four selected Asian countries, Indonesia, Korea, Malaysia and Thailand, is provided in Figure 1.

Given their diverse economic backgrounds, and their very distinct government policies, the size of firms varies considerably across these countries. In Korea, for example, there are many examples of gigantic manufacturing enterprises (*chaebols*), whereas in Indonesia, Malaysia and Thailand, the economy is still heavily reliant upon small family-owned manufacturing firms. Large firms, with their greater asset value, can gain access to better credit terms to smooth over the shocks whilst small firms have very restricted access to credit, and at higher interest rates, thus amplifying the shock.

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1 The real-side response is measured by the growth rate of the manufacturing production index (MPI).

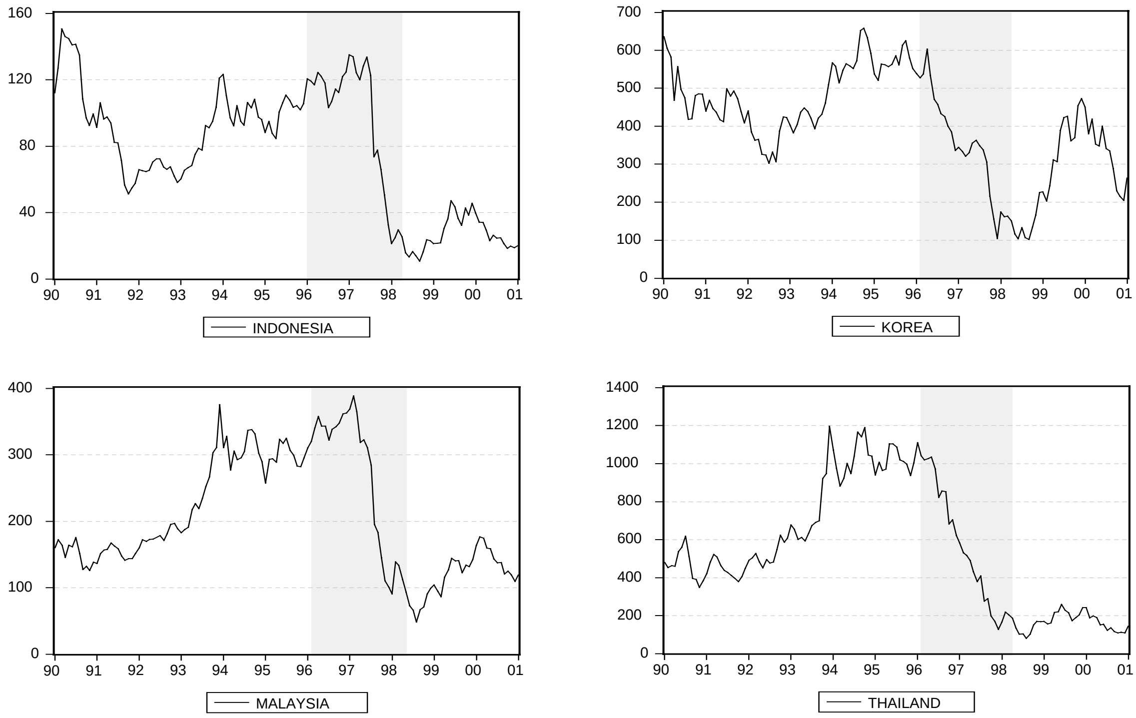


Figure 1 Stock price index of selected Asian countries, January 1990 to January 2001

There are essentially two mainstream theories that attempt to explain output volatility from a financial market perspective. The first approach concentrates on the imperfectness of the credit market (credit constraints) to explain output volatility. Kiyotaki and Moor (1997), for example, developed a model where firms' borrowing was restricted to the value of their collateral; when the value of collateral falls, the firms' borrowing becomes more constrained, thus causing a reduction in the capital available for production, and hence, a decline in output.

The second approach, generally referred to as the 'financial accelerator theory', concerns risk premiums. Under this approach, Bernanke, et. al. (2000) demonstrated that firms are faced with a risk premium which is essentially a function of their debt-capital ratio. When firms are faced with a monetary shock, there is a corresponding decline in both their production level and their net worth, leading to an increase in risk premiums which saddles them with more debt and leads to a further reduction in output. Thus, firms with higher risk premiums have higher output volatility.

The model adopted for this study is a simplified risk premium model where firms' debts are loosely constrained (at high levels) prior to the crisis (lending boom) but become tightly constrained (at low levels) during the period of the crisis (lending bust).

Firm size plays an important role in determining the magnitude of output volatility; indeed manufacturing firms' responses to aggregate fluctuations have been shown to be related to firm size, since small firms have greater difficulty in securing access to short-term financing during a period of recession (Gertler and Gilchrist, 1994). Bernanke, et. al. (1996) examined the relationship between firm size and the business cycle to solve the 'small shock, large cycle' puzzle; their central theme was that small firms tend to behave as an accelerator which actually amplifies the shock.

Oliner and Rudebush (1993) demonstrated that investments are cut back relatively quicker in small firms than large firms when there is a reduction in cash flow. In this paper, as opposed to studying the impacts of monetary policy, we focus on a lending 'boom and bust' scenario during the period of the Asian financial crisis, and construct a simple, small open economy to explain the effects of firm size on output volatility. The basic mechanism within this small economy involves large and small firms facing different lending rates, and collateral playing a major role in determining the interest rate applied to the loans.

Chang and Velasco (1998) assumed that the risk premium attached to interest rates was a function of collateral, whilst Caballero and Krishnamurthy (2000, 2001) used international and domestic collateral to explain a sharp rise in interest rates. Auernheimer and Garcia-Saltos (1999) examined a small open economy in which the borrowing interest rate depended upon the value of assets as implicit collateral, whilst Aizenman (1989) and Agenor (1997) also incorporated the idea of total debt as a determinant of the interest rates faced by domestic borrowers.

In this paper, firms use capital as collateral when borrowing from banks, with the lending rate being a function of the debt-capital ratio. In addition to their borrowing from domestic banks, we also allow firms to borrow from foreign banks. If firms have only limited access to the credit market (higher credit constraints), then they will have lower levels of bank financing and will therefore accumulate less capital, thus, they will ultimately become small firms. Given their lower collateral, small firms face higher risk premiums which ultimately lead to a much greater reduction in output when a credit crunch suddenly occurs. Our model predicts that small firm size will accelerate unanticipated shocks; therefore, output volatility is greater in countries with small firms than in those with large firms.

The remainder of this paper is organized as follows. In the next section, we present some stylized facts in the aftermath of the Asian financial crisis, followed in the subsequent section by presentation of the model adopted in this study. Thereafter, we examine the impact on output stemming from fundamental shocks. Shock contagion is introduced into the model in the penultimate section, followed, in the final section, by the conclusions drawn from this study.

SOME STYLIZED FACTS

Prior to our construction of the model, we examine some of the stylized facts on firm size and output within the manufacturing sector for four countries, Indonesia, Korea, Malaysia and Thailand. These countries are selected, based not only on our focus on the countries that were worst affected by the Asian financial crisis, but also on the fact that they were experiencing lending booms prior to the onset of the crisis, as regards their extremely high corporate debt-to-equity ratios (4:1 in Thailand, over 5:1 in Korea and even higher for Indonesia).[2]

[2] See Corsetti, et. al. (1999).

Our data demonstrates that the larger the size of the firm, the smaller fall in production output, and if we compare bank lending to the private sector in Korea with similar bank lending in the other three countries, we find that greater accessibility to the credit market can help to smooth out the reduction in output.

Firm Size

In an effort to provide a better understanding of the distribution of firm size in Asia, we list the 1997 value of firm assets for the four countries in Table 1. As the table shows, average firm assets were the largest in Korea, at US$422.78 million, followed by Malaysia with US$394.03 million, Thailand with US$317.55 million, and Indonesia with the smallest average level of firm assets, at US$263.01 million.

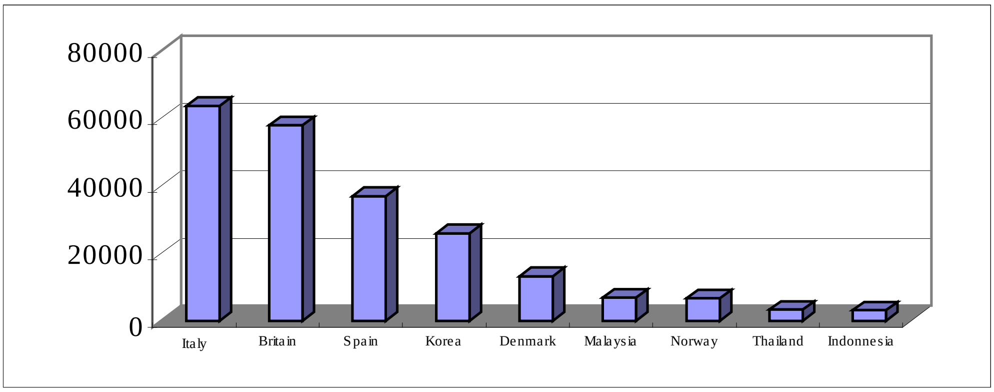
Table 1 Distribution of asset value (US$ millions) in manufacturing firms, 1997

Country	Obs.	Mean	Std. Dev.	Skewness	Kurtosis	Min	Max
Korea	772	422.78	1710.98	8.81	99.38	0.22	25667.12
Malaysia	134	394.03	681.52	3.98	21.06	1.65	4744.19
Thailand	139	317.55	750.48	5.41	36.53	12.12	6244
Indonesia	120	263.01	593.23	5.29	36.29	7.15	4807.03

Source: Hyundai Securities, KLSE, JSX, SET and Taiwan Securities.

If the sample focuses on the top ten companies in each country, we still find that Korea has the largest firm assets. Figure 2 provides details of the asset values of the top ten firms in several countries for comparison. In order to remove the scale effect, we divide the total asset value of the top ten firms by GDP and present the results in Figure 3; the ranking is, nevertheless, the same. Korean firms still have the greater asset-GDP ratio (0.54), followed by Malaysia (0.49), Thailand (0.27) and Indonesia with the smallest (0.17). As the data indicates, of our four selected countries, Korea has the largest firms.

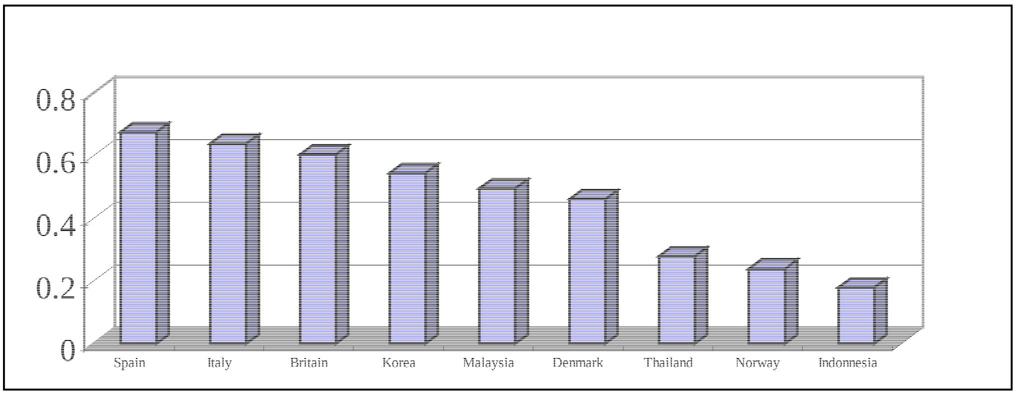
The growth of most firms in Asia depends on external financing (bank loans) which may also help to explain the variation in firm size; we therefore present details of bank lending to the private sector for the four Asian countries under examination in Table 2.



Note: * 1992 ERM crisis, and 1997 Asian financial crisis.

Source: TWTC trade report (1996).

Figure 2 Average asset values of the top ten firms



Note: * 1992 ERM crisis, and 1997 Asian financial crisis.

Source: TWTC trade report (1996).

Figure 3 Total asset values to GDP of the top ten firms

Korean firms have better access to the credit market because they are able to borrow funds from banks owned by the same *chaebol* to which they belong. From 1993 to 1997, the aggregate bank lending to the private sector in Korea was around two to three times greater than in Malaysia, Indonesia or Thailand. Such easier access to bank loans enables the firms in Korea to grow faster, and thus leads to a general increase in firm size.

Table 2 Selected bank loan terms for corporations/SMEs

Country/ Bank	Lending Rate and Calculation	Collateral	Summary of Selected Loan Terms
Asian Development Bank	The cost of ADB's fixed rate borrowing of US$, Japanese yen, or Swiss francs at the time of each disbursement, *plus* a lending spread	Lending spread associated with backed-up assets (collateral), excluding equipment, land, buildings or the project itself.	An additional repayment premium may be charged on the basis of present value of the difference between the interest rates prevailing at the time of the original loan pricing and those prevailing at the time of repayment or cancellation. Maturity is up to 15 years, including a suitable grace period. Longer maturities may be considered depending on availability of funds.
Korea (Korean Exchange Bank)	The aggregate of LIBOR for that interest rate period, *plus* margin	Margin associated with collateral; borrower's property (assets), bills and other negotiable instruments and securities.	The interest period applicable to the loan is six months. Unless otherwise agreed, the borrower repays to the lender the principal amount of the loan in one lump sum, together with all accrued interest and any other monies due on the repayment date.
Malaysia (Exim Bank of Malaysia)	Ringgit loans are at the bank's cost of funds *plus* a spread. Other currencies are based on SIBOR/ LIBOR plus a margin.	Liquid assets	Maturity is a maximum of 10 years including a grace period not exceeding 2 years. Repayment is quarterly or biannually.
Thailand (GSB)	Commercial banks' minimum overdraft or minimum lending rate, *plus* interest rate spread	Land, buildings and equipment	Loans up to a maximum of Baht 10 million ($270,000) in the case of private sector borrowers. Repayment over a maximum of 10 years.
Indonesia (Bank Rakyat Indonesia)	Fixed interest rate, *plus* margin	Fixed assets, current assets and cash flow	Maximum borrowing period is one year. If there is still work remaining on the project after one year, loans can be extended accordingly.

Source: ADB, Korean Exchange Bank, Exim Bank of Malaysia, GSB and Bank Rakyat Indonesia.

Output in the Manufacturing Sector

With the outbreak of the Asian financial crisis, all four countries experienced declining output. The production growth rates in the manufacturing sectors of the four countries are provided in Figure 4.[3] As the figure shows, there was a severe decline in production in 1998, with the maximum decrease being in Indonesia (23 per cent), followed by Thailand (15.8 per cent), Malaysia (10.9 per cent) and Korea (9.5 per cent). Production in Thailand and Indonesia fell by between 1.5 and 2.4 times as much as in Korea. Most importantly, if we compare firm size and the production response for each country, we find that the smaller the average size of firms in a given country, the greater the production response.

[3] Production growth is measured by the growth rate in the manufacturing production index.

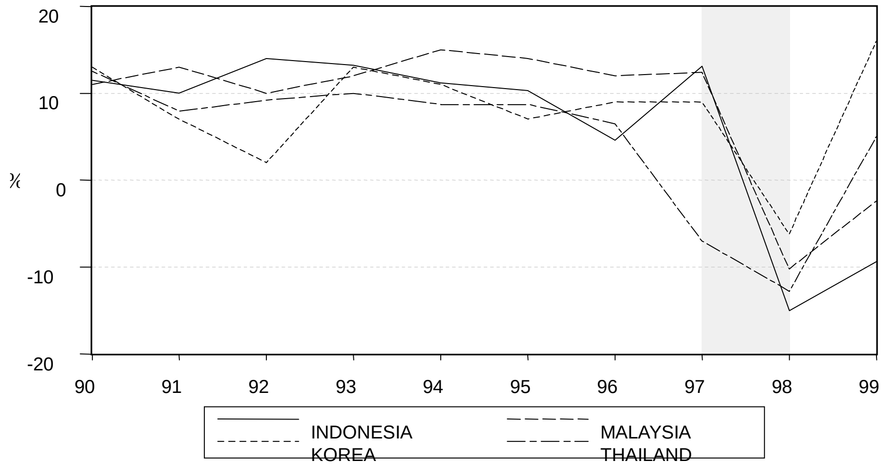
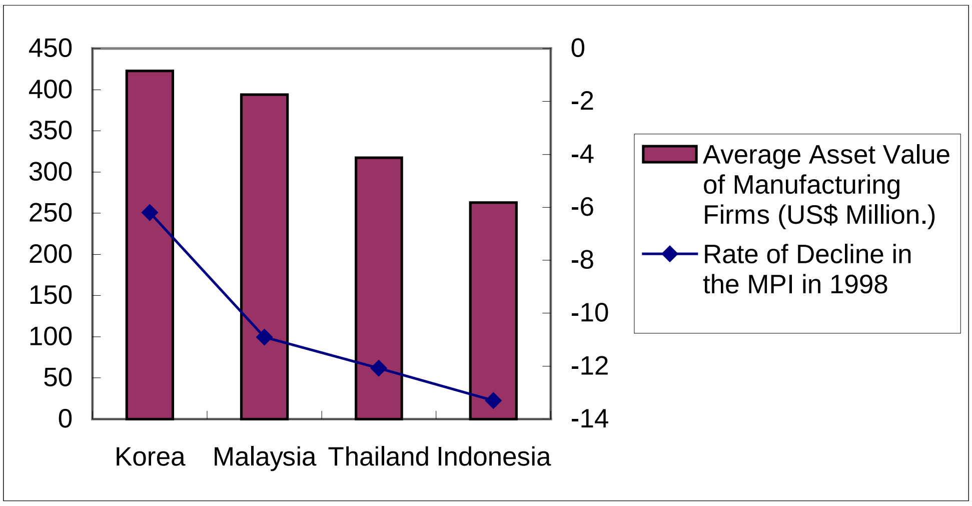


Figure 4 *Annual growth rate of manufacturing production index (MPI) in selected Asian countries*

Figure 5 combines the data on MPI growth rate (from Figure 4) with the data on firm size (from Table 1). As the figure clearly illustrates, Korea has the largest average firm size, but the smallest decline in manufacturing production output, whereas in contrast, Indonesia has the smallest firm size and the greatest decline in GDP, supporting our proposition that the greater the firm size, the lower the reduction in output.

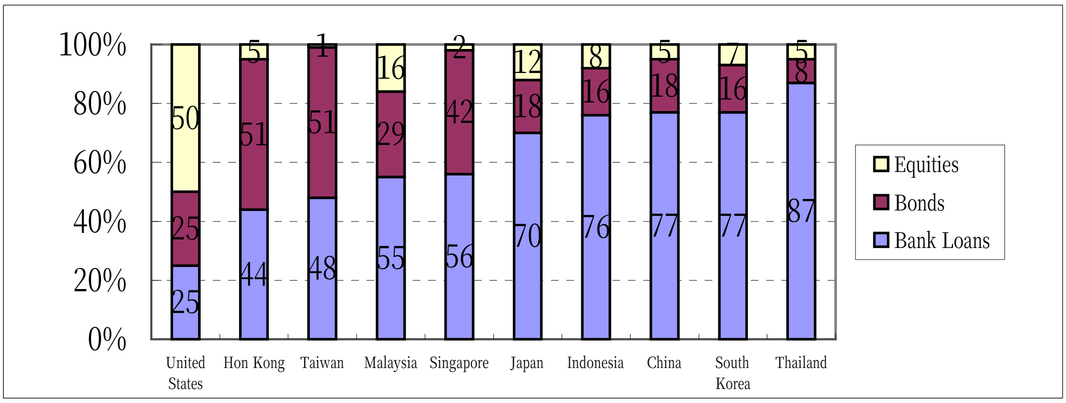


Source: TWTC Trade Report, and IFS 2000

Figure 5 *Firm size and post-crisis production response*

Linkage between Non-availability of Loans and Output Volatility

We now turn to an examination of the relationship between accessibility to the credit market and firm size noting that firms in Asia rely heavily on bank loans. Figure 6 provides firm level data for 1997 on the composition of firms' total liabilities. In the US, equity comprised of up to 50 per cent of liabilities whilst bank loans accounted for around 25 per cent; however, the situation in Asia is totally different. Equity comprised of only 5 per cent of liabilities in Thailand, 7 per cent in South Korea, 8 per cent in Indonesia and 16 per cent in Malaysia, whilst bank loans were much higher, accounting for up to 87 per cent of liabilities in Thailand, 77 per cent in Korea, 76 per cent in Indonesia, and 55 per cent in Malaysia.



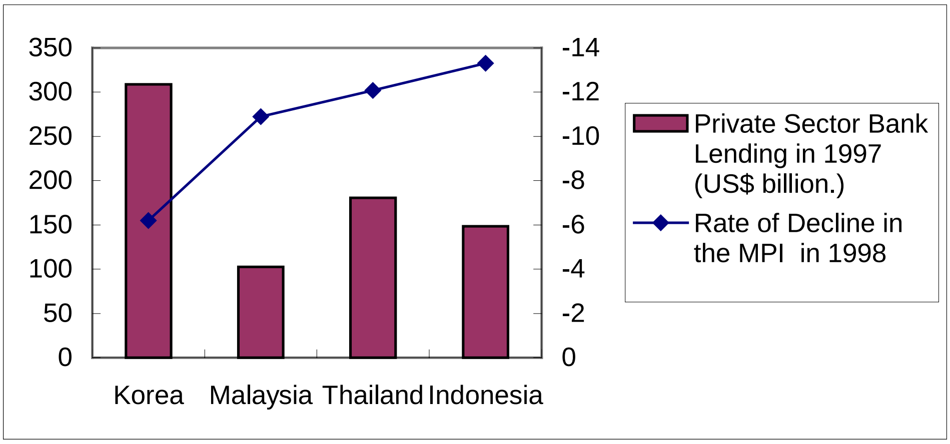
Source: Bank for International Settlement, International Monetary Fund, International Finance Corporation (IFC), International Federation of Stock Exchange (FIBV); and World Bank

Figure 6 Composition of firm's total liabilities, 1997

A loan agreement usually comprises of the principal (the sum borrowed), the maturity period (short-term or long-term loan) and the pricing method (fixed or floating lending rate); a floating lending rate may be 'prime-plus' or 'times-prime'.[4] Credit analysis is often undertaken prior to making the loan decision and one of the factors considered in the credit analysis is debt-capital ratio, which works as an indicator of a firm's repayment ability. Table 2 shows how banks decide the lending spread; the lower the debt-capital ratio, the higher the credit rating and the lower the price of the loan.

[4] Prime-plus means that the lending rate is equal to a prime rate "plus" a spread. Times-prime means the lending rate is the prime rate multiplied by a number.

Firms are, however, required to provide collateral if they wish to borrow, with examples of collateral being accounts receivable, equipment, machinery, real estate and inventory; the higher the value of the collateral, the more the banks will lend to a firm.[5] Figure 7 shows the loan availability and output reduction rate, confirming, in the case of Korea for example, that firms' production output is less volatile where there is greater bank loan availability.[6]



Source: EIU, IFS and author's calculations.

Figure 7 Bank lending and output volatility

Financial Aid from the IMF

In the aftermath of the financial crisis, Indonesia, Korea and Thailand each received financial support from the International Monetary Fund (IMF), as shown in Table 3, with IMF programs being put in place between 1997 and 1998 in order to restore economic confidence and rebuild the economies of these countries. According to the IMF's annual report (1998), the equivalent of US$35 billion was provided for economic reforms in these countries in 1997, with a further US$77 billion in financial aid being provided from multilateral or bilateral resources.

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5 See Greenbaum and Thakor (1995).

6 We consider only firms' lending from domestic banks since this was the main source of borrowing once foreign investors withdrew during the Asian financial crisis. Domestic bank lending to the private sector in 1997 was US$308.95 billion in Korea, US$102.61 billion in Malaysia, US$180.73 billion in Thailand and US$148.57 billion in Indonesia.

Table 3 International community commitments and IMF disbursements in response to the Asian financial crisis [a]

Unit: US$ billions

Country	IMF	Multilateral [b]	Bilateral	Total	Disbursement/ GDP (%)
Indonesia	11.2	10.0	21.1 [c]	42.3	13.0
Korea	20.9	14.0	23.3 [c]	58.2	6.0
Thailand	4.0	2.7	10.5	17.2	4.0
Total	36.1	26.7	54.9	117.7	-

Notes:

[a] Figures are as at July 1998.

[b] Multilateral includes World Bank and Asian Development bank.

[c] Bilateral to Indonesia and Korea are a contingent second line of defense.

Sources: IMF Annual report 1998, and IFS.

In the case of Indonesia, a further US$1 billion was approved by the IMF in mid 1998, along with another US$5 billion in multilateral and bilateral aid. However, if we focus too much on the influence of IMF loans, we run the risk of missing the bigger picture. It is clear that both South Korea and Indonesia received significant international support following the crisis, yet Korea was able to rebound strongly and get its economy back on track at a much faster pace. There is therefore no discernible link between the financial assistance provided by the IMF and the economic recovery of the countries under examination; clearly, therefore, there are other factors that were important to the recovery of these countries.

THE MODEL

We assume a small open economy comprising of six economic sectors, households, firms, retailers, domestic banks, foreign banks and the government, with this economy possessing only one tradable good. Let E_t represent the real exchange rate and define E_t as the domestic currency price of the good in relation to the foreign currency price of the good. Assuming that there is parity in purchasing power, we normalize the foreign currency price of the tradable good as 1; E_t is then equal to the domestic currency price of the good. We use ε_t to represent the depreciation/appreciation rate of E_t; i.e., $\varepsilon_t = \dot{E}_t / E_t$.

Households

We assume that households own firms and banks and they consume and make deposits in the domestic banks. Their utility function is:

$$\int_0^{\infty} \log(c_t)\exp(-\beta t)dt\,, \tag{1}$$

where c_t represents the consumption of goods and β is the subjective discount rate. The households accumulate assets (deposits) with a flow constraint of:

$$\dot{d}_t^h = r_t^d d_t^h + \Omega_t^f + \Omega_t^{b^d} + \Omega_t^{b^f} + \Pi_t - c_t\,, \tag{2}$$

where d_t^h represents deposits; r_t^d is the real interest rate paid on deposits; Π_t is the lump-sum transfer from government to households; Ω_t^f denotes dividends from firms; $\Omega_t^{b^d}$ represents profits from domestic banks; and $\Omega_t^{b^f}$ stands for profits from the foreign banks. The first order conditions imply that:

$$\frac{1}{c_t} = \lambda, \tag{3}$$

$$\dot{\lambda} = \lambda(\beta - r_t^d)\,, \tag{4}$$

where λ is the multiplier associated with the inter-temporal budget constraint, (Equation (2)). Substituting out λ in Equation (4) with Equation (3), we get the transition of c_t:

$$\dot{c}_t = c_t(r_t^d - \beta)\,. \tag{5}$$

Firms

Firms can borrow from the domestic banks ($d_t^{f^d}$) or from the foreign banks ($d_t^{f^f}$). When firms borrow from the foreign banks, their contracts are signed in foreign currency. The total debt d_t^f equals:

$$d_t^f = d_t^{f^d} + d_t^{f^f}\,. \tag{6}$$

We assume that firms can hold debt d_t^f and equity h_t; together, these are denoted as the capital stock of firms (k_t):

$$k_t = d_t^f + h_t . \tag{7}$$

We assume that firms require intermediate goods to produce final goods; however, firms do not have intermediate goods of their own, but can readily obtain them from retailers. There are numerous identical retailers, each of which is endowed with entrepreneurial skills (the ability to produce intermediate goods using resources) and has one unit of labor.[7] By using its 'skilled' labor, a retailer can produce intermediate goods out of the capital stock offered by the firm. Each retailer has Leontif technology which is capable of producing one unit of intermediate goods out of one unit of labor and one unit of capital stock. Each retailer can ultimately produce exactly one unit of intermediate good for the firm and will be paid at a wage rate of w_t. The capital stock does not depreciate and the firm accumulates new capital; hence, firms will offer all of their capital stock k_t, and pay $w_t k_t$ to retailers, in order to get I_t $(= k_t)$ units of intermediate good.

The production function of firms producing the final good is $Y_t = A I_t^{\alpha}$, where A is productivity and $\alpha \in (0,1)$. Firms reinvest new capital stock I_t from new debt d_t^f (external financing) and equity accumulation h_t (internal financing). The difference between debt and equity is that debt repayment is deducted from the firm's income tax.[8] Given this advantage, the firm may wish to use 100 per cent debt; however, there are credit constraints for firms.[9] Banks lend no more than a benchmark plus a fraction of a firm's assets; the benchmark (γ) is an unsecured loan (i.e., no collateral is required), but this will depend on the firm's established creditworthiness.

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7 See Chakraborty and Lahiri (2003).

8 This is known as the 'tax shielding' effect.

9 Aghion, et. al. (2001) presented a model where currency crisis is driven by the interaction between credit constraints and nominal price rigidity.

If firms wish to borrow more than the benchmark, the banks will demand collateral in order to reduce the risk of default; firms' assets can be regarded as collateral. These collateral loans are a fraction (λ) of the firms' assets; hence, the collateral loans to firms from the domestic and foreign banks are $\lambda_i k_t$, $i = d, f$, where $0 < \lambda < 1$, d represents the domestic banks and f represents the foreign banks. The variable λ_i measures how much access firms have to the credit market. Therefore, the firm's debt (credit constraint) is:

$$d_t^{f^i} \leq \gamma_i + \lambda_i k_t \, . \tag{8}$$

Defining $\gamma = \gamma_d + \gamma_f$ and $\lambda = \lambda_d + \lambda_f$, the credit constraint for firms becomes:

$$d_t^f \leq \gamma + \lambda k_t \, . \tag{9}$$

We assume that the credit constraints are always binding, thus ensuring that firms use both debt and equity. We use $r_t^{f^d}$ and $r_t^{f^f}$ to represent the loan interest rates of the domestic and foreign banks, respectively. According to the 'no arbitrage' condition, the difference between $r_t^{f^d}$ and $r_t^{f^f}$ is the depreciation rate of E_t; i.e., $r_t^{f^d} = r_t^{f^f} + \varepsilon_t$.

Differentiating Equation (7) with respect to the time, we can obtain:

$$\dot{k}_t = \dot{d}_t^f + \dot{h}_t = \lambda \dot{k}_t + \dot{h}_t \, . \tag{11}$$

Internal financing h_t is defined as the post-tax revenue net of debt repayment and wage payment, minus dividends:

$$\begin{aligned} \dot{h}_t &= (1-\tau)(Y_t - w_t k_t - r_t^{f^d} d_t^{f^d} - r_t^{f^f} d_t^{f^f} - \varepsilon_t d_t^{f^f}) - \Omega_t^f \\ &= (1-\tau)(Y_t - w_t k_t - r_t^{f^d} d_t^f) - \Omega_t^f \, , \end{aligned} \tag{12}$$

where τ is the corporate income tax rate in the manufacturing sector and Ω_t^f are the dividends from the firm distributed to households.

Firms maximize their value, V, which is defined by Modigliani-Miller as the sum of the discounted cash flows of the shareholder and the cash flow of the debt holder:

$$\int_0^\infty [(1-\tau)(Y_t - r_t^{f^d} d_t^f - w_t k_t) - \dot{h}_t + r_t^{f^d} d_t^{f^d} + (r_t^{f^f} + \varepsilon_t) d_t^{f^f}]\exp(-r_t^f t)dt\,. \tag{13}$$

After collection of the terms, we obtain the firms' maximization problem as:

$$V = \max_{h_t} \int_0^\infty [(1-\tau)(Y_t - w_t k_t) - \dot{h}_t + \tau r_t^{f^f} d_t^f]\exp(-r_t^f t)dt\,. \tag{14}$$

The optimal choice for firms is therefore:

$$(1-\tau)(A\alpha k_t^{\alpha-1} - w_t) = (1-\lambda-\lambda\tau) r_t^{f^f}\,. \tag{15}$$

Retailers

This section completes our discussion on retailing. We assume that retailers are identical and that a perfect competition market exists for all retailers, who are free to enter or exit the market. The number of retailers is determined by the demand for intermediate goods. The more intermediate goods that are required, the more retailers there are in the market. Each retailer earns a wage which it spends on consumption goods. Therefore, each retailer's maximization problem is:

$$\max \int_0^\infty \log(c_{i,t}^r)\exp(-\beta t)dt\,, \qquad \text{s.t. } c_{i,t}^r = w_t$$

where $c_{i,t}^r$ is the consumption for a retailer, i.

Wages are determined by the firms' optimal condition and hence are exogenous to the retailer, and each retailer consumes its total wage. Since k_t retailers are hired for the intermediate good, there will be, on aggregate, $w_t k_t$ units of final good consumed by all retailers (c_t^r); i.e.:

$$c_t^r = w_t k_t\,. \tag{16}$$

Domestic Banks

Domestic banks take deposits from households which they use to makes loans to firms. The net assets of the bank are:

$$a_t = d_t^{f^d} - d_t^h . \tag{17}$$

The flow constraint for the domestic banks is:

$$\dot{a}_t = r_t^{f^d} a_t + (r_t^{f^d} - r_t^d) d_t^h - \Omega_t^{b^d} .$$

From the flow constraint, the profit of domestic banks is:

$$\Omega_t^{b^d} = r_t^{f^d} a_t + (r_t^{f^d} - r_t^d) d_t^h - \dot{a}_t . \tag{18}$$

Banks maximize their profits by:

$$\max_{d_t^h} \int_0^{\infty} \Omega_t^{b^d} \exp(-r_t^{f^d} t) dt , \quad \text{s.t.} \quad a_t = d_t^{f^d} - d_t^h ,$$

which gives us the following maximization condition:

$$r_t^{f^d} = r_t^d . \tag{19}$$

Foreign Banks

In a world filled with the problem of moral hazard, foreign banks base their lending rates on firms' ability to repay (risk premium), with this repayment ability being measured by the firm's total debt-capital ratio (following Bernanke, et. al., 2000). The loan interest rate charged by the domestic banks is equal to the base rate (r^*) plus the risk premium. We assume that the base rate is determined by the government's monetary policy, i.e.:

$$r_t^{f^f} = r^* + (\frac{d_t^f}{k_t}) = r^* + (\frac{\gamma}{k_t} + \lambda) . \tag{20}$$

Equation (20) shows that the risk premium for non-collateral loans is $\frac{\gamma}{k_t}$, whilst the premium for collateral loans is λ.

Without loss of generality, we assume that households do not place deposits into the foreign banks;[10] therefore, the flow constraint of the foreign banks is:

$$\dot{d}_t^{ff} = r_t^{ff} d_t^{ff} - \Omega_t^{bf} . \tag{21}$$

Government

The government collects taxes from the firm and returns the tax revenue to households as lump-sum transfers. We assume that the government runs a balanced budget with the government's budget constraint being:

$$\tau(Y_t - r_t^{f^d} d_t^f - w_t k_t) = \Pi_t . \tag{22}$$

Economic Resource Constraint

Combining Equations (2), (7), (11), (12), (17), (18), (19), (21) and (22), we can determine the flow constraint of the economy in equilibrium:

$$\dot{k}_t = Y_t - c_t - c_t^r . \tag{23}$$

The Dynamic System

We now aim to build up a dynamic system in c_t and k_t. From Equations (5), (19) and (20), we can obtain the differential equation of c_t, which is:

$$\dot{c}_t = c_t(r_t^{f^d} - \beta) = c_t[r^* + (\frac{\gamma}{k_t} + \lambda) - \beta] . \tag{24}$$

From Equations (16) and (23), we can obtain the differential equation of k_t, which is:

$$\dot{k}_t = Y_t - c_t - w_t k_t .$$

From Equations (15) and (20), we have:

$$w_t = A\alpha k_t^{\alpha-1} - \frac{1-\lambda-\lambda\tau}{1-\tau}[r^* + (\frac{\gamma}{k_t} + \lambda)] .$$

[10] Allowing households to place deposits into the foreign banks merely complicates the model without changing the results.

So we can rewrite the transition of k_t as:

$$\dot{k_t} = (1-\alpha)Ak_t^{\alpha-1} + \frac{1-\lambda-\lambda\tau}{1-\tau}[(r^* + \lambda)k_t + \gamma] - c_t. \tag{25}$$

Equations (24) and (25) constitute a two-differential equation dynamic system in c_t and k_t. Within this system, the steady states are:

$$k_{ss} = \frac{\gamma}{\beta - r^* - \lambda}, \tag{26}$$

$$c_{ss} = (1-\alpha)Ak_{ss}^{\alpha-1} + \frac{1-\lambda-\lambda\tau}{1-\tau}[(r^* + \lambda)k_{ss} + \gamma], \tag{27}$$

$$Y_{ss} = Ak_{ss}^{\alpha}. \tag{28}$$

By linearizing the dynamic system around the steady states, we obtain:

$$\begin{bmatrix} \dot{k_t} \\ \dot{c_t} \end{bmatrix} = \begin{bmatrix} (1-\alpha)\alpha Ak_{ss}^{\alpha-1} + \dfrac{1-\lambda-\lambda\tau}{1-\tau}(r^* + \lambda) & -1 \\ -\dfrac{\gamma}{k_{ss}^2}c_{ss} & 0 \end{bmatrix} \begin{bmatrix} k_t - k_{ss} \\ c_t - c_{ss} \end{bmatrix} = J \begin{bmatrix} k_t - k_{ss} \\ c_t - c_{ss} \end{bmatrix} \tag{29}$$

where J is the Jacobian matrix of the differential system; the determinant of the Jacobian matrix is:

$$|J| = -\frac{\gamma}{k_{ss}^2}c_{ss} < 0,$$

hence; the system contains one positive root and one negative root and exhibits a saddle path.[11] Figure 8 presents the phase diagram of the system.

[11] See appendix 1 for detail.

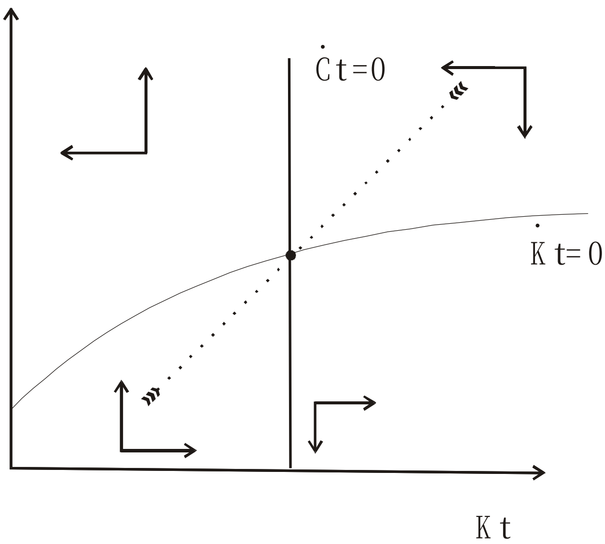

Figure 8 Phase diagram

FUNDAMENTAL SHOCKS

In this section, we study the reaction of an economy when a lending bust is followed by a temporary or permanent credit crunch. We assume that with the same assets, firms can get higher collateral loans during the lending boom, but that these collateral loans will shrink during the subsequent lending bust (tightening credit constraints). That is, λ is high during a lending boom, and declines during a lending bust.

In order to analyze the impacts of firm size on output volatility during a financial crisis, we first need to distinguish between small and large firms.

Definition of Firm Size

The size of a firm is measured by the steady-state value of its capital, k_{ss}. The higher the level of k_{ss}, the larger the firm. From equation (26), we derive:

$$\frac{\partial k_{ss}}{\partial \gamma_i} = \frac{1}{\beta - r^* - \lambda} > 0 \quad \text{and} \quad \frac{\partial Y_{ss}}{\partial \gamma_i} = A\alpha\left(\frac{1}{\beta - r^* - \lambda}\right)^{\alpha-1} > 0 \quad , \quad i = d, f \; ,$$

hence; given β, r^* and λ, the steady-state value of capital (k_{ss}) is an increasing function of γ_i, $i = d, f$. Intuitively, better credit will allow better access to unsecured loans, which will in turn help firms to accumulate more capital and produce greater output.

Hence, those firms belonging to the same *chaebol* as the banks in Korea (high γ_d) can secure higher bank lending to accumulate more capital and become large firms.

Unanticipated and Permanent Lending Bust (Fundamental Shock)

The fundamental shock during a financial crisis is referred to as a credit crunch because of the inherent weakness of the banking system, which is represented in the model by a decrease in λ_d. We first assume that the decrease in λ_d in period T_1 is both unanticipated and permanent.

$$\lambda_d = \begin{cases} \lambda_d^H & \text{if} \quad t < T_1 \\ \lambda_d^L & \phantom{\text{if}} \quad t \geq T_1 \end{cases} \qquad \text{where} \quad \lambda_d^H > \lambda_d^L .$$

Note that a decrease in λ_d will lower the value of λ. This decrease causes firms to change their debt-to-equity composition and leads to a fall in capital/output. We define Λ as the percentage change in the steady-state value of output with the change of λ:

$$\Lambda = \frac{\partial Y_{ss} / Y_{ss}}{\partial \lambda} > 0 .$$

We then compare the value of Λ for different firm sizes. Note that:

$$\frac{\partial \Lambda}{\partial k_{ss}} = \frac{\partial\left(\frac{\partial Y_{ss} / Y_{ss}}{\partial \lambda}\right)}{\partial k_{ss}} = \frac{\partial\left(\frac{\partial Y_{ss} / Y_{ss}}{\partial k_{ss}}\right)}{\partial \lambda} = \frac{\partial(\alpha / k_{ss})}{\partial \lambda} = -\frac{\alpha}{\gamma} < 0 \tag{30}$$

Equation (30) shows that the percentage change in output is smaller for firms that are large in size, and vice versa. This result is outlined in proposition 1.

Proposition 1 When a permanent shock of tightening credit constraints occurs, there will be a greater decline in output in countries with small firms.

Since output is a monotonic increasing function of k_{ss}, output behavior can be studied by the dynamics of capital. Figure 9 shows the transitions of capital and consumption for two countries with different firm sizes when there is a permanent decrease in λ. We use points A and C to represent the countries with large and small firm size, respectively, and assume that the two countries are initially at steady states.

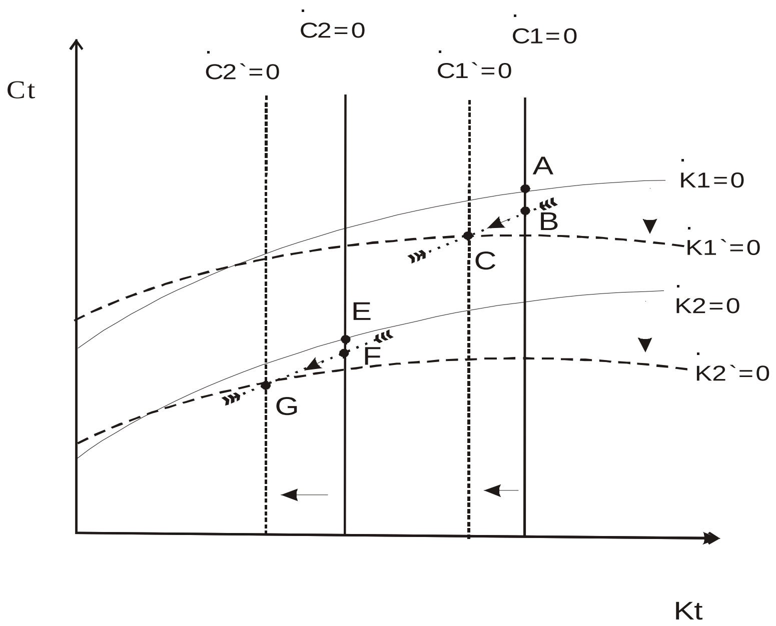

Figure 9 Permanent shock on λ

With a decrease in λ, the curve representing $\dot{c} = 0$ will shift to the left whilst the curve representing $\dot{k} = 0$ will rotate clockwise. There will be a smaller percentage change in output/capital for those countries with large firms, as Proposition 1 suggests. When a credit crunch occurs, the system will jump from point A to point B and will then converge at point C.[12] However, there will be a larger percentage change in output/capital for those countries with small firms; therefore, when a fundamental shock occurs, the system will jump from E to F and then converge at G.[13]

Temporary Lending Bust

We now turn to an analysis of output volatility when the shock of credit constraints is unanticipated and temporary. That is:

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[12] Note that depending on parameter values, point B could be above or below point A because the new saddle path could be above or below the original saddle path; however, this will only affect the transition in consumption and will not affect the transition in capital/output.

[13] Point F could be above or below point E.

$$\lambda_d = \begin{cases} \lambda_d^H & \text{if} \quad t < T_1, t \geq T_2 \\ \lambda_d^L & \quad\quad T_1 \leq t < T_2 \end{cases} \quad \text{where} \quad \lambda_d^H > \lambda_d^L .$$

Figure 10 illustrates the transitions in both capital and consumption. For those countries with large firms, the system jumps from point A to point B and then, with the tightening of credit constraints in period T_1, follows the new dynamic path.

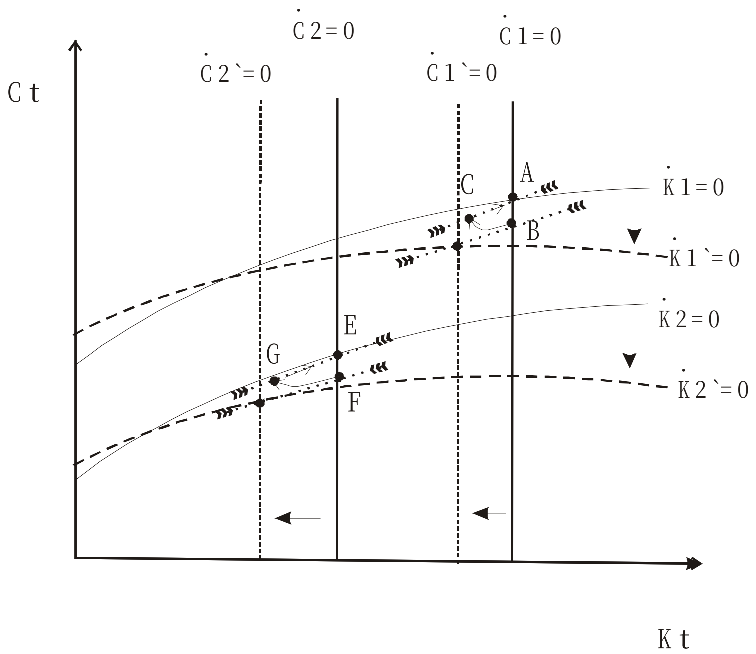

Figure 10 Temporary shock on λ

Since the shock is only temporary, starting from period T_2, the system will jump to point C and then move back along the original saddle path to converge at point A. However, for those countries with small firms, the system jumps from point E to point F in period T_1 and then follows the new dynamic path. In period T_2, λ goes back to its original level and the system will jump to point G before converging at point E. These two paths are identical, but since they start from different levels of capital, the percentage change in capital (and output) is different. Proposition 2 summarizes these results.

Proposition 2 When there is a temporary credit crunch, output volatility will be amplified by a reduction in firm size.

Proposition 2 explains why we observe a greater reduction in output in Indonesia than in Korea; during a financial crisis, tightened credit constraints lead to small firms suffering more than large firms, which in turn, leads to a greater reduction in output.

SHOCK CONTAGION AND INTEREST RATE POLICY

Given the severity of the trade competition with other Asian countries, in November 1997, the Korean government allowed the Won to depreciate by 25 per cent.[14] In this section, we analyze the impact on production output stemming from shock contagion and examine those areas where a government should be prepared to intervene when the economy is hit by financial crisis.

Shock Contagion

We have shown, in Equation (8), that the credit constraints placed upon a firm depend on the firm's creditworthiness. Given that devaluation of the domestic currency (an increase in E_t) will increase a firm's foreign debt burden, the foreign banks will lower their credit limits based on the fear of an increase in default risk. Hence, the ability of firms to repay their loans can be represented as an inverse function of E_t: $\gamma_f(E_t)$ and $\gamma_f'(E_t) < 0$.

Looking at the transition in capital, note that when the magnitude of the increase in E_t is unanticipated, the curve representing $\dot{c} = 0$ will shift to the left, whilst the curve representing $\dot{k} = 0$ will descend. Figure 11 shows the transition in k_t and c_t where the shock is temporary in nature. The system will jump from point A to point B and then move to point C before returning to point A. If the shock contagion causes fundamental changes (a temporary decrease in λ_d), then the curve representing $\dot{c} = 0$ will shift even further to the left, whilst the curve representing $\dot{k} = 0$ will rotate clockwise. The system will jump to point D, and then move to point E where the capital level is even lower, before moving back to point A.

[14] Corsetti, et. al. (1999) argued that this dramatic fall in the local currency led to an increase in Korea's foreign debt burden and a worsening of the effects of the financial crisis on the domestic economy.

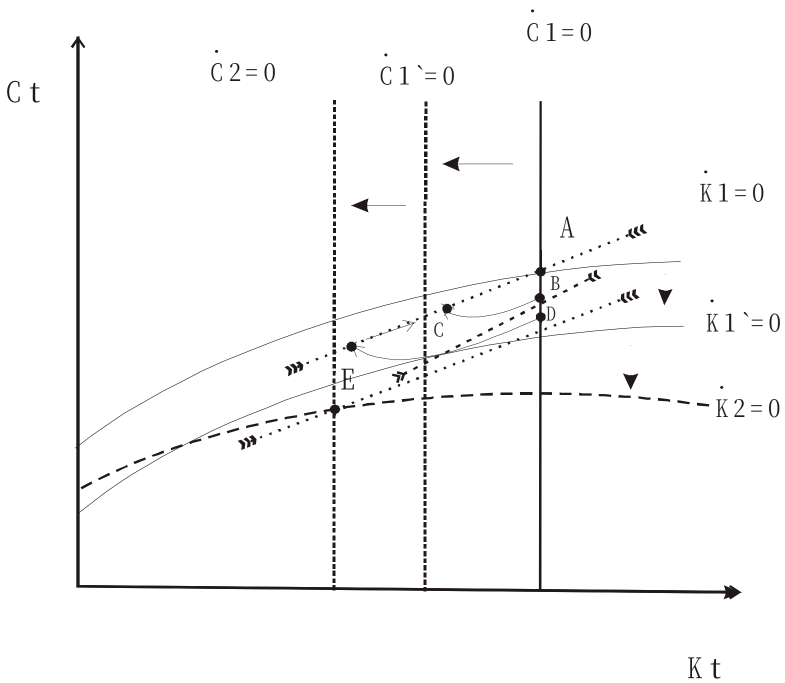

Figure 11 Temporary shock on γ

Interest Rate Policy

The decision by a government on whether to raise or lower interest rates to cope with a crisis is very difficult. Common wisdom dictates that raising interest rates will make the domestic currency more attractive to the world market, and thus help to relieve any potential run on international reserves. Vegh and Lahiri (2003) showed that higher interest rates can succeed in delaying a balance of payment (BOP) crisis; however, raising the interest rate also increases the burden on firms, because they then have to pay more for their loans.

In this paper, we argue that a government can lessen the reduction in output by adopting a policy of increasing the interest rate, r^*. We begin our analysis at the steady state of the dynamic system and examine an extreme case where interest rate policy can eliminate all of the volatility in capital/output. From Equation (20), when there is a decline in λ (or γ), the central bank should increase the real interest rate, r^*, in order to ensure that the steady-state value of capital remains unchanged.

Proposition 3 During a financial crisis, the government should increase interest rates to reduce output volatility.

If a financial crisis is the result of fundamental shocks only, the level to which the interest rate should be raised in order to eliminate output volatility can be calculated by taking the total derivative with respect to r^* and λ in Equation (20), giving:

$$dr^* = -d\lambda .$$

According to our model, if the rise in r^* is the same as the decrease in λ, then the government can totally eliminate output volatility.

If a financial crisis is the result of shock contagion, the level to which the interest rate should be raised in order to eliminate output volatility can be calculated by taking the total derivative with respect to r^* and γ in Equation (20) giving:

$$dr^* = -\frac{1}{k_{ss}} d\gamma .$$

In this case, the required rate of increase in the interest rate is a fraction of the decrease of γ with this fraction being an inverse of the steady-state level of capital.

If the shock contagion causes a fundamental change, this implies that λ is a function of γ. Then:

$$dr^* = -[\frac{1}{k_{ss}} + \lambda'(\gamma)] d\gamma .$$

Although the government may be unable to control the interest rate so perfectly, raising interest rates during a financial crisis can nevertheless lead to a significant reduction in output volatility.

CONCLUSIONS

In this paper, we present a simple, small open economy to facilitate a study of the impact of firm size on production output following the outbreak of the Asian financial crisis. Stylized facts are provided on Indonesia, Korea, Malaysia and Thailand which show that firms that are smaller in size experienced a greater reduction in production output. The main distinction between the credit markets in Korea and those in other countries is that Korean *chaebols* actually own banks, which clearly makes it much easier for those firms within the same *chaebol* to secure loans. Greater accessibility to financing allows firms to maintain their production output levels and thereby become larger. Since small firms have less collateral available to them, they suffer from greater variations in risk premiums when there is a tightening of credit constraints, thus leading to a greater fall in production output. Output volatility is therefore greater in small firms than in large firms.

The implications of these results are that the governments of Indonesia, Malaysia and Thailand should consider helping their small, loosely organized family businesses to evolve into larger and more formally organized companies. On their way towards growth, these firms can gain better financial discipline, as well as greater accountability and corporate governance, leading to a stronger economic system. This should of course be adopted as a long-term plan for economic development; nevertheless, in the short term, what a government can do in the immediate aftermath of a financial crisis is to raise interest rates so as to reduce output volatility.

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Appendix 1

The Dynamic System of the Model

The dynamic system is constituted by Equations (24) and (25). By setting $\dot{c}_t = 0$ in Equation (24), we obtain:

$$k_t = k_{ss} = \frac{\gamma}{\beta - r^* - \lambda}. \tag{A1}$$

Equation (A1) is presented as the line $\dot{c}_t = 0$ in Figure 1. Setting $\dot{k}_t = 0$ in Equation (25), we derive:

$$\dot{k}_t = (1-\alpha)Ak_t^{\alpha-1} + \frac{1-\lambda-\lambda\tau}{1-\tau}[(r^* + \lambda)k_t + \gamma] - c_t. \tag{A2}$$

Equation (A2) is presented as the line $\dot{k}_t = 0$ in Figure 1. The Jacobian matrix of this system is:

$$J = \begin{bmatrix} \left.\frac{\partial \dot{k}_t}{\partial k_t}\right|_{ss} & \left.\frac{\partial \dot{k}_t}{\partial c_t}\right|_{ss} \\ \left.\frac{\partial \dot{c}_t}{\partial k_t}\right|_{ss} & \left.\frac{\partial \dot{c}_t}{\partial c_t}\right|_{ss} \end{bmatrix}.$$

The coefficients of the Jacobian matrix are:

$$\left.\frac{\partial \dot{k}_t}{\partial k_t}\right|_{ss} = (1-\alpha)\alpha A k_{ss}^{\alpha-1} + \frac{1-\lambda-\lambda\tau}{1-\tau}(r^* + \lambda), \qquad \left.\frac{\partial \dot{k}_t}{\partial c_t}\right|_{ss} = -1,$$

$$\left.\frac{\partial \dot{c}_t}{\partial k_t}\right|_{ss} = -\frac{\gamma}{k_{ss}^2}c_{ss}, \qquad \left.\frac{\partial \dot{c}_t}{\partial c_t}\right|_{ss} = 0.$$

The determinant of the Jacobian matrix is: $|J| = -\frac{\gamma}{k_{ss}^2}c_{ss} < 0$. Hence, the system contains one positive root and one negative root and exhibits a saddle path.

Note that when γ decreases, the line representing $\dot{c}_t = 0$ will shift to the left and the curve representing $\dot{k}_t = 0$ will descend. When λ decreases, the line representing $\dot{c}_t = 0$ will shift to the left and the curve representing $\dot{k}_t = 0$ will rotate clockwise