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AN OPEN ECONOMY MODEL OF THE CREDIT CHANNEL APPLIED TO FOUR ASIAN ECONOMIES

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An Open Economy Model of the Credit Channel Applied to Four Asian Economies[1]

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Abstract

This paper provides a theoretical model of an open economy credit channel including currency mismatch and financial fragility where exporting firms have access to international credit but non-exporting firms do not. It considers the post-crisis outcome which is predicted to be dramatically different for exporters/non-exporters. We examine firms' access to external finance in four Asian economies after 1997 using a large panel of balance sheet data. Our paper demonstrates that firm heterogeneity is critical to understanding the open economy credit channel effects post-crisis since smaller and less profitable firms are indeed less likely to obtain credit than larger, export-oriented firms.

Keywords: Credit Channel, External Finance, Asian Crisis
JEL Codes: E32, E44, E51

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1. Introduction

The circumstances surrounding the Asian crisis have been a fertile ground for new models of currency crises and contagion. Among this vast literature the observations of currency mismatch in portfolios of firms and the fragility of the financial sector when faced with mismatches in their own portfolios (as capital inflows came to a 'sudden stop' c.f. Calvo, 1999) have been embedded in many of the more prominent models (c.f. Krugman, 1998, Furman and Stiglitz, 1998, Radlett and Sachs, 1998). These features have now been identified as potential underlying causes of the crisis itself and also a reason to believe that the crisis affected financial institutions and real activity in the aftermath. Krugman (1998) has stressed that because corporations' balance sheets determine access to external finance and capital flows influence the domestic currency cost of foreign currency borrowing, they are 'candidates for third generation crisis modelling'. Goldfajn and Valdes (1997) and Chang and Velasco (1998, 1999) have emphasized the dependence of corporations and financial intermediaries on foreign capital as a reason for twin crises. When a sudden stop occurs, the withdrawal of funds from banks has the potential to trigger a Diamond-Dybvig style run depleting reserves that support a fixed exchange rate (causing a currency crisis) and reducing external capital available to financial intermediaries (causing a banking crisis).

Recent papers by Cespedes (2001), Devereux and Lane (2003), Gertler et al. (2003), Choi and Cook (2004) and Cook (2004) have explored the implications of currency mismatch and dependence of domestic firms and banks on foreign currency sources. Calvo and Reinhart (2000) have termed this effect 'liability dollarization' to emphasize the significance of foreign currency denominated funds on the liability side of the balance sheet. Using sticky-price DGE small open economy models these authors simulate the real effects of a crisis in a model where an accelerator effect is driven by falling net worth as the exchange rate depreciates in an open economy. These papers extend the closed economy modelling and simulations of Carlstrom and Fuerst (1997), Bernanke et al. (2000) to an open economy. Sticky-price DGE small open economy models are natural extensions of the closed-economy financial accelerator framework, with the advantage that allows for a detailed analysis of the dynamics during the aftermath of a currency crisis. The disadvantage is that the analysis is carried out within a representative firm framework that restricts attention to average behavior ignoring the possibility that some firms might be able to cope better than others after the crisis. The open economy literature in general has very limited evidence documenting corporate finance and firm-level activity using panel data to support the simulation work of the authors cited above.[2] With this in mind we have developed an open economy model of the credit channel that is a natural extension of the closed economy version (Bougheas, Mizen and Yalcin, 2006, Diamond, 1991, Hoshi, Kashyap and Scharfstein, 1992, Repullo and Suarez, 2000, and Holmstrom and Tirole, 1997). Within this framework we can explicitly account for firm heterogeneity and thus analyze how a firm's specific characteristics (e.g. size and balance sheet details) are likely to affect its post-crisis performance.

[2] One reason for the lack of evidence thus far is the fact that balance sheet information accrues annually and until recently too few years had passed to allow meaningful exploration in panels. To our knowledge the only detailed studies of the crisis using firm level data exist for Korea by Borensztein and Lee (2003), which explores the role of financial intermediaries in providing credit to corporations, and Gilchrist and Sim (2004), which considers the impact of balance sheet factors on investment.

We expect the processes of currency mismatch, liability dollarization and financial fragility to have a heterogeneous effect on the relationships between financial institutions and firms. In this paper we seek to explain the heterogeneous effects of the crisis on firms from four Asian economies most affected by the crisis – Thailand, Indonesia, Malaysia and Korea. We build a simple theoretical model using Bolton and Scharfstein (1990) and Caballero and Krishnamurthy (2001) as building blocks, to illustrate the binding nature of credit after the crisis on firms serving domestic markets, and the unconstrained behavior of exporting firms. The dichotomy between domestically-oriented firms and exporters derives mainly from the fact that for domestic producers credit is more constrained because they have domestic currency collateral assets that deteriorate in value after a crisis and are dependent on banks that are themselves less likely to obtain funds to on-lend. Exporters on the other hand have international sources of credit that are justified on collateralized export revenues that do not deteriorate after the crisis. We make use of the Thomson-Primark database 1996-2004 to examine firms' balance sheets and profit and loss accounts to consider the post-crisis response of financial composition and real performance by different types of firms.

What our study highlights is the extent to which the high degree of bank dependence by certain types of firms in Asian economies made those firms more prone to long lasting effects of the crisis as their own creditworthiness declined and fragile financial institutions drew back loans as their sources of funds dried up. Crucially for a credit-channel model that argues that firm heterogeneity is a major factor in the response to adverse conditions, we are able to shed more light on the likely impact of a crisis and subsequent policy stance on firms of different types. Domestically-focused firms, which are on average smaller and less profitable, would not benefit from the expansion of the export market after a crisis and would be more negatively affected than larger firms with international sales. Therefore the crisis itself and the tightening monetary policy after the crisis would be likely to affect domestically oriented firms much more than exporting firms.[3]

The paper is organized as follows. Section 2 presents brief stylized facts about the Asian crisis, section 3 develops our theoretical model that is used to explore the influence of firm-specific characteristics on the variation in the composition of external finance as a consequence of the crisis. The data sources and empirical methodology are discussed in section 4 followed by the results in section 5. Section 6 concludes.

2. The Asian Crisis

The roots of the Asian crisis are now well documented. Strong investment and GDP growth was built on the vast inflows of capital to emerging markets, where the returns were much greater than those in more

[3] Radlett and Sachs (1998) and Furman and Stiglitz (1998) argue – with empirical support from Baig and Goldfajn (2002), Demirguc-Kunt and Detragiache (1997) and Goldfajn and Gupta (1999) – that tightening monetary conditions made matters worse not better post crisis. Aghion, Bacchetta and Banerjee (2001, 2004) argue that when credit supply responds adversely to increasing nominal interest rates it is better to loosen monetary policy after a crisis. We suggest that for domestically-focused firms tightening monetary conditions will have strong negative effects but access to international capital may enable exporting firms to survive and grow after the crisis. In other words there is not one story for all types of firms.

established markets. Kaminsky and Reinhart (2000), Cook (2004) and Choi and Cook (2004) illustrate the high dependence of firms and the financial sector in Asia prior to the crisis on funds obtained from US or Japanese sources.[4]

Investment in these markets may have been undertaken without a full appreciation of the risks involved. Asset markets had become overheated, fixed exchange rates were tied down by monetary policy, and these arrangements were taken as implicit guarantees of exchange rate levels. Firms borrowed heavily in foreign currency, and banks, which were poorly regulated or supervised, were imprudent in lending. The fact that domestic lending to domestic producers was justified by assets denominated in domestic currency created the potential for assets and liabilities to diverge in value particularly if the domestic currency were to devalue.[5] When commercial bank credit inflows of $50bn to the region in 1996 shifted to outflows of $21bn in 1997 the mismatch in currencies led to a substantial difference on the balance sheet between the domestic currency value of assets backing the borrowing and the debts built up by escalating commitments to loans obtained in foreign currency. This has since become a central plank in models of the crisis, as has the financial fragility of firms and financial institutions.

Post-crisis the depreciation in exchange rates and the subsequent loss of confidence caused stock market and property prices to fall, further undermining the creditworthiness of firms and financial institutions. Combined with the deterioration of capital flows, firms were unable to obtain credit due to the poor state of their own balance sheets and, because the currency crisis rapidly affected the stability of Asian financial sectors, weak financial institutions focused on restructuring and recapitalizing and reduced their lending to domestic borrowers. Monetary policy tightened in the aftermath of the crisis to counter the depreciating currency, which hit credit markets particularly hard. International agencies and commercial banks supported the countries in the post-crisis period with official assistance and loan rollovers of short-term debt and lengthened maturities of existing debts.

Post-crisis there was a sharp initial deterioration in real investment and GDP growth. For all four economies the real investment growth was negative in 1998 as was real GDP growth. Indonesia experienced a 46.6% real reduction in investment growth, similar to Malaysia at 40.5%, Thailand at 37.0%, with Korea slightly less severe at 26.8%. GDP was strongly affected by investment and fell by 14.4% in Indonesia, 6.9% in Malaysia, 8.0% in Thailand, and 5.5% in Korea according to the International Monetary Fund *World Economic Outlook*, 1998. The most severe experiences were in those countries with the most highly leveraged companies prior to the crisis – Korea, Thailand and Indonesia. Much of the corporate debt was foreign currency denominated; therefore the reversal of capital inflows with the subsequent

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4 Cook (2004) cites some 88% of syndicated bank loans to emerging East Asian countries 1992-97 were from industrialized countries denominated in dollars or yen. The borrowing by domestic banks from foreign banks in dollars or yen amounted to between 33.7 percent in Korea and 60.7 percent of total borrowing in Thailand in December 1996 according to BIS and US Treasury sources.

5 Choi and Cook (2004) point out that although asset values of firms might appreciate with a devaluation of the currency provided there are not nominal rigidities, the assets of banks, which are denominated in domestic currency will not typically appreciate.

depreciation of the exchange rate had a sharp adverse effect on investment and output. Indebtedness of the corporate sector measured by external debt to GDP jumped by 150% in Indonesia, and by 50% in Thailand and Korea, in Malaysia the jump was more modest at 20%, but over time most countries brought these figures back to pre-crisis levels. All four economies bounced back to positive growth from 1999 and much of the improvement in growth rates was due to the positive impact of the devaluation of currencies on the external sector. All four countries experienced a sharp depreciation of the exchange rate versus the US dollar in the first year after the crisis, most countries (except Indonesia which had political turmoil as well as economic woes) saw a sharp appreciation in 1998 followed by several years of mild depreciations but even after six years none of the countries returned to their original exchange rates. The current accounts as a percentage of GDP in these countries show that after the initial impact of the crisis, modest surpluses emerged for all four countries. Exports were relatively competitive while imports were more expensive and the volume of exports to imports rose favouring those companies that were oriented towards export markets.

3. The Theoretical Model

We build a model with three periods (0, 1, 2). Period 0 is the planning period when all financial contracts are agreed and initial investments are made. Period 1 is an interim period when the returns on short-term technologies are realized and creditors decide on whether to liquidate firms or provide them with new funds. In the final period, the returns of long-term technologies and those on short-term technologies that were extended credit the period before are realized and financial claims are settled. All agents are risk-neutral and they do not discount the future.

There are two countries: a small open economy (domestic economy) and the rest of the world. Let e denote the exchange rate (domestic currency units per unit of foreign currency). We assume that in period 0 the government pegs the exchange rate at $e = 1$ and that all agents expect that the peg will be maintained for the following two periods. In other words the economy is in its pre-crisis state with no prior knowledge of a crisis in the future.

3.1 Firms and Technologies

There is a continuum of firms located in the small open economy. The only difference between firms is their endowment of capital that has period 1 market value k. This endowment captures any fixed assets that firms possess in period 0. The distribution of endowments is represented by the function F and has support on the interval $[\underline{k}, \bar{k}]$ and this will be a key determinant of creditworthiness, access to credit and ultimately the ability to produce goods. There are four goods. One is a domestic input that we use as the numeraire. There is a second input that is imported from abroad and each unit costs one unit of foreign currency. The other two are consumption goods; one is consumed domestically and we refer to it as the 'domestic good' and the other is consumed abroad and we refer to it as 'exports'.

It takes one period to complete production of domestic goods. Thus, investments are made in periods 0 and 1 and revenues are realized in periods 1 and 2, respectively. To produce one unit of the domestic good requires one unit of a composite input that consists of a fraction φ of a unit of the domestic input

and a fraction $1\text{-}\varphi$ of a unit of the imported input.[6] There is demand uncertainty in the domestic market. The price of domestic goods in periods 1 and 2 is equal to p with probability π while with probability $1\text{-}\pi$ demand vanishes. The demand shocks are independently distributed across firms and time. All period 1 profits are distributed to firm owners. We assume that investment in the domestic technology is efficient; i.e. $\pi p > 1$.[7] We also assume that revenues are observed only by firm owners.[8]

Production of exports takes two periods. Our model captures two observations made in the international trade literature: that large firms are more likely to export, and given that a firm exports its export volume is positively related to its size.[9] To this end we assume that firms that wish to export need an initial investment of θ units of the domestic input. In addition each unit of export requires one unit of the domestic input.[10] We further assume that firms face capacity constraints with respect to exports that are directly related to their size, i.e. their ownership of fixed assets. Without any loss of generality we assume that for each unit of assets that they possess they can supply one unit of exports.[11] Export revenues are deterministic but the export market is still subject to uncertainty since collapse of the domestic market can trigger default to domestic and international lenders by exporters. Let p^* denote the price of a unit of exports. We assume that $\pi p^* > 1$.

3.2 Domestic and International Borrowing

We make the conventional assumption that all firms are financially constrained and they need external funds to finance production. We then make three additional assumptions that are justified by the data. First, creditors fall into two categories: domestic creditors offering short-term loans and foreign creditors offering long-term loans.[12] Second, the domestic creditors obtain their funds from foreign sources.[13] Third, following Caballero and Krishnamurthy (2001), we assume that firms can pledge to creditors two

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6 To keep things simple we assume that the technology is Leontief. It will become clear that allowing for input substitution will only complicate the model without adding any additional insight.

7 The right-hand side of this condition corresponds to costs given that the exchange rate is pegged.

8 We can allow creditors to observe revenues. What we actually need is a weaker assumption that revenues cannot be verified by third parties.

9 There is a large international trade literature that makes a positive link between entry to export markets and firm size through sunk costs c.f. Bernard et al. (2003), Bernard and Jensen (2004), Campa (2004), Helpman et al. (2004), Roberts and Tybout (1997), Roberts et al. (1997) and Tybout (2003). Empirical support for this view is cited in Girma et al. (2004) and Greenaway et al. (2006) for firms from Germany, Italy, Latin America, Spain, the UK and the US. To our knowledge the only studies that use data from East Asia is Aw and Hwang (1995) and Aw et al. (2000) that draw the same conclusions from a sample of Taiwanese and South Korean firms and Kraay (1999) on China.

10 Given that in period 1 there is no purchase of inputs for the production of exports, assuming that only the domestic input is used in the production of exports is inconsequential.

11 We do this not only to impose a limit on exports but also to relate that limit to firm size. We could instead have introduced a cost function that increases with production but decreases with k but our formulation is simpler.

12 This assumption is verified in BIS-IMF-World Bank statistics on external debt, which indicates the proportion of total external debt in the Asia Pacific region designated long term debt was 83.1% in 1990 and 73.8% in 2003. Data for individual countries reveals similar proportions.

13 Evidence from the BIS reporting banks' summary of international positions indicates that reporting banks' claims by region/country in 2005Q3 were $110.3bn (Asia Pacific), $9.9bn (Malaysia), $17.0bn (Indonesia), $5.2bn (Thailand) and $11.1bn (Korea) some of which would be to public/public guaranteed bodies including public sector banks as well as private institutions. Domestic money markets are relatively thin in the Asia-Pacific region.

types of collateral. When a firm is liquidated domestic creditors receive the proceeds from the sales of its assets, k. In contrast, foreign creditors are pledged export revenues.[14]

Exporters obtain loans from domestic and international lenders and if domestic creditors liquidate the firm then they cannot fulfil their export obligations and will default on their foreign loans. Clearly, even if there is no uncertainty directly related to the export market, foreign loans are risky. Thus, firms finance domestic sales with domestic loans while they obtain funds from abroad to finance exports. They do so because foreign lenders do not wish to participate in bankruptcy procedures and thus do not accept the domestic collateral while domestic lenders cannot verify export revenues. Nevertheless, we need to make sure that firms have an incentive to use the borrowed funds for their intended purpose; namely, to use foreign loans to finance exports and domestic loans to finance the production of goods sold domestically.

We assume that financial markets are competitive and we set the interest rate equal to zero. We, first, consider the domestic financial contract. The domestic financial environment is very similar to the one considered by Bolton and Scharfstein (1990). Given that in period 2 domestic revenues are not verified and assets are completely depreciated a firm will always choose to default rather than make repayments. However, the firm might have an incentive to make high repayments in period 1 if the creditors always liquidate the firm's assets when the firm defaults. If the firm meets its financial obligations in period 1 then the lenders offer a new loan of the same size to finance next period's production.[15]

Let R denote the period 1 repayment and q the level of production. These two choice variables must satisfy the incentive compatibility constraint $(pq - R) + \pi pq \geq pq$. Given that demand does not vanish in period 1, the left-hand side shows the firm's profits when it does not default. The first term shows period 1 revenues net of loan repayments and the second term shows the period 2 expected revenues. The right-hand side shows the firm's profits when it defaults (in that case the creditors liquidate the firm). The constraint can be simplified to

$$\pi pq \geq R \qquad (IC_d)$$

where the subscript d stands for domestic. The repayment must also satisfy the creditor's individual rationality constraint $q(1+\pi) = \pi R + (1-\pi)k$. The left hand side equals the expected value of loans and the right hand side shows expected payoffs. The constraint can be written as

$$R = [q(1+\pi) - (1-\pi)k]/\pi \qquad (IR_d)$$

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[14] Evidence from Campa and Shaver (2001) suggests liquidity constraints for exporters are less binding, and cash flow is more stable because business cycles in foreign markets are not highly correlated. Chaney (2005) suggests that this allows these firms to access more external finance for entry to export markets; Girma et al. (2004) and Greenaway et al. (2006) show that it is larger and more liquid firms that tend to enter export markets. Our model uses export revenues as collateral, which ensures the positive effects on competitiveness of a depreciation are not offset by a deterioration in foreign currency value of pledged collateral as in Chaney (2005).

[15] A key difference between the Bolton and Scharfstein economy and ours is that they consider the case of a fixed project size while we allow the firm to choose its level of production. A minor difference is that they have allowed revenues in the bad state to be positive (however, can be arbitrarily low) while we have set them equal to zero. In both cases, the only reason that lenders are willing to grant second-period loans is because the first-period repayment is sufficiently high.

Combining the two constraints we get $q(\pi(\pi p-1)-1) > -(1-\pi)k$. Notice that if p is sufficiently high the last constraint will be satisfied for any choice of output. As profits are increasing in output the optimal strategy would be to borrow as much as possible irrespective of the level of fixed assets (firm size). Therefore we impose the restriction that $\pi(\pi p-1)-1<0$ which together with the above constraint implies that

$$q \leq \frac{1-\pi}{1-\pi(\pi p-1)}k \tag{1}$$

Clearly in equilibrium the constraint will be binding. Intuitively, for high values of p the repayment can be set sufficiently high to cover the expected value of the loans; in that case a firm would be able to borrow even if it did not possess any collateral. However, this is not the case for low values of p and as result the value of collateral sets a limit to a firm's borrowing capacity.

Next, we turn our attention to the export market. Let R^* denote the repayment of foreign loans that must satisfy the following individual rationality constraint of the foreign creditor

$$R^* = [\theta + k]/\pi \tag{IR$_f$}$$

where $\theta + k$ equals the size of the loan and the subscript f stands for foreign. Note that the creditor is repaid with probability π since with probability $1\text{-}\pi$ the firm is liquidated and therefore is unable to meet its obligations in the foreign market. For a firm with assets, k, expected profits from exports are equal to $\pi p^* k - \theta - k$. Setting this expression equal to zero and solving for k we find that only those firms with a level of domestic collateral higher than

$$\underline{k} \equiv \frac{\theta}{\pi p^* - 1} \tag{2}$$

can profitably invest in the export market.

As we mentioned above, we also need to make sure that firms have an incentive to use domestic loans to finance domestic sales and foreign loans to finance exports. It is clear that firms do not have an incentive to use domestic funds, to finance exports since they already produce at capacity.[16] However, this is not the case with foreign funds which introduces moral hazard. A firm may use foreign loans to finance domestic sales but if it does so it will default in period 1. This is because if it stays active, the absence of export revenues will reveal the misuse of international funds. Misdirection of funds is not in the international lenders' interests since there will not be export revenues to repay them. The following proposition determines which firms will obtain loans from international creditors:

[16] A similar conclusion would be obtained had we assumed that they face an increasing cost function. In that case foreign lenders would be willing to finance the first-best optimum level.

Proposition 1:

a) *If* $\pi(p^* - p) < 1$ *none of the firms will receive a foreign loan, and*

b) *If* $\pi(p^* - p) \geq 1$ *only those firms with* $k \geq \underset{\sim}{k} \equiv \frac{\theta(\pi p + 1)}{\pi(p^* - p) - 1}$ *will receive foreign loans.*

Proof: The expected total profits of a firm that uses the foreign funds to finance exports are given by $\pi[(pq - R) + \pi pq] + \pi(p^* k - R^*)$ while the corresponding profits when the firm uses the funds to finance domestic sales and defaults in period 1 are given by $\pi p(q + k + \theta)$. Then the proposition follows by substituting (IR_d), (IR_f) and (1) in the two expressions and then subtracting the second expression from the first one.

Thus, there are two conditions that must be satisfied in order for foreign creditors to provide loans. The first is that the return on exports must be sufficiently high to ensure the firm can repay foreign creditors in period 2. The second is the incentive compatibility condition

$$k \geq \underset{\sim}{k} \equiv \frac{\theta(\pi p + 1)}{\pi(p^* - p) - 1} \qquad (IC_f)$$

Notice that $\underset{\sim}{k} > \underline{k}$, which implies that the incentive compatibility constraint binds to ensure the firm is not tempted by the moral hazard. Only those firms with high production capacity earn sufficiently high profits from exports to have an incentive to use the funds appropriately.[17]

3.3 Currency Crisis

Suppose that in period 1 the government is forced to abandon the peg. Let the new value of the exchange rate be $e=1+x$, so that $x>0$ captures the rate of depreciation. Our interest is in the post-crisis economy over the remainder of period 1 and period 2.[18]

The devaluation of the domestic currency will affect firms through three distinct channels. We refer to the first channel as the *financial channel*. This raises the distinction between domestic lenders that remain solvent and those that become insolvent. Suppose the devaluation causes a currency mismatch on the balance sheets of domestic creditors in the post-crisis period – this occurs because domestic banks obtain their funds from foreign investors and these liabilities (foreign loans owed by domestic banks) are denominated in foreign currency, but their assets (loans owed by domestic firms) are in domestic currency. This implies that after the unexpected collapse of the currency the value of their

[17] There are a few papers that use a similar moral hazard problem to analyze how the firm's net worth (Hoshi, Kashyap and Scharfstein, 1992, Repullo and Suarez, 2000, and Holmstrom and Tirole, 1997) or reputation capital (Diamond, 1991) determines its access to market and bank finance. In these papers firms can misuse funds by investing them in a high-risk technology that also yields some private benefits.

[18] The empirical section considers the outworkings of the post-crisis economy over several periods.

assets might fall short of the value of their liabilities, thus, driving them to insolvency. This has an implication for firms. Suppose a firm borrowed from a bank that turned out to be insolvent after the crisis. Despite the fact that the firm was successful in period 1 it would not receive any new funds in period 1 for production in period 2.

Even those firms that received funds from banks that remained solvent will be affected by the crisis. This is because the devaluation of the currency increases production costs because of the higher cost of imported inputs. Given that the size of the second period loan is fixed in domestic currency units firms have to cut down production and thus profits.[19] We refer to this second channel as the *cost of production channel* because it has some similarities with the Barth and Ramey (2001) *cost channel*. In Barth and Ramey (2001) a tightening of monetary policy has supply-side implications for firms, which must borrow at higher interest rates, and consequently produce at higher cost. In our model the currency crisis has a supply-side implication because a devaluation increases the cost of imported inputs and with a fixed loan size reduces production levels.

A third *competitiveness channel* refers to the effects of increased competitiveness as the devaluation makes exports cheaper and improves creditworthiness for firms that have access to export markets. In what follows, we examine in detail the effects of each of these channels in the post-crisis period.[20]

We first notice that a proportion $1-\pi$ of all firms would have been liquidated with the domestic creditors receiving k, whether or not a crisis occurred. These firms would have failed even if the peg had been maintained and from now on we concentrate only on those firms that did not fail. We assume that a proportion z of all firms borrowed funds in period 0 from banks that were forced to insolvency by the depreciation. We further assume that the distribution of initial endowments of this set of firms is identical to the distribution for all firms.

We first examine the impact of devaluation on the firms that received loans from solvent banks and, for the moment, we restrict attention to those firms with $k < \tilde{k}$; i.e. firms that do not produce exports and hence are influenced only by the first and second channels. The domestic contract is designed so that, given that the peg is maintained, these firms are indifferent between repaying R to domestic creditors and defaulting. The devaluation of the currency implies that the unit cost of the domestic good has risen to $1+(1-\varphi)x$. Given that the size of the second loan is fixed at q, period 1 production and hence profits must decline. Indeed, the new production level is equal to $\frac{q}{1+(1-\varphi)x}$ and the corresponding decline of profits is equal to $pq\left(\frac{(1-\varphi)x}{1+(1-\varphi)x}\right)$. The above argument implies that firms will default on their domestic loans unless creditors accept to renegotiate.

[19] Given that banks face a liquidity crisis they are unable to adjust the size of the loan.

[20] Given that our analysis is carried within a partial equilibrium framework it ignores any indirect effects of devaluation on prices.

Proposition 2: *Consider those firms that received loans from solvent banks with endowments* $k < \underset{\sim}{k}$. *If* $\frac{1-\pi}{1-\pi(\pi p-1)}\left(1-p\pi\frac{(1-\varphi)x}{1+(1-\varphi)x}\right)>1$ *the contract will be renegotiated; otherwise the firm defaults and liquidation follows.*

Proof: When creditors liquidate a firm they receive k, while if they renegotiate their return will be equal to $R-pq\frac{(1-\varphi)x}{1+(1-\varphi)x}-q$. The first term equals the initial agreed repayment, the second term equals the amount by which the repayment must be reduced (which equals the decline in profits) in order to induce firms to stay in business and the last term is the size of the new loan. The proposition follows by substituting the equilibrium solutions for R and q in the above expression and rearranging.[21]

Next, we turn our attention to those firms that produce exports among those firms who received loans from solvent banks, which also benefit from the third channel. We make two observations. First, these firms benefit from the abandoning of the peg because the domestic currency value of exports increases. Second, if export profits are sufficiently high then the threat of default is not credible. We can show the following:

Proposition 3: *Consider those firms that received loans from solvent banks with endowments* $k \geq \underset{\sim}{k}$. *If* $\underset{\sim}{k} \geq \frac{\theta}{\left[\pi p^*(1+x)-1-p\frac{(1-\varphi)x}{1+(1-\varphi)x}\left(\frac{1-\pi}{1-\pi(\pi p-1)}\right)\right]}$ *loans will not be renegotiated.*

Proof: The fixed cost θ means firms' export profits are increasing at an increasing rate in k. Export profits of the smallest firm capable of producing exports are given by $\pi p^*(1+x)\underset{\sim}{k}-\theta-\underset{\sim}{k}$. If these profits are higher than the decline in domestic profits (which are increasing at a constant rate with k) then firms will not have an incentive to default.

For these firms profits might either increase or decrease with the abandoning of the peg because domestic profits decline while profits from exports increase. Nevertheless, overall profits increase with firm size.

Now, consider those firms that received loans from insolvent banks. These are firms that will not receive new loans in period 1. It is clear that firms that do not produce exports will default and hence will be liquidated. For firms that produce exports we have the following proposition:

Proposition 4: *Consider these firms that received loans from insolvent banks with endowments* $k \geq \underset{\sim}{k}$. *There exists a cut off level for the value of assets* $\hat{k}$ *such that those firms with* $k \geq \hat{k}$ *repay their loans in period 1 and are not liquidated while those firms with* $\underset{\sim}{k} \leq k < \hat{k}$ *default and are liquidated.*

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[21] Notice that the proposition is automatically satisfied when x = 0; i.e. under the peg. Also, the higher the import content of production costs, the higher is the likelihood that firms will default.

Proof: A firm that defaults avoids making the repayment R but sacrifices export profits. Therefore a firm defaults if and only if $\pi p^{*}(1+x)\underset{\sim}{k}-\theta-\underset{\sim}{k}<R$. The proposition follows after substituting for R in the above expression and rearranging terms.

These firms that received loans from insolvent banks will cease supplying the domestic market. The firms that will remain active after the currency crisis are firms that are sufficiently large and profitable and will service only the foreign market.

3.4 Predictions

In a world without a currency crisis a proportion $1\text{-}\pi$ of all firms would have faced liquidation by failing to meet their financial obligations with domestic creditors. In this section we make predictions about the consequences of a crisis in the post-crisis period for firms of different types. Proposition 2 indicates that abandoning the peg pushes firm failures up to $1-\pi+\pi zF(\hat{k})$. The proportion of non-exporters that survives is equal to $\pi(1-z)F(\underset{\sim}{k})$, while the proportion of exporters remaining active is equal to $\pi[z(1-F(\hat{k})+(1-z)(1-F(\underset{\sim}{k})]$. The former can renegotiate their loans but the abandoning of the peg forces them to cut down their production level, the latter are relatively large exporters that received funds from eventually insolvent banks and exporters that received funds from eventually solvent banks.

A critical linkage in our model is the connection between access to external finance and production in the next period. Failure to obtain sufficient credit will result in curtailed output: some firms will not produce output at all, others will obtain only short-term domestic finance to produce domestic goods, while others will obtain domestic and long-term international finance to produce domestic and export goods. This will be accentuated by the post-crisis conditions such as domestic demand and export demand influenced by improved competitiveness, but also by creditworthiness of the firm as indicated by collateral assets, liquidity, solvency, profitability and indebtedness.

To isolate the effect of credit constraints from demand effects we consider the ratio of short term to total debt following Kashyap, Stein and Wilcox (1993) and Oliner and Rudebusch (1996). We examine sales growth to indicate the level of activity of the firm following Bond et al. (2003). We expect to find that creditworthiness and macroeconomic conditions jointly influence access to credit and activity of the firm, but the type and scale of finance (and hence by implication activity) will be driven by the size of the firm. Our theoretical model predicts that the firm's capital is a critical factor in determining whether a firm is more likely to survive, produce domestic goods or export. This leads us to make three predictions from our model as a result of the crisis:-

P1: *The number of firm failures increases. We do not observe failure directly, but our model predicts the types of firms more likely to fail are those indicated to be less creditworthy and relatively small. These will obtain less long-term credit and will have lower sales growth.*

P2: *Our model indicates that relatively small and less profitable firms that focus on the domestic market face falling demand, worsening balance sheets, and find their external funding is reduced (an implicit accelerator mechanism). The net effect on the short-term debt-total debt ratio is ambiguous, but since firms obtain less external finance sales growth should fall.*

P3: *Relatively larger firms are more likely to meet the criteria to export (sufficient assets and production capacity) and will benefit from improved competitiveness, larger profits, stronger balance sheets and therefore have greater access to long-term credit and higher sales growth.*

Therefore, in common with the closed economy credit channel models, we expect to see financially weaker firms obtain less long-term credit as a proportion of total credit offered, but some will not be offered credit at all and will fail. In distinct contrast to the closed economy models, however, finance may not be offered even to creditworthy firms if financial intermediaries cannot obtain the funds to on-lend and this will particularly affect domestic firms borrowing from domestic banks. This means that even for an improvement in creditworthiness for smaller domestically-oriented firms there may be less improvement in their short-term debt to total debt ratio and sales growth compared to exporters. Exporters have the edge because they have favorable terms on which to trade in international markets and international lenders that accept the collateral they can offer. These features should be apparent in the comparison between the response to creditworthiness indicators in debt structure and sales growth for smaller and larger firms.

4. Data and Methodology

In this paper we make use of data from the Thomson-Primark database from 1996-2004 with reference to four countries that were affected in the aftermath of the Asian crisis – Korea, Malaysia, Indonesia, Thailand. We use a dynamic panel data framework to explain manufacturing firms' debt structure i.e. the ratio of short-term debt in total debt and their sales growth using two main sets of variables, which indicate the macroeconomic conditions post-crisis and firm-specific creditworthiness. Debt structure reveals whether a firm obtains a larger or smaller proportion of short-term debt in total debt (a higher or lower ratio), which we use to indicate the extent to which it finds external finance more difficult to access compared to firms with lower ratios. Sales growth is a measure of the real activity of the firm, which ought to be strongly related to access to credit, but with a lag.

The empirical model used in the estimations is:

$$y_{it} = \sum_{k=1}^{p} \alpha_k y_{i,t-k} + x_{it}\beta_1 + w_{it}\beta_2 + \eta_i + v_{it}\,; \qquad t=q+1,...,T_i; \qquad i=1,...,N$$

y_{it} is the dependent variable (the short-term debt ratio or sales growth) and $y_{i,t-k}$ represents up to p lagged values of this variable. x_{it} is a vector of exogenous variables including GDP growth, the interest rate and exchange rate levels to measure macroeconomic conditions after the crisis that affect all firms by driving demand for goods and credit. w_{it} are endogenous variables measuring the creditworthiness of each firm based on observable balance sheet data including collateral asset values, profitability,

liquidity, solvency, cash flow and debt to asset ratios. Time dummies are unnecessary since macroeconomic variables capture time varying factors for all firms, η_i and v_{it} are individual specific effects and disturbance terms respectively.

We estimate the dynamic panel model described above by employing the differenced Generalized Method of Moments (*GMM*) following Arellano and Bond (1991) and Bond (2002). The macroeconomic variables enter as levels since they have no firm-specific effects, but endogenous variables are replaced with suitable instruments using lagged values up to t-3. Before we estimate our empirical model we reduced the impact of outliers by trimming 0.5 percent of observations from upper and lower tails of the distribution for profit, debt, solvency, cash flow and the liquidity ratios and sales growth.[23] To ensure that we have accurate yearly data we have adjusted the balance sheet reports for the date of issue during the year. Most firms report information on their balance sheets and profit (loss) accounts by the end of December (financial year-end) but some report at the end of March or other months. We adjust all our firm-specific variables from financial years to calendar years i.e. if a firm reports in March variables are re-calculated using data from two years in proportions 25:75. Table 1 provides the number of manufacturing firms across years and countries.

We report several results to evaluate our theoretical framework. First, we report results for the whole sample of firms in each country to establish whether the relationship between creditworthiness indicators and macroeconomic variables is consistent with what we would expect. Second, we report results where all variables are interacted with a dummy indicating whether a firm is relatively small or large.[24] The interaction term plays a crucial role in separating the effects of particular variables on smaller and larger firm types that the theory suggests are likely to behave differently in the post-crisis period. This allows us to compare the responses of debt structure and sales growth in two ways. We are able to observe whether the differences are significant by comparing whether there is a significant coefficient on interaction terms for small (or large) firm types – a significant interaction term indicates that the response by firms that are small (or large) differs from the response of the rest of the sample. Depending on the sign we can then establish whether the response to creditworthiness or macroeconomic variables is greater or lesser for a firm of a particular type. We can also compare the responses for firms that do not belong to a particular type to cross check whether our findings are upheld. For example, we might find evidence that the response to creditworthiness indicators for small firms is less than that for large firms as our theory predicts due to larger and significant coefficients for small firm interaction terms v. large firm interaction terms in columns 2 and 3 of Tables 3 and 4, respectively. But this should also be confirmed by the finding that the response of 'not small firms' is greater than the response of 'not small firms' in the same columns of each of the Tables.

The validity of our estimated model is determined by m_1 and m_2 statistics which are computed to test for the first and second order correlation. We would expect a negative first order serial correlation (m_1) but no evidence of second order serial correlation (m_2) in the first differenced error terms when we have

[23] Tangible assets-total asset ratio and maturity take values in the range of zero to one hundred; therefore these variables are not trimmed.

[24] Firms are classified into categories based on size using lower 25 percent/upper 25 percent of the appropriate distribution for real assets in the period before 1997 for all countries.

serially uncorrelated error terms. We also report the Sargan test of overidentifying restrictions, which is widely used to test for the suitability of the instruments in the GMM procedure. It is asymptotically distributed as chi-square with as many degrees of freedom as overidentifying restrictions, under the null hypothesis of the validity of the instruments. The Sargan statistic calculated from the two-step procedure is suggested for selecting instruments and specifying the model (Arellano and Bond, 1991) as it is heteroskedasticity-consistent under the two-step GMM procedure.

5. Empirical Results

5.1 Debt Structure

Our data shows that smaller firms receive a larger proportion of debt in short-term loans compared to larger firms for all four countries in every year. On the basis of our earlier predictions we would expect the maturity of the debt to respond to indicators of creditworthiness after the crisis, and for larger and more profitable firms we expect the ratio of short-term debt to total debt to fall more with an improvement in creditworthiness indicators than for small firms. This is because the large firms have more favorable terms to sell their goods, and access to international creditors in contrast with domestically oriented firms. The results in Table 3 are reported country-by-country and respective columns in each panel show the estimated responses of debt structure to variables when the regression is based on the whole sample of firm observations in column 1, and results for small and large firm types in columns 2 and 3. The results separate the effects of the post-crisis macroeconomic conditions from the effects of creditworthiness indicators for firms of each type. We are able to confirm the predicted effects from the theoretical model in our data.

Turning to the results for the whole sample of firms for each country, we observe that the structure of debt maturity is persistent, so that the lagged dependent variable is a significant explanatory variable for the current short-term debt to total debt ratio in our empirical model. The degree of persistence varies from country to country with Malaysia showing the greatest persistence and Korea the least, and Thailand and Indonesia in between, most likely for institutional reasons. In all cases the lagged dependent variable is strongly significant at the one percent level and the degree of significance does not alter for samples selected by firm type in any country.

Although debt maturity is persistent, balance sheet characteristics that indicate creditworthiness also have the expected effects on the maturity structure of firm-level debt in each country as predicted. We observe significant negative coefficients on liquidity, collateral, and solvency variables in column one for all four countries consistent with the argument that these variables are important determinants of access to credit. A firm with deteriorating balance sheets (poorer liquidity, collateral, and solvency) will experience an increase in the proportion of short-term debt to total debt, other things equal, but a firm with improving financial health (higher liquidity, collateral, and solvency) will have access to longer maturity debt causing the ratio to decrease. This prediction is supported by Campa and Shaver (2001), Girma et al. (2004) and Greenaway et al. (2006) who find better financial health is associated with exporting, although the latter make a distinction between continuing exporters and new exporters, finding that it is existing exporters that display this relationship.

The ratio of total debt to total assets is a further indicator of financial health: the higher the total debt to total asset ratio the more leveraged is the firm in relation to its assets. Here, deterioration in financial health results in a decrease in the proportion of shorter term maturity debt as the total debt to total asset ratio falls. Hence firms with a higher ratio of liabilities to assets are able to obtain fewer additional loans even at short maturities. Greenaway et al. (2006) found more leveraged firms were less likely to export because they were more likely to be financially constrained, which is consistent with our finding that more highly indebted firms will tend to obtain less short-term credit other things remaining equal. It is also consistent with the idea that successful firms may be more highly leveraged yet will obtain loans with longer maturities because they have good prospects.[25] We observe the expected significant negative coefficients in our sample for Thailand, Indonesia and Korea and only for Malaysia do we find negative but insignificant coefficients, liquidity excepted. This is possibly due to the fact that capital controls mitigated the effects of currency depreciation on firms and financial institutions. This in itself is a test of our theoretical model since the predictions we derive are driven by depreciation of the currency that provide opportunities for exporting firms and threats for non-exporting firms. In Malaysia, exporters did not experience significant balance sheet influences on debt maturity through the exchange rate channel because capital controls were in place (the nominal exchange rate remained unchanged from 1999-2004 and therefore there was not the same real exchange rate adjustment found in other countries, see Table 2).

There is some evidence of significant macroeconomic effects on the ratio of short-term debt to total debt. The coefficient on GDP growth rate is negative and significant for Thailand and Indonesia and marginally significant at the 10% level for Malaysia; the magnitude of these effects is large. All of the countries concerned experienced large nominal and real GDP growth rates in the period after the crisis. Lending rates at all maturities also rose, and these had the opposite effect on maturity structure, but this is significant only for Korea and Thailand. Only in the case of Thailand is there direct evidence that the real exchange rate movement shifted the maturity structure of debt. In this case the initial fall in the real exchange rate would have meant a larger proportion of short-term debt was held, but as the real exchange rate improved this would have been reversed to some extent. There were no significant direct effects for other countries.

We now turn to the comparison of the response by firms of different types in the post-crisis period. Distinguishing between small v. large firms that are most likely to be domestically and internationally oriented respectively reveals how these firm types were affected in the aftermath of the crisis. The second and third columns of Table 3 report the comparative effects of creditworthiness indicators and macroeconomic conditions for small and large firm types. As explained earlier, the significance of the interaction term indicates whether the response for a firm of the particular type differs from the response

[25] There are two other potential factors that influence this ratio. To the extent that firms hold foreign currency denominated debt there can be an increase in the ratio that reflects the upward revaluations of debt as a result of currency depreciation. Equally, should asset values fall with loss of confidence this too will increase the ratio. There is some evidence that the impact of the crisis caused the total debt to total asset ratio to increase initially, and subsequently to fall. Only in Korea and Thailand did the ratio fall below levels seen pre-crisis; for Indonesia and Malaysia the debt to asset ratio increased steadily after the initial jump. We seek to control for these effects by allowing the exchange rate to enter the empirical model as a separate variable since it reflects revaluations of debt in domestic currency terms and capital flight.

for the rest of the sample. Also, by comparing the coefficients for firms not of the particular type e.g. not small v. not large we can confirm the results from the interaction terms.

In all cases the signs of the variables for 'not small' and 'not large' firms remains unchanged in comparison with column 1, although the magnitudes differ because the response for firms that are small (or large) are omitted. The significance of the interaction term indicates whether the response is different from the remainder of the sample, and the sum of the coefficient and the interaction term indicates the response by a firm that is small (or large).

We find that there are strongly significant interaction terms on indicators of creditworthiness for small firms in Indonesia and Korea, but not for Malaysia or Thailand.[26] There are few significant interaction terms for large firms in any of the four countries considered.

Our model predicts that smaller firms with a domestic orientation for their goods and domestic finance are likely to have been offered less debt or a shorter maturity of debt increasing the maturity ratio in the post crisis period. Larger international oriented firms' debt is predicted to increase and maturity to lengthen as export conditions improve post crisis. These results are confirmed by our model, but the comparison of responses to small v. large firms indicates that for small firms the coefficients on creditworthiness indicators are less negative than for large firms. This suggests that these firms do obtain proportionally more short-term debt to total debt when their creditworthiness declines, but also they experience less improvement in the debt structure i.e. longer debt maturity as long-term debt takes a greater share of total debt with an improvement in creditworthiness indicators compared to large firms. For the same improvement in liquidity, solvency, collateral or debt to asset ratios small domestically-oriented firms would obtain less of an improvement in access to long-term debt compared to larger exporting firms. This is exactly what our model predicts since smaller firms do not have access to export markets or international finance and therefore face a double hardship of deteriorating domestic goods markets and constrained lending from domestic financial institutions.

Comparison of the responses for 'not small' firms and 'not large' firms shows that in the majority of cases the response to creditworthiness indicators is greater for the 'not small' firms versus the 'not large' firms for Indonesia and Korea.[27] This is a confirmation of the previous finding and support for the model. The greater sensitivity of lenders to large as opposed to small firms' balance sheets reverses a conventional finding in empirical closed economy credit channel studies (c.f. Gertler and Gilchrist, 1994, Gilchrist and Himmelberg, 1995). But the reversal of the argument is entirely consistent with the theory and evidence on access to export markets reported in Bernard et al. (2003), Bernard and Jensen (2004),

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[26] Malaysia and Thailand exhibit exceptional circumstances making comparison between small and large firm responses more difficult. Malaysia shows very little response to balance sheet effects for small or large firms because exchange controls probably limited any beneficial effects of depreciation after the initial impact of the crisis as mentioned earlier. Thailand experienced exceptionally fragile conditions among financial institutions which were compelled to merge with international banks or consolidate. Thus neither large nor small firms were afforded access to substantial funds from these institutions whatever their creditworthiness or market focus and instead firms sought alternative sources of external finance. The Bank of Thailand reports annual data on private sector securities issues jumped from bhat 213,971m in 1996 to bhat 431,832m in 1998 and bhat 871,453m in 1999 before stabilizing around figures closer to the 1998 levels in subsequent years. The majority of these securities issues were shares and medium-term debentures issued by larger firms. In other words, successful firms sought non-bank external finance.

[27] Again the comparison of Malaysia and Thailand proves difficult for reasons explained earlier.

Campa (2004), Girma et al. (2004), Greenaway et al. (2006), Helpman et al. (2004), Roberts and Tybout (1997), Roberts et al. (1997) and Tybout (2003). We would expect a larger firm size and a healthy balance sheet to be key determinants of access to export markets, and therefore improved terms for credit in our model also. The domestic focus of small firms' activities compared to the international export focus of larger firms makes size a key distinction as far as lenders are concerned in open economy credit channel models but this is also closely linked to profitability. Small firms in Asia would have had poor prospects for the use of funds, and since the domestic market was weakened by the crisis they would have had low profitability and unhealthy balance sheets.[28] The reverse would have been true for large firms with a focus on export markets, and in addition these firms would have had collateral assets acceptable to international lenders i.e. export revenues. Hence there were likely to be few incentives for financial intermediaries to lend long term to small firms but greater incentives to lend to large firms. Also, since large firms borrow from domestic and international lenders, and international lenders are unlikely to be affected by the shortage of funds that affects the domestic lenders, there is less prospect of a supply-side credit crunch for larger firms. Thus, when conditions improve for the exporters, following a devaluation, international lenders are likely to supply longer maturity funds to those firms with healthy balance sheets.

The reversal of the conventional result is not restricted to small and large firms. The results are repeated for low v. high solvency ratio firms, low v. highly indebted firms, low v. high collateral asset firms, more profitable v. less profitable and low v. high liquidity firms (although the results are not reported here) with consistent negative signs on collateral, liquidity, solvency, profitability and debt variables.

5.2 Sales Growth

The theoretical model suggests that the currency crisis will have similar repercussions for the activity of firms as it does for firms' access to external finance. The initial effect of the crisis is likely to cause a deterioration in conditions and an adverse effect on sales growth with a lag. This will be seen through the impact of macroeconomic conditions (economic growth, interest rates, and the real exchange rate) and through indicators of creditworthiness from the balance sheet. All firms are expected to find conditions worsen initially, but for some types of firms – the export-oriented firms – the depreciation of the currency after the crisis is likely to improve real sales growth.

The results for the whole sample of firm observations are reported in column 1 in Table 4, and results for small v. large firms in columns 2 and 3. Sales growth is highly cyclical over the post-crisis period as the negative coefficient on lagged sales growth demonstrates. Controlling for the cyclicality, we examine the influence of balance sheet and macroeconomic variables for the four countries that we examined.

Looking at the whole sample of firms for each country including smaller and larger firms the net effect of balance sheet variables and macroeconomic conditions is consistent with results from the previous section. Sales growth is positively influenced by the scale of the firm, since the coefficient on logarithm of real assets is strongly significant and positive. The debt to asset ratio has a consistent negative and

[28] Dollar and Hallward-Driemeier (1998) on a survey of 1200 Thai firms found that it was the weakness of the domestic market that was responsible for reduced borrowing.

significant influence over sales growth for all countries examined except Thailand, where it is insignificant. Firms with higher leverage are less likely to export because their financial health is poor (c.f. Campa and Shaver, 2001). Other creditworthiness indicators play a more peripheral role, but macroeconomic indicators such as GDP growth had a positive impact on sales growth as we might expect, and the level of the interest rate, which was generally much lower in the post crisis period than immediately before and after the crisis, had a positive effect on sales growth. [29] Movements in the real exchange rate had a negligible direct effects on sales growth in Malaysia, where capital controls were implemented, and Thailand. In Indonesia, where there was a substantial fall in the real exchange rate and a subsequent depreciation driven by political events, the effect of the prolonged improvement in competitive terms was a boost to sales growth as illustrated by the improved export performance (Table 2). In Korea by contrast the depreciation of the currency was short lived, and although the real exchange rate settled at a lower level it had a negative direct effect on sales growth offset by the positive indirect effects derived from lower interest rates and higher output growth.

Comparing the interaction terms to determine the response of sales growth to creditworthiness and macroeconomic indicators, we find that there is no evidence of a significantly different response by small or large firms. But comparison of the responses of 'not small' and 'not large' firms shows that the coefficients are generally larger for 'not small' firms suggesting that responses to firm size, GDP growth and interest rates were greater for firms that are regarded as 'not small', consistent with our model. The differential between the coefficients for the logarithm of real assets variable (size) shows that there is a very significant benefit to greater size, and this is compatible with the observation that larger firms have access to export markets and international sources of finance. The fact that sales growth responds to this variable more than to others, and the magnitude of the differential between coefficients for 'not small' and 'not large' firms, indicates that scale as an access to international markets is more important than other indicators of creditworthiness that might allow a firm to access domestic (but not international) financial markets.

6. Conclusions

This paper presents a simple theoretical model of an open economy credit channel with transmission channels driven by currency mismatch between assets and liabilities for both firms and financial institutions, and the costs and benefits of depreciation for production costs and revenues. Our model predicts that a crisis will lead to more firm failures, but critically that these will be predominantly among smaller, less profitable firms with less exposure to international markets and finance. We contribute empirically by examining whether the evidence is consistent with these hypotheses. Firm level heterogeneity on the balance sheet is vitally important to the impact of the crisis. Smaller, domestically focused firms are hit hardest by the crisis because their markets are undermined by the crisis and their lenders more likely to withhold funds to less creditworthy firms as their own balance sheets are upset by currency mismatch of assets and liabilities. For some of these firms the insolvency of their lender will

[29] Endogeneity is an issue here, since causation between growing indicators of creditworthiness and sales might run either way. We control for endogeneity in estimation with the use of instruments, and infer the relationship between profitability, collateral assets, leverage etc in previous years (i.e. from lags used as instruments) and sales growth.

cause them to fail. Exporters, on the other hand, find their markets benefit from an improvement in competitiveness which improves their prospects after the initial impact of the crisis. They can obtain funds from international lenders unaffected by a credit crunch, and even where they suffer from insolvency among domestic lenders the most profitable firms will find that they can continue to produce exports. Our results show that firms' access to external bank finance and sales growth are affected by these considerations and critically longer maturity loans are more readily extended to larger and more profitable firms with greater access to export markets.

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Table 1. Number of Manufacturing Firms by Country

	Indonesia	Korea	Malaysia	Thailand
1997	117	223	261	191
1998	118	238	265	181
1999	121	292	278	175
2000	118	319	283	174
2001	118	320	285	175
2002	117	324	283	171
2003	113	320	270	171
2004	0	248	107	37

Notes: Few firms had reported their 2004 figures to Thomson Financial Primark database at the time the data were extracted.

Table 2. Basic Macroeconomic Indicators

Export of goods and services as percentage of GDP

	Indonesia	Korea	Malaysia	Thailand
1997	27.9	33.0	93.3	48.0
1998	53.0	33.3	115.7	58.9
1999	35.5	32.4	121.3	58.3
2000	41.0	37.7	124.4	66.8
2001	38.2	35.5	116.4	65.9
2002	32.0	33.9	114.6	64.2
2003	30.7	35.6	113.4	65.6
2004	30.9	39.7	121.2	70.5
Average	36.1	35.1	115.0	62.3

External debt as percentage of GDP

	Indonesia	Korea	Malaysia	Thailand
1997	60.5	36.3	48.5	69.4
1998	157.1	51.1	61.9	93.1
1999	105.2	37.6	53.9	77.6
2000	85.5	32.2	47.0	65.0
2001	80.8	30.6	51.9	58.5
2002	64.2	30.2	51.3	48.8
2003	64.7	26.6	47.2	40.3
2004	63.0	26.1	46.0	32.1
Average	85.1	33.8	51.0	60.6

Real GDP Growth Rate (Percent)

	Indonesia	Korea	Malaysia	Thailand
1997	4.91	5.51	7.70	-1.34
1998	-13.30	-6.69	-6.70	-10.77
1999	0.85	10.89	5.80	4.22
2000	4.78	8.81	8.63	4.40
2001	3.44	3.03	0.45	1.94
2002	3.66	6.35	4.12	5.22
2003	3.60	3.07	5.64	6.74
2004	5.13	4.64	7.07	6.08
Average	1.6	4.5	4.1	2.1

Inflation Rate (Percent)

	Indonesia	Korea	Malaysia	Thailand
1997	6.1	4.4	2.7	5.6
1998	57.2	7.5	5.3	8.1
1999	21.7	0.8	2.7	0.3
2000	3.8	2.3	1.5	1.5
2001	11.5	4.3	1.4	1.7
2002	11.9	2.8	1.8	0.6
2003	6.8	3.6	1.1	1.8
2004	6.2	3.6	1.5	2.9
Average	15.6	3.7	2.3	2.8

Table 2. Macroeconomic Indicators (cont.)

Exchange Rate (Per US $)

		Indonesia	Korea	Malaysia	Thailand
	1997	2909.4	951.29	2.8132	31.364
	1998	10013.7	1401.44	3.9244	41.360
	1999	7855.2	1188.82	3.8000	37.814
	2000	8421.8	1130.96	3.8000	40.112
	2001	10260.8	1290.99	3.8000	44.432
	2002	9317.1	1251.09	3.8000	42.960
	2003	8577.2	1191.88	3.8000	41.485
	2004	8956.4	1145.49	3.8000	40.223
Average		8288.9	1194.0	3.7	40.0

Gross International Reserves (in million US $)

		Indonesia	Korea	Malaysia	Thailand
	1997	17396	20405	20899	26968
	1998	23517	52041	25675	29536
	1999	27257	74054	30645	34781
	2000	29268	96198	29576	32661
	2001	28018	102821	30526	33041
	2002	31577	121414	34277	38924
	2003	36253	155355	44576	42148
	2004	36304	199069	66448	49831
Average		28698.8	102669.7	35327.8	35986.1

Current Account Balance as percentage of GDP

		Indonesia	Korea	Malaysia	Thailand
	1997	-2.22	-1.59	-5.18	-1.97
	1998	4.27	11.54	13.53	12.66
	1999	4.11	5.50	15.92	10.17
	2000	4.82	2.65	9.14	7.61
	2001	4.19	1.83	8.27	5.41
	2002	3.83	1.11	7.82	5.89
	2003	3.04	1.71	12.98	5.57
	2004	1.12	4.05	13.38	4.44
Average		2.9	3.4	9.5	6.2

Lending Rates (Percent)

		Indonesia	Korea	Malaysia	Thailand
	1997	21.82	11.88	9.53	13.65
	1998	32.16	15.25	10.61	14.42
	1999	27.66	9.40	7.29	8.98
	2000	18.46	8.55	6.77	7.83
	2001	18.55	7.71	6.66	7.25
	2002	18.95	6.77	6.39	6.88
	2003	16.94	6.27	6.13	5.94
	2004	14.13	5.90	6.05	5.50
Average		21.1	9.0	7.4	8.8

Table 3. Debt Structure and Size

	Indonesia[1]			Korea[2]		
	Whole Sample	TYPE= Small	TYPE= Large	Whole Sample	TYPE= Small	TYPE= Large
$MAT_{i,t-1}$	0.349***	0.324***	0.298***	0.213***	0.183***	0.213***
	(5.73)	(4.88)	(5.22)	(3.70)	(3.37)	(3.77)
$PROFITA_{it}$	-0.158	-0.088	-0.132	0.045	-0.057	0.042
	(1.71)*	(0.94)	(1.24)	(1.29)	(0.33)	(1.26)
$PROFITA_{it}$*TYPE		0.055	0.027		0.080	-0.042
		(0.22)	(0.13)		(0.46)	(0.27)
COL_{it}	-0.176	-0.109	-0.257	-0.351***	-0.460***	-0.352***
	(1.21)	(0.65)	(1.53)	(3.24)	(3.87)	(2.66)
COL_{it}*TYPE		-0.397	0.098		0.158	-0.303
		(1.44)	(0.39)		(0.62)	(1.46)
$SOLVE_{it}$	-0.168***	-0.252***	-0.146***	-0.082	-0.197*	-0.099
	(3.19)	(3.55)	(2.82)	(1.40)	(1.90)	(1.46)
$SOLVE_{it}$*TYPE		0.222*	-0.334		0.244*	0.151
		(1.83)	(1.25)		(1.95)	(1.19)
LIQ_{it}	-0.124***	-0.147**	-0.168***	-0.141***	-0.247***	-0.134***
	(2.75)	(2.11)	(3.30)	(2.94)	(5.06)	(2.83)
LIQ_{it}*TYPE		0.117	0.103		0.154**	-0.322***
		(1.51)	(1.62)		(2.23)	(3.54)
$DEBTA_{it}$	-0.183**	-0.294***	-0.172**	-0.151	-0.386***	-0.180
	(2.21)	(3.42)	(2.04)	(1.47)	(2.82)	(1.49)
$DEBTA_{it}$*TYPE		0.514***	-0.288		0.436**	0.096
		(3.10)	(0.86)		(2.31)	(0.59)
GDP_t	-1.370***	-1.655***	-1.230**	-0.194	-0.271*	-0.222
	(2.70)	(2.77)	(2.27)	(1.23)	(1.68)	(1.13)
GDP_t*TYPE		1.313	-0.737		0.381	0.020
		(1.47)	(0.66)		(0.71)	(0.07)
$INTR_t$	-0.952**	-0.980**	-0.965**	-0.046	-0.085	-0.002
	(2.23)	(2.21)	(2.17)	(0.24)	(0.45)	(0.01)
$INTR_t$*TYPE		0.097	-0.040		0.915*	0.123
		(0.16)	(0.06)		(1.73)	(0.40)
$RFXRATE_t$	-0.045	0.016	-0.066	0.177	0.209*	0.195
	(0.43)	(0.13)	(0.55)	(1.35)	(1.68)	(1.49)
$RFXRATE_t$*TYPE		-0.046	0.024		-0.089	-0.026
		(0.23)	(0.11)		(1.47)	(0.69)
CONSTANT	24.415**	20.620**	25.807***	-13.472	-15.849	-14.923
	(2.41)	(2.18)	(2.62)	(1.06)	(1.34)	(1.19)
m_1	-5.69	-5.21	-5.62	-8.03	-7.64	-7.91
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
m_2	-0.31	-0.35	-0.34	-0.73	-0.64	-0.60
	(0.75)	(0.71)	(0.73)	(0.46)	(0.52)	(0.55)
Sargan Test	61.49	75.16	87.10	122.81	145.97	152.15
	(0.20)	(0.38)	(0.11)	(0.27)	(0.28)	(0.18)

Table 3. Debt Structure and Size (cont.)

	Malaysia(3)			Thailand(4)		
	Whole Sample	TYPE= Small	TYPE= Large	Whole Sample	TYPE= Small	TYPE= Large
$MAT_{i,t-1}$	0.586***	0.554***	0.554***	0.334***	0.301***	0.304***
	(8.34)	(8.00)	(9.40)	(5.71)	(5.35)	(4.91)
$PROFITA_{it}$	-0.010	-0.013	-0.011	-0.137	-0.144	-0.174
	(0.84)	(0.90)	(0.88)	(1.25)	(1.42)	(1.29)
$PROFITA_{it}$*TYPE		-0.040	-0.263		-0.090	0.143
		(1.00)	(1.22)		(0.45)	(0.65)
COL_{it}	-0.180	-0.193	-0.165	-0.125	-0.160	-0.201
	(1.58)	(1.28)	(1.31)	(0.77)	(0.83)	(1.20)
COL_{it}*TYPE		0.045	-0.132		0.317	0.083
		(0.22)	(0.48)		(0.93)	(0.23)
$SOLVE_{it}$	-0.002	-0.004	-0.003	-0.050	-0.113*	-0.037
	(0.38)	(0.63)	(0.45)	(1.13)	(1.73)	(0.72)
$SOLVE_{it}$*TYPE		0.006	0.052		0.004	-0.115
		(0.33)	(0.24)		(0.04)	(0.74)
LIQ_{it}	-0.022***	-0.025***	-0.017**	-0.080***	-0.084**	-0.114***
	(2.66)	(2.60)	(2.47)	(2.59)	(2.04)	(4.31)
LIQ_{it}*TYPE		0.048	-0.060*		0.031	0.085**
		(1.13)	(1.70)		(0.63)	(2.09)
$DEBTA_{it}$	-0.010	-0.020	-0.011	-0.154**	-0.204**	-0.144**
	(0.99)	(1.42)	(1.06)	(2.36)	(2.50)	(2.09)
$DEBTA_{it}$*TYPE		0.022	-0.024		-0.209	0.022
		(0.93)	(0.07)		(1.10)	(0.10)
GDP_t	-0.491**	-0.664***	-0.426*	-1.049***	-1.394***	-1.013***
	(2.15)	(2.73)	(1.71)	(3.15)	(3.53)	(3.10)
GDP_t*TYPE		0.826	-0.134		1.315**	0.476
		(1.35)	(0.25)		(1.98)	(0.63)
$INTR_t$	-0.288	-0.432*	-0.234	-1.230***	-1.578***	-1.125***
	(1.40)	(1.94)	(0.99)	(3.20)	(3.48)	(3.10)
$INTR_t$*TYPE		0.611	-0.146		1.203*	0.577
		(1.21)	(0.32)		(1.79)	(0.77)
$RFXRATE_t$	0.141	0.159	0.111	0.336*	0.442**	0.299*
	(1.21)	(1.32)	(0.94)	(1.93)	(2.40)	(1.91)
$RFXRATE_t$*TYPE		-0.175	0.041		-0.315*	-0.145
		(1.24)	(0.33)		(1.75)	(0.72)
CONSTANT	-4.831	-2.988	-3.593	-0.537	-2.078	0.134
	(0.50)	(0.32)	(0.38)	(0.05)	(0.20)	(0.01)
m_1	-7.26	-7.17	-7.37	-6.89	-7.07	-6.53
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
m_2	-0.11	-0.24	-0.21	0.08	-0.18	-0.12
	(0.91)	(0.81)	(0.84)	(0.94)	(0.85)	(0.90)
Sargan Test	134.47	156.68	152.94	138.09	157.28	147.32
	(0.11)	(0.12)	(0.17)	(0.15)	(0.39)	(0.61)

Robust z statistics in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%,

(1): No. of observations: 716; No. of Firms: 124; (2): No. of observations: 1760; No. of Firms: 334; (3): No. of observations 1594; No.of firms: 271, (4): No. of observations: 1175; No. of firms: 200. Estimations are based on the firm type dummies that are employed as a component of the interaction terms for all variables. For example, in the first column we do not use any interaction term while in the second and third columns, we use the interaction terms based on TYPE=small and TYPE=large, respectively. The hypothesis of having serial correlation based on m_2 is rejected while the hypothesis of valid instruments based on Sargan test is not rejected in all regressions with 5 percent significance level.

Table 4. Sales Growth and Size

	Indonesia(1)			Korea(2)		
	Whole Sample	TYPE= Small	TYPE= Large	Whole Sample	TYPE= Small	TYPE= Large
$DLRSALE_{i,t-1}$	0.003	-0.012	-0.018	-0.166***	-0.182***	-0.192***
	(0.04)	(0.17)	(0.24)	(3.76)	(4.36)	(4.46)
$DLRSALE_{i,t-2}$	-0.119***	-0.121***	-0.121***			
	(5.11)	(5.08)	(5.45)			
$LRASSET_{it}$	60.277***	56.831***	35.520***	51.656***	59.784***	46.741***
	(4.28)	(3.96)	(2.86)	(8.47)	(8.93)	(6.06)
$LRASSET_{it}$*TYPE		-0.607	26.516***		-30.078*	11.640
		(0.05)	(2.98)		(1.83)	(0.92)
$PROFITA_{it}$	0.449**	0.363*	0.491***	0.218	0.334	-0.099
	(2.49)	(1.75)	(2.78)	(0.94)	(1.41)	(0.36)
$PROFITA_{it}$*TYPE		0.096	-0.040		-0.561*	0.827
		(0.35)	(0.09)		(1.75)	(1.29)
LIQ_{it}	0.015	-0.022	-0.048	-0.170***	-0.123***	-0.161***
	(0.31)	(0.35)	(1.03)	(5.95)	(4.82)	(4.89)
LIQ_{it}*TYPE		0.004	0.130		-0.114	0.191
		(0.05)	(1.45)		(1.38)	(0.54)
$DEBTA_{it}$	-0.499**	-0.519***	-0.370**	-0.798***	-0.581***	-1.068***
	(2.38)	(3.09)	(2.13)	(4.36)	(3.07)	(4.70)
$DEBTA_{it}$*TYPE		0.011	0.171		-0.538**	0.977***
		(0.04)	(0.52)		(2.03)	(2.65)
GDP_t	11.293***	10.894***	10.412***	2.215***	2.015***	2.617***
	(9.78)	(10.15)	(8.21)	(5.34)	(4.69)	(6.67)
GDP_t*TYPE		0.514	0.912		1.254	-0.495
		(0.36)	(0.52)		(1.56)	(1.03)
$INTR_t$	6.296***	5.939***	6.001***	1.177***	1.113***	1.056***
	(3.59)	(3.58)	(3.30)	(3.65)	(3.71)	(3.24)
$INTR_t$*TYPE		0.500	-0.087		0.544	-0.322
		(0.48)	(0.07)		(1.04)	(0.95)
$RFXRATE_t$	-1.125***	-1.012***	-0.679***	1.180***	1.194***	1.109***
	(3.80)	(3.32)	(2.64)	(2.73)	(2.92)	(2.76)
$RFXRATE_t$*TYPE		0.033	-0.241		0.231	-0.564**
		(0.13)	(0.83)		(1.17)	(1.96)
CONSTANT	15.070***	13.971***	12.874***	-1.885**	-1.720**	-2.250***
	(5.55)	(5.44)	(5.23)	(2.46)	(2.19)	(3.04)
m_1	-5.05	-5.38	-5.31	-5.64	-5.38	-6.17
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
m_2	0.98	0.93	0.85	-1.04	-1.65	-1.38
	(0.33)	(0.31)	(0.40)	(0.30)	(0.11)	(0.17)
Sargan Test	79.91	97.69	94.97	172.75	167.41	163.26
	(0.17)	(0.85)	(0.89)	(0.11)	(0.12)	(0.17)

Robust z statistics in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%,

(1): No. of observations: 614; No. of Firms: 108; (2): No. of observations: 1361; No. of Firms: 208; (3): No. of observations 1707; No.of firms: 257, (4): No. of observations: 342; No. of firms: 147. Estimations are based on the firm type dummies that are employed as a component of the interaction terms for all variables. For example, in the first column we do not use any interaction term while in the second and third columns, we use the interaction terms based on TYPE=small and TYPE=large, respectively. The hypothesis of having serial correlation based on m_2 is rejected while the hypothesis of valid instruments based on Sargan test is not rejected in all regressions with 5 percent significance level. A maximum four lagged levels of predetermined and dependent variables and levels of exogenous (macro) variables are used as instruments in all regressions.

Table 4: Sales Growth and Size (cont.)

	Malaysia[3]			Thailand[4]		
	Whole Sample	TYPE= Small	TYPE= Large	Whole Sample	TYPE= Small	TYPE= Large
$DLRSALE_{i,t-1}$	-0.230***	-0.226***	-0.241***	-0.103	-0.128	-0.120
	(2.70)	(2.92)	(2.96)	(0.90)	(1.28)	(1.07)
$LRASSET_{it}$	11.341	0.684	13.595**	110.182***	117.339***	110.891***
	(1.48)	(0.06)	(2.27)	(4.16)	(4.60)	(4.49)
$LRASSET_{it}$*TYPE		11.952	-4.540		12.062	-24.479
		(0.82)	(0.30)		(0.43)	(0.64)
$PROFITA_{it}$	-0.012	-0.071	-0.089*	-0.318***	1.250***	-0.326***
	(0.11)	(1.08)	(1.90)	(4.25)	(2.74)	(4.23)
$PROFITA_{it}$*TYPE		0.091	1.092**		-1.565***	0.515
		(0.72)	(1.98)		(3.43)	(0.66)
LIQ_t	0.008	0.048	0.007	-0.078	-0.176	-0.089
	(0.25)	(0.48)	(0.26)	(0.77)	(1.44)	(0.80)
LIQ_{it}*TYPE		-0.060	-0.158**		0.149	0.462
		(0.61)	(2.01)		(1.05)	(1.36)
$DEBTA_{it}$	-0.108**	0.255	-0.118**	0.147	0.491	0.094
	(2.51)	(0.90)	(2.38)	(1.23)	(1.09)	(0.78)
$DEBTA_t$*TYPE		-0.358	1.319**		-0.288	-0.118
		(1.24)	(2.11)		(0.59)	(0.22)
GDP_t	2.569***	2.436***	2.411***	2.238***	2.936***	1.952**
	(7.82)	(6.88)	(6.68)	(3.15)	(3.76)	(2.54)
GDP_t*TYPE		0.496	0.225		-1.458	0.362
		(1.21)	(0.48)		(1.41)	(0.43)
$INTR_t$	-1.292***	-1.403***	-1.284***	0.837	1.113*	0.504
	(6.32)	(7.22)	(6.45)	(1.43)	(1.68)	(0.80)
$INTR_t$*TYPE		0.338	-0.304		-0.334	1.099
		(0.86)	(0.90)		(0.44)	(1.55)
$RFXRATE_t$	-0.820*	-0.722	-0.731	0.878	0.987	1.122
	(1.88)	(1.63)	(1.58)	(0.71)	(0.73)	(0.96)
$RFXRATE_t$*TYPE		-0.050	-0.165		0.100	-0.676
		(0.24)	(0.78)		(0.37)	(1.40)
CONSTANT	-2.824***	-2.785***	-2.897***	3.982	4.338	4.101
	(2.94)	(3.05)	(2.87)	(1.07)	(1.10)	(1.18)
m_1	-3.70	-3.29	-3.05	-4.43	-4.87	-4.36
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
m_2	-0.74	-1.07	-1.35	0.74	0.25	0.73
	(0.46)	(0.29)	(0.18)	(0.46)	(0.80)	(0.46)
Sargan Test	105.58	247.68	231.52	75.95	87.26	94.71
	(0.07)	(0.28)	(0.55)	(0.13)	(0.59)	(0.37)

Appendix. Data Definitions

MAT_{it} debt maturity ratio defined as (short-term debt/total debt)*100

COL_{it} (collateral) is the ratio of tangible assets to total assets*100

LIQ_{it} (liquidity) is the ratio of the current assets excluding work in progress and inventories to current liabilities i.e. (Current assets- work in progress- stocks) / (total liabilities – shareholders equity-long-term loans - other long liabilities)*100

$SOLVE_{it}$ (solvency) is the ratio of shareholder's equity to total assets*100

$PROFITA_{it}$ is the ratio of profit before tax to total assets*100

$DEBTA_{it}$ is the ratio of total debt to total assets*100

$LRASSET_{it}$ is the logarithm of real assets

$DLRSALE_{it}$ is the change in the log of real sales*100

GDP_t is the GDP growth rate

$INTR_t$ is the Treasury Bill interest rate (percent)

$RFXRATE_t$ is the real exchange rate (based on data from the BIS)