Does Short-Term Debt Increase Vulnerability to Crisis? Evidence from the East Asian Financial Crisis*

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Abstract

Does short-term debt increase vulnerability to financial crisis, or does causality go the other way, so that short term debt reflects rather than causes the incipient crisis? We approach this question empirically by examining the banking sector in five East Asian economies that were affected by the financial crisis of 1997-8. We put together a firm-level database that includes information on banks' debt obligations as well as on bank failures following the crisis. We deal with potential endogeneity of short term debt by using certain long term debt obligations as instruments. These are bonds that mature at the time of the crisis, and therefore add to the bank's vulnerability, but since they were contracted many years previously, cannot be mistaken as an endogenous response to changing conditions or expectations in the period immediately before the crisis. We find that such bonds that were contracted four years or more before the crisis have a negative, albeit sometimes insignificant effect on the probability of failure. Our results are therefore consistent with an interpretation of short-term debt as reflecting, rather than causing, distress in the banking sector. However, our findings do not rule out the hypothesis that exposure to roll-over risk contributed to bank failure in the East Asian crisis.

JEL classification:

Keywords: Short-Term Debt, Financial Crises, East Asian Crisis, Bank Runs.

1. Introduction

The role of short term debt in instigating the East Asian financial crisis of 1997-98 has been the subject of some debate. On one hand, many authors in the international finance literature have focused on international illiquidity, whereby long-term domestic projects were financed by short-term foreign capital, predominantly via domestic banks. According to this view, the resulting maturity mismatch has created an inherent vulnerability to crisis. Essentially, by refusing to roll over their loans, short term creditors can potentially turn an otherwise manageable adverse shock into a full-fledged financial crisis. Thus there was a self-fulfilling element to the crisis, since the accumulation of short term debt shifted the affected economies into a danger zone where a crisis equilibrium could emerge[1].

On the other hand, a number of scholars offer a markedly different account, one that turns the causality from short term debt to financial crisis on its head. According to this view, the accumulation of short term debt may be the optimal choice for borrowers who experience a deterioration in the quality of their assets, and is therefore a symptom of the crisis rather than a cause. In the context of banks in particular, this view of the East Asian crisis has been expressed forcefully by Diamond and Rajan (2001a). In their model, domestic banks serve as useful intermediaries between investors and illiquid entrepreneurs. However, the banks cannot commit to fully repay the investors once a project has been completed. This can be remedied by very liquid lending to the bank, since the threat of a bank run that is always present with this form of finance provides the necessary incentive to repay. In this setting, if the projects being financed are seen as becoming less liquid due to an adverse shock to fundamentals, the bank will find it harder to secure long term financing from investors, and will increase its short term borrowing as a result. The accumulation of short term debt in many East Asian economies prior to the crisis can therefore be seen not as creating vulnerability due to liquidity mismatch but rather as a response to the vulnerability of the underlying projects being financed[2].

[1]Contributions espousing this view as a major or ancillary cause of the crisis include, among others, Furman and Stiglitz (1998), Radelet and Sachs (1998), Corsetti, Pesenti, and Roubini (1999), Rodrik and Velasco (2000), Eichengreen (2004), and Calvo (2005). Obstfeld (1996) and Cole and Kehoe (2000) analyze the earlier Mexican crisis of 1994 along similar lines.

[2]The models by Tirole (2003) and Jeanne (2004, 2009) also emphasize the role of short term financing as a discipline mechanism for borrowers.

Which view is closer to the facts? Was the build-up of short term debt in East Asian economies prior to 1997 a cause or an effect of the incipient crisis? This paper is the first to address this debate empirically, using firm-level data. We construct a new dataset using individual bank level data, which includes information on commercial banks in the five East Asian countries most affected by the crisis: Indonesia, Malaysia, the Philippines, South Korea, and Thailand. We have detailed information on these banks' debt obligations as well as their performance during and after the crisis. We are therefore able to link, at the individual bank level, between a bank's exposure to debt of different types prior to the crisis and the its eventual success (or failure) in surviving the crisis.

Given the theoretical debate, and in particular the ambiguous direction of causality, it is essential to deal with endogeneity in a robust way. We employ the following strategy to correctly identify the effect of a bank's exposure to roll-over risk on its probability of failure: instead of examining the effect of short term obligations on bank failure, we examine the effect on bank failure of certain long term obligations, those that are scheduled to mature during or immediately after the time of the crisis. Some of these bonds were issued many years prior to the crisis, and therefore cannot be mistaken as somehow being part of a response to deteriorating conditions. However, they do add to the bank's overall need to roll over its debt obligations, in the same way that short term obligations do, thereby increasing the bank's vulnerability. By instrumenting for short term debt in this way, we are able to accurately estimate the separate effect of roll-over risk on bank failure.

We find that bonds issued four years or more before the outset of the crisis, and that had been scheduled to mature in or immediately after the crisis years (1997-2001), have had a negative, albeit not always significant effect on the probability of bank failure. We interpret this result as supportive of the view of short-term debt as an equilibrium response to worsening asset quality. Our results indicate that the issuance of a bond prior to 1994 that was scheduled to mature during the crisis years not only did not predict failure, but may even have predicted success, i.e. that the bank would survive the crisis. The Diamond and Rajan (2001a) view of these longer term bonds would be that at their time of issue fundamentals seemed sound, so that creditors had no reason to prefer short-term debt. Therefore it stands to reason that an increase in issuance of these bonds would not increase the probability of failure, and indeed may be a sign of confidence. This is in contrast to

the alternative view emphasizing roll-over risk, according to which these longer-term bonds should have increased failure rates, since they matured during the crisis. It is important to stress, however, that our findings cannot unambiguously determine whether the issuance of short-term bonds increased bank probability of failure. It is possible, even likely, that elements of both explanations were at play. Our claim is different, namely, that in view of our findings regarding longer-term bonds, it is very unlikely that exposure to roll-over risk was in itself the dominant factor. Rather, our results suggest that starting in 1994 investors were expecting deteriorating performance from banks' underlying assets, and were lending to banks accordingly.

There is a large empirical literature on the cross-country association between the accumulation of short term debt and the occurrence of financial crises[3]. However, as pointed out by, for example, Froot (2000) and Detragiache and Spilimbergo (2004), a positive and significant coefficient of short term debt should not be interpreted necessarily as supportive of the short-term debt-causing-vulnerability story; without a convincing strategy of dealing with the ambiguous direction of causality, it is no more than a correlation. Our paper is the first to our knowledge to examine whether the empirical evidence is indeed consistent with such an interpretation. Clearly this would not be possible without utilizing data at the individual bank level, which we assembled for this purpose[4].

The paper proceeds as follows: Section 2 summarizes the two approaches to the role of short-term debt in financial crises and clarifies what predictions follow from each. Section 3 presents the construction of our data. Section 4 presents our identification strategy and estimation results. Section 5 concludes.

[3]The results are mixed. Radelet and Sachs (1998) and Rodrik and Velasco (2000) find that a high ratio of short-term debt to reserves helps predict the occurrence of capital account reversals, while Frankel and Rose (1996) and Milesi-Ferretti and Razin (2000) find that short-term debt has no predictive power for the occurrence of currency crises. Berg and Pattillo (1999) find an effect for some of the East Asian countries, but not for others. More recently, Jeanne (2007) finds that short-term debt has predictive power for currency crises, but not for capital account reversals.

[4]Related papers which utilize micro-level data include Eichengreen and Mody (2000), who use data on individual international bank loans to examine the pricing of risk, and Schmukler and Vesperoni (2006), who use firm balance sheets to detect the effect of financial liberalization on debt maturity.

2. Short Term Debt and Bank Failure: Theory

In this section we briefly describe the two approaches linking short-term debt to bank failure. According to the first approach, taking on short-term debt increases a bank's exposure to a run, and therefore the bank is more likely to fail. The second approach emphasizes that short-term borrowing is endogenous and is potentially the only way that a bank in difficulties can finance itself. Therefore any increased likelihood of failure is not necessarily driven by short-term debt itself, but rather is a consequences the original difficulties.

2.1. Short-term Debt and the Vulnerability to Financial Crises

Chang and Velasco (2001) build on the framework of Diamond and Dybvig (1983), in which banks financed by demand deposits optimally bridge between the liquidity needs of depositors and the inherently illiquid nature of investments. Specifically, they assume that one dollar invested in a project at date 0 will yield $r < 1$ at date 1, and $R > 1$ at date 2. There is also a liquid world capital market where the interest rate is fixed at zero. Some depositors will need to cash in early on their investments; there is a positive probability λ that they will turn out to be "impatient" and will choose to consume at date 1. In the model consumer type is unknown at date 0, and moreover is considered private information at all times. Chang and Velasco (2001) characterize the optimal allocation of consumption and investment under these conditions, an allocation which prescribes a special role to foreign borrowing: in the optimum, the bank will use foreign loans to repay depositors who turn out to be impatient at date 1:

$$\lambda \widetilde{c}_1 = \widetilde{b}, \tag{1}$$

where $\widetilde{c}_1$ is consumption of the impatient type in the social optimum, and $\widetilde{b}$ denotes new loans extended to the bank in the social optimum. The bank anticipates this and therefore does not borrow too much at date 0, so as to not run against the economy's exogenously imposed credit ceiling:

$$\widetilde{d} < f, \tag{2}$$

where $\widetilde{d}$ denotes date-0 borrowing in the social optimum, and f is the economy's credit ceiling. Clearly this is optimal: providing for the impatient depositors' liquidity needs by foreign borrowing is less costly than liquidating some of the project. A bank financed with

demand deposits can implement this optimal allocation: there is a truthful equilibrium in which impatient depositors cash in early, and patient depositors wait until date 2 to withdraw their deposits. the incentive compatibility condition is simply $\widetilde{c}_2 \geq \widetilde{c}_1$, so that there is no incentive to pretend to be impatient.

Of course, the bank may be subject to a run: if all depositors decide to demand payment at date 1, the bank may fail. The exact conditions under which this may happen depend on the extent of the banks' commitment to foreign creditors. For example, if the bank can commit to pay foreign creditors under any circumstance, then the portion of the project that it will be able to liquidate in the event of a run is given by

$$l^+ = (R\widetilde{k} - f)/R, \tag{3}$$

where $\widetilde{k}$ is the socially optimal investment in the project. This upper bound l^+ in turn helps determine the degree of the bank's illiqudity. The bank may be subject to a run only if

$$z^+ \equiv \widetilde{c}_1 - (\widetilde{b} + rl^+) > 0, \tag{4}$$

i.e. only if, in the case where all depositors decide to exercise their right under the deposit contract to demand $\widetilde{c}_1$at date 1, the bank is not able to raise enough funds, through new foreign borrowing and liquidation, to honor all deposits.

A more relevant case is where the bank cannot commit to pay all of its foreign creditors, which are therefore subject to coordination failure much in the same way as depositors. This can be expressed as a refusal on the part of foreign creditors to extend new loans (in effect reducing ex post the bank's line of credit to zero), or even recalling existing loans. For some parameter values, such actions by some creditors may cause a bank run, in which case creditors acting in this way are individually optimizing. Chang and Velasco (2001) makes the important point that such behavior by the foreign creditors may instigate a run where none would have happened otherwise. That is because foreign creditors' suscepitibility to panic increases the bank's "run zone".

To see this, consider the case in which the loans taken at date 0 can be recalled at date 1 at the creditors' discretion. The bank then may face a run if

$$z^b \equiv \widetilde{c}_1 + \widetilde{d} - r\widetilde{k} > 0 \tag{5}$$

i.e. if the *combined* total of deposits and debt exceed the liquidation value of the investment. Note that in the run equilibrium no new loans will be extended, since the bank is unable to honor existing obligations. Now compare this to the case where loans taken at date 0 are guaranteed payment at date 2. This pre-commitment prevents any coordination failure on the part of the date-0 creditors, but this does not extend to new loans, since these are not covered by the guarantee. The bank's liquidation limit is now given by

$$l^a = (R\widetilde{k} - \widetilde{d})/R, \tag{6}$$

and therefore a run is possible when

$$z^a \equiv \widetilde{c}_1 - rl^a > 0. \tag{7}$$

It is easy to show that $z^b > z^a > z^+$: the more liquid the bank's liabilities are at date 1, the wider the "run zone" becomes. Note that the extent of the loans $\widetilde{d}$ does not matter for the bank's likelihood to fail, nor does it matter if they were originally issued as one period bonds or two period bonds. What matters is whether at date 1 the bank's creditors can demand payment or refuse extension of credit. If this is the case, it exposes the bank to a greater risk of switching to a run equilibrium and therefore failure. This leads us to the following prediction:

Prediction 1: Any debt obligation, regardless of original maturity, has a positive affect on the probability of failure on its maturity date.

2.2. The Endogeneity of Short-term Debt

Diamond and Rajan (2001a) rely on a different theory of banking (more fully delineated in Diamond and Rajan [2001b]) to explain the connection between short term debt and bank failure. In their model, an investment project derives much of its value $C > 1$ from the human capital of the project's entrepreneur. This creates a potential hold-up problem for investors, which is solved by financing the project through a bank which has intimate knowledge of the project. In particular, the bank can replace the entrepreneur, which will result in a reduction of the project's value to $\theta C > 1$. In essence, investors employ the bank as their agent to negotiate effectively with the project's entrepreneur and in this way collect payment, which cannot exceed θC. The bank, in turn, may wish to extract a rent in return

for these unique intermediation and collection skills. In bargaining with investors, the bank will succeed in extracting a fraction of the collected payment, say $\theta C/2$.

Diamond and Rajan (2001a) show that a system of demand deposits can prevent the bank from extracting any rent. That is because the coordination problem of depositors (which investors do not have) creates a valid disciplining device. Since the market value of the loan is now $\theta C/2$, whereas deposit contracts amount to θC, an attempt by the bank to re-negotiate its obligation to the depositors will result in a run. In such a case, depositors will seize the loan contract with the entrepreneur and negotiate directly with her, as a result depriving the bank from the rent it was aiming to get by re-negotiating with the depositors in the first place. Faced with the loss of its intermediation rent, the bank will not try to re-negotiate, and will transfer all collected payments to the depositors.

Demand deposits therefore serve a disciplinary role in this framework. But it is the very rigidity of this form of finance which makes it unwieldy when there is uncertainty about the bank's assets, since an adverse shock to asset value will precipitate a bank run. In an uncertain world then, banks will usually be financed by a mix of demand deposits and investor capital. Diamond and Rajan (2001a) model uncertainty in project completion date, where the probability of a date-1 completion is α. This implies that at date 1 the bank will be able to pay to its investors and depositors the following:

$$\frac{1}{2}max[\alpha\theta C + (1-\alpha)c - d, 0] + d. \tag{8}$$

The first term is the payment to capital, which is one half of the residual value of the bank's assets after all deposits have been honored. Recall that one half of the residual value is retained by the bank as rent. The bank will be able to collect θC with probability α, and with probability $1-\alpha$ the bank will be able to sell the project for $c < \theta C$ (the restructuring value of the project). After deducting deposits (which are paid before capital), this gives the residual value.

Suppose now that after deposits have been taken by the bank, the value of α suddenly falls, i.e. the project becomes more illiquid. In this case the capital investors will have to adjust the value of their investment downwards, since depositors are liable to run on the bank at the first sign that their deposits might be in danger. The relative flexibility of capital can sometimes prevent a run and allow the bank to remain open. Therefore in this

framework finance by capital investment is problematic: not only does the bank extract a rent from the investors, it also forces them to absorb drops in its asset quality. Banks that are perceived has having less attractive assets will therefore find it very hard to obtain long-term investor capital, relying to a large extent on short-term loans that can be more easily recouped. These banks naturally will be more likely to eventually fail due to the lower quality, or greater illiquidity, of their assets. This leads to the following prediction:

Prediction 1A: Original maturity matters: Banks with relatively more short term debt are more likely to fail, as their underlying asset quality is the reason for relying on short-term financing. However banks with relatively more long term debt will be less likely to fail.

3. Data and Summary Statistics

Our dataset is at the individual bank level, covering banks that were in operation in the years leading to the crisis in the five affected East Asian countries : Indonesia, South Korea, Malaysia, the Philippines, and Thailand. We started our construction of the dataset by extracting financial data (assets, profitability, etc.) from Bankscope, a publicly available database that covers 28,200 banks worldwide. We have limited our search to data pertaining to banks located in the five relevant countries, in the years 1991-2002. There are 415 banks in the database that meet these conditions. The distribution of the banks across the five countries is as follows: 112 in Indonesia, 76 in South Korea, 97 in Malaysia, 64 in the Philippines, and 66 in Thailand. Next, for each bank in our dataset, we collected information as to whether that bank has survived the crisis or failed. We made use of several sources in order to collect this information, which we utilized in the following order:

1. First, we performed an Internet search using the publicly available archives of a daily industry newsletter. The Asia-Pacific edition of the newsletter - Troubled Company Reporter - has been appearing continuously since February 1998[5]. The fully searchable newsletter reports events such as profit and loss announcements, negotiations of rescheduling of debt, government actions regarding a particular firm, etc.

2. Second, we cross-referenced any information found on the web-site with other available

[5]The newsletter archives are available at: http://www.bankrupt.com/TCRAP_Public/index.html.

sources. A number of authors provide partial lists of bank outcomes. In particular, Arena (2005) provides a relatively comprehensive list of failed banks during the East Asian crises, covering all five countries. Kim (1999) gives detailed outcome information on most of the Korean banking industry. Chou (1999) lists Indonesian banks that were placed under government control, and Kawai and Takayasu (1999) provide a detailed history of bank outcomes in Thailand.

3. Third, we performed a general Internet search for each bank that is in our Bankscope dataset. This additional step was especially useful in the case of surviving banks, since these banks' web-sites often would include detailed corporate histories, in particular dates of mergers and acquisitions, as well as name changes if any.

In our classification of bank outcomes, we define the failure of a bank if, within five years following the crisis (i.e. no later than 2002), it meets at least one of the following conditions:

1. The bank is closed down by the government or one of its agencies (its assets sold or declared worthless).

2. The bank is taken over by the government or one of its agencies, to be sold or dismantled.

3. The bank is forced to merge into another bank or a consortium of banks without being formally taken over by the government.

Our classification strategy is similar to the one used by Arena (2005).

We have found information that enabled us to clasify 359 cases out of the 415 banks that are in our initial Bankscope dataset. The distribution of these 359 banks includes: 109 in Indonesia, 58 in South Korea, 91 in Malaysia, 53 in the Philippines, and 48 in Thailand. The remaining 56 banks were dropped out of the dataset[6]. To our list of 359 banks, we added an additional 52 banks for which we have been able to find outcome information, but are not included in the Bankscope database. Our final data set includes 411 banks, out of which 212 banks meet at least one of our definitions for failure. Table 1 reports the

[6]Most of these are not commercial banks; they include central banks, development banks, and investment banks, among others.

distribution of bank failures across countries and along the years in our sample. We see that the crisis was of varying intensity in different countries, and followed different trajectories. Korea and Thailand were hit especially hard, with 82% and 74%, respectively, of the sample banks located in these countries failing by 2002. However Thailand experienced a rush of failures in 1997 that subsided in later years (with a later peak in 2001), whereas in Korea the crisis evolved more gradually, reaching its peak (in terms of bank failures) in 1999, and gradually subsiding afterwards. Indonesia and Malaysia, both with 44% of their banks failing by 2002, exhibit a pattern similar to Korea, with the crisis reaching its peak in 1999 and 2000, respectively. The Philippines, the least affected country at 18% sample failure rate, also exhibits a similar pattern, peaking in 1999.

We augment our dataset using information on bonds issued by banks in the five relevant countries. Our bond data is taken from the SDC Platinum database, covering all bond issues in these countries from 1976 to 2002. SDC Platinum is a comprehensive international data set that provides information about every bond issued anywhere in the world, including (depending on availability) the terms of the bond (original maturity, principal amount, interest rate, currency) and information on the issuer and the market in which the bond was issued. In order to capture as many banks as possible, we searched all financial firms in the aforementioned five countries, identified by their ISIC code. This has produced 1,020 bond issuers. We then matched the two datasets, allowing for the quite common occurrence of banks changing their names, e.g. following a merger or an acquisition. The resulting dataset reflects the state of affairs in 1997 with respect to bank names and affiliations, so that debt obligations that were taken by a bank which was then acquired by another before 1997, are seen in our dataset as if they were taken by the acquiring bank. We have successfully matched 208 of the 411 banks for which we had financial and / or survival data with data on their bond issues. These banks are distributed by country as follows: 50 in Indonesia (of which 38 failed), 51 in South Korea (of which 43 failed), 26 in Malaysia (of which 11 failed), 16 in the Philippines (of which five failed), and 65 in Thailand (of which 55 failed). Given the comprehensive coverage of SDC Platinum we can classify the banks for which information on bonds is not available as banks that did not issue bonds during our sample period.

Table 2 gives summary statistics of bonds that were issued by banks in our dataset. The vast majority of bonds are denominated in foreign currency, of which by far the most

prevalent is the U.S. dollar: 73% of all bonds issued by banks that we include in our dataset are denominated in dollars. In terms of amount borrowed, there is a great deal of variance both within and across countries. In terms of bond maturity, however, bonds issued by banks across the region are quite similar. This may be due to banks in all five countries competing to borrow funds in similar capital markets. Given the cross-country differences in timing and severity of the crisis shown earlier in Table 1, it is interesting that banks across the region seem to have been quite similarly exposed to short-term debt.

As a first cut of the data, Table 3 presents the differences in the original debt maturity between failed and non-failed banks in our dataset. Recall that the panel structure of our data allows us to examine financing choices of individual banks taken years, and in some cases decades, before the onset of the crisis in 1997. As Panel A of the table demonstrates, failed banks issue, on average, debt of shorter maturity, however the difference in means between failed and non-failed banks is small and statistically insignificant. We also find that the maturity distribution of debt issued by failed banks is very similar to that of non-failed banks. The only difference we detect between the distributions of maturity is in the extreme right tail: the maximum maturity of a bond issued by a failed bank in our dataset is 15 years, while the maximum maturity of a bond issued by a non-failed bank stands at 25 years.

Panel B of Table 3 explores further the maturity distributions of the two groups, comparing bond maturity by year of issue as well. As Panel B shows, comparing debt maturity of the two groups of banks in the decade 1980-1990, we find that failed banks actually issued bonds of *longer* maturity than non-failed banks. However, when we compare bonds issued closer to the crisis, we find that failed banks issue debt of significantly shorter maturities. It is interesting to note that the average bond maturity of both groups declined in the 1990s relative to the 1980s, potentially reflecting lenders' concerns about East Asian economies. Furthermore, debt maturities of banks that eventually failed during the East Asian crisis declined more relative to those that did not fail.

The results in Panel B of Table 3 are consistent with *both* explanations: on the one hand, borrowing more short-term debt in the years before the crises could have made the banks that eventually failed more vulnerable to roll-over risk and financial crisis. On the other hand, adverse changes to asset quality or loan repayment schedules in these banks, which would increase their likelihood of failing, could have led to more reliance on short term debt

on the part of these banks[7]. After 1997 however, banks which eventually survived increased their bond maturity significantly, while those that eventually failed relied on debt of much shorter maturity. This suggests that even in the immediate aftermath of the crisis, market participants could distinguish between banks of varying quality, implying that the observed variation across banks is informative.

We next move to a simple analysis of the determinants of the maturity of the bonds in our sample. We focus on foreign-currency denominated bonds, i.e. bonds which were issued in a currency other than the domestic currency of the issuing bank. The first two columns of Table 4, Panel A, present the results of OLS regressions in which bond maturity (in years) is regressed on a dummy variable which takes the value 1 if the issuing bank has failed according to our definition, and zero otherwise. In the second column we add a dummy variable which takes the value 1 if the bond in question was rated by Standard & Poor's. In both regressions we include year and country fixed effects, as well as an interaction term of year with the failure dummy. We see that bonds issued by failed banks were of shorter maturity, approximately 1.6 years lower on average relative to bonds issued by banks which survived the crisis. Adding the bond rating dummy in the second regression adds some explanatory power, but does not change the quantitative effect. We see that having a Standard & Poor's rating is associated with a significantly increased bond maturity. The next two columns in Panel A of the table present the results of probit regressions (marginal effects are reported), where the dependent variable is the probability that the bond's maturity is equal to or less than one and two years, respectively. We again include year and country fixed effects, as well as an interaction term as before. The probit results shown here are consistent with the OLS regressions: the probability of a failed bank issuing a bond due one year or less from the date of issuance is 28% higher relative to a surviving bank, taken at the sample mean. For bonds due in two years or less, that probability is 40% higher for failed banks relative to surviving banks, again taken at the sample mean. We see here as well that a bond rated by Standard & Poor's has a lower probability of having a very short maturity. These results of course are subject to concerns about endogeneity, since bank failure may be driven by debt maturity. Indeed, the results in Panel A are inherently unstable: in Panel B of the table we split the

[7]In the case of Korea, Noland (2005) ascribes Korean banks' increasing reliance on short-term debt in the 1990s to the Korean government's policy of discouraging long-term debt.

sample to bonds issued through 1997 (left two columns), and bonds issued after 1997. We see that in both OLS and probit specifications, the results change susbtantially. According to the OLS specification, bonds issued through 1997 by failed banks have a much shorter maturity, almost six years less, relative to bonds issued by surviving banks. However, the same specification applied to bonds issued after 1997 shows a positive, and highly significant, association between failure and bond maturity. The probit regressions, applied to the split sample, are also highly unstable: for bonds issued through 1997, we now get a negative association between likelihood of short maturity and failure, whereas for bonds issued after 1997 we see an insignificant effct. As already seen in Section 2, the relationship between bank failure and maturity of debt issued by banks is likely to be complex. The regressions shown in Table 4 illustrate that this is the case empirically as well.

In order to produce a more coherent analysis of bank failure and bond maturity, we proceed to aggregate our bond data at the bank level, so that for our main analysis the unit of observation is not a single bond, as in Tables 3 and 4, but rather a bank-year pair. For each bank in our dataset, and for each year from 1997-2002, we calculate the total debt issued by the bank that matures in that year. In order to focus on the East Asian crisis, we include only the years from 1997 onwards[8]. We then further separate the maturing debt by year of origination. Thus we know the amount of debt of Bank i that is scheduled to mature in year t, and that was originated in years $t-1$, $t-2$, $t-3$... and so on. This method creates a snapshot of the bank's exposure to roll-over risk at any given year, while keeping track of the original maturity of the bonds involved. Moreover, we can relate this information to other financial characteristics of the bank in that given year, such as asset size and overall profitability. Finally, recall from Table 1 that we have the year of failure for each bank in our dataset. Our main regressions, therefore, will examine the effect, for each bank-year pair, of the bank's characteristics and amount of maturing debt on the probability of failure in the given year.

Table 5 presents banks summary statistics for size, profitability, and roll-over exposure, where the unit of observation is a bank-year pair. We observe 78 such pairs in which the bank failed in the given year, and 1,206 pairs in which the bank in question does not fail in the given year. We find that for pairs in which the bank fails, the average bank size is

[8]We do not observe any bank failures prior to 1997 in our sample.

much larger relative to the non-failed pairs: $8,670.9 million compared to $4,979.9 million. The failing banks are also less profitable in the year of failure: the mean profitability (return on assets) of banks in the failed pairs is -8.53%, compared to -0.44% for the banks in the non-failed pairs. For both comparisons, equal means tests indicate that the differences are highly significant. Banks who fail in a given year are also in greater need of debt roll-over: expressed as a fraction of overall assets, maturing debt which has originated at any time before 1997 is larger by a factor of 2.5 compared with banks who did not fail, 2.58% and 0.98%, respectively. Banks who fail exhibit, in the year of failure, a higher or equal ratio of maturing debt to overall assets regardless of the year in which the debt was issued, as Table 5 shows, though the mean differences are significant only for maturing debt originating at any time before 1997 or 1995. Note that by excluding more recent bond issues, as we do in Table 5 when moving to the right, we are able to observe banks' exposure to roll-over risk that is wholly due to *long term obligations* issued years before the crises. This will be key to our identification strategy for estimation, as explained more fully in the next section.

4. Identification and Estimation

Our identification strategy is based on the idea that the original maturity of debt that is currently due can be important in explaining bank failure only to the extent that the debt is determined endogenously given the riskiness of the bank. According to this view accumulation of long term debt that eventually becomes shorter term should not be correlated with higher risk and likelihood of failure, since the decision to lend to the bank predates any news on the soundness of the bank's assets. In contrast, in models that predict that short term debt increases the vulnerability to crises, the original maturity of the debt that is currently due is not important; what matters for the vulnerability of the bank is the debt roll-over regardless of its original maturity. In this paper we utilize our information on banks' long term obligations to determine which of the two stories fits better with the data. Our instrument - the amount of maturing long term debt - provides the best indicator available to gauge a bank's roll-over risk, the crucial determinant of bank failure according to the Chang and Velasco model. It is untainted by a possible endogenous response to bad news, a response that would be consistent with the general shortening of debt maturities in the

1990's that we see in 3. Moreover, our data are comprehensive, in that we have the universe of debt obligations issued by banks, going back to 1976. We also have the full balance sheet information on the issuing banks, but we cannot account for any off-balance-sheet transactions such as swaps; hedges of this sort seem to have played a relatively minor role however, and were in any case secondary to foreign borrowing[9]. All told, our measure of exposure to roll-over risk is superior to any that has been suggested in the literature to date.

4.1. Baseline Regressions

We define an indicator variable that takes on the value of one when a bank i fails at year t and zero otherwise. Using probit regressions we estimate different variants of the following specification:

$$Pr(Failure_{i,t} = 1|\, size_{i,t},\, profitability_{i,t},\, debt_{i,t}^{YEAR}) = \int_{-\infty}^{z} \phi(k)dk, \qquad (9)$$

where $\text{size}_{i,t}$ denotes the logarithm of bank i's book value of assets in year t, $\text{profitability}_{i,t}$ denotes bank i's profitability in year t (as measured by its return on assets), and $\text{debt}_{i,t}^{YEAR}$ denotes banks i's maturing debt obligations in year t (as a fraction of overall assets) that originate before the specified year. For example, the variable $\text{debt}_{i,t}^{97}$ denotes debt obligations that originate at any time before 1997 and mature in year t (as a fraction of bank i's overall assets in year t), therefore including both short and long term debt[10]. In contrast, the variable $\text{debt}_{i,t}^{94}$ includes only maturing debt obligations that originate at any time before 1994, i.e excluding short-term debt, $\phi(k)$ is the standard normal density, and $z = \beta_1 size_{i,t} + \beta_2 profitability_{i,t} + \gamma debt_{i,t}^{YEAR}$. Table 6 reports different specifications of regression (9) and displays marginal coefficients (at the mean) for the explanatory variables. The displayed t-statistics are calculated using standard errors that are clustered by country.

Through the table, each column reports a different debt variable used in the regression, ranging from $\text{debt}_{i,t}^{97}$ in the leftmost column to $\text{debt}_{i,t}^{93}$ in the rightmost column. In Panel A we run the regressions without any fixed effects. We find that both size and profitability are highly significant and robust to the different definitions of debt included in each of the regressions. As expected less profitable banks were more likely to fail. Furthermore, larger

[9]Furman and Stiglitz (1998) argue that derivatives served to make regulation more difficult by disguising banks' and firms' true exposure to risk.

[10]Recall that our regressions include only foreign-currency denominated debt.

bank were more likely to fail during and immediately after the crisis, possibly indicative of greater exposure by these banks to low quality assets, or of relatively high leverage. The main point of interest however lies in the coefficients of our short-term debt variables. These exhibit a clear difference between the effect of bonds of different original maturities. As we move from left to right, the regressions portrayed in the Table 6 include less and less bonds that were originaly issued as short-term debt. We find that going back as far as three years prior to the crisis, i.e. when we exclude bonds that originate in or after 1995, we still get a positive and significant effect. This effect is both statistically and economically significant: for example, an increase of one standard deviation in maturing debt issued before 1997 increases the probability of failure by 67 basis points, which constitude an increase of 11 percentage points in the sample probability of failure, given at 6.07% (see Table 5). In contrast, debt that was issued in 1994 or before does not have a statistically significant effect on the probability of bank failure in this specification. Debt issued before 1994, i.e. at least four years before the crisis, comes in with a negative sign, although in this specification the effect is imprecisely measured.

Panel B of Table 6 presents the results of these regressions, now including country and year fixed effects. We see that the coefficients for asset size are now smaller, as well as insignificant. The coefficients for bank profitability are almost unchanged. The coefficients for maturing debt which includes relatively short-term debt are not at all robust to the inclusion of fixed effects: they lose their statistical significance, are much smaller, and in one instance even change sign. On the other hand, the coefficients for longer-term maturing debt (i.e. bonds issued before 1994) retain their negative signs, and moreover are now statistically significant. In particular, a one standard deviation increase in maturing debt issued before 1993, *decreases* the probability of bank failure by 43 basis point, corresponding to a seven percentage point relative decrease. This negative effect of longer-term maturing debt is large, as well as precisely measured, and will be robust to other specifications, as we shall see presently.

Given our identification strategy, our findings in Table 6, in Panel B in particular, indicate that roll-over risk in itself fails to explain bank failure. Recall that the direction of causality with regards to short-term debt is ambiguous, so the apparent positive effect of such debt on the probability of failure in Panel A should not be taken at face value. With country

and year fixed effects, the apparent explanatory power of relatively short-term debt is much reduced in any case. Long-term bonds, however, do not suffer from this ambiguity, and it is therefore significant that these bonds do not have a simliar effect. Indeed, when fixed effects are included, these bonds negatively affect the probability of failure, a result completely at odds with the idea that roll-over risk was an important cause of bank failure. Recall that according to Prediction 1, any maturing debt obligation, regardless of original maturity, has a positive affect on the probability of failure. This prediction fails to hold in the case of debt issued before 1994, as Panel B of the table clearly shows. In contrast, Prediction 1A does better: we see longer-term debt reducing probability of failure, as would be the case if indeed weaker banks could only get short-term financing, since in that case banks financed with relatively more longer-term debt are the stronger banks, the ones with less risky assets. We therefore conclude that to the extent that maturing, relatively short term debt positively affects the probability of failure, it does so above and beyond the roll-over effect, i.e beyond the mere fact that the debt is indeed maturing. The year 1994 is the apparent threshold year, in that maturing bonds issued prior to that year can safely be deemed as non-contributory to bank failure. As we later show, the exact threshold year is quite robust to changes in specification, and we will use 1994 in our data driven definition of "long term" vs. "short term" debt, i.e. debt issued before 1994 vs. debt issued in 1994 or afterwards.

It is interesting to see to what extent our results are sensitive to the particular method used. We therefore also perform survival analysis on our bank data. In this method we examine how the explanatory variables affect a bank's hazard function, i.e. the likelihood of failure as a function of time passed since year 0, in this case 1996. We estimate the regressions using the Cox proportional hazard model, which is semi-parametric and therefore less restrictive than fully parametric estimation. Here we look at individual banks through the period 1997 - 2002, and not at bank-year pairs as before. Another major difference between the methods is in censoring: when estimating the likelihood of failure via probit, we do not have to drop any post-failure observation, which may contain useful information pertaining to the timing of failure. Survival analysis, however, does require us to drop these observations. Our results are broadly similar, however, with differences mainly in the statisitcal significance of the various coefficients, but with remarkably close estimates of economic significance. The results are given in Table 7: we see in Panel A, where we estimate

without fixed effects, that maturing debt which includes short-term debt, i.e. includes debt issued in or after 1994, has a significantly positive effect on the likelihood of bank failure, whereas maturing debt that does not include these short-term bonds has a negative effect, though not always significant. Comparing these results to Panel A of Table 6, note that the economic magnitudes we estimate are quite similar. In Panel B, where country and year fixed effects are included, we see again that the coefficients for maturing debt which includes short-term debt are now smaller and in some cases less significant, whereas the coefficient on pre-1993 debt is now statistically significant. Here as well we note that economic magnitudes are very similar, comparing these results to Panel B of Table 6.

5. Conclusion

Our findings can therefore be summarized as follows: to the extent that long-term debt which is currently due represents roll-over risk without contamination by short-term expectations regarding asset quality, we find that roll-over risk does not in itself contribute to the likelihood of failure of banks in our daraset. In other words, Prediction 1 in Section 2 is not borne out by the evidence. Moreover, in some specifications, as we have seen, a higher fraction of such debt out of overall assets actually reduces a bank's probability of failure, a finding which is hard to explain using only the maturity mismatch approach to explain bank failure. These findings are, however, consistent with the alternative approach of Diamond and Rajan, which explains bank failure on fundamentals, i.e. on the quality of banks' underlying assets. Prediction 1A in Section 2 accords quite well with our results: banks with relatively more long term debt (where "long term" turns out to mean pre-1994) are indeed less likely to fail. We find that banks with relatively more short-term debt are more likely to fail; however that result should be viewed as a correlation rather than an effect due to the issue of endogeneity. It is important to emphasize, however, that our results cannot rule out the maturity mismatch explanation out of hand, since we cannot properly identify the direction of causality for the effects of short-term debt. Our identification strategy focuses on roll-over risk per se, and rules out that as the sole, or even main, factor behind bank failure during and after the East Asian financial crisis.

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Table 1: **Bank Failures**

This table provides descriptive statistics for East Asian banks included in our empirical analysis. See the main text for our definition of bank failure. The table includes only those banks for which we have established outcome following the crisis.

	Failed Banks As	Failed Banks By Year of Failure (As Fraction of All Banks)					
Country	Fraction of All Banks	1997	1998	1999	2000	2001	2002
Indonesia	52/119 (44%)	4 (3%)	20 (17%)	26 (22%)	1 (1%)	1 (1%)	0 (0%)
Korea	49/60 (82%)	11 (18%)	12 (20%)	18 (30%)	5 (8%)	3 (5%)	0 (0%)
Malaysia	42/96 (44%)	1 (1%)	12 (13%)	5 (5%)	24 (25%)	0 (0%)	0 (0%)
The Philippines	10/56 (18%)	0 (0%)	1 (2%)	5 (9%)	3 (5%)	0 (0%)	1 (2%)
Thailand	59/80 (74%)	22 (28%)	20 (25%)	4 (5%)	0 (0%)	13 (16%)	0 (0%)
All Countries	212/411 (51%)	38 (9%)	65 (16%)	58 (14%)	33 (8%)	17 (4%)	1 (0%)

Table 2: **Issued Debt - Summary Statistics**

This table provides summary statistics for debt obligations which were issued by the banks included in our empirical analysis.

		Principal (Million US$)		Maturity (Years)		Currency Composition		
	Obs.	Mean	Std. Dev.	Mean	Std. Dev.	Domestic	US$	Other Foreign
Indonesia	315	52.6	45.1	3.7	2.4	38 (12%)	275 (87%)	2 (1%)
Korea	804	134.0	155.7	4.1	2.8	0 (0%)	635 (79%)	169 (21%)
Malaysia	137	127.4	103.1	3.9	3.6	82 (60%)	41 (30%)	14 (10%)
The Philippines	60	79.0	52.6	4.1	2.4	0 (0%)	56 (93%)	4 (7%)
Thailand	523	76.3	92.2	4.4	2.6	151 (29%)	338 (65%)	34 (7%)
All Countries	1839	101.4	123.9	4.1	2.7	271 (15%)	1345 (73%)	223 (12%)

Table 3:
Original Maturity Issuance

Panel A: Original Maturity of Bond Issues 1976-2002

	Mean	25th Percentile	Median	75th Percentile	Standard Deviation	Min	Max	Observations
Failed banks	4.10	3.0	3.0	5.0	2.64	0.0	15.0	1,483
Non-failed banks	4.17	3.0	3.0	5.0	3.04	0.0	25.0	363
Difference	-0.07							
T-test	(-0.47)							

Panel B: Evolution of Original Maturity for Failed and Non-failed Banks Over Time

	1980-1990	1991-1997	1992-1996	1995-April 1997	May 1997-2002	1998-2002	1999-2002	2000-2002
Failed banks	6.8	3.9	3.9	3.9	3.1	2.9	2.9	2.9
(observations)	(180)	(1037)	(829)	(514)	(345)	(259)	(243)	(180)
Non-failed banks	4.8	4.2	4.6	4.3	3.6	3.8	4.7	5.3
(observations)	(24)	(239)	(178)	(129)	(126)	(97)	(62)	(50)
Difference	2.0	-0.3	-0.7	-0.4	-0.6	-0.9	-1.8	-2.4
T-test	(2.86)	(-1.83)	(-3.56)	(-1.64)	(-2.02)	(-2.58)	(-4.48)	(-5.15)

Table 4: **Original Maturity Regressions**

The regressions presented in this table include only foreign-currency denominated bonds issued by banks in our dataset. Failed equals 1 if the issuing bank has met the conditions for failure in any of the years 1997-2002. Rated equals 1 if the bond received a Standard and Poor's rating. Estimation was performed by OLS and probit (marginal effects reported), as appropriate. t-statistics, calculated using standard-errors that are clustered by year, are reported in parentheses. All regressions include year and country fixed effects, as well as an interaction term of year with Failed.

Panel A: All Foreign - Denominated Bonds

Dependent Variable=	Maturity	Maturity	Pr(Maturity≤1)	Pr(Maturity≤2)
Failed	-1.58 a	-1.66 a	0.28 a	0.40 a
	(-7.36)	(-7.20)	(21.59)	(26.57)
Rated		1.79 a	-0.07 b	-0.15 a
		(7.04)	(-2.54)	(-2.83)
Adjusted R^2	0.28	0.33	0.16	0.20
Observations	1,568	1,568	1,492	1,492

Panel B: Comparisons of Bonds Issued Before and After Crisis

	Bonds Issued through 1997		**Bonds Issued after 1997**	
Dependent Variable=	Maturity	Pr(Maturity≤2)	Maturity	Pr(Maturity≤2)
Failed	-5.47 a	-0.49 a	3.15 a	-0.17
	(-7.20)	(-14.74)	(3.02)	(-1.26)
Rated	1.75 a	-0.08 a	1.46 a	-0.28 c
	(5.29)	(-2.73)	(6.05)	(-1.83)
Adjusted R^2	0.30	0.12	0.27	0.15
Observations	1,315	1,213	253	253

Table 5: **Characteristics of Failed and Non-failed Banks**

This table compares means of characteristics of banks that failed and banks that did not fail, in a particular year, during the East Asian crisis. Observations here are bank-year pairs, for the years 1997-2002. Size is if the dollar value of the bank's assets, given current exchange rates. Profitability is defined as return on assets (ROA). Long-term debt due this year is the dollar amount of long-term debt principal that is due in the current year and was issued several years ago. The table reports means for each of the subsamples and t-statistics for equal means test.

			(Long-term Debt due this year)/Assets					
	Size	Profitability	issued pre 1997	issued pre 1996	issued pre 1995	issued pre 1994	issued pre 1993	Observations
Failed banks	\$8,670.9m	-8.97%	2.58%	1.28%	0.49%	0.12%	0.0199%	78
Non-failed banks	\$4,979.9m	-0.44%	0.98%	0.53%	0.15%	0.06%	0.0191%	1,206
Difference	\$3,691.0m	-8.53%	1.60%	0.75%	0.34%	0.06%	0.0008%	
T-test	(2.43)	(-7.33)	(2.27)	(1.45)	(2.34)	(0.77)	(0.03)	

Table 6: **Short-term Debt and Bank Failure with Bank-Level Financial Controls**

The dependent variable in the regressions is a dummy variable that equals 1 for failed banks in the year of failure. Size is the log of the dollar value of the bank's assets. Profitability is defined as return on assets (ROA). Debt maturing this year is the principal amount of debt, issued before particular years, that is due in the current year, expressed as a fraction of overall bank assets. All regressions include an intercept (not reported), panel B specifications include country and year fixed-effects. Regressions are estimated using probit (marginal effects are reported). *t*-statistics, calculated using standard-errors that are clustered by country, are reported in parentheses. Magnitudes are calculated relative to the observed probability of bank failure in our sample, given at 6.07%

Panel A: Bank Failures

Dependent Variable=	Pr(Failure)	Pr(Failure)	Pr(Failure)	Pr(Failure)	Pr(Failure)	Pr(Failure)
Size	0.017 a	0.016 a	0.017 a	0.016 a	0.017 a	0.017 a
	(3.46)	(3.41)	(3.45)	(3.41)	(3.44)	(3.38)
Profitability	-0.003 a	-0.003 a	-0.003 a	-0.003 a	-0.003 a	-0.003 a
	(-4.51)	(-4.78)	(-4.63)	(-4.59)	(-4.55)	(-4.52)
Debt maturing		0.111 a	0.091 a	0.333 a	-0.119	-2.147
this year		(5.87)	(4.81)	(11.80)	(-0.36)	(-1.37)
issued		*pre* 1997	*pre* 1996	*pre* 1995	*pre* 1994	*pre* 1993
Pseudo R^2	0.11	0.11	0.11	0.11	0.11	0.11
Observations	1,284	1,284	1,284	1,284	1,284	1,284
Magnitude of the effect			*Long-term debt due this year issued:*			
		pre 1997	*pre* 1996	*pre* 1995	*pre* 1994	*pre* 1993
one σ change		11.0%	6.6%	6.7%	-	-

Panel B: Bank Failures Fixed-effects Regressions

Dependent Variable=	Pr(Failure)	Pr(Failure)	Pr(Failure)	Pr(Failure)	Pr(Failure)	Pr(Failure)
Size	0.005	0.005	0.005	0.005	0.005	0.005 c
	(1.54)	(1.52)	(1.55)	(1.51)	(1.63)	(1.60)
Profitability	-0.002 a	-0.002 a	-0.002 a	-0.002 a	-0.002 a	-0.002 a
	(-15.18)	(-15.57)	(-15.15)	(-15.44)	(-15.22)	(-15.23)
Debt maturing		0.029	-0.007	0.063	-0.309 c	-2.027 a
this year		(1.19)	(-0.23)	(1.21)	(-1.93)	(-2.49)
issued		*pre* 1997	*pre* 1996	*pre* 1995	*pre* 1994	*pre* 1993
Fixed-Effects						
Country and Year	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.20	0.20	0.20	0.20	0.20	0.20
Observations	1,284	1,284	1,284	1,284	1,284	1,284
Magnitude of the effect			*Long-term debt due this year issued:*			
		pre 1997	*pre* 1996	*pre* 1995	*pre* 1994	*pre* 1993
one σ change		-	-	-	-3.37%	-7.02%

Table 7: **Hazard Regressions: Short-term Debt and Bank Failure**

These regressions are estimated using the Cox semi-parametric maximum likelihood proportional hazard model. The dependent variable is the annual probability of failure, i.e. the hazard function of time until failure, starting from 1996. Size is the log of the dollar value of the bank's assets. Profitability is defined as return on assets (ROA). Debt maturing this year is the dollar amount of debt principal, issued before particular years, that is due in the current year, as a fraction of overall assets. Panel B specifications include country fixed-effects. *t*-statistics, calculated using standard-errors that are clustered by country, are reported in parentheses.

Panel A: Bank Failures						
Dependent Variable=	Pr(Failure)	Pr(Failure)	Pr(Failure)	Pr(Failure)	Pr(Failure)	Pr(Failure)
Size	0.340 a	0.335 a	0.337 a	0.334 a	0.344 a	0.344 a
	(4.12)	(4.35)	(4.20)	(3.87)	(4.14)	(4.06)
Profitability	-0.023 a	-0.024 a	-0.023 a	-0.023 a	-0.023 a	-0.023 a
	(-9.23)	(-9.51)	(-9.34)	(-9.27)	(-9.11)	(-8.90)
Debt maturing		2.007 a	1.077 b	2.82	-5.054 b	-28.005
this year		(3.20)	(2.32)	(0.85)	(-1.97)	(-1.06)
issued		*pre* 1997	*pre* 1996	*pre* 1995	*pre* 1994	*pre* 1993
Observations	1,462	1,462	1,462	1,462	1,462	1,462
Magnitude of the effect			*Maturing debt due this year issued:*			
		pre 1997	*pre* 1996	*pre* 1995	*pre* 1994	*pre* 1993
one σ change		12.26%	5.18%	4.80%	-3.40%	-
Panel B: Bank Failures Fixed-effects Regressions						
Dependent Variable=	Pr(Failure)	Pr(Failure)	Pr(Failure)	Pr(Failure)	Pr(Failure)	Pr(Failure)
Size	0.152 b	0.154 b	0.151 b	0.149 b	0.154 b	0.157 b
	(2.01)	(2.00)	(1.96)	(1.96)	(2.06)	(2.05)
Profitability	-0.043 a	-0.043 a	-0.043 a	-0.043 a	-0.043 a	-0.043 a
	(-13.56)	(-13.36)	(-13.63)	(-13.80)	(-14.10)	(-13.90)
Debt maturing		0.438	-0.488	3.014 a	-2.666	-28.768 b
this year		(0.74)	(-0.41)	(3.20)	(-0.64)	(-2.00)
issued		*pre* 1997	*pre* 1996	*pre* 1995	*pre* 1994	*pre* 1993
Fixed-Effects						
Country and Year	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,462	1,462	1,462	1,462	1,462	1,462
Magnitude of the effect			*Maturing debt due this year issued:*			
		pre 1997	*pre* 1996	*pre* 1995	*pre* 1994	*pre* 1993
one σ change		-	-	3.01%	-	-6.57%