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Trade in Financial Services, Capital Flows, and the Value-at-Risk of Countries

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Abstract

In light of the recent financial crises in the emerging markets, the coming-into-force of the financial services agreement under the GATS has been considered a success. While the agreement provides for little new liberalization but rather formalizes the status quo, it was feared that governments could even backtrack on previous commitments in the belief that more open markets could increase the degree of susceptibility by undermining financial stability. Strengthening the financial system's ability to evaluate and manage risk has therefore been identified as a precondition for more ambitious liberalization efforts in the future (Dobson and Jacquet, 1998). Encouragingly, in some countries banks have begun to implement *Value-at-Risk* approaches as a tool to assess their balance sheet vulnerability. As this paper argues, such an approach could also play a useful role in determining the extent of market risk on the macroeconomic level, with potentially important implications regarding trade in financial services, capital account convertibility, and international crisis management.

JEL: F32, O16

Key words: Financial crises; trade liberalization; capital flows; risk management.

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I. Introduction

The financial services agreement (FSA) under the General Agreement of Trade in Services (GATS), which became effective on March 1, 1999, is widely regarded as a milestone for the World Trade Organization (WTO). Providing a legal framework for cross-border trade and market access in financial services and a mechanism for dispute settlement, the FSA concentrates on one of the three major services sectors, where - along with telecommunications services and information technology products - multilateral liberalization agreements have recently been reached. The FSA covers around 95 percent of the world market for financial services, whose volume is estimated at about 60 billion US dollars.

How much the FSA will actually achieve in terms of dismantling barriers to access and hence fostering the development of efficient financial sectors remains to be seen, however. Those who had feared that the signatory states could backtrack on previous commitments in light of the recent financial crises in Asia (1997-98), Russia (1998), and Brazil (1999), have hailed the agreement as a major success. Others, by contrast, have argued that the agreement largely formalizes the status quo and merely represents a first step toward more open and efficient financial systems. Unless the FSA were followed up by more courageous efforts to liberalize financial services trade, its impact would in their view remain marginal.

There are at least three reasons why countries have been rather cautious in lowering trade barriers in the area of financial services. To begin with, the financial sector is often regarded as 'strategic' to economic development and, according to this view, should best be owned and controlled by domestic interests. Moreover, although consumers stand to benefit from liberalized markets, there may be political backlash from those who lose from sectoral reforms. Most importantly, however, the experience with financial deregulation and liberalization has been rather mixed. Several countries have suffered serious banking crises following the opening of their financial markets, and, as formal econometric work shows, banking crises have generally been good predictors of currency crises (for an overview, see Kaminsky and Reinhart, 1999).

Against this background, strengthening the financial system's ability to evaluate and manage market risk has been identified as a precondition for more ambitious liberalization efforts in the future (Dobson and Jacquet, 1998). First and foremost, this entails improving the internal risk management of individual financial institutions, for example, on the basis of *Value-at-Risk* (VaR) models, in order to assess their balance sheet vulnerability with respect

to changes in asset prices, such as exchange rates, interest rates, or equity prices. As a result, the risk of international illiquidity should be reduced. According to Valesco and Chang (1999), this phenomenon appears to have been the key factor behind the financial turmoil in virtually all Asian countries, with the consolidated financial system having potential short-term obligations in foreign currency that exceed the amount of foreign currency it can have access to on short notice.

However, while international illiquidity of financial institutions may be *sufficient* to trigger a crisis, the experience in Mexico (1994) or the ERM (1992-93), for example, suggests that financial turmoil may also arise from other factors. For governments to promote financial integration by dismantling barriers to trade in financial services and introducing capital account convertibility, it would therefore be important to enhance their risk management also on the macro level, focusing on the country's balance sheet vulnerability as opposed to a regime's sustainability. Such a macro risk management tool has recently been developed by Blejer and Schumacher (1998), employing the same methodology as used in VaR models for individual financial institutions. Their approach focuses on a country's central bank as a lender of last resort. While central banks can not fail commercially as they retain the ability to issue high-powered money at any time, they behave, as Blejer and Schumacher argue, in a manner closely resembling a conventional commercial failure when forsaking a commitment to a pre-announced nominal regime. The probability of such an outcome increases, of course, with the risk that the central bank becomes insolvent – in the sense that its capital is exhausted. Various factors may be responsible for this, including a systemic banking crisis where foreign creditors stop rolling over and demand immediate payment on existing loans to domestic banks and companies resulting in a situation of international illiquidity.

As we discuss in this paper, Blejer's and Schumacher's approach should be expanded in two important ways, namely by (i) consolidating the accounts of the central bank and the treasury and (ii) taking into account off-balance sheet items. Thus amended, the VaR approach should help governments pay greater attention to alleviate excessive risk exposure on the macro level, which could have important policy implications. As some believe (e.g., Dornbusch, 1998), countries employing macro VaRs may live perfectly well with an open capital market and highly mobile capital; as a result, they may show a greater willingness to dismantle barriers to financial services trade, which in turn should help foster financial intermediation and economic growth. To the extent that VaR approaches became mandatory, they could help reduce the problem of moral hazard inherently associated with IMF lending:

any country that is found deficient would not qualify for IMF support, while honest crises would be generously solved with IMF credits.

In discussing the potential role of VaR models on the macro level, the rest of the paper is organized as follows: Section 2 reviews the general principles of GATS and assesses the importance of the recent FSA. Section 3 examines the relationship between financial services trade and capital flows. Section 4 focuses on the role of micro VaRs in reducing the risk of international illiquidity. Section 5 discusses how this methodology can be applied on the macro level. Section 6, finally, concludes.

II. Liberalization of Trade in Financial Services under the GATS

Rather than representing a liberalization agreement itself, the GATS provides only a framework for liberalization of trade in services.¹ In so doing, it is based on three pillars. First of all, it includes a framework agreement, which contains general provisions covering all sectors (i.e. financial services, telecommunications, and information technology). Second, special sector annexes and other agreements, such as the Understanding on Financial Services, contain provisions focusing specifically on the sector concerned. The third pillar, finally, consists of scheduled commitments on market access, national treatment and other commitments. As regards the last point, the GATS defines trade in financial services, like in other services, in terms of four modes of supply:²

- (1) *Cross-border supply*, not requiring the physical movement of consumers or suppliers (e.g., consumers or financial institutions in one country are permitted to take a loan or purchase securities from a foreign bank).
- (2) *Consumption abroad*, whereby consumers are allowed to purchase financial services while travelling abroad (e.g., a resident in one country crosses the border and opens a bank account in a foreign country).
- (3) *Commercial presence*, or permanent establishment of service-providing entities in the territory of the consumer (e.g., a country allows the establishment of foreign banks in its territory).

¹ A detailed discussion on the history of the GATS and the structure of its provisions can be found in Dobson and Jacquet (1998) and Kono et al. (1997).

² Note that the exact definition of the transactions limits the scope of the agreement. For example, while Mode 2 requires the authorities of country A to permit its residents to open a bank account in country B, the GATS does not require the authorities of country B to allow foreigners to make deposits in its banks.

- (4) *Movement of natural persons* who supply financial services in the territory of a foreign country (e.g. a bank opens a subsidiary abroad and is allowed to send personnel to that country).

While the FSA goes far beyond previous regional trade agreements (e.g., EU and NAFTA), in terms of actually dismantling trade barriers in the area of financial services, it has done little more than formalizing the status quo. True, the FSA has enabled most of the main players to bind existing practices in an international agreement. However, the agreement entails little new liberalization. Indeed, the main emerging markets (EM) countries, with few exceptions, have offered little new access to their banking sectors, which often dominate their financial industries, although some of them have taken a more liberal approach towards their insurance sectors.

The GATS rules are based on the same general principles as trade in goods, i.e., most-favored-nation treatment (MFN) (Article II) and transparency (Article III). There are important limitations, however, which render them weaker than those of the General Agreement on Tariffs and Trade (GATT). For example, national treatment is not an automatic but negotiable right. Exemptions to the MFN obligation in specific sectors are permitted, provided that the measures are listed in the list of MFN exemptions and that such exemptions, in principle, should not extend beyond 10 years. Specific obligations regarding market access and national treatment (Articles XVI and XVII, respectively) are based on a positive list or bottom-up approach, that is, they apply only to services that are inscribed in the Schedules of Commitments of countries where specific commitments are listed in the form of limitations or measures applicable. Such limitations are listed for each of the four modes of supply and may be either cross-sectional or sector-specific. Clearly, this approach is less liberal than the negative-list or top-down approach employed in NAFTA and OECD agreements where all sectors are covered unless specifically excluded. This also applies to financial innovations, where the GATS allows countries to impose discriminatory restrictions on their supply.

Furthermore, the Annex on Financial Services recognizes that countries may take measures for prudential reasons, including for the protection of investors, depositors, and for preserving the integrity and stability of the financial system. While such measures shall not be used as a means to circumvent a country's commitments or obligations under the GATS, they do not need to be inscribed in the Schedules of Specific Commitments, whether or not they are in conformity with any other provisions of the agreement. However, there is no definition of prudential rules, and as Sorsa (1997) argues, the broad prudential carve-out in

the GATS can imply very broad departures from the basic principles of the agreement. Potentially, the measures can permit discrimination among countries, for example, on the basis of capital adequacy ratios or discretion in approving banking licenses, which can go against the MFN principle or national treatment.

However, even in the absence of such measures, the GATS may not be sufficient to ensure foreign suppliers' market access. While Article XVII requires that foreign suppliers must receive treatment '*no less favorable*' than national suppliers, in some cases better-than-national treatment may actually be necessary for foreign institutions to be able to compete. For instance, a regulator in a member country, which prohibits universal banking, could preclude branches of a bank from a member state that allows universal banking (Woolcock, 1997, p. 8). While during the negotiations general agreement emerged that each country must have the right to regulate its financial industry in order to ensure stability, there will thus always be a potential that these policies form barriers to market access. Removing all potential barriers to market access therefore requires harmonizing regulatory policies, for which the GATS, however, does not provide an adequate framework.

Finally, recognizing that financial instability and external imbalances may be closely intertwined, the GATS also allows members to introduce temporary restrictions in the event of serious balance of payments problems - subject to consultations with WTO members (Article XII). However, as Sorsa (1997) argues the role of the WTO Committee on Balance of Payments Restrictions appears vague, given that the IMF independently approves restrictions on current account payments that fall under its jurisdiction. As a matter of fact, if a particular restriction on payments and transfers is approved by the IMF, the BOP Committee's role may be limited to improving what the Fund has already done under its mandate.

III. Financial Services Trade and Capital Account Convertibility

Capital account restrictions are also subject to approval by the WTO BOP Committee, but only to the extent that they affect international transfers and payments for transactions relating to specific commitments under the agreement. For example, a country which has committed itself to providing market access to foreign banks under Mode 3 (commercial presence) would be required to allow capital inflows in conjunction with the initial share capital of a foreign institution. For Mode 2 transactions, not even this obligation exists. Rather, under Mode 2 countries seem to be free to set restrictions on capital transfers related to services supplied under the market access commitments made. As Kono et al. (1997, p. 23) emphasize, "(t)he GATS focuses upon seeking improvements in the terms and

conditions of market access and non-discriminatory treatment for foreign suppliers of financial services, and not on the question of how far and how fast a government liberalizes capital account restrictions.”

While it is important to recognize that financial services liberalization does not necessarily imply capital account liberalization, it appears that the relationship between trade in financial services and capital flows is particularly close under Mode 1 (cross-border supply). To the extent that governments are committed to allowing foreign banks to provide loans to domestic residents involving international capital, the movement of capital related to the underlying transaction should be free of restrictions.³ As a result, liberalization of financial services trade under this mode is likely to result in a significant increase in capital flows, with a strong bias towards short-term lending (Table 1).

Table 1: Effects of Financial Services Commitments on Capital Flows and the Financial System, As Affected by the Mode of Supply and the Range of Instruments

	By Mode of supply		By range of instruments which can be supplied	
	Mode 1	Mode 3	Narrow ^{a)}	Broad
Capacity building				
Improved transparency/information	weak	strong	weak	strong
Incentive to improve regulation/supervision	weak	strong	weak	strong
Infrastructure/market development	weak	strong	weak	strong
Risk management	weak	strong	weak	strong
Capital flows				
More capital flows	yes	limited	b)	b)
Bias toward short-term lending	strong	weak	possibly strong	weak
Increased volatility	strong	weak	possibly strong	weak
Efficiency/local benefits				
More competition/efficiency	strong	strong	weak	strong
Skills/technology transfer	weak	strong	weak	strong
Local employment creation	weak	strong	weak	strong

Source: Kono and Schuknecht (1998)

- a) Commitments exclude or limit provision of important instruments/allow only lending and deposit-taking.
b) Depends on the instrument and mode of supply permitted, and market conditions.

³ This case needs to be clearly distinguished from the case where a domestic bank provides a loan to domestic residents involving foreign capital. Such a transaction would entail international capital flows but not trade in financial services. For a more detailed discussion on the links between financial services liberalization and capital account liberalization, see Kono and Schuknecht (1998).

Imposing restrictions on transactions that fall under this mode would be subject to approval, which gives the WTO BOP Committee a potentially important role. Suppose, for instance, a Mode 1 country experienced large capital inflows and imposed restrictions in response to mounting concerns about the exchange rate and sudden reversals of flows. In practice, however, the potential role of the Committee seems rather limited, given that at present relatively few countries have made commitments under Mode 1, reflecting fears that a more liberal trade policy could seriously undermine financial stability.

In light of the severe financial turmoil over the last few years, the question arises whether some countries would not have been better advised to pursue a more cautious approach to capital account convertibility and financial services trade. Rather than dismantling barriers to trade in financial services across-the-board, it might have been preferable for them to maintain at least restrictions under mode 1. This applies primarily to countries with weak financial systems. For these countries, Kono and Schuknecht (1998, p. 29), in a recent WTO working paper, caution against modal neutrality, i.e., equal liberalization commitments between, for example, cross-border supply and supply through commercial presence. While in their view, "...countries with stable financial systems and a sound macroeconomic and regulatory framework have every reason to apply a very broad liberalisation strategy and commit to far-reaching trade liberalisation across all modes of supply," they recognize that in countries with weak financial systems potentially volatile capital flows can be highly destabilizing, resulting in banking and currency crises. Thus, with respect to these countries they counsel to confine commitments to the commercial presence of foreign institutions, requiring only limited liberalization of capital flows in the GATS context.

Kono's and Schuknecht's conclusions are based on a rating system that tries to quantify the modal bias in a number of EM countries involved in the recent financial turmoil. This rating system ranges from -2 to 2 (Table 2). As a matter of fact, most EM countries are unbound in terms of Mode 1 commitments, that is, they have made no commitments for cross-border supply (=0). There are two notable exceptions, however, namely Indonesia and Malaysia. Indeed, Indonesia has virtually no restrictions on cross-border trade, and because of the potential bias towards short-term volatile capital flows this policy brings about, the authors grade this country as 2 in this category. Under mode 3 liberalization, which is assumed to bring about stabilizing effects for the domestic financial system, Indonesia is given a -1 (partial liberalization), resulting in a modal bias of 1. By contrast, Argentina has made virtually no commitments in terms of cross-border supply (= 0), whereas it pursues a very liberal policy with respect to the commercial presence of foreign institutions, promoting balanced and stable capital flows and stable financial systems (-2). Argentina's total score is

thus -2, the lowest possible result. Note that none of the countries earned the highest and least stability-enhancing score of “2” in the Kono-Schuknecht study, as none has committed to fully liberal trade under mode 1 while making no commitments under mode 3. Indeed, most EM countries show a negative modal bias - as advocated by Kono and Schuknecht, with Malaysia being the only country in the sample with modal neutrality.

**Table 2: Assessment of Financial Services Commitments in the GATS,
Selected Emerging Markets**

	Level of Commitments ^{a)}		Indicator of modal bias ^{b)}	Indicator of lending bias ^{c)}
	Mode 1	Mode 3		
Asia				
Hong Kong	0	-1	-1	0
Indonesia	2	-1	1	2
Korea	0	-1	-1	4
Malaysia	1	-1	0	0
Philippines	0	-1	-1	0
Thailand	0	-1	-1	2
Latin America				
Argentina	0	-2	-2	0
Brazil	0	-1	-1	0
Chile	0	-1	-1	0
Mexico	0	-1	-1	2
Venezuela	0	-1	-1	2
Eastern Europe				
Czech Rep.	0	-1	-1	0
Hungary	0	-1	-1	0
Poland	0	-1	-1	4
Slovak Rep.	0	-1	-1	0

Source: Kono and Schuknecht (1998)

- a) 0 = unbound; 1/-1 = commitments to partial liberalization, 2/-2 = commitment to full liberalization.
b) Difference between first and second columns, ranging from -2 to 2.
c) 0 means equal commitments for lending and securities or more liberal commitments for securities; 2 and 4 mean weak/strong bias in favor of lending liberalization.

While the majority of countries considered here are neutral with respect to their commitments for lending and securities, some countries do show at least a weak bias in favor of lending liberalization (last column in table 2). This group includes, for example, Indonesia, a country that already appeared relatively susceptible due to its modal bias. The same degree of lending bias is given to Thailand, Mexico, and Venezuela, whereas an even stronger bias is found in the cases of Korea and Poland. Taken together, six countries show a positive indicator as the sum of the two sub-indices (i.e., Indonesia, Korea, Thailand, Mexico, Venezuela, and Poland). While this indicator should not be interpreted as an early warning indicator for financial crises as it ignores such important variables as macroeconomic and regulatory policies, it would seem to provide a useful instrument to help assess the risk of erratic capital flows.

IV. International Illiquidity and VaR

Sudden reversals of short-term capital flows have played a key role in all the recent EM crises. According to the International Monetary Fund (1999), net capital flows to the five crisis countries in Asia (i.e. Indonesia, Korea, Malaysia, the Philippines, and Thailand) totaled more than 60 billion US dollars in 1996, more than twice as much as in 1992 (Table 3). More than one-third was attributed to commercial bank lending. In 1997-98, however, the five countries suffered from huge capital outflows of almost 70 billion US dollars, with commercial bank lending having proved to be particularly volatile. As a matter of fact, foreign banks reduced their net exposure to this group of countries by almost 90 billion US dollars during this period.

Table 3. Net Private Capital Flows to Selected Emerging Markets, 1992-98

(in billions of USD)

	1992	1993	1994	1995	1996	1997	1998
Asia							
Total	17.9	57.3	66.4	95.1	100.5	3.2	-55.1
Foreign direct investment	14.8	33.0	45.3	49.8	55.1	62.2	50.0
Portfolio investment	7.8	21.0	9.4	10.9	12.6	0.9	-15.4
Bank loans & other	-4.7	3.3	11.7	34.4	32.8	-60.3	-89.7
Five affected Asian Countries ^{a)}							
Total	26.6	31.9	33.2	62.5	62.4	-19.7	-46.2
Foreign direct investment	6.3	6.7	6.5	8.7	9.5	12.1	4.9
Portfolio investment	5.3	16.5	8.3	17.0	20.0	12.6	-6.5
Bank loans & other	15.0	8.7	18.4	36.9	32.9	-44.5	-44.5
Brazil							
Total	14.1	12.0	10.0	33.1	35.2	20.5	17.1
Foreign direct investment	1.9	0.8	2.0	2.8	10.0	15.5	25.0
Portfolio investment	14.5	12.3	51.1	11.7	21.4	10.5	17.5
Bank loans & other	-2.3	-1.2	-43.2	18.6	3.8	-5.5	-25.4
Russia							
Total	0.7	5.9	2.1	15.1	-2.6	1.0	14.7
Foreign direct investment	0.7	0.9	0.5	1.7	1.7	3.6	1.2
Portfolio investment	0.0	5.0	16.5	14.4	21.9	17.2	4.5
Bank loans & other	0.0	0.0	-14.9	-1.1	-26.3	-19.8	-20.4
Memorandum items:							
Total net private capital flows as percent of recipient countries' GDP							
Asia	0.9	2.5	2.7	3.3	3.1	0.1	-1.8
Five affected Asian countries ^{a)}	4.0	4.4	4.0	6.3	5.8	-2.0	-7.1
Brazil	3.6	2.7	1.8	4.7	4.5	2.6	2.2
Russia	0.8	3.2	0.8	4.3	-0.6	0.2	-5.2

a) Indonesia, Korea, Malaysia, the Philippines, and Thailand.

Source: International Monetary Fund (1999), pp.52-53.

While little progress seems to have been made in identifying those factors - among the many weaknesses exhibited by the afflicted countries - that are *necessary* for a crisis to occur,⁴ more recently, a new promising strand of literature has emerged, which has identified international illiquidity as a single factor *sufficient* to trigger a crisis. In these models, international illiquidity is perceived as a situation in which a country's consolidated financial system has potential short-term obligations in foreign currency that exceed the amount of foreign currency it can have access to on short notice. As Chang and Velasco (1999) argue, international illiquidity is what the very diverse recent crises in emerging markets have had in common: a sudden loss of confidence, prompting creditors to stop to roll over and demand immediate payment on existing loans, resulting in sharply rising ratios of hard currency short-term liabilities to liquid assets, asset price collapses and widespread bankruptcies.

A detailed analysis of the dynamics of creditor panics in Asia is provided by Radelet and Sachs (1998 a and b) who emphasize the role of credit to the private sector. Much of the rapid expansion of credit was financed by offshore borrowing by the banking sector, and to make things worse, a significant share of the credit was funneled into speculative investments in the real estate markets, rather than into increasing productive capacity for manufactured output. Thus, borrowers who were not earning foreign exchange faced growing dangers of insolvency in the event of a marked depreciation, while the maturity transformation (i.e., borrowing offshore in short-term maturities and lending onshore with long maturities) exposed the financial sector to heightened risks of massive bank runs.

Why have banks shown such a strong bias towards short-term borrowing, if short-term debt increases the risk of becoming illiquid? In explaining this phenomenon, Chang and Valesco (1999) point to a number of market failures. To the extent that excessive short-term borrowing is indeed the result of the banks' failure to internalize the social effects of reducing their liquidity, government intervention to discourage short-term borrowing would appear to be justified.⁵ A natural candidate for a policy, which aims at lengthening the maturity of debt, is a tax on short-term capital inflows, such as the one imposed by the Chilean authorities. Clearly, such a policy would also have serious implications for the liberalization of financial services trade under mode 1, which, as discussed above, tends to be associated with a significant bias in favor of short-term flows. As Dobson and Jacquet (1998, p. 34) argue,

⁴ As Berg and Patillo (1999) have recently shown, existing models of early-warning indicators and speculative attacks have generally failed to predict the recent EM crises out of sample.

⁵ As Chang and Valesco (1999) argue, this conclusion is subject to two important caveats, however. First of all, short-term debt serves some useful functions, for example, as a commitment device. Second, foreigners are not the only short-term creditors. Hence, abolishing short-term debt is neither a necessary nor a sufficient condition for ruling out crises.

however, “capital controls (...) substantially reduce users’ freedom to buy financial services directly from foreign financial institutions and may also discourage entry...”

Another reason why there has been “too much” short-term foreign borrowing may simply be sought in the lack of adequate risk management, however. Thus, possible market failures notwithstanding, it would appear imperative to improve the banks’ capability to assess their balance sheet vulnerability as a precondition for opening the capital account and liberalizing the cross-border supply of financial services. Encouragingly, in a number of EM countries important steps have already been taken in this regard, and in some of them banks are now required to employ so-called *value-at-risk* techniques in order to assess and manage their exposure to adverse changes in asset prices. In the industrial countries, these techniques have already become standard, not only with respect to the banks’ internal risk management but also for banking supervision.⁶ According to the new set of rules, commercial banks may choose between the *standardized* (8 percent) *approach* and the internal model approach, with the ultimate goal being the sole use of the latter.

While the basic idea of this approach stems from standard portfolio theory, VaR models are relatively new. Their development has largely been motivated by the growing use of derivatives and the fact that the largest financial losses were mainly the result of the poor monitoring of market risk. These cases include, for example, Barings Inc, which collapsed in 1995 as a result of a USD 1.3 bn loss triggered by one of its trader’s speculation in the Japanese stock market. Another high profile case was Germany’s Metallgesellschaft which lost a substantial sum in the oil futures market. Other examples are Daiwa, Orange County, Kashima Oil, and Showa Shell Sekiyu (Jorion, 1997, pp. 24-46). Without going into too much technical detail here, it appears useful to outline the fundamental structure of these models, with a view to applying later a VaR approach to the macroeconomic level (on the technical basics see appendix).

Broadly speaking, VaR approaches aim at assessing the vulnerability of a particular portfolio by calculating the maximum potential loss over a certain target horizon (typically 24 hours) within a given confidence interval.⁷ In its simplest form, the VaR approach assumes that all asset-price changes can be modeled as conditionally normally distributed. In order to

⁶ While until recently banking supervision in the G-10 countries was determined on the basis of the 1988 Basle Accord, which required banks to hold a minimum amount of capital of 8 percent as a safety cushion against bankruptcy, from the beginning of 1998 commercial banks have been permitted to determine their regulatory capital requirements for financial risk exposure using VaR models. On the 1996 Market Risk Amendment by the Basle Committee of Banking Supervision, see Chorafas (1998).

illustrate the basic idea of the VaR methodology, consider the following simple example where a portfolio consists of only one asset. Suppose a Thai bank, benefiting from mode 1 liberalization of financial services trade, has borrowed USD 1 mn from a US bank and is hence exposed to changes in the THB/USD exchange rate. Suppose further that under specific assumptions about the probability distribution the worst movement of the exchange rate in the next 24 hours, at the 99 percent confidence interval, is a 15 percent depreciation of the THB. If the current exchange rate is $\text{THB/USD} = 35$, the VaR of holding the USD position is THB 5,125 mn. This means that according to the VaR there is only 1 chance in 100 that a loss greater than THB 5,125 mn would occur in the next 24 hours.

Of course, in reality portfolios typically consist of many assets which are exposed to different risks of adverse price movements. However, under the assumption of normality the portfolio return is given by a linear combination of Gaussian variables and is also characterized by a normal distribution. Thus, the mean vector and the variance-covariance matrix of contemporaneous price changes together suffice for calculating the worst loss within a given confidence interval. This simple approach is known as the *delta-normal* or *standard variance-covariance* VaR model. On the basis of this standard approach, more sophisticated models have been developed, taking into account that the distribution of asset price changes for many securities usually has thicker tails than predicted by a normal distribution (i.e., extreme movements seem to occur much more frequently than is the case under a Gaussian assumption) and that complex derivatives possess non-linear payoff structures.⁸

Reflecting these developments, a large number of financial institutions have begun to employ nonparametric VaR approaches, for which relatively few assumptions are made about the underlying distribution. In this context, many banks have implemented *Monte-Carlo methods*, which entail the creation of complete numerical simulations of a whole group of financial variables. More recently, it has also become increasingly popular to subject VaR calculations to *stress testing*, an approach, which involves calculating outcomes under ‘extreme scenarios’. By violating some key assumptions, this procedure aims to assess the

⁷ Good introductions to the VaR approach are provided, for example, in Best (1998), Dowd (1998), and Jorion (1997).

⁸ For example, while a 99-percent confidence interval is given by 2.33 standard deviations under a normal distribution, the recent shocks in the emerging markets were equivalent to about 6-7 standard deviations. The experience with these shocks has triggered various new approaches. While, for example, so-called *CondVaRs* estimate the probability-weighted average of the tail (and hence includes all values of the tail), *HeadVaRs* refer to the highest point in the tail (implying that the tail needs to go out far enough that one can be sure it is the highest value. Yet others have begun to experiment with *Extreme Value Theory* in order to derive a functional tail form on the basis of a limited amount of data. For a discussion on these developments, see James (1999).

impact on the VaR methodology's performance of the breakdown of assumed relationships pertaining to relative prices, correlations, volatilities, and other essential summary quantities. The analysis of low-probability adverse events may also be used to examine causal relationships among core market factors, co-movements in market and credit risk, and other fundamental patterns, all of which can become excessively strained during the period of dislocation coinciding with a state of financial crisis (Crouhy, Galai, and Mark, 1998, p. 16).

V. Developing Macroeconomic VaRs

While the wider use of VaR models in EM economies could be an important step towards greater stability in the banking sector as a precondition for opening the capital account and liberalizing trade in financial services, it will not always be sufficient to prevent financial crises. As the experience in Asia suggests, international illiquidity of the banking sector can be assumed to be sufficient for a crisis to occur, but there may be also other reasons. In the case of Mexico, for example, we know that it was the government's inability to roll over its large stock of short-term debt (in particular, the Tesobonos) that was the key factor in triggering the currency crisis in December 1994 (Garber, 1999). Similarly, the recent currency crisis in Brazil has largely been the result of an unsustainable fiscal position. Finally, the ERM crisis in 1992/93 had little to do with international illiquidity caused by imprudent business practices of UK commercial banks.

However, once a crisis occurs, it causes almost always serious repercussions for the banking sector. Even in countries where banks appear comparatively robust, can currency crises seriously undermine financial stability, which, in turn, may aggravate the authorities' efforts to stabilize the macroeconomy. This seems all the more likely the more open the capital account is, helping to explain why some countries that are fairly advanced with respect to risk management on the micro level and banking supervision (notably Argentina) have been rather cautious in dismantling barriers to trade in financial services according to mode 1. Thus, for a country to reap the benefits of greater access to foreign savings while limiting the potentially destabilizing effects of international capital flows it appears essential to implement an all-encompassing risk approach, assessing the vulnerability of the overall balance sheet of the economy.

A basic approach, which should help draw the authorities' attention to alleviating excessive risk at an early stage, has recently been suggested by Blejer and Schumacher (1998) who concentrate on the balance sheet of a country's central bank as a lender of last resort (see appendix). As a matter of course, central banks cannot commercially fail as they retain the ability to issue high-powered money at any time. While they therefore cannot become

illiquid, they may, however, become insolvent in the sense that their capital gets exhausted. Should the markets believe that the central bank might indeed become insolvent, there would likely be a run on the country's foreign exchange reserves, possibly resulting in international illiquidity.

Indeed, as Blejer and Schumacher (1998) argue central banks behave in a manner closely resembling a conventional commercial failure when forsaking a commitment to a pre-announced nominal regime. This analogy seems particularly obvious in the case of a fixed exchange rate regime but may additionally be applied to other types of nominal regimes. Since a default in central bank commitments represents the predictable outcome of a loss of central bank solvency, a VaR analysis pointing to increasing vulnerability in the central bank's position could serve as a useful indicator for the probability of a devaluation or other major adjustments necessary to fulfill a nominal commitment. If such an outcome were to be avoided, the stance of financial policies would need to be changed in anticipation of an impending deterioration.

One important risk facing the central bank obviously stems from a systemic failure of the banking system. In the case of a banking crisis, financial institutions might not be able to service their liabilities, and as a lender of last resort the central bank must be prepared to inject huge amounts of liquidity to assist banks suffering from large withdrawals of deposits in order to ensure financial stability. VaRs calculated by individual banks should help reduce this risk, as explained above. However, for a central bank monitoring and managing its risk of becoming insolvent, it would be important to estimate the value of its contingent liability resulting from its lender of last resort function, whether there is an explicit or implicit deposit insurance scheme in place.

As Blejer and Schumacher (1998) emphasize, a deposit insurance scheme may be perceived as a put option sold by the central bank to the financial sector, whereby the value of the option depends on the commercial banks' leverage, the volatility of banks' assets, and the interest rate. In this analogy, banks hold the right to exercise the option when the value of their assets (the "underlying" asset of the put) falls below the value of the debt (the exercise price), that is, they fail. In exercising the option, the banks sell their assets to the central bank and get paid an amount equivalent to their debt that they use to pay their creditors. The more leveraged the banks are and the more risk they undertake, the more valuable the put option is. The value of the option rises with the level of interest rates, since bank assets usually have a longer duration than their liabilities. An increase in the interest rate thus reduces the market value of the banks' capital and makes the exercise of the put option with the central bank

more likely. Similarly, the degree of currency transformation affects the value of the option. Permitting greater access to financial services supplied by foreign institutions and opening up the capital account could thus have an important impact on the central bank's balance sheet. The greater the value of the put option, the larger the liability of the central bank, and in determining this value, VaRs may play an important role.

However, central banks face not only risks stemming from their function as lenders of last resort, but they are also exposed to risks of movements in market prices. Foreign exchange reserves, for example, are typically held in other countries' government securities (most commonly triple-A rated and highly liquid US Treasuries) and are hence subject to the risk of price changes in the bond markets. In most countries, central banks' portfolios are diversified across various currencies and, as a result, subject to changes in the cross rates in the FX markets. As far as domestic assets are concerned, credit to the banking system may be perceived as a long position of the central bank, whereby a decline in the domestic interest rate increases the discounted value of the outstanding stock of loans. In many countries, the central bank also holds government securities, which are subject to price fluctuations. On the liabilities side, by contrast, the monetary base represents a "short" position of the central bank. The same applies to foreign liabilities, where the counterparty usually receives a fixed coupon, with the central bank also bearing the risk of devaluation.

For a VaR analysis to serve its intended function properly, it is imperative that not only on-balance sheet operations but also all off-balance sheet transactions, such as forwards and foreign exchange swaps, be properly accounted for. Indeed, such transactions are commonplace among central banks in emerging markets. Usually, they are designed to provide hedges to operators when financial markets are incomplete. However, they have also been used (e.g., in Thailand) to strengthen the credibility of exchange-rate pegs, whereby they have normally been kept as off-balance sheet operations.

Blejer's and Schumacher's approach can be relatively easily expanded in two significant ways (for details, see appendix). First of all, it would appear important to consolidate the central bank's and the relevant treasury accounts. In their original model, Blejer and Schumacher assume that the central bank holds the entire stock of government foreign assets and foreign debt, denominated in foreign currency. Moreover, the government is not expected to repay its debt to the central bank. These assumptions can be easily relaxed, however, enabling the VaR approach to deal with the risk implications of direct lending to government and foreign borrowing by the treasury. Amalgamating the different accounts would also appear important given that debt issued by the treasury in domestic currency is

often held by foreigners which could represent a significant contingent liability regarding the country's foreign exchange reserves. Furthermore, the VaR approach would need to take into account that the government may hold sizable foreign exchange reserves of its own.

Integrating the central bank's and the treasury accounts, is not enough, however. While conventional fiscal analysis tends to concentrate on governments' *direct explicit liabilities* (e.g., foreign and domestic sovereign borrowing and budgetary expenditures), the fiscal authorities – like the central bank - may also face important off-balance sheet liabilities. Second, therefore, one would need to take into account that such implicit liabilities may affect the true extent of market risk the country is exposed to. These liabilities may arise from a moral obligation of the government that reflects public and interest-group pressures. To the extent that these liabilities represent an obligation of the government regardless of a particular event, they may be labeled as *direct implicit liabilities* (Polackova, 1999). Typically, such liabilities affect the longer-term sustainability of the public finances, and ignoring them could result in a serious underestimation of the budget deficit and an overestimation of the true extent of fiscal adjustment. As Blejer and Cheasty (1993) and Buiters (1983, 1985) argue, the (change in the) net worth of the government would therefore appear to be a superior measure from a conceptual point of view.

However, there may also be important *contingent liabilities*, which may result in an obligation of the government if a particular event occurs. Such an event may be triggered, for example, by adverse developments of asset prices. Contingent liabilities may also represent a non-trivial fiscal risk and can take the form of *explicit* or *implicit* obligations (Polackova, 1999). As regards the former, typical examples include state guarantees for non-sovereign borrowing and obligations issued to sub-national governments and public and private sector entities (e.g. development banks); umbrella state guarantees, for example, for small business loans; trade and exchange rate guarantees issued by the state; or state guarantees on private investments. However, even in the absence of explicit guarantees, the government may feel obliged to step in, for example, in the case of defaults of sub-national government or public or private entities; the cleanup of liabilities of entities being privatized; the failure of a non-guaranteed pension fund or employment fund; or bailouts following a reversal in private capital flows. While these liabilities are not officially recognized until after a failure occurs, they may seriously increase the vulnerability of the country.

Such a formalized, all-encompassing approach would have the important advantage of revealing in a consistent way a country's vulnerability to market risk and policies to reduce it. Clearly, the analysis should be subjected to stress tests, just in the same way as VaR

approaches for individual financial institutions as we discussed in the preceding section. This would appear all the more important in countries where the authorities choose to dismantle barriers to trade in financial services and open up their capital accounts, exposing the economy to the vicissitudes of volatile capital flows. While it would of course be naïve to assume that the approach suggested in this paper could eliminate the risk of a crisis, arguably a rigorous shift in attention from analyzing the sustainability of regime towards assessing its vulnerability could at least have limited the recent turmoil in the emerging markets. In our view, the VaR approach could thus have important implications not only for those countries that actually implement it but also for the global economy.

VI. Conclusions

In this paper, we have discussed an approach, which could be employed to assess the market risk exposure of countries as opposed to the balance sheet vulnerability of individual financial institutions. By focusing on the worst possible outcome, or the *value-at-risk*, this approach aims at shifting the emphasis away from examining the sustainability of a regime towards analyzing the risk of its failure. In so doing, the VaR approach proposed here is compatible with the various generations of models of balance of payments crises and speculative attacks, which have been developed over the last two decades or so, namely (i) the first-generation, or canonical, models (Krugman, 1979), which focused on the importance of inconsistent policies; (ii) the second-generation models (e.g., Obstfeld, 1997) that were designed under the assumption of optimizing policy makers; and, finally (iii) the third-generation models, which have focused on factors such as corruption, imperfect democracy, and cronyism.

Admittedly, the practical implementation of such a comprehensive macro VaR approach may pose important challenges, especially in countries where the degree of technical expertise is rather limited. Another important risk may result from the quantitative accuracy the models pretend to have, and in the hands of those who do not know what they are doing, even the best VaR system can lead to serious problems. Indeed, as the recent experience with VaRs on the level of individual financial institutions suggests, this risk should not be under-estimated. Thus, rather than focusing exclusively on the result itself, it appears even more important to understand the process of getting to the final number. In this sense, the VaR approach would force the authorities to pay greater attention to alleviate excessive risk, helping them prevent financial crises and, if financial turmoil does occur, identify the necessary measures to solve the crisis in the most efficient way. As a result, governments might show a greater willingness to open up their capital accounts, thus

benefiting from better access to foreign savings, higher efficiency in the financial sector and improved growth prospects, while managing the risk international financial integration may bring about. Therefore, the use of VaR models could in our view represent an important step towards a more open trading system regarding financial services, which could result in greater financial stability in the world economy and help resources allocate more efficiently on a global basis.

As Dornbusch (1998) argues, macro VaRs could serve an important purpose in terms of international crisis management, namely to tell “honest” crises from “dishonest” ones. In his view, VaRs should become mandatory for a country to have access to IMF resources. Any country that has not implemented such an approach or failed to react to the signals provided by the model, would not qualify for Fund support. Honest crises, by contrast, would be generously solved with IMF credits (and support from other multilateral and bilateral creditors). In this context, VaRs could play a particularly important role in determining a country’s access to the Fund’s Supplemental Reserve Facility and the Contingent Credit Lines. According to the IMF’s guidelines, financing can be provided where a member country faces “exceptional payments difficulties due to a large short-term financing need,” as a result of “...circumstances that are largely beyond the control of the member and that stem primarily from adverse developments in international capital markets consequent upon developments in other countries.” Thus, the VaR approach could represent an important pillar in the new international financial architecture.

Appendix: The Basics of VaR

The Variance-Covariance Approach^a

Suppose all risks are normal and the portfolio is a linear function of these normal risks. The VaR, or the maximum expected loss over a given horizon period at a given level of confidence, thus is a multiple of the portfolio standard deviation, and the portfolio standard deviation is a linear function of individual volatilities and covariances.

Consider first the case of a portfolio that consists of two assets, 1 and 2, with a relevant amount, w_1 , held in asset 1, and the relative amount, w_2 , held in asset 2 ($w_1 + w_2 = 1$). If asset i has a return with variance σ_i^2 , the variance of the portfolio, σ_p^2 , is:

$$\sigma_p^2 = [w_1^2 \sigma_1^2 + w_2^2 \sigma_2^2 + 2w_1 w_2 \rho_{1,2} \sigma_1 \sigma_2] \quad (A1)$$

where $\rho_{1,2}$ denotes the correlation coefficient between the returns to the two assets. The VaR of the portfolio is thus given by

$$\text{VaR} = -\alpha \sigma_p W = -\alpha [w_1^2 \sigma_1^2 + w_2^2 \sigma_2^2 + 2w_1 w_2 \rho_{1,2} \sigma_1 \sigma_2]^{1/2} W \quad (A2)$$

or

$$\text{VaR} = [\text{VaR}_1^2 + \text{VaR}_2^2 + 2\rho_{1,2} \text{VaR}_1 \text{VaR}_2]^{1/2} \quad (A3)$$

VaR_1 is the undiversified value-at-risk associated with asset 1 (i.e., $-\alpha w_1 \sigma_1 W$, with α reflecting the level of confidence on which the VaR is predicated), while VaR_2 is the undiversified value-at-risk associated with asset 2 (i.e., $-\alpha w_2 \sigma_2 W$). (A3) defines the VaR of the portfolio in terms of the individual variances, portfolio weights and the correlation coefficients as the underlying portfolio factors and in terms of the undiversified VaRs of the component assets.

If assets returns are perfectly correlated, i.e., $\rho_{1,2} = 1$, the portfolio VaR is simply the sum of the individual undiversified VaRs and there is no diversification of risk. By contrast, if returns are perfectly negatively correlated, i.e., $\rho_{1,2} = -1$ the two individual VaRs offset each other in their impact on the aggregate VaR. If they are also of the same size, the portfolio VaR is zero.

^a This section follows Dowd (1998). Other good descriptions can be found in the sources referred to in the main text.

Finally, if the returns are independent, i.e., $\rho_{1,2} = 0$, the portfolio VaR is given by $[\text{VaR}_1^2 + \text{VaR}_2^2]^{1/2}$.

In the general case of n assets, the VaR of the portfolio, VaR_p , can be calculated as follows:

$$\begin{aligned}\text{VaR}_p &= -\alpha\sigma_p W \\ &= -\alpha[\mathbf{w}\boldsymbol{\sigma}\mathbf{C}\mathbf{w}^T]^{1/2} W \\ &= -\alpha[\mathbf{w}\boldsymbol{\Sigma}\mathbf{w}^T]^{1/2} W \\ &= [\mathbf{VaR}^*\mathbf{C}^*\mathbf{VaR}^T]^{1/2} \quad (\text{A4}),\end{aligned}$$

where \mathbf{w} represents the $1 \times n$ weight vector $[w_1, w_2, \dots, w_n]$, $\boldsymbol{\sigma}$ the $n \times n$ diagonal standard deviation matrix, \mathbf{C} the $n \times n$ correlation matrix, \mathbf{w}^T the transpose of \mathbf{w} , \mathbf{VaR} the $n \times 1$ vector of individual VaRs $[\text{VaR}_1, \text{VaR}_2, \dots, \text{VaR}_n]$, and \mathbf{VaR}^T its transpose. Thus, if all returns are perfectly correlated, the \mathbf{C} matrix becomes a matrix of ones. If the returns are less than perfectly correlated, the portfolio VaR is less than the sum of the undiversified VaRs, implying benefits from portfolio diversification.

Consider now the case where returns are non-linear functions of risk variables, as is often the case with derivatives and bonds, or when the risk variables themselves are non-normal. Provided that the degree of non-linearity is sufficiently limited, a common method is the delta-normal approach, or first-order approximation.^b For illustrative purposes, consider an equity call option, whose value c depends on the price of the underlying stock, the exercise price of the option, and the volatility of the underlying stock price. Focusing on the underlying stock price, the delta-normal approach employs a first-order Taylor series approximation of the change in the option value:

$$\Delta c \approx \delta \Delta S \quad (\text{A5})$$

where $\Delta c = c - c^*$ and $\Delta S = S - S^*$. S is the underlying stock price, δ denotes the option's delta, and the asterisks refer to the current values of the variables. Thus,

$$c \approx c^* - \delta S^* + \delta S = k + \delta S \quad (\text{A6})$$

^b The first-order approximation appears plausible, for example, if the time horizon is very short, and if the products themselves have a relatively linear pay-off profile. In other cases, however, the delta-normal approach may not be appropriate, and more sophisticated techniques are required, such as delta-gamma approaches. For details, see Dowd (1998).

where $k = c^* - \delta S^*$ is treated as a constant. The option value-at-risk, $\text{VaR}^{\text{option}}$, is then given by:

$$\text{VaR}^{\text{option}} \approx \delta \text{VaR}^s = -\delta \alpha \sigma S \quad (\text{A7})$$

The delta-normal approach may also be applied to fixed income products. While the relationship between bond prices and yields is generally non-linear, an approximation around the current combination of price (P) and yield (y) is given by:

$$P(y + \Delta y) \approx P(y) + (dP/dy)\Delta y \quad (\text{A8})$$

Where Δy is some small change in yield. Given that $dP/dy = -D^m P$, with D^m denoting the bond's modified duration, the percentage change in the bond price is

$$\Delta P/P \approx -D^m \Delta y = -D^m y (\Delta y/y) \quad (\text{A9})$$

With the volatility of bond prices given by $\sigma_R = \sigma_P \approx D^m y \sigma_y$, and assuming that the yield is normally distributed, the VaR can be approximated by

$$\text{VaR}^{\text{bond}} = \alpha \sigma_R B \approx -\alpha D^m \sigma_y B \quad (\text{A10}),$$

where B is the bond's present price.

Estimating a central bank's VaR: The Blejer-Schumacher (1998) approach

According to a representative central bank balance sheet, the monetary authority holds foreign and domestic assets and has short positions in the monetary base and in domestic and foreign debt:

Central Bank	
Assets	Liabilities
Gross FX reserves (R_{CB})	Monetary base (H)
FX forwards (F^d)	Stock of foreign debt (C_{CB})
Net domestic credit to banks (D_{CB})	FX forwards (F^x)
Net domestic credit to the Government (G_{CB})	Central bank guarantees to the financial sector (P)

Given the unique nature of the central bank, it is important to measure the economic, and not the historical, values of assets and liabilities. Thus, all balance sheet items should be discounted employing the relevant interest rates. The economic value of the central bank portfolio, V , may thus be expressed as:

$$V = R_{CB}\Pi^i S + F^d\Pi^d + D_{CB}\Pi^d + \gamma G - H - C_{CB}\Pi^f S - F^x\Pi^i S - P[\Pi^d, (L/A), \sigma_A^2] \quad (A11),$$

where $\Pi^d = e^{-(i^d)}$ is the price of a domestic zero coupon bond denominated in domestic currency; $\Pi^i = e^{-(i^i)}$ is the price of the international zero coupon bond; and $\Pi^f = e^{-(i^f)}$ is the price of the country's foreign currency zero coupon bond. For simplicity, all assets and liabilities are assumed to have the same maturity, $t = 1$. Moreover, i^d , i^i , and i^f are the yields on the domestic zero coupon, international zero coupon and foreign currency zero coupon bonds, respectively. Assuming uncovered interest rate parity and introducing a sovereign country risk factor, ϕ , we obtain $i^d = i^i + E(ds) + \phi$, where $E(ds)$ is the expected change in the spot exchange rate, S , within period 1. Furthermore, $i^f = i^i + \phi$. Central bank guarantees to the financial sector, P , may be explicit or implicit and are a function of the domestic interest rate, the financial system's liabilities to assets ratio, or leverage ratio (L/A), and the volatility of the financial institutions' assets, σ_A^2 .

Employing a number of simplifying assumptions,^c the central bank's VaR_{CB} may be estimated by total differentiation of A11:

$$VaR_{CB} = [\sigma_S^2(R_{CB}\Pi^i - C_{CB}^S\Pi^f - F^x\Pi^i)^2 + \sigma_{\Pi^i}^2(R_{CB}S - F^xS)^2 + \sigma_{\Pi^d}^2(D_{CB} + F^d - (\partial P/\partial \Pi^d))^2 + \sigma_{\Pi^f}^2(-C_{CB}S)^2 - \sigma_G^2 - \sigma_{CCB}^2(S\Pi^f)^2 + \text{covariances}]^{1/2} k \quad (A12),$$

where k depends on the confidence level. According to A12, the central bank VaR is a function of the volatilities of the exchange rate, of the bonds' prices and of the level of the exposures.

^c Apart from normality, Blejer and Schumacher assume that (i) the monetary base expands in response to changes in international reserves and central bank credit to the private sector and the Government (i.e., $dH = dG_{CB} + dR_{CB} + dD_{CB}$); (ii) the Government does not repay its debt to the central bank (i.e., $\gamma = 0$); (iii) new reserves are invested at par value; (iv) new loans to the banks are granted at par value; and (v) interest rate parity ensures that $dF^d\Pi^d = dF^xS\Pi^i$.

Expanding the Blejer-Schumacher framework

In reality, the treasury is also subject to market risk. Specifically, the treasury may also hold FX reserves, R_G , and may be engaged in direct lending operations vis-à-vis enterprises, E (i.e., holds a long position). On the liabilities side, it borrows from the banking system (i.e., the central bank, G_{CB} , and deposit money banks, G_{DMB}) as well as from the public by issuing bonds, G_B . Moreover, the government may hold part of the country's stock of foreign debt, C_G . Finally, there may be explicit or implicit state guarantees, SG . With $R = R_{CB} + R_G$, $C = C_{CB} + C_G$, $D = D_{CB} - G_{DMB}$ and consolidating G_{CB} we get:

Consolidated Balance Sheet	
Assets	Liabilities
Total FX reserves (R)	Monetary base (H)
FX forwards (F^d)	Borrowing from the public (B)
Net domestic credit to banks (D)	Total stock of foreign debt (C)
Credit to enterprises (E)	FX forwards (F^x)
	Financial sector guarantees (P)
	State guarantees (SG)

The value of the consolidated balance sheet is thus

$$V = R\Pi^i S + F^d \Pi^d + D\Pi^d + E\Pi^d - H - B\Pi^d - C\Pi^f S - F^x \Pi^i S - P[\Pi^d, (L/A), \sigma_A^2] - SG[\Pi^f, (FD/A), \sigma_E^2] \quad (A13),$$

where state guarantees are assumed to be a function of the foreign interest rate, the foreign debt to assets ratio of the enterprise sector and the volatility of the sector's assets. The VaR may then be calculated as followed:

$$VaR = [\sigma_S^2 (R\Pi^i - C^S \Pi^f - F^x \Pi^i)^2 + \sigma_{\Pi^i}^2 (RS - F^x S)^2 + \sigma_{\Pi^d}^2 (D + E + F^d - B - (\partial P / \partial \Pi^d))^2 + \sigma_{\Pi^f}^2 (-CS - (\partial SG / \partial \Pi^f))^2 - \sigma_C^2 (S\Pi^f)^2 + \text{covariances}]^{1/2} k \quad (A14).$$

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