The Banking Exposure to International Lending: Regional Differences or Common Fundamentals?

by Elena Kalotychou and Sotiris K. Staikouras

The present study unveils the importance of regional characteristics of sovereign debt crises in Latin America and South East Asia. It proposes and empirically corroborates a refinement of the logit approach, for assessing sovereign risk, which draws upon a region-specific parameterization—composite estimator. The analysis identifies some common features of debt crises that largely reflect domestic solvency, liquidity factors and, to a lesser extent, trade-balance variables and external shocks. Nonetheless, heterogeneity effects and regional signals point towards the use of region-specific models. Such approach depicts specific risk factors such as openness and debt burden for Latin America and reserves, output and government expenditure for Asia, thereby suggesting distinctive aspects to debt crises. Out-of-sample forecast comparisons further support the use of the composite estimator. The latter outperforms the simple pooled and random effects approach on the basis of various criteria, albeit slightly biased towards false non-crises predictions.

I. INTRODUCTION

Competing in global markets, multinational banks are seriously affected, through their loans, by worldwide economic changes and the prices of energy products. In recent years such exposure has caused enormous problems for US banks lending to less developed countries (LDC), Latin America and Asia (Saunders and Cornett, 2003). Over the last two decades, the magnitude of sovereign debt repayment problems has reached unprecedented levels and the subsequent scale of losses has increasingly involved commercial banks[1]. In 1982, when Mexico and Brazil announced their debt moratoria, 80% of the US banks' sovereign exposure was concentrated in Latin America[2]. One could easily argue that in many cases these loans appear to have been made with little judgment

---

[1] For an excellent discussion on sovereign risk of multinational banks the interested reader is referred to Heffernan (1984, 2004) and Saunders and Cornett (2003).

[2] For the effects of banks' loan-loss reserve announcements see Grammatikos and Saunders (1990).

regarding sovereign creditworthiness. The financial crises in Mexico (1994–95), Asia (1997–99), Latin America (1999–01) and the misjudgment of credit rating agencies have been the impetus of the recent growing interest in modeling sovereign credit risk. Only at this time US financial institutions, armed with the experience of the 1980s, limited their exposure as compared to their counterparts in Europe and Japan. Improved risk assessment techniques did play an important role.

The potential risk exposure to international borrowers has also increased the regulators' concerns, who prompted for refined risk evaluation procedures of a bank's international loan portfolio (ILSA, 1983; Basel II, 2001)[3]. The Basel II proposal allows banks to use internal default rates to determine the regulatory capital against their credit exposure. Financial institutions use default probabilities to feed their value-at-risk models, to price loans and determine concentration limits. Default rates remain at the center of international capital allocation and their accurate estimation is therefore crucial. The sovereign credit evaluation is a two-stage process, where the repayment record is first assessed and then reliable signals about the future stability of a borrower are sought. Measuring that with a degree of confidence is indeed convoluted, yet necessary for the financial institutions' viability. The importance of sovereign risk analysis has also been recently emphasized by Kristin Forbes (MIT and US Treasury) who pointed out[4]: "What we should care about and what I would like to see is more work go into models predicting things such as external financing difficulties and financial systems vulnerabilities, just as a few examples".

One lesson from World War II was that economic distress often leads to political turmoil, international tensions and military conflict. Factors that trigger sovereign risk could be attributed to various and complicated dynamics such as an economic decline, social unrest, possibility of war or a change in political ideology. Such uncertainties are clearly illustrated by the rapid global changes that followed the unexpected invasion of Kuwait in 1990 and the collapse of Eastern Europe during the last decade. The importance of sovereign risk analysis is perceptible in various fronts. First, it is necessary to monitor the performance of existing loans and other investments. Second, organizations such as the IMF and the World Bank would be able to prevent crises and effectively support countries exhibiting signs of financial instability. Third, the effects of a financial crisis are not only felt in emerging markets, but strong economies might suffer "equally" well by such turmoil. Fourth, sovereign risk analysis is not a tool for solely predicting financial crises; it is a vehicle of improving the decision-making process regarding capital budgeting and/or financing. Fifth, serious banking problems (or even failures) in developed economies, due to

---

[3] ISLA stands for the International Lending Supervision Act. For more details on the examination and supervision of international lending see Martinson and Houpt (1989). The interested reader is also referred to the Basel Committee on Banking Supervision (2001) as well as its subsequent amendments.
[4] Economic Forum organized by the IMF 2001.

international lending, are presumed to generate serious negative externalities. Finally, due to integration and interdependence of financial markets it is sensible that foreign direct investment in LDC is necessary if global markets are to prosper.

The theoretical literature has provided some rationalization of sovereign debt crises within the ability-to-pay and willingness-to-pay frameworks. The former scheme relates to the idea of credit rationing in which the occurrence of default is a demand-supply disequilibrium situation where the international credit market does not clear at the interest rate ceiling (McFadden, Eckaus, Feder, Hajivassiliou and O'Connell, 1985). In this case, the demand for new loans exceeds the maximum supply at the upper-ceiling interest rate at which bankers are willing to lend and the determinants of default are those that shift the demand and supply curves. The willingness-to-pay approach postulates that the sovereign default event is the outcome of a utility cost-benefit comparison by a sovereign debtor (Eaton, Gersovitz and Stiglitz, 1986), where the borrower defaults if the expected value of the discounted utility of consumption with default exceeds that with repayment. Theoretical interpretations have been accompanied by ample empirical evidence to quantify the contribution of each factor [Feder, Just and Ross (1981), Moghadam and Samavati (1991), Chang and Velasco (2000), Detragiache and Spilimbergo (2001), Manasse, Roubini and Schimmelpfennig (2003), Kalotychou and Staikouras (2004, 2005)]. Further work on credit ratings [Cantor and Packer (1996), Juttner and McCarty (1998)] and sovereign spreads [Eichengreen and Mody (1998), Kamin and Kleist (1999)] has also provided some guidance in this respect. Albeit the presence of some fundamental determinants of creditworthiness (for instance, debt service to exports for liquidity, reserves to imports for solvency, and inflation as economic proxy), it is unlikely to observe the same macroeconomic pattern triggering a debt crisis across different regions. Regional differences have so far been advocated in the relevant context of currency crises [Kaminsky and Reinhart (1996), Burkart and Coudert (2002)]. The existing literature has paid little attention to differentiating among regional debt crises and thus the determinants of such incidents are not clear-cut as yet.

The current work aims to fill this void and contributes to the literature by addressing possible differences across regions, which in turn determine changes in the credit quality of sovereign borrowers. To this end, the importance of common *vis-à-vis* region-specific fundamentals is assessed, and a new approach to modeling default risk is examined. The latter builds on constructing panel logit models that incorporate region-specific economic indicators for Latin America and South East Asia. Moreover, the paper explores the conjecture that should regional differences be detected, region-specific estimators should yield better predictions than the conventional pooled specifications. Several criteria are deployed for assessing performance, as the latter should rely heavily upon the consistency of the particular model. The cross-modeling analysis

focuses on the out-of-sample ability of the above approaches to predict pending debt crises.

In what follows, Section II reviews the literature on sovereign risk analysis. Section III, introduces the data and delineates the methodology. Section IV presents the empirical results and compares them to those of other studies. Finally, Section V overviews the major findings and points out avenues for future research.

II. THE INTERNATIONAL CREDIT RISK EXPOSURE

This section is divided into two parts. The first part briefly reviews the literature on debt servicing issues and modeling sovereign debt; while the second part sketches the international credit environment over the last decades.

OVERVIEW OF THE EMPIRICAL STUDIES

International credit markets have witnessed a vast and diverse amount of theoretical and empirical work. This section endeavors to briefly group the various studies and outline the findings of the pertinent empirical research. A detailed review and theoretical discussion on sovereign risk can be found in Eaton, Gersovitz and Stiglitz (1986). Comprehensive surveys of the empirical literature are provided in Babbel (1996) and Aylward and Thorne (1998). Regarding the definition of a debt crisis, earlier studies used rescheduling of debt, while Feder, Just and Ross (1981) were the first to introduce the element of arrears on interest and/or principal. McFadden, Eckaus, Feder, Hajivassiliou and O'Connell (1985) and Hajivassiliou (1987, 1989) included three elements (arrears, rescheduling and IMF assistance), while the independent variables were those driving the demand and supply of new loans. Manasse, Roubini and Schimmelpfennig (2003) defined a country to be in a debt crisis if classified as being in default by Standard and Poor's, or if it has access to excessive IMF financing.

The first statistical work on the determinants of sovereign default made use of discriminant analysis (Frank and Cline, 1971), where debt to amortization, imports to reserves and the debt service ratio were identified as significant indicators. In a similar manner, Abassi and Taffler (1984) identified inflation, external debt to exports, domestic credit to GDP and loan commitments per capita. Using logit analysis Feder and Just (1977) reported additional signals, namely real export growth rate, per capita income and capital inflows to debt service payments ratio. Detragiache and Spilimbergo (2001) highlighted the role of external liquidity. The effect of macroeconomic domestic volatility shocks in explaining variations in sovereign default probabilities was considered by Catao and Sutton (2002). Elsewhere, Staikouras (2005) showed that debt ratios, trade resources, domestic factors and financial flows were the most prominent economic signals. Under the willingness-to-pay framework, Lee (1991) modeled the

event of a sovereign default on the basis of relative utility for a sovereign debtor. Signals such as interest rates, GDP per capita growth, debt/GNP and domestic credit of government/GDP were significant in explaining repayment performance. In a different vein, Clark and Zenaidi (1999) modeled the willingness to pay as an American option and developed a methodology for an empirical estimation of its value. They found the unwillingness to pay variable is highly significant when standing alone and when combined with the other variables. They also found a strongly significant ARCH effect, a significant region effect for Latin America and a strong country-specific effect for all the countries in our study.

Somerville and Taffler (1995) contrasted the ability of the Institutional Investor credit ratings and that of multivariate statistical models to predict external debt-service capacity among LDC. Although a higher predictive accuracy of the statistical models was documented, the latter deemed not necessarily superior when allowing for differential misclassification costs. Haque, Kumar, Mark and Mathieson (1996) indicated that economic fundamentals such as reserves to imports, current account balance to GDP, growth and inflation explained a large amount of the credit ratings' variation. Regional location and the nature of exports were also found to be important. Finally, Cantor and Packer (1996) summarized the information content of the leading agency ratings in few variables, such as debt service to exports, debt to GDP, reserves to external debt, inflation and growth.

A strand of the literature has developed a critical attitude towards the assumption of homogeneous repayment performance across countries. A number of studies reported significant regional fixed effects (Feder, Just and Ross, 1981). McFadden, Eckaus, Feder, Hajivassiliou and O'Connell (1985) and Hajivassiliou (1987, 1989) controlled for country heterogeneity using random effects models. Without analyzing the sources of heterogeneity per se, they attributed more than half of the variation in debt repayment to country-specific unobservable effects rather than common fundamentals. Staikouras (2005) found significant regional heterogeneity across Eastern Europe, Latin America and Asian countries.

Research on international lending has also its roots extended in various directions. A number of studies have examined the impact of political instability on serving debt obligations [Shapiro (1985), Feder and Uy (1985), Brewer and Rivoli (1990), Balkan (1992), Berg and Sachs (1998)]. Yet, the fact that political factors are difficult to quantify and forecast may be a limitation worth considering. Heffernan (1985) examined the international financial situation and identified factors for the demand and supply of sovereign loans. Others concentrated on issues related to pricing efficiency on LDC traded loans [Urrutia (1995), Lee, Sung and Urrutia (1996), Choi, Hauser and Kopecky (1999)] where evidence indicated that their returns conform to those expected in an efficient market. Moreover, other authors explored the dynamics between banking and currency crises [Frankel and Rose (1996), Demirgüç-Kunt and Detragiache (1998), Berg

and Pattillo (1998), Kaminsky and Reinhart (1999), Staikouras (2004)]. Finally, implicit default probabilities, extracted from sovereign bonds, and portfolio selection issues have been examined by Izvorski (1998), Trova (2000), Ciraolo, Berardi and Torva (2002) and Janosi, Jarrow and Yildirim (2002).

The International Debt Markets

Sovereign governments, in the Standard and Poor's database, rose from 39 during 1824 to 201 in 1999 and defaults took place repeatedly, and on a substantial scale, throughout the 20th century. Crises fell to low levels only in the first four decades after World War II, when cross-border bond issuance was also minimal. The last two decades will be remembered as a period of high default rates. The type of problems faced in the 1980s, however, is different from those in the 1990s. More specifically, the 1980s reflect default risk on private debt and high international interest rates, while the 1990s embed default risk on foreign currency bonds and smaller scale of involvement by private international creditors. The latter also incorporates the peak of the debt-servicing problems across LDC during 1992–93. Moreover, the 1990s witness the Asian debt crisis whose impact is evidenced by the defaults of Pakistan and Indonesia, the sharp deterioration in credit quality of Thailand, Korea, Malaysia and, subsequently, the large-scale default by Russia. Despite the recent turmoil, sovereign ratings were slightly more stable overall in 1999 than the historical average. The unprecedented default experiences illustrate that sovereign default in the bond front has begun to figure more prominently in recent years. Ecuador was the newcomer in sovereign defaults in 1999. In August and October it defaulted on about $6 billion in Brady Bonds and $500 million in government Eurobonds respectively. During 1999, a number of sovereigns remained in default after experiencing problems in previous years. In January, Brazil's state governor declared a moratorium on the state's debts. In March, Indonesia restructured a $500 million syndicated bank credit. Russia, by far the largest such issuer, defaulted on $1.3 billion of its MinFin series III bonds (plus other Soviet era debt) during May 1999. Russia is probably one of the most striking examples of how political power can be connected to determining the distribution of economic rewards in a new market-based economy. The $988 million commercial debt default of Pakistan widened in subsequent years. An exchange offer of $610 face value Eurobonds resulted in an effective default and downgrade during 1999. In December 2001, Argentina defaulted on $130 billion in government issued debt and, in 2002, passed legislation that led to defaults of $30 billion of corporate debt owed to foreign creditors[5]. Looking back, three different regimes can be identified over the last two decades. The deterioration of external debt-servicing capacity of LDC was moving at an accelerating pace throughout 1981–1992, mounting at a peak around 1993 and then remaining stable but still at very

---

[5] For a discussion and analysis of the Latin American crisis see Kalotychou and Staikouras (2004, 2005).

high levels to the end of the decade. The phenomenon is apparent when studying the proportion of countries experiencing some sort of repayment difficulties. In general, changes in a sovereign's credit standing is the result of endogenous factors such as reversals on structural reforms (Russia), deteriorating banking sector and political uncertainty (Indonesia, Pakistan, Russia). It is typically decisions taken by policyholders, usually over several years, which result in up or downgrading. When exogenous factors do exert some sort of influence, it is usually the result of either overestimating a policyholders' capacity to respond or underestimating a business cycle's amplitude.

The aforesaid cases clearly indicate that the development of a stable, market-orientated financial system is one of the forthcoming challenges. On this should be added policy challenges related to debt management and contingent liabilities, stemming from a weak banking system and fiscal discipline. In some countries the banking system and adequate regulatory structures were actually nonexistent. The latter combined with inadequate banking supervision, the mushrooming of small banks and lack of credit appraisal experience has resulted in a large number of non-performing loans. Thus, the above discussion clearly points out the various aspects and implications of sovereign risk analysis for both financial institutions and national planning designs.

III. DATA AND METHODOLOGY

The empirical work is based on data for 24 Latin American (LA) and South East Asian (SEA) countries during the period 1982 to 1998. Annual data on financial and macroeconomic factors, as well as on external debt obligations are obtained from the World Bank electronic database. The dataset is an unbalanced panel as the time series length for each country varies due to the availability of the indicators. All models are constructed in-sample over 1982–1996, leaving two years 1997–1998 for out-of-sample evaluation. The latter encompasses the Asian crisis and thus provides an ideal setting for model validation.

An important consideration when dealing with credit crisis predictions is the construction of the dependent variable, which signals repayment problems. But what is the relevant sovereign credit event that would trigger a debt crisis? The issue has recently attracted particular attention as alternative definitions have been proposed for the most appropriate indicator to represent debt repayment difficulties[6]. The leading rating agencies define debt crises as sovereign defaults, whereas the majority of the studies conceptualize debt crises as large arrears or rescheduling agreements (Detragiache and Spilimbergo, 2001). More recently, definitions that draw upon excessive IMF financing (Manasse, Roubini and Schimmelpfennig, 2003) and market-based measures such as sovereign bond distress (Pescatori and Sy, 2004) have also been advocated.

---

[6] The authors are grateful to the referees for triggering this discussion.

This paper employs accumulated arrears as a proportion of long-term total external debt, as well as rescheduling agreements with official and/or private creditors[7]. Rescheduling agreements may technically occur separately of arrears, as some sovereigns may avoid delaying their debt payments simply by early negotiating debt rescheduling. Arrears above a certain threshold of external debt would be considered as an alarming indication of default. We use a country-specific threshold aiming to distinguish between different country arrear capacities. The latter is set equal to the mean value of the arrears to external debt ratio. The use of a threshold is in line with the credit-rationing approach, where short-term illiquidity and unavailability of reserves, as measured by a negligible share of sovereign debt in default, do not necessarily imperil international credit markets. Our debt crisis definition which follows the rating agencies' and a big strand of the literature aims at capturing outright defaults and semi-coercive restructuring, but not liquidity crises. Although there is no consensus as to which the most suitable definition is, it is unlikely that incorporating the latter would impact the importance of regional origins of debt crises.

More specifically, our focus on long-term debt arrears and reschedulings to proxy for foreign debt-servicing difficulties stems from three reasons. First, data on short-term debt arrears and reschedulings is not available. Second, for most of the countries in our sample bond spreads became widely available post 1994 after the commercial bank debt was securitized, converted into Brady- and Euro-bonds and emerging market bonds became actively issued and liquid. Third, IMF programs aim to alleviate balance of payment problems, which do not necessarily reflect sovereign debt problems. Large IMF loans capture liquidity crises for a solvent but illiquid country that is on the verge of default because of investors' unwillingness to rollover maturing short-term debt and a default was partly avoided via the bailout package.

The selection of independent variables (risk signals) draws upon previous empirical studies and theoretical justifications on the determinants of sovereign debt crises, credit ratings and sovereign spreads. A large set of 25 potential indicators is considered at the outset to account for the heterogeneity of the economies in the sample. Transformations are employed to reduce the degree of skewness and kurtosis inevitable in financial ratios as well as to dampen the effect of outlier observations. The variables are thus transformed as $Log(1 + x)$ where x is expressed as a proportion. When ratios exhibit negative values (e.g. trade balance) then the transformation changes to $-Log(1 + |x|)$. The variables are re-examined and any remaining outliers for each series in each group (crises, non-crises) are winsorized; that is, they are replaced by limiting values of 2.5 standard deviations from the mean. The initial variable set was reduced using an in-sample stepwise general to specific logit procedure. At each step, the least significant variable is eliminated and the process continues until all variables are

---

[7] The agreement is listed in the World Bank Global Development Finance 2001 database. World Bank assigns the date for rescheduling to the year when it was publicly announced that the rescheduling negotiations were concluded.

significant at the 5% level[8]. Using the entire country sample we construct the pool and random effects inter-regional logit functions in which, overall, 14 domestic and 2 international factors are identified as common crisis determinants. In contrast, our proposed composite approach (see following section) uses a regional breakdown of the sample to uncover a potentially smaller set of region-specific risk factors. The countries employed for this analysis along with the leading warning/risk indicators are presented in appendix 1.

The current panel data set covers a sample of N countries, where each country $j = 1, \ldots, N$ is considered over T_j periods. The debt-servicing problem is to be modeled in terms of various exogenously specified signals. The underlying response variable, the probability of default, is not directly observable. Instead, the dichotomous dependent variable (y_j) takes the value of one if a country experiences debt-servicing problems at a certain period t (the time index t is omitted for expositional simplicity) and zero otherwise. That implies that y_j can be represented by a binomial distribution

$$Pr(y_j = 1) = P_j$$

$$Pr(y_j = 0) = 1 - P_j \tag{1}$$

where P_j denotes the probability of country j experiencing problems at a given period. A link function can relate P_j to the set of k explanatory signals (x_j). The usual link is the logit function formulated as follows

$$P_j = [1 + exp(-x_j'\beta)]^{-1} \tag{2}$$

where β is a $k \times 1$ vector of unknown parameters. The specification is sometimes expressed in terms of the log-odds ratio

$$log[P_j/(1 - P_j)] = x_j'\beta \tag{3}$$

It is expected that a subset of the N countries will experience debt-servicing problems. Assuming independence, the joint density function is the product of the M struggling economies with the $N - M$ sound borrowers, formulated as

$$p(y_1, \ldots, y_N) = L = \prod_{i=1}^{N} P_j^{y_j}(1 - P_j)^{1-y_j} \tag{4}$$

We maximize the logarithm of L by substituting for the logistic function from Equation (2)

$$Log\ L(y; \beta) = \sum_{i=1}^{M} x_j'\beta - \sum_{i=1}^{N} log[1 + exp(x_j'\beta)] \tag{5}$$

[8] Experimentation using a stricter cut-off of 1% left the results unchanged. We also considered a comparison of each indicator's distribution for the two groups of countries (i.e. in debt crisis and in tranquil periods), which gave similar results to the stepwise selection procedure. Given the diversity of economies the use of a large number of variables is rather typical in the literature (Aylward and Thorne, 1998).

The desirable properties of the maximum likelihood are that the parameters are efficient and asymptotically consistent. In addition, *t*-tests can be applied since estimators are known to be asymptotically normal, while for a subset or all the coefficients a likelihood ratio test can be employed. The above presentation briefly summarizes the logit approach in its simplest formulation[9]. To allow for unobservable country heterogeneity (e.g. political instability, social unrest, economic policy) we also employ a random effects logit estimator, which implies independent and identically distributed country-specific error components.

IV. ESTIMATION RESULTS

The analysis starts with the modeling of international debt-servicing capacity aiming at detecting early warning signals within the global sample and across the two individual regions. Through in- and out-of-sample comparisons, the study also compares the proposed regional approach against the traditional pool-logit and random effects estimators. The number of defaults and the volume of arrears relative to external debt illustrate the magnitude of the international lending exposure over the last two decades. A graphical depiction of these variables is given in Appendix 2, Figures 1 and 2. The graphs reveal the magnitude of the financial distress in the LA countries, whereas for Asia the overall picture is less worrisome. Latin American debt peaks in the nineties, where LA countries experience their share of debt crises. For the Asian countries the late 1990s is the period where the financial crisis spreads all over the region and even reaches Japan.

Splitting the sample into crisis and non-crisis (country-period) observations the distribution of each indicator in the two groups can be contrasted. The discriminatory power of each of our selected variables is assessed by examining whether its mean/median varies between the crisis and the non-crisis group. The skewed nature of the macro-ratios inflicts the use of the median to corroborate the results. It is found that the majority of the risk factors selected in the stepwise regression exhibit a statistically significant difference between the two groups. Table 1 presents the result of such analysis.

On this basis, the indicators are expected to have some power in distinguishing between countries that timely service debt and those experiencing debt-repayment problems. The diversity of countries and the heterogeneity among the regions examined are the main factors behind the choice of a large set of possible indicators. The analysis proceeds with the estimation of the pool-logit (inter-regional pool) model and its corresponding random effects (inter-regional random) specification for the entire sample of the 24 countries over 1982–1996. The random effects estimator is chosen on the basis of the Wu (1973)-Hausman (1978) test, which discriminates between fixed and random effects (see at the bottom of Table 2 for a brief description of the test). Country heterogeneity (fixed/random unobservable effects) implies that financially 'similar' countries

[9] For more details the interested reader is referred to Maddala (1983).

Table 1: Statistics of crisis *Vs* non-crisis years

	Crises/Non-crises years	
	Mean	Median
Government expenditure over GDP	0.108/0.094	0.106/0.091
	(4.51)	[4.91]
Credit to private sector over GDP	0.225/0.355	0.177/0.297
	(7.65)	[8.05]
Gross capital formation over GDP	0.180/0.218	0.175/0.207
	(7.13)	[6.59]
Money supply to gross inter. reserves	0.052/0.047	0.040/0.032
	(1.59)°	[3.39]
GNP per capita	7.395/7.416	7.487/7.724
	(0.21)°	[1.13]°
Real exchange rate	0.083/0.098	0.098/0.076
	(0.50)°	[0.31]°
IMF credits over exports	0.112/0.076	0.114/0.044
	(4.03)	[4.27]
Reserves over imports	0.042/0.041	0.036/0.036
	(0.23)°	[0.51]°
Trade over GDP	0.360/0.408	0.368/0.388
	(2.92)	[2.21]
Trade balance over GDP	−0.016/−0.017	−0.020/−0.016
	(0.24)°	[0.13]°
Official debt over total debt	0.560/0.502	0.577/0.531
	(6.06)	[5.72]
Short-term debt over total debt	0.160/0.141	0.154/0.126
	(2.39)	[2.46]
Short-term debt over net reserves	0.915/0.739	0.780/0.598
	(3.32)	[3.08]
Debt over GDP	0.480/0.363	0.455/0.356
	(7.29)	[6.03]

The results are based on the whole country sample.
∘ Insignificant differences based on the reported statistics.
(·) Figures in parentheses indicate *t*-statistics, testing the difference in means.
[·] Figures in the square brackets indicate the Wilcoxon test statistic, testing the difference in medians. This is a nonparametric alternative to the two-sample *t* test; in fact, the test requires only that the population be continuous (not necessarily normal).

exhibit different debt repayment behaviors. Hajivassiliou (1989) notes that persistent country heterogeneity[10] may be the result of religious attitudes, types of governments, colonial histories and possibly other attributes not easily

---

[10] In econometric terms, persistent country heterogeneity with pooled cross-section and time-series data violates assumptions about the randomness of the error term and casts doubt on the consistency of the estimated coefficients and their significance.

Table 2: Economic signals from inter-regional estimators

	Pool-Logit			Random effects[†]		
	β	ME	t-ratio	β	ME	t-ratio
MCE	−19.88	−2.75	−3.72	−	−	−
MRCE	−	−	−	−37.61	−3.97	−8.90
Government expenditure over GDP	25.25	3.49	3.41	24.37	2.57	3.89
Credit to private sector over GDP	−4.57	−0.63	−2.43	−7.36	−0.78	−4.52
Gross capital formation over GDP	−9.13	−1.26	−1.84[*]	−	−	−
Money supply to gross inter. reserves	32.34	4.47	3.60	40.39	4.27	5.76
GNP per capita	−1.42	−0.20	−4.46	−1.85	−0.20	−7.31
Real exchange rate	−	−	−	2.71	0.29	2.28[**]
IMF credits over exports	−6.74	−0.93	−2.29[**]	−	−	−
Trade over GDP	−11.51	−1.59	−5.19	−11.40	−1.20	−8.22
Trade balance over GDP	−11.49	−1.59	−2.56	−8.22	−0.87	−2.73
Official debt over total debt	21.60	2.99	3.61	40.58	4.29	8.69
Short-term debt over total debt	24.25	3.35	4.14	44.40	4.69	8.89
Short-term debt over net reserves	2.61	0.36	3.40	3.23	0.34	6.37
Debt over GDP	17.98	2.48	6.40	16.86	1.78	10.16
OECD growth	−0.24	0.03	−2.64	−0.26	−0.28	−4.09
Long-term interest rates	0.44	0.06	3.88	0.48	0.05	5.51
SDRCE	−	−	−	1.61	0.14	9.03
McFadden R^2	0.463			0.513		
WH$\sim\chi^2$ (13) [0.8671]	7.6264					

β: Estimated coefficients via inter-regional logit models.
MCE: Mean of country effect.
MRCE: Mean of random country effect.
ME: Marginal effects of the estimated coefficients.
*/** Significant coefficient at the 10%/5% level. The rest of the coefficients are significant at the 1% level.
† The choice of this estimator over the rival fixed effects model is based on the Wu-Hausman (WH) test. The null (random effects) and the alternative (fixed effects) hypotheses are specified as follows H_0: $Cov(a_i, x_{it}) = 0$ and H_1: $Cov(a_i, x_{it}) \neq 0$, where a_i is the country specific effect and x_{it} is the exogenous factor. Under H_0 both estimators are consistent, but the random effects approach is more efficient. Under H_1 the random effects estimator is inconsistent.
[·] The figure in the square bracket, next to the WH test, indicates probability value.
SDRCE: Standard deviation of random country effect.

measured. He also points out that a large part of his debt repayment variation is country specific rather than attributable to macroeconomic variables. Fuertes and Kalotychou (2004a), however, find that homogeneous models dominate rival panel estimators on the basis of out-of-sample forecast accuracy.

The regressors in all models are lagged one year to alleviate endogeneity bias and inconsistency of estimates. Harvey (1989) suggests that a lagged value should be used which is automatically characterized as predetermined. Using financial data,

endogeneity might arise because an equation is part of a larger system of simultaneous equations. If signals are dependent to this system and correlated with the residuals in the stochastic part of the model, then the estimates would be inconsistent. The econometric results of the two estimators are presented in Table 2.

The table presents the results of the two inter-regional models where the parameters of the leading indicators are estimated for the whole sample of countries. The variables differ between the two estimators as the stepwise selection process is applied separately to each model. The non-linearity of the models implies that the marginal effect of the independent variables on the probability of default is not represented by the estimated coefficients (β), but depends on the values of the independent variables. In this study, the variables are set at their mean values and the marginal effects show the percentage change in the probability of crisis for 1% change in the signals.

The results on the significance and sign of the variables are, in general, consistent with expectations and recent research in modeling international credit crises [Haque, Kumar, Mark and Mathieson (1996), Aylward and Thorne (1998), Detragiache and Spilimbergo (2001), Staikouras (2005)]. It is evident that all indicators are highly significant apart from the gross capital formation. Both modeling approaches, suggest that the debt to GDP, government expenditure, money supply, official debt and short-term debt ratios have the biggest impact on determining crises and all have the expected positive sign. The negative sign of the trade to GDP ratio, which is a proxy for the degree of trade openness of an economy, indicates that more integrated countries are less likely to experience a debt crisis. The latter corroborates the findings of Detragiaghe and Spilimbergo (2001) and a plausible interpretation is that trade integration increases growth through export revenues (Bekaert, Harvey and Lundblad, 2005). Furthermore, more trade openness may render a country more vulnerable to credit sanctions if it defaults, which in a willingness-to-pay framework implies higher opportunity costs of default (Bulow and Rogoff, 1989). The IMF credit and the credit to private sector have apparently counterintuitive sign. Manasse, Roubini and Schimmelpfennig (2003) argue that certain countries benefit from last minute IMF rescue packages and prevent default; this argument postulates a negative parameter for the former ratio. A plausible explanation for the negative effect of the credit to private sector is provided under the region-specific analysis that follows. Looking at the random effects estimator, the increased significance of the indicators is noticeable, while in a few cases the marginal effects of the various risk factors have increased as well. It is also worth noting that 44.1% of the variation underlying repayment problems is due to the persistence of the country effect[11]. As far as the coefficient of determination is concerned, it remains at reasonable levels for qualitative response panel data analysis and with no big differences between the two estimators.

---

[11] The formula is $\text{SDRCE}^2/(\text{SD}^2 + \text{SDRCE}^2)$ where SD stands for the standard deviation of the disturbance. The latter is set at $\sqrt{\pi^2/3}$ in logit models.

The paper has so far identified early warning signals at an inter-regional level. The above analysis can be further refined in terms of identifying region-specific signals. Kaminsky and Reinhart (1999) and Burkart and Coudert (2002) consider regional differences within a currency crises framework. Significant discrepancies in the volatility of leading indicators are observed before the crisis in Asia, in Latin America and in other countries. Moreover, different leading indicators of currency crises are identified across regions, for instance, reserves to imports and inflation for Latin America and real domestic credit growth rate, openness and short term debt for Asia. Subsequently, region-specific models should be used, with different leading indicators, each of which would forecast better than any other 'global' estimator. Others have shown possible links between different regional crises via the correlated information assumption (King and Wadhwani, 1990) and/or via the correlated liquidity shock channel [Calvo (1999), Yuan (2000)]. Under the correlated information theory, prices in one market have power in changing the value of assets in other markets. Under the correlated liquidity approach, the need for asset liquidation by some market participants may take place in various markets simultaneously, resulting in transmitting the shock. Schinasi and Smith (2000) discuss the liquidity issues in the context of portfolio management. Interestingly, an alternative route may be responsible for those spillovers known as the cross-market rebalancing channel (Kordes and Pritsker, 2002).

Thus, to account for possible heterogeneity between the regions, in the context of international lending, the proposed third specification selects the respective leading indicators for the Latin American and South East Asian sub-samples separately. The signals are obtained through the aforesaid stepwise general to specific methodology. A homogeneity test (HT) of whether it is reasonable to pool the various economies in one inter-regional model rather than employing region-specific estimators rejects the null hypothesis of homogeneity between the two regions (see at the bottom of Table 3 for a brief description of the test). Table 3 presents the estimation results of the two regional models, which employ leading indicators identified for Latin America and South East Asia.

The two regions share in common only four out the ten factors. That is, credit to private sector to GDP, money supply, short-term debt to reserves and debt to GDP appear as systematic determinants of debt crises. The appearance of short-term debt to reserves ratio as a common crisis fundamental justifies the IMF guidelines to monitor the ratio as a leading indicator of financial crises. The credit to private sector exhibits a negative correlation with the probability of debt repayment problems for both estimators. It can be supported that the variable may exhibit either signs[12]. One may wish to argue that if the size of the economy is high relative to external debt a high value of the credit to private sector ratio can be sustained. In that case cash flows are shifted towards the private sector for further development and hence lowering the probability of credit problems. The latter assumes that

---

[12] Note that this is not the only ratio that can have a twofold interpretation. See, for example, Acharya and Diwan (1993) and Saunders and Cornett (2003) for the real investment to GNP ratio.

Table 3: Region specific pool-logit modeling

	Latin America			South East Asia		
	β	ME	t-ratio	β	ME	t-ratio
MCE	−10.05	−2.49	−2.64	−58.94	−0.03	−2.70
Government expenditure over GDP	–	–	–	100.48	0.05	3.10
Credit to private sector over GDP	−5.16	−1.28	−2.64	−34.84	−0.02	−2.44
Money supply to gross inter. reserves	26.02	6.45	2.68	175.26	0.08	2.94
GNP per capita	–	–	–	−5.80	−0.003	−2.53
Reserves over imports	–	–	–	−330.57	−0.15	−3.12
Trade over GDP	−8.28	−2.69	−4.21	–	–	–
Official debt over total debt	21.60	5.36	3.86	–	–	–
Short-term debt over total debt	20.36	5.05	3.40	–	–	–
Short-term debt over net reserves	2.17	0.54	2.43	2.96	0.001	2.48
Debt over GDP	9.95	2.47	4.48	44.79	0.02	2.87
OECD growth	−0.23	−0.06	−2.36	−0.06	−0.07	−0.19°
Long-term interest rates	0.51	0.13	4.23	0.19	0.00003	0.50°
McFadden R^2	0.331			0.678		
HT~χ^2 (15) [0.000]	48.89					

β: Estimated coefficients via regional-logit models.
MCE: Mean of country effect.
ME: Marginal effects of the estimated coefficients.
∘ Insignificant coefficient. The rest of the coefficients are significant at the 1% level or the 5% level.
HT: Homogeneity test distributed as χ^2 with $(r − 1)\, k$ degrees of freedom, where r is the number of groups/regions and k is the number of regressors. It is calculated as $\Sigma(Ll_{\text{LA, SEA}})–Ll_{\text{pooled logit}}$, where Ll is the log likelihood.
[·] The figure in the square bracket, next to the HT test, indicates probability value.

growth and prosperity in the private sector is actually realized[13]. On the other hand, the higher the indebtedness of the private sector compared to the size of the economy, the higher the likelihood of mass private defaults (e.g. by large banks and/or companies) in case of a cyclical downturn; hence the higher the probability of a banking crisis, which may force the government to bail out large banks and slither itself into payment difficulties.

Interestingly, a number of crisis signals seem to be region-specific. For instance, debt ratios and trade openness for Latin America; and reserves, growth

---

[13] An alternative, but similar interpretation, is that the negative sign might indicate more efficient resource allocation under the assumption that private enterprises are more efficient than governments. Thus, a higher ratio increases the inflow to the private sector and implies more efficient resource allocation, which in turns lowers the probability of default. The authors are grateful to Professor Ephraim Clark for suggesting and commenting on this issue.

and government expenditure for South East Asia. Comparing the two regional estimates, it is obvious how misleading the magnitude of the inter-regional coefficients from the pooled dataset could be. The impact of money supply, official debt, short-term debt and trade openness for Latin America has significantly increased compared with the ones in Table 2. Looking back in the history of the Latin American countries, it is actually these factors that have played an important role in determining their economic fate. The aforesaid debt ratios and the integration of the region with global financial markets seem to be idiosyncratic signals for Latin America. The trade openness proxy is in line with the efforts of the region to deregulate the financial system and eliminate foreign currency transactions and controls on capital flows.

The regional logit specifications indicate that the ratio of reserves to imports is important to Asian countries as opposed to Latin America. GNP per capita and government expenditure are also Asian specific factors, and are consistent with the traditional interpretations of the Asian crisis. Although the signs remain according to expectations, the magnitude of the marginal effects in the regional models shows that the impact of variables on the Asian probability of default is significantly smaller than in Latin America. The two international variables, industrial growth and interest rates, although significant for LA, appear to exert little impact on the probability of default. The latter is true regardless of whether an inter-regional or LA estimator is employed. The marginal effect of the growth in industrial countries remains negative, as higher foreign growth should strengthen exports and hence lower the probability of crisis. The significance of the external signals in Latin America is in contrast with other studies where external developments do not seem to play an important role in determining financial crises [Kumar, Moorthy and Perraudin (2003), Staikouras (2005)].

As far as the goodness of fit is concerned, the coefficient of determination for the Asian group has almost twice the size of the Latin American countries. This is probably indicative of the higher degree of homogeneity across Asian countries, such as the existence of common structural and financial problems that are captured by the region-specific variables. Experimentation by splitting the time period in half provides hardly any evidence of differences among the exogenous variables. The latter could be interpreted as that globalization has not really modified the structural forces that determine crises. In conclusion, both the homogeneity test and the distinct factors for the regional estimators support the use of the two different estimators. This becomes more evident when the out-of-sample predictive ability of the proposed models is examined, which is what the paper turns to next.

The paper proceeds to compare and contrast the three estimators employed so far. The reported findings pertain to the in- and out-of-sample predictions, 1982–1996 and 1997–1998, respectively. The latter provides an ideal setting for model validation since a number of crises took place during that period. The cross-modeling comparison focuses on the inter-regional logit, the inter-regional random effects and the composite approach. The estimates from the first two are obtained using the designated signals as derived from the whole sample. The

Table 4: Forecasting performance evaluation measures

	Cut-off point = 0.35			Cut-off point = 0.40		
In-sample results (1982–1996)	IRL	IRRE	CMP	IRL	IRRE	CMP
% of correctly predicted observations	84.66	83.92	85.99	85.80	84.50	86.27
% of correctly predicted crises	90.32	81.45	92.86	87.10	79.03	91.27
% of correctly predicted non-crises	81.58	80.69	82.25	85.09	87.61	89.69
False alarms ratio[†]	27.3%	24.1%	21.7%	23.9%	21.6%	18.7%
Noise to signal ratio[‡]	20.4%	23.7%	19.1%	17.1%	15.7%	11.3%
Forecasting results (1997–1998)						
% of correctly predicted observations	72.39	76.72	81.25	74.48	77.53	81.25
% of correctly predicted crises	74.99	75.69	77.78	74.99	75.69	77.78
% of correctly predicted non-crises	71.79	76.96	82.05	74.36	77.96	82.05
False alarms ratio[†]	58.0%	59.1%	50.0%	59.0%	59.1%	50.0%
Noise to signal ratio[‡]	37.6%	30.4%	23.1%	34.2%	29.1%	23.1%

IRL: Inter-regional logit model.
IRRE: Inter-regional random effects estimator.
CMP: Composite approach. Logit for LA and Logit for SEA using region-specific estimators.
† False alarms over total alarms, which is the number of type II errors divided by the number of predicted crises.
‡ This is the percentage of false alarms over the percentage of correctly predicted crises. The former is equal to the number of type II errors divided by the number of non-crisis observations.

composite approach uses the exogenous indicators obtained from the regional models. Thus, when Latin American or Asian countries are considered, the estimation and prediction are performed using the respective region-specific logit functions. To classify countries as being in financial distress the probabilities are transformed into warning signals by using the in-sample probability of default (35%) as a threshold. The sensitivity of the results to higher thresholds is examined by setting the latter at 40%. The resulting goodness of fit is shown in Table 4 for both thresholds.

The above table presents the prediction accuracy of the various modeling specifications using a range of criteria. In what follows, the paper derives some insight from the results reported in Table 4. Prior research has somehow failed to comment on the out-of-sample 'noises/bias', if any. Across all models, the out-of-sample forecasting results reveal a decrease in the overall correctly predicted cases and a significant increase in the false alarms and noise to signal ratios.

Nevertheless, it would be enlightening to explore in more detail the composite model (CMP) based on the reported findings. The results indicate that the CMP approach seems to outperform the inter-regional logit and random effects

estimators on the basis of both in- and out-of sample evaluations. That is, there is a distinctive decrease in the false alarms and the noise-to-signal ratios when the CMP estimator is employed. Furthermore, the correctly predicted cases increase for both crisis and non-crisis years. At the same time, comparing the in- and out-of sample performance, one cannot overlook that the CMP model is not favored by the significant drop in the correctly predicted crises (from 92.86% to 77.78%) and hardly any change in the correctly predicted non-crises (from 82.25% to 82.05%). This, in turn, is translated to an increase from 7.14% (in-sample) to 22.22% (out-of-sample) for the type I error, and from 17.75% (in-sample) to 17.95% (out-of-sample) for the type II error[14]. But what has actually caused such increase? A closer look unveils that the increase in missed defaults (type I error), during the holdout period, is the result of the noticeable decrease in total alarms issued by the model. For the 0.35 cut-off point, the in-sample total alarms figure[15] is 81.8% while the equivalent out-of-sample is 35.9%. On the other hand, the false alarms ratios, across the three estimators, exhibit an average increase of 38.7% points. Evidently, this is the result of the decrease in total alarms (denominator), as mentioned above, rather then an increase in false alarms (numerator). Taken all together, the CMP estimator is indeed better than the other two, but the results also indicate an increase in missed crises, which in turn implies a bias towards a type I error.

Changing the threshold rate to a slightly more conservative figure (0.4) produces similar results. It is worth noting that in the in-sample estimates the noise-to-signal ratio reduces significantly when increasing the threshold, especially in the case of the CMP estimator. This is because a higher threshold allows fewer incidents to be classified as crises, thereby reducing the number of false alarms at the expense of more missed crises. High cut-off rates[16] have financial implications for banks and policymakers, as the former aims for risky investments whilst the latter have to bear the repercussions of debt crises. Equally important, when low thresholds are chosen more alarms are issued. In this case, banks are risk-averse[17] and policymakers have to bear the economic costs of preventive policy measures. Type I errors or unpredicted debt crises are often

---

[14] The type I and type II errors are obtained by subtracting the percentage of correctly predicted crises and non-crises from unity, respectively. Type I error is a default state predicted as non-default (missed crisis) and vice versa for the type II error (false alarm). The null hypothesis involved is that the borrower defaults. If the null is true and it is rejected, then a type I error is committed. Conversely, if the null is false and accepted, the decision is incorrect and a type II error is incurred.

[15] Note that the reported figures are not the number of alarms per se. They actually represent the proportion of alarms over the number of non-crises. The total alarm figures can be recovered from Table 4 as: (1 – percentage of correctly predicted non-crises)/false alarms ratio.

[16] High cut-off rates produce less type II and more type I errors; while low thresholds generate less type I and more type II errors.

[17] The risk-averse institution assigns more weight to the cost of missing crises rather than issuing false alarms.

considered most costly as they entail realized losses and increase of reserves; thus the threshold rates employed in the analysis were chosen to account for this. On the other hand, one could determine the threshold rate by minimization of a utility function. Exact specification of the relative costs would, however, require appealing to complex decision-theoretic approaches[18]. In an in-depth econometric analysis, Fuertes and Kalotychou (2004b) attempt to establish the optimal threshold rate and warning horizon in the design of an early warning system for different degrees of risk aversion towards missing crises[19].

Finally, predictions on a country-by-country basis provide additional support for the adequacy of the composite estimator. The results of such analysis are presented in appendix 3. An interesting finding is that for some countries their actual status changes from 1997 to 1998 and the composite approach seems to be able to accurately capture it. More specifically, the CMP predicts the debt crisis in Indonesia and Pakistan in 1998 as well as Bolivia's exit from financial distress in the same year. In the case of Ecuador, the model persists in predicting the crisis for 1997 and 1998 and, interestingly, it is one year later that the country enters sovereign default. Similarly for Argentina, the composite estimator starts signaling problems as early as 1998, in line with the 'death-foretold' rationale put forward by many experts analyzing Argentina's credit failure. Finally, note that Korea and Malaysia are assigned a non-default actual status in the holdout years as our default definition focuses on long-term debt obligations. Despite the rapid growth of the Asian countries, the crisis emerged, mainly, as a result of illiquidity. A negative gap and a substantial degree of real estate investments leaded to severe debt crisis when the property bubble burst.

V. CONCLUSION

There is a natural proclivity to think of economic crises as rare events. Over the last two decades, systemic financial jitters have emerged all over the world and the need to understand their origins is all the more urgent. Debt crises unfold in different ways without precluding the existence of common fundamentals. Thus, the present study attempts to add further evidence by examining the systematic economic factors behind the financial crises in Latin America and South East Asia and identifying region-specific features. To this end, the paper reviews some empirical evidence and briefly describes the international lending situation. Furthermore, a cross-modeling analysis is carried out, while different estimators are assessed through their in-and out-of-sample forecasting performance.

More specifically, the analysis has identified some common economic indicators, such as credit to private sector, short-term debt to reserves, money supply

---

[18] The authors are grateful to the referees for pointing out the discussion with respect to the optimal threshold rate that "balances" the trade-off between type I and type II errors.
[19] The loss function employed is a weighted average of the type I and type II error probabilities.

and debt burden that trigger debt crises across regions. Relative to the effects of domestic indicators, both external shocks (US interest rates, industrial country growth) and external-balance variables (real exchange rate, export-import changes) have a small impact on default probability. Tests of heterogeneity confirm the existence of country specific unobservable effects. The presence of heterogeneity supports the use of either random effects or regional models. The latter identifies different leading indicators for each continent with new indicators emerging as a result of the region-specific analysis.

Focusing on individual regions the findings suggest that debt and trade openness appear most important in Latin America, while the Asian region has been mostly affected by reserves, GNP level and government expenditure. Forecast comparison among the three approaches favors the proposed composite estimator. The composite model outperforms even the random effects model, which allows for country specific unobservables, on the basis of all four goodness-of-fit measures that are employed to evaluate crisis prediction models. Interestingly, the composite approach is also able to predict both default entries and exits, from one period to another, as it appears in three sovereign states. Despite the good performance of the model, forecasting indicators show a bias towards a type I error, that is, fewer false alarms at the expense of missing defaults.

There are many that support the view that deteriorating market fundamentals are the core of financial crises. Others have suggested self-fulfilling crises or investors' herding attitude. Future research should highlight the need for a global approach to the various problems, which may not only be problems of debt but also income and internal turmoil. Whatever the reasons, it is critical for forthcoming studies to emphasize the complexity of international crises in the sense of being the result of diverse dynamics, which go above and beyond economic fundamentals. That is, political, social, cultural[20] and legal attributes could equally prevent the timely fulfillment of debt obligations. Yet, there is no guarantee that the balance among signals will not change in the future, as external factors might outweigh domestic policy imbalances or vice versa. Finally, debt repayment problems are only one side of the coin, as they also mirror the effect of negative externalities to global financial markets. To the extent that multinational banks are viewed as special, governments may seek political and economic avenues to reduce defaults of sovereign borrowers (Saunders and Cornett, 2003). Sovereign states should vigorously pursue changes, as the international economic environment is heavily dependent on the policies that individual nations pursue. The experience of those countries that have made it through the international debt crises suggest that others in a similar situation can only get out if they institute broad systemic reforms.

---

[20] An interesting example of country risk occurred after the price of crude oil fell dramatically in 1986. Many Islamic borrowers with significant indebtness to US banks invoked the doctrine of *sharia*, which holds that the payment of interest is against the teachings of Koran.

VI. APPENDICES

Appendix 1: Country list and description of exogenous risk signals

Latin American Countries	South-East Asian Countries
Argentina	Bangladesh
Bolivia	China
Brazil	India
Chile	Indonesia
Colombia	Korea
Costa Rica	Malaysia
Ecuador	Pakistan
Guatemala	Philippines
Mexico	Thailand
Panama	Sri Lanka
Paraguay	
Peru	
Uruguay	
Venezuela	

Government expenditure over GDP: Government spending on consumption, national security and defense.

Credit to private sector over GDP: CPS includes the domestic financial resources provided to the private sector, such as loans, purchases of non-equity securities, trade credits and other accounts receivable that establish a claim for repayment.

Gross capital formation over GDP: Gross capital formation (gross domestic investment) consists of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories. Fixed assets include land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways and the like, including schools, offices, hospitals, private residential dwellings and commercial and industrial buildings. Inventories are stocks of goods held by firms to meet temporary or unexpected fluctuations in production or sales, and "work in progress". According to the 1993 SNA (system of national accounts), net acquisitions of valuables are also considered capital formation.

Money supply to gross international reserves: Money and quasi money comprise the sum of currency outside banks, demand deposits other than those of the central government, and the time, savings, and foreign currency deposits of resident sectors other than the central government. This definition is frequently called M2; it corresponds to lines 34 and 35 in the International Monetary Fund's (IMF) International Financial Statistics (IFS). Gross international reserves comprise holdings of monetary gold, special drawing rights, reserves of IMF members held by the IMF and holdings of foreign exchange under the control of monetary authorities. The gold component of these reserves is valued at year-end (12/31) London prices.

GNP per capita: The gross national product divided by midyear population. GNP is the sum of value added by all resident producers plus any product taxes (less subsidies) not included in the valuation of output plus net receipts of primary income (compensation of employees and property income) from abroad. Data are in constant 1995 USD.

Real exchange rate: Deviation of real exchange rate from the long-run trend. The idea of this proxy for FX misalignment is similar to the ones in Frankel and Rose (1996) and Kaminsky and Reinhart (1999) except for the calculation of the trend.

IMF credits over exports: The repurchase obligations to the IMF for all uses of IMF resources as a share of export earnings. These obligations comprise purchases outstanding under the credit tranches, including enlarged access resources, and all special facilities (the buffer stock, compensatory financing, extended fund, and oil facilities), trust fund loans and operations under the structural adjustment and enhanced structural adjustment facilities.

Reserves over imports: Net international reserves in weeks of imports. Net international reserves is defined under the short-term debt to net reserves ratio.

Trade over GDP: It is the sum of imports and exports relative to the value of GDP converted to international $ using PPP rates. It indicates the degree of trade openness/integration/liberalization of an economy.

Trade balance over GDP: Trade balance relative to GDP. Trade balance is defined as the difference between exports and imports.

Official debt over total debt: Public and publicly guaranteed debt comprises long-term external obligations of public debtors, including the national government, political subdivisions (or an agency of either), autonomous public bodies and external obligations of private debtors that are guaranteed for repayment by a public entity. Data are in current USD.

Short-term debt over total debt: Short-term debt includes all debt having an original maturity of one year or less and interest in arrears on long-term debt.

Short-term debt over net reserves: Net international reserves comprise special drawing rights, reserves of IMF members held by the IMF and holdings of foreign exchange under the control of monetary authorities. Data are in current USD and gold holdings are excluded.

Debt over GDP: Total external debt relative to GDP. Total external debt includes public and publicly guaranteed, private non-guaranteed and long and short-term debt and loans from the IMF and the World Bank.

OECD growth: It is the real GDP per capita growth of high-income OECD countries.

Long-term interest rates: The yield on a 10-year US Treasury bond. It aims to capture global liquidity and interest rate effects.

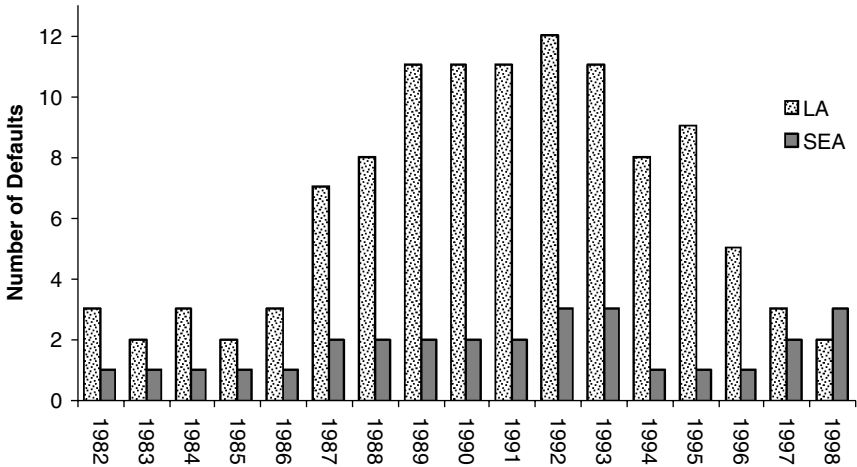Appendix 2: Illustrations for Latin America and South East Asia

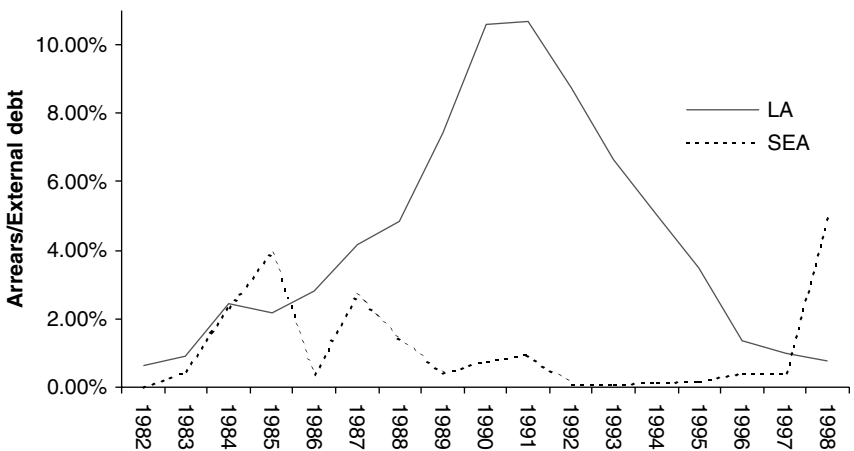
Figure 1: Number of default cases

Figure 2: Volume of arrears as a percentage of total debt

Appendix 3: Out-of-sample predictions using the composite (CMP) model

Countries	Year 1997 Status/Forecast		Year 1998 Status/Forecast	
Argentina	0/0	[29.69%]	0/1	[57.16%]
Bangladesh	0/0	[4.74%]	0/0	[3.52%]
Bolivia*	1/1	[62.10%]	0/0	[28.69%]
Brazil	0/0	[20.77%]	0/0	[8.06%]
Chile	0/0	[0.06%]	0/0	[0.21%]
China	0/0	[0.00%]	0/0	[0.02%]
Colombia	0/0	[5.15%]	0/0	[3.94%]
Costa Rica	0/0	[24.46%]	0/0	[27.72%]
Ecuador	0/1	[87.77%]	0/1	[87.48%]
Guatemala	1/1	[64.31%]	1/1	[71.02%]
India	0/0	[0.16%]	0/0	[0.39%]
Indonesia*	0/0	[2.74%]	1/1	[63.69%]
Korea	0/0	[0.00%]	0/0	[0.23%]
Malaysia	0/0	[0.00%]	0/0	[0.00%]
Mexico	0/0	[13.76%]	0/0	[10.40%]
Pakistan*	0/0	[4.98%]	1/1	[69.61%]
Panama	0/0	[27.69%]	0/0	[32.17%]
Paraguay	0/0	[24.01%]	0/0	[27.09%]
Peru	1/1	[89.79%]	1/1	[87.19%]
Philippines	0/0	[0.00%]	0/0	[0.00%]
Sri Lanka	1/0	[1.19%]	1/0	[0.40%]
Thailand	0/0	[0.00%]	0/0	[0.01%]
Uruguay	0/1	[65.77%]	0/1	[74.59%]
Venezuela	0/1	[58.44%]	0/1	[58.44%]

0 and 1 represent non-crises and crises cases respectively.
The shaded figures represent inaccurate predictions.
[·] Figures in square brackets indicate the probability of crisis.
* These countries switch from one status to another during 1997 and 1998.

VII. REFERENCES

Abassi, B. and R.J. Taffler. 1984. "Country risk: A model for predicting debt-servicing problems in developing countries." *Journal of the Royal Statistical Society*, Series A 147:541–568.

Acharya, S. and I. Diwan. 1993. "Debt conversion schemes of debtor countries as a signal of creditworthiness: Theory and evidence." *International Economic Review* 34:795–815.

Aylward, L. and R. Thorne. 1998. "Countries' repayment performance Vis-à-vis the IMF." *IMF Staff Paper* 45:595–619.

Babbel, D.F. 1996. "Insuring sovereign debt against default." *World Bank Discussion Paper*, 328, Washington: The World Bank.

Balkan, E.M. 1992. "Political instability, country risk and probability of default." *Applied Economics* 24:999–1008.

Bekaert, A., C.R. Harvey and C. Lundblad. 2005. "Does financial liberalization spur growth?" *Journal of Financial Economics*, forthcoming.

Berg, A. and C. Pattillo. 1998. "Are currency crises predictable?" A test, *IMF Working Paper*, 154.

Berg, A. and J. Sachs. 1998. "The debt crisis: Structural explanations of country performance." *Journal of Development Economics* 29:271–306.

Brewer, T.L. and P. Rivoli. 1990. "Politics and perceived country creditworthiness in international banking." *Journal of Money, Credit and Banking* 22:357–369.

Bulow, J. and K. Rogoff. 1989. "Sovereign debt: Is not to forgive to forget?" *American Economic Review* 79:43–51.

Burkart, O. and V. Coudert. 2002. "Leading indicators of currency crises for emerging countries." *Emerging Markets Review* 3:107–133.

Calvo, G.A. 1999. "Contagion in emerging markets: When Wall Street is a carrier." Working paper, University of Maryland.

Cantor, R., and F. Packer. 1996. "Determinants and Impact of Sovereign Credit Ratings." *FRBNY Economic Policy Review*, October:37–52.

Catao, L. and B. Sutton. 2002. "Sovereign defaults: The role of volatility." *IMF Working Paper* 149:1–26.

Chang, R. and A. Velasco. 2000. "Banks, debt maturity and financial crises." *Journal of International Economics* 51:169–194.

Choi, J.J., S. Hauser and K.J. Kopecky. 1999. "Does the stock market predict real activity? Time series evidence from the G-7 countries." *Journal of Banking and Finance* 23:1771–92.

Ciraolo, S., A. Berardi and M. Trova. 2002. "Predicting default probabilities and implementing trading strategies for emerging market bond portfolios." *Working paper*, Universita di Verona: 1–23.

Clark, E. and A. Zenaidi. 1999. "Sovereign debt discounts and the unwillingness to pay." *Revue Finance* 20:185–199.

Demirgüç-Kunt, A. and E. Detragiache. 1998. "The determinants of banking crises in developing and developed countries." *IMF Staff Papers* 45:81–109.

Detragiache, E. and A. Spilimbergo. 2001. "Crises and liquidity: Evidence and interpretation." *IMF Working Paper* 2:1–29.

Eaton, J., M. Gersovitz and J.E. Stiglitz. 1986. "The pure theory of country risk." *European Economic Review* 30:481–513.

Eichengreen, B. and A. Mody. 1998. "What explains changing spreads on emerging market debt: fundamentals or market sentiment?" *NBER Working Paper 6408*, Cambridge, Massachusetts.

Feder, G. and R.E. Just. 1977. "A study of debt-servicing capacity applying Logit analysis." *Journal of Development Economics* 4:25–38.

Feder, G., R.E. Just and K. Ross. 1981. "Projecting debt-servicing capacity of developing countries." *Journal of Financial and Quantitative Analysis* 16:651–669.

Feder, G., L.V. Uy. 1985. "The determinants of international creditworthiness and their policy implications." *Journal of Policy Modelling* 7:133–156.

Frank, C.R. and W.R. Cline. 1971. "Measurement of debt-servicing capacity of developing countries: An application of discriminant analysis." *Journal of International Economics* 41:327–344.

Frankel, J.A. and A.K. Rose. 1996. "Currency crashes in emerging markets: An empirical treatment." *Journal of International Economics* 41:351–366.

Fuertes, A. and E. Kalotychou. 2004a. "Modeling sovereign default using panel models: A comparative study." Paper presented at the Conference of the *Econometric Society European Meeting (ESEM)*, Madrid.

Fuertes, A. and E. Kalotychou. 2004b. "Elements in the design of an early warning system for sovereign default." Paper presented at the Conference of the *Society of Computational Economics & Finance*, Amsterdam.

Grammatikos, T. and A. Saunders. 1990. "Additions to bank loan loss reserves." *Journal of Monetary Economics* 25:289–304.

Hajivassiliou, V. 1987. "The external debt repayment problems of LDS's: An econometric model based on panel data." *Journal of Econometrics* 36: 205–230.

Hajivassiliou, V. 1989. "Do the secondary markets believe in life after debt?" In I. Diwan and I. Hussain, *Dealing with Debt Crisis*, Washington DC: The World Bank.

Haque, N.U., M.S. Kumar, N. Mark, and D.J. Mathieson. 1996. "The economic content of indicators of developing country creditworthiness." *IMF Staff Papers* 43:688–724.

Harvey, A.C. 1989. "*Forecasting structural time series models and the Kalman filter.*" UK: Cambridge University Press.

Hausman, J. 1978. "Specifications tests in econometrics." *Econometrica* 46:1251–1271.

Heffernan, S.A. 1984. "*Sovereign risk analysis.*" London: Unwin Hyman.

Heffernan, S.A. 1985. "Country risk analysis: The demand and supply of sovereign loans." *Journal of International Money and Finance* 4:389–413.

Heffernan, S.A. 2004. "*Modern banking.*" London: Wiley.

Izvorski, I. 1998. "Brady bonds and default probabilities." *IMF Working Paper* 16:1–24.

Janosi, T., R. Jarrow and Y. Yildirim. 2002. "Estimating default probabilities implicit in equity prices." *WorkingPaper*, Johnson Graduate School of Management, Cornell University:1–39.

Juttner, J.D. and J. McCarthy. 1998. "Modeling a rating crisis." *Mimeo*, Macquarie University, Sydney.

Kalotychou, E. and S.K. Staikouras. 2004. "Credit exposure and sovereign risk analysis: The case of South America." *Frontiers in Finance and Economics* 1:46–56.

Kalotychou, E. and S.K. Staikouras. 2005. "An empirical investigation of the loan concentration risk in Latin America." *Working Paper*, Cass Business School, City University, London.

Kamin, S. and K. Von Kleist. 1999. "The evolution and determinants of emerging market credit spreads in the 1990s." *Bank for International Settlements Working Paper*, 68, Basel.

Kaminsky, G. and C.M. Reinhart. 1999. "The twin crises: The cause of banking and balance of payments problems." *American Economic Review* 3:473–500.

King, M.A. and S. Wadhwani. 1990. "Transmission of volatility between stock markets." *Review of Financial Studies* 3:5–33.

Kordes, L.E. and M. Pritsker. 2002. "A rational expectations model of financial contagion." *Journal of Finance* 57:769–799.

Kumar, M., U. Moorthy, and W. Perraudin. 2003. "Predicting emerging market currency crashes." *Journal of Empirical Finance* 10:427–454.

Lee, S.H. 1991. "Ability and willingness to service debt as explanation for commercial and official rescheduling cases." *Journal of Banking and Finance* 15:5–27.

Lee, S.H., H.M. Sung and J.L. Urrutia. 1996. "The behavior of secondary market prices of LDC syndicated loans." *Journal of Banking and Finance* 20:537–54.

Maddala, G.S. 1983. "*Limited-dependent and qualitative variables in econometrics*." Cambridge University Press.

Manasse, P., N. Roubini and A. Schimmelpfennig. 2003. "Predicting sovereign debt crises." *IMF Working Paper* 221:1–40.

Martinson, M.G. and J.V. Houpt. 1989. "Transfer risk in US banks." *Federal Reserve Bulletin* 75:255–258.

McFadden, D., R. Eckaus, G. Feder, V. Hajivassiliou and S. O'Connell. 1985. "Is there life after debt? An econometric analysis of the creditworthiness of developing countries." In *International Debt and the Developing Countries*, 179–209, Edited by Gordon Smith and John Cuddington. Washington DC: The World Bank.

Moghadam, M.R. and H. Samavati. 1991. "Predicting debt rescheduling by less-developed countries: A probit model approach." *Quarterly Review of Economics and Business* 31:3–14.

Pescatori A. and A.N. Sy. 2004. "Debt crises and the development of international capital markets." *IMF Working Paper* 44:1–33.

Saini, K. and P. Bates. 1984. "A survey of the quantitative approaches to country risk analysis." *Journal of Banking and Finance* 8:341–356.

Saunders, A. and M.M. Cornett. 2003. "*Financial institutions management: A risk management approach*." New York, McGraw-Hill.

Schinasi, G.J. and R.T. Smith. 2000. "Portfolio diversification, leverage and financial contagion." *IMF Staff Papers* 47:159–176.

Shapiro, A.C. 1985. "Currency risk and country risk in international banking." *Journal of Finance* 40:881–91.

Sommerville, R.A. and R.J. Taffler. 1995. "Banker judgment versus formal forecasting models: The case of country risk assessment." *Journal of Banking and Finance* 19:281–297.

Staikouras, S.K. 2004. "A chronicle of the banking and currency crises." *Applied Economics Letters* 11:873–878.

Staikouras, S.K. 2005. "Multinational banks, credit risk and financial crises: A qualitative response analysis." *Emerging Markets Finance and Trade* 41: 82–106.

Trova, M. 2000. "Emerging markets, Brady bonds and default probabilities: A portfolio selection approach." *Working Paper*, Intesa Asset Management, Milan.

Urrutia, J. 1995. "Test of random walk and market efficiency for Latin American emerging markets." *Journal of Financial Research* 18:299–309.

Wu, D. 1973. "Alternative tests of independence between stochastic regressors and disturbances." *Econometrica* 41:733–750.

Yuan, K. 2000. "Asymmetric price movements and borrowing constraints: A rational expectations equilibrium model of crisis, contagion and confusion." *PhD Thesis*, Massachusetts Institute of Technology, Boston, USA.

VIII. NOTES ON CONTRIBUTORS/ACKNOWLEDGMENTS

Elena Kalotychou is a post-doctoral fellow in finance at Cass Business School, City University, London. Her major research interests are forecasting, financial econometrics and risk analysis. Her works has been presented in seminars held at the Bank of England as well as international conferences. She holds a Ph.D. degree in finance from Cass Business School.

Sotiris K. Staikouras currently serves as associate professor of finance at Cass Business School, City University, London. His major research interests are risk analysis and management of financial institutions, asset pricing and financial modelling. Dr. Staikouras has worked as a research advisor at London Clearing House and as financial analyst for other institutions. He holds a Ph.D. degree in finance from Cass Business School, and his research has been published in US and European journals.