Understanding Bilateral Exchange Rate Volatility*

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Revised July 1, 2002

Abstract

This paper develops an empirical model of bilateral exchange rate volatility. We conjecture that for developing economies, external financial liabilities have an important effect on desired bilateral exchange rate volatility, above and beyond the standard Optimal Currency Area (OCA) factors. By contrast, industrial countries do not face the same set of constraints in international financial markets. In our theoretical model, external debt tightens financial constraints and reduces the efficiency of the exchange rate in responding to external shocks. We go on to explore the determinants of bilateral exchange rate volatility in a broad cross section of countries. For developing economies, bilateral exchange rate volatility (relative to creditor countries) is strongly negatively affected by the stock of external debt. For industrial countries however, OCA variables appear more important and external debt is generally not significant in explaining bilateral exchange rate volatility.

JEL Classification: F330, F410
Keywords: Exchange Rate Volatility, Optimal Currency Area, Financing Constraints

* Prepared for the conference *Empirical Exchange Rate Models,* Madison, Wisconsin Sept 28-29, 2001. Devereux: devm@interchange.ubc.ca, Lane: plane@tcd.ie We thank Martin Berka and Charles Larkin for research assistance, and Rainer Widera of the BIS for help with data. We also thank the two anonymous referees, the guest editor John Rogers, Richard Lyons, Charles Engel, Andrew Rose, Patrick Honohan, Claudia Buch, Frank Warnock, Jonathan Wright and participants at the conference and at seminars at NYU, ECARE and the CEPR/LBS workshop for comments. This paper is part of a research network on 'The Analysis of International Capital Markets: Understanding Europe's Role in the Global Economy', funded by the European Commission under the Research Training Network Programme (Contract No. HPRNCT-199900067). Devereux thanks SSHRC of Canada for research support, and Lane also gratefully acknowledges the support of a TCD Berkeley Fellowship.

Section 1: Introduction

What are the principal determinants of exchange rate volatility? This has been perhaps the biggest research question in international finance over the last three decades. Despite hundreds of follow-up papers, the results of Meese and Rogoff (1983) suggesting that movements in exchange rates are largely unpredictable remain largely intact.

Our paper also focuses on exchange rate volatility. But we take an alternative perspective to the literature that has directly followed in the tradition of Meese and Rogoff. Rather than focusing exclusively on the time series properties of exchange rates relative to a single large currency such as the dollar or the euro, we are concerned with understanding what drives bilateral exchange rate volatility across countries. Looking at a large cross section of both developing and developed countries, we seek to identify the main determinants of bilateral exchange rate volatility between country pairs.

Our starting point is the Optimal Currency Area (OCA) hypothesis of Mundell (1961). Mundell isolated the key economic factors that make two regions or countries part of a common currency area. These factors include trade interdependence and the degree of commonality in economic shocks[1]. As in previous work (e.g. Bayoumi and Eichengreen 1998, Hausmann et al. 2001, Larrain and Tavares 2000), we use these as explanatory variables in modeling bilateral exchange rate variability across countries.

But in addition to the standard set of OCA variables, we add a further set of determinants measuring financial linkages between countries. Recent theoretical literature suggests that these variables may be of key importance in understanding exchange rate variability, especially for developing economies. Our central hypothesis is that for developing countries, high levels of financial linkages with a creditor country C (in the form of portfolio debt or bank loans) will, ceteris paribus, be associated with a lower level of bilateral exchange rate variability vis-à-vis country C.

This hypothesis is derived from a substantial recent body of work that points to the importance of financial factors in understanding exchange rates in emerging market economies. Many writers have questioned the neglect of financial market structure in standard macroeconomic models. Bernanke, Gertler and Gilchrist (1999) stress the importance of balance sheet effects in understanding the properties of business cycles. Among others, Krugman (1999), Cook (2000), Aghion et al. (2001), Cespedes, Chang and Velasco (2000, 2001), Devereux and Lane (2001), Gertler, Gilchrist and Natalucci (2001) and Eichengreen (2002), have extended these ideas to the open economy. All these papers highlight a fundamental failure of the 'Modigliani-Miller' theorem: balance sheet effects matter for macroeconomic outcomes and especially for the exchange rate.

One conclusion of this literature is that, combined with these balance sheet effects, the presence of external debt (denominated in foreign currency) may have an important effect on the way in which movements in the exchange rate impact on an economy. Fluctuations in exchange rates, in the presence of large stocks of un-hedged foreign-currency denominated debt may be important through its effects on the financial sector and corporate balance sheets. This introduces a cost of exchange rate variability quite separate from the traditional theory. Eichengreen and Hausmann (1999) suggest that many emerging market economies may have little ability to tolerate a high degree of exchange rate volatility against their major creditors. The observation that many countries, especially emerging market economies, display a 'fear of floating' (Calvo and Reinhart 2002) offers supporting evidence for the hypothesis that OCA factors alone

[1] See also Alesina and Barro (2002).

cannot provide a full account of the degree bilateral exchange rate volatility that emerging market economies experience[2].

Accordingly, the central empirical hypothesis of the paper is that in addition to the standard OCA factors, bilateral exchange rate volatility is related to the stock of bilateral financial claims across countries. For the 'rich' countries that are not constrained in international capital markets and can freely borrow by issuing assets denominated in their own currencies, it is unlikely that international balance sheet considerations have a large impact on their choice of exchange rate regime. But for developing economies that are subject to various borrowing constraints and must issue debt in foreign currency, exchange rate volatility may have an extra cost, beyond that suggested by the standard OCA criteria. Accordingly, we test the hypothesis that bilateral exchange rate volatility is especially negatively related to bilateral financial claims for developing economies.

The paper begins by developing a simple model of exchange rate choice for a small open economy vulnerable to external terms of trade disturbances. Exchange rate policy matters due to nominal price stickiness. Our model allows for the exploration of two separate cases. For an economy free of credit constraints, we show that exchange rate adjustment is desirable, and the exchange rate should respond to external shocks according to OCA theory. We then show that the presence of credit constraints, in combination with external debt, leads to a significant decline in the optimal response of exchange rates to shocks. If the credit constraints are significant enough, it may be optimal to have essentially no adjustment of the exchange rate in response to external shocks.

[2] A related, but separate rationalization for `fear of floating' is provided by Caballero and Krishnamurty (2001). They stress the importance of internal versus external collateral during a currency crisis.

In our empirical estimates we examine the determinants of bilateral exchange rate volatility in a broad cross section of countries, using a number of standard OCA variables that have been employed in the literature, such as trade interdependence, differences in economic shocks, and country size. We then add a series of financial variables. One represents internal finance, capturing the degree of financial depth within countries. A second set of variables measures external financial factors. One of these comes from banking data (obtained from the BIS), and represents exclusively creditor-currency denominated loans, so it captures the importance of foreign currency liabilities. The second measure comes from the IMF's International Portfolio Survey, and represents bilateral portfolio debt liabilities between countries.

Our empirical results find that financial variables do play a significant role in explaining exchange rate volatility, in addition to the standard OCA set of variables. For the most part, the results indicate that the effect of OCA variables on exchange rate is consistent with standard theory. Greater bilateral trade reduces bilateral exchange rate volatility, and economic size increases volatility. This holds both for developed and developing countries. For the full sample, bilateral exchange rate volatility is reduced by both internal finance and by external financial linkages.

But the results are sharply different for developed economies and the developing country sample. For developed economies, bilateral exchange rate volatility is either positively affected by external financial linkages, or affected insignificantly. By contrast, for the developing country sample, bilateral exchange rate volatility is significantly reduced by external financial linkages. Thus, the dichotomy between developed and developing economies suggested by the model is supported by our empirical results. In fact, we see the same dichotomy with respect to internal finance; this variable tends to increase exchange rate volatility for developed economies, but reduces it for the developing economies.

The paper is organized as follows. The next section develops a simple model of the optimal exchange rate policy for a small economy, following in the tradition of the recent 'new open economy macroeconomics' literature. Section 3 outlines the data and the empirical strategy used in the paper. Section 4 discusses the empirical results. Some conclusions then follow.

Section 2. An illustrative model

We first outline an illustrative model of optimal exchange rate volatility in a small open economy. Here we give an intuitive description of its main elements. There is a single small economy, where all households are alike, consuming an imported good and a non-traded good, and supplying labor[3]. The economy produces a non-traded good and an export good. Prices of both import and export goods are determined in the rest of the world, but non-traded goods prices are determined domestically.

Household preference is separable in labor supply and aggregate consumption[4]. Demand for the non-traded good and imported goods is $C_N = a\left(\frac{P_N}{P}\right)^{-\rho} C$ and $C_M = (1-a)\left(\frac{P_M}{P}\right)^{-\rho} C$, respectively, where a is the weight on non-traded goods in aggregate consumption, and ρ is the elasticity of substitution between import goods and

[3] This is a very simple version of a 'new open macro' model (see Obstfeld and Rogoff 1995, 2000, and Lane 2001).

[4] Let utility be defined as $U = \frac{C^{1-\sigma}}{1-\sigma} - \frac{\eta}{1+\psi} H^{1+\psi}$. For simplicity, we focus on a static economy.

non-traded goods. P_N represents the non-traded good price, and P_M is the import good's price. The foreign currency price of import goods, P_M^*, is determined abroad, so the domestic price must satisfy $P_M = SP_M^*$, where S is the nominal exchange rate. The household's implicit labor supply is given by $W_t = \eta P_t C_t^\sigma H_t^\psi$, where σ and ψ represent the inverse of the elasticity of inter-temporal substitution in consumption, and consumption-constant elasticity of labor supply, respectively.

Firms in the non-traded sector employ only labor (H_N), using one unit of labor per unit of output. Firms choose prices in advance to maximize expected profits.

In the export sector, firms must use both labor and an intermediate import good. The typical exporting firm has a fixed proportions production function given by $Y_X = \mathrm{Min}[\frac{V}{\omega}, \frac{I}{(1-\omega)}]$, where $V = H_X$ represents value-added, equal to employment. The export price is given by $P_X = SP_X^*$. Intermediate imports are provided by a separate importing sector, at price Q. Let $q = Q / P_X$. Then free entry in export goods implies

$$\frac{P_X}{\omega}(1-q(1-\omega)) = W\ . \qquad (1)$$

Firms in the intermediate input sector purchase inputs from abroad and sell them to exporters. These firms may face credit constraints in the purchase of intermediate inputs. The rationalization is as follows. Intermediate importers initially borrow an amount B^* from foreign banks to finance the purchase of intermediate inputs. Then intermediate importers may purchase imports from the foreign suppliers at price Q^*. Due to default risk, the intermediate importers are required to pay an extra 'risk-premium' per unit of imported intermediate inputs. Following Bernanke et al (1999), assume that the risk premium is an increasing function of the amount borrowed, relative to net worth. Thus, the total variable cost for the intermediate importing firm, in domestic currency terms, is given by $SQ^{*}I(1+z(\varphi))$, where $\varphi \equiv \frac{SB^{*}}{P_N}$ denotes the ratio of borrowing to net worth[5]. Assume that net worth of the intermediate input sector is fixed in terms of the non-traded good, and therefore for simplicity we can normalize it to unity. The function $z(\varphi)$ satisfies $z'(\varphi) > 0$.

The key feature is that the balance sheet position of intermediate input firms determines the sensitivity of the risk premium to the exchange rate. The elasticity of the intermediate input's price with respect to the exchange rate is $1+\gamma$, where $\gamma = \frac{z(\bar{\varphi})}{1+z(\bar{\varphi})} \frac{z'(\bar{\varphi})\bar{\varphi}}{z(\bar{\varphi})}$, and $\bar{\varphi}$ denotes the ratio of debt to net worth. As an example, take $z(\varphi) = \varsigma \frac{\varphi^2}{2}$, where ς is a constant. Then it is clear that γ is increasing in $\bar{\varphi}$. For the rich economies, we would anticipate that $\bar{\varphi}$ would be very small, and hence γ negligible. But for developing economies, we might expect higher values of $\bar{\varphi}$ and hence γ.

With free entry into the intermediate importing sector, the price of intermediate imports charged to export producing firms must then be

$$Q = SQ^{*}(1+z(\varphi)) \qquad (2)$$

Without loss of generality, we take the exchange rate as an exogenous policy variable that can be chosen by the domestic monetary authority. The only external shocks in the model are those to the terms of trade. The terms of trade can be described

[5] At the end of the period, the bond is repaid to the foreign creditor, so there are no net flows of capital into the country.

as the export price, relative to a composite of import prices (prices of both consumer good imports and intermediate good imports). Holding P_M^* constant, we allow for shocks to P_X^* and to Q^*.

In equilibrium, output in the non-traded goods sector must equal demand

$$H_N = a\left(\frac{P_N}{P}\right)^{-\rho} C . \tag{3}$$

Equilibrium in the balance of payments requires that value added in the export sector equals imports

$$\frac{P_X H_X}{\omega}\left(1-q(1-\omega)\right) = (1-a)P_M\left(\frac{P_M}{P}\right)^{-\rho} C . \tag{4}$$

Finally, from the zero profit conditions in the export sector, combined with the equilibrium wage, and labor market clearing ($H = H_X + H_N$), we get

$$\frac{P_X}{\omega}(1-q(1-\omega)) = \eta P C^{\sigma}(H_X + H_N)^{\psi} . \tag{5}$$

Given the policy rule for the exchange rate, and the predetermined non-traded goods price, these three equations can be implicitly solved for consumption C, and employment in each sector, H_X and H_N.

The model can be solved by linearizing equations (3) –(5) around an initial steady state. Lowercase letters represent log deviations from the steady state, so that for any variable X, let $x = \ln(X/\bar{X})$. From (3), we have

$$h_N = \rho(1-a)s + c . \tag{6}$$

Non-traded output is an increasing function of consumption and the nominal exchange rate. From equation (4), using also (2) we have

$$p_X^* - \frac{(1-\omega)}{\omega} q^* + h_X - \gamma \frac{(1-\omega)}{\omega} s = -\rho a s + c \, . \qquad (7)$$

The left hand side represents the net value-added in the export sector, which includes the direct effects of the terms of trade shock, the effect of increased employment, and finally, the impact of the exchange rate on real income through a tightening of the credit constraint. The right hand side of (7) then just represents changes in the demand for imported goods.

A linearization of (5) gives

$$s + p_X^* - \frac{(1-\omega)}{\omega} q^* - \gamma \frac{(1-\omega)}{\omega} s = (1-a)s + \sigma c + \psi(a h_n + (1-a) h_X) \, . \quad (8)$$

The left-hand side represents the change in the value of the marginal product of labor in the export sector, including direct exchange rate effects, the terms of trade, and indirect exchange rate effects through the credit constraints. The right hand side just represents the change in the nominal wage.

The domestic authorities choose the optimal exchange rate rule to maximize domestic expected utility, which may be written as (see Woodford, 1999).

$$EU = \frac{(1-\sigma)}{2} Ec^2 - \frac{(1+\psi)}{2} Eh^2$$

where $h = a h_N + (1-a) h_X$ represents aggregate employment. We assume that the exchange rate rule is chosen before the external shocks are known, but that the rule allows the authorities to respond directly to the realizations of the shocks.

Optimal Exchange Policy Without Credit Constraints

First we look at the case without credit constraints, so that the risk premium term γ, is set to zero. We may then solve equations (6)-(8) for consumption and employment:

$$c = \frac{a}{\sigma + \psi} s + \frac{(1 + (1-a)\psi)}{\sigma + \psi} (p_X^* - \frac{(1-\omega)}{\omega} q^*) \tag{9}$$

$$h = \frac{a}{\sigma + \psi} s + \frac{(1 - (1-a)\sigma)}{\sigma + \psi} (p_X^* - \frac{(1-\omega)}{\omega} q^*) \tag{10}$$

Substituting (9) and (10) into (the approximation of) expected utility, it is easy to then show that the optimal exchange rate rule is:

$$s = -p_X + \frac{(1-\omega)}{\omega} q^* . \tag{11}$$

The exchange rate is adjusted to fully respond to terms of trade disturbances and shocks to the real price of intermediate inputs. Intuitively, a positive shock to the terms of trade requires a real exchange rate appreciation. In face of sticky non-traded goods prices, the real appreciation is achieved by nominal appreciation. In fact (11) replicates the equilibrium of the economy where the non-traded goods price is fully flexible.

Optimal Exchange Policy With Credit Constraints

When the intermediate inputs sector is subject to a credit constraint, the policy maker must take into account that movements in the exchange rate affect the real cost of the intermediate input, through the response of the risk-premium. Again using (6)-(8), we obtain the response of consumption and employment as:

$$c = \frac{(a - \frac{\gamma(1-\omega)}{\omega}(1 + \psi(1-a)))}{\sigma + \psi} s + \frac{(1 + (1-a)\psi)}{\sigma + \psi} (p_X^* - \frac{(1-\omega)}{\omega} q^*) \tag{12}$$

$$h = \frac{(a - \frac{\gamma(1-\omega)}{\omega}(1 - \sigma(1-a)))}{\sigma + \psi} s + \frac{(1 - (1-a)\sigma)}{\sigma + \psi} (p_X^* - \frac{(1-\omega)}{\omega} q^*) \tag{13}$$

Contrasting with equations (9) and (10), we see that the effects of a terms of trade shock on consumption and employment are as before. But exchange rate depreciation may have a perverse impact on aggregate consumption, since it reduces output in the traded goods sector, and reduces the marginal product of labor in traded goods.

We may use equations (12) and (13), in conjunction with the objective function, to derive the optimal exchange rate rule. The optimal rule may be written as

$$s = -\frac{\left[(1-\sigma)\theta_1(a-\tilde{\gamma}\theta_1)-(1+\psi)\theta_2(a-\tilde{\gamma}\theta_2)\right]}{\left[(1-\sigma)(a-\tilde{\gamma}\theta_1)^2-(1+\psi)(a-\tilde{\gamma}\theta_2)^2\right]}\left(p_X^* - \frac{(1-\omega)}{\omega}q^*\right) \qquad (14)$$

where $\theta_1 = (1+(1-a)\psi)$, $\theta_2 = (1-\sigma(1-a))$, and $\tilde{\gamma} = \frac{(1-\omega)}{\omega}\gamma$.

In general, it is not possible to determine the sign of the exchange rate response. When $\gamma = 0$, (14) implies a full offset of shocks as in equation (11). To explore the impact of the credit constraint more generally, we calibrate the model. Let the share of non-traded goods in GDP be 50 percent, so *a*=0.5 (see Devereux and Lane (2001) for justification). Assume that the share of intermediate inputs in export production is 40 percent, so that $\omega = 0.6$. Let the elasticity of labor supply be unity, so $\psi = 1$. Finally, following the benchmark of recent literature, let $\sigma = 2$. Calibrating for γ is more difficult. But from the definition given above, when the z function is assumed to be quadratic, there is a monotonic relationship between γ and the risk-premium. So we illustrate the optimal policy under a variety of different values for the risk premium.

Figure 1 illustrates the dependence of the exchange rate rule on the risk premium under this calibration. As the risk premium rises, the optimal exchange rate response to terms of trade or intermediate input price shocks falls. At a risk-premium of 30 percent, the optimal exchange rate response is zero. Thus, as the credit constraints in international financial markets become increasingly important, the direct benefits of adjusting the exchange rate to terms of trade shocks are offset by the indirect costs, in terms of a rising risk-premium (cost of intermediate inputs), which is itself sensitive to movements in the exchange rate. This reduces the optimal exchange rate response to external shocks. Figure 1 also shows the case of σ=1.5. In this case, because policy-makers are more willing to accept consumption volatility, the optimal monetary rule is more activist, and the risk premium at which the exchange rate response is zero rises to 60 percent[6].

These results thus support our view that financial market distortions may offset the direct stabilization properties of exchange rate policy in developing economies.

Section 3 Data and Empirical Methodology

We have argued that standard OCA variables should be augmented with consideration of financial factors in understanding the benefits and costs of exchange rate fluctuations, especially in regard to developing countries. Accordingly, a key part of our empirical approach is to introduce a measure of international financial dependence as a potential determinant of exchange rate volatility.

We examine bilateral nominal exchange rate volatility for a large set of countries. The closest antecedent to our work is Bayoumi and Eichengreen (1998). Bayoumi and Eichengreen examine the empirical determinants of bilateral exchange rate volatility for a group of industrial countries, focusing on standard OCA factors as explanatory variables. Our sample includes a wider set of countries, including developing countries. In addition, we address the role played by financial linkages in determining exchange rate

[6] These results are not sensitive to variations in the parameter values. As long as σ is large enough (greater than 1.5), the policy maker will put sufficient weight on consumption variation in the objective function so as to reduce exchange rate variability in response to terms of trade shocks, for empirically plausible values of the risk-premium.

volatility[7]. Larrain and Tavares (2000) and Engel and Rose (2000) consider determinants of real exchange volatility but again do not consider financial factors. Alternatively, Fernandez-Arias et al (2001) and Poirson (2001) do consider financial factors (specifically, the ability to issue international debt in domestic currency) but study multivariate exchange rate volatility and only for a limited number of countries.

The bilateral approach is an essential part of our methodology. First, to adequately assess the importance of conventional OCA theory in explaining exchange rate volatility, it is essential to look at pairwise volatility between countries with different characteristics. But a bilateral perspective is also important for assessing the effects of financial interdependence, since the cost of exchange rate volatility is likely to be greater against those countries with which the country has substantial debts, particularly debts denominated in creditor country currencies. In the regressions below, we also report results when we restrict the analysis to a small group of creditor country/currencies.

Our empirical specification is to model exchange rate volatility by

$$VOL_{ij}^{ER} = \alpha + \beta X_{ij} + \gamma FIN_j + \sigma EXTFIN_{ij} + \rho\, FIN_j * EXTFIN_{ij} + \varepsilon_{ij}$$

where VOL_{ij}^{ER} is the level of bilateral nominal exchange rate volatility between countries i and j, X_{ij} is a set of standard OCA variables, FIN_j is the size of the domestic

[7] As in Bayoumi and Eichengreen (1998), we assume that at least part of bilateral exchange rate volatility can be represented as an endogenous policy choice conditioned on underlying OCA and finance-related variables. An alternative would be to include some indicator of the overall `exchange rate regime'. However, a growing recent literature (e.g. Levy –Yeyati and Sturzennegger 2001, Calvo and Reinhart 2002, Reinhart and Rogoff 2002) stresses the difficulty that arises when the degree of exchange rate flexibility is assigned from official classifications, due to the substantial differences between de jure classification and de facto exchange rate behaviour. These papers also tend to assign exchange rate policy based on observed exchange rate variability. Moreover, the bilateral dimension allows us to identify against which currencies country X values stability --- for a developing country, our point is that financial links in addition to trade links determine attitudes regarding bilateral volatility

financial sector and $EXTFIN_{ij}$ is a measure of the financial dependence of country j on country i. We measure bilateral exchange rate volatility as

$$VOL_{ij}^{ER} = STDEV[d(\log(s_{ij})]$$

where s_{ij} is the nominal exchange rate between countries i and j.[8] This is constructed using monthly data over 1995.1 to 2000.9, drawn from the IMF *International Financial Statistics* CD-ROM.[9] Table 1 reports summary statistics for this variable for (i) the full (FULL) sample; (ii) the set of industrial (IND) countries; and (iii) the set of developing (DEV) countries.[10] We observe that both the mean and standard deviation of exchange rate volatility is much higher for the DEV sample than the IND sample.

Since each observation of our dependent variable is a country *i, j* pair, the question of spatial correlation between observations arises. This might reduce the significance of our estimates. As noted by Bayoumi and Eichengreen (1998) however, spatial correlation presents less of a problem for regressors expressed in second moment terms. While the change in the exchange rate between currency *i* and currency *j* is correlated with the change in the *i* – *k* exchange rate, this not automatically true of the covariance between *i* –*j* and *i* –*k* rates.

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[8] The data appendix provides more details on data construction and sources.
[9] Measuring exchange rate volatility over a relatively short period runs the risk of "peso problems", in which the results are particularly sample dependent. However, since our data on external finance is limited in time, we are constrained on this dimension. In fact, it makes little difference if we take the average over a longer period such as 1990.1 to 2000.9 but the more recent period allows the inclusion of more transition countries. For the euro-zone members, volatility after 1999.1 is equal to volatility for the euro but the results would be unchanged if we had measured volatility for these countries until 1998.4.
[10] The IND countries are the OECD members: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Switzerland, Sweden, United Kingdom, United States. The IND sample is the set of bilateral observations between the 'creditor' countries in Table 2 (see below) and the industrial countries listed in Table 3. The DEV sample is the set of bilateral observations between the 'creditor' countries in Table 2 (see below) and the developing countries listed in Table 3.

Regarding the standard OCA variables included in the analysis, *Trade* is the sum of exports and imports between i and j, expressed as a ratio to country j's GDP.[11] It is included for the standard logic that the benefit of a floating nominal exchange rate is inversely related to the level of trade with a given partner country. *Cycle* is the degree of business cycle asymmetry: it is the standard deviation of the growth rate differential between countries i and j, measured over 1975-98.[12] This indicator is included to proxy for asymmetric shocks, which should increase the desirability of a flexible exchange rate as an adjustment mechanism. *Size* is the log of the product of the GDPs of i and j. *Size* is intended to proxy for the microeconomic benefits of exchange rate stability: smaller countries should be more reluctant to tolerate fluctuations in the nominal exchange rate.

The size of the domestic financial sector *Finance* is measured as the ratio of liquid liabilities to GDP.[13] We include this proxy for domestic financial development since the financial frictions we emphasized in the theoretical model are likely to be less important, the more sophisticated is the domestic financial sector.

We consider two measures of the financial dependence of country j on country i. In Tables 4 and 7 below, we set $EXTFIN = ALLD_{ij}$ where $ALLD_{ij} = BISAD_{ij} + PD_{ij}$ is the sum of the own-currency bank claims and the portfolio debt claims of country i on country j.[14] The former is based on internal BIS data and is measured as an average over

[11] We enter TRADE in log form.

[12] This interval is longer than the period over which we measure exchange rate volatility but we only have annual data for GDP. We obtain similar results if we calculate *Cycle* over 1990-98.

[13] This measure is the most widely available indicator of financial development. Other indicators such as the ratio of private credit to GDP or stock market activity are available only for a smaller number of countries.

[14] We enter $EXTFIN$ in the form of $\log(1+EXTFIN/GDP_j)$. This takes into account the presence of zero values for $EXTFIN$ and facilitates the specification for the instrumental-variables estimation

1995.1 to 2000.12; the latter is taken from the International Monetary Fund's *International Portfolio Survey* and is measured at end-1997.[15] As such, this variable is a broad measure of the debt liabilities owed by country j to country i. However, the IMF data on portfolio debt holdings do not identify the currency denomination of these claims. This is a limitation: for instance, most Latin American bond debt is denominated in US dollars while the industrial nations bonds are often denominated in domestic currency.[16]

For this reason, we try an alternative measure in Tables 5 and 8 by setting $EXTFIN = BISAD_{ij}$ in Tables 5 and 8. By focusing only on bank claims, this permits the inclusion of a greater number of data points and consists entirely of own-currency loans.[17] This may better capture the notion of foreign-currency liabilities: if country X borrows money from country Y but in the currency of country Z, then country X may care more about exchange rate stability vis-à-vis country Z than country Y. By looking at just own-currency liabilities, we restrict attention to debts owed by country X to country Y in the currency of country Y.

We include the interaction term *Extfin*Finance* since we expect external financial dependence to be less relevant for exchange rate policy, the more sophisticated the domestic financial sector --- recall that external financing only matters in our theoretical model if financial frictions (the risk premium) are important.

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procedure that we describe below. Unfortunately, we do not know the currency breakdown of portfolio debts.

[15] We convert both variables into constant 1995 US dollars.

[16] Since our model suggests the importance of foreign currency liabilities in affecting the risk-premium, we would ideally like data on the aggregate amounts of portfolio debt owed by each country in each currency. But we do not currently have such data. The IMF data are based on surveys of the creditor countries: it is possible that there is variation across reporting countries in terms of the quality of the information but this should not vary systematically across the debtor countries.

[17] Importantly, restricting attention to bank debt permits the inclusion of Germany as a creditor country (the IMF Portfolio Survey does not include Germany). For the United Kingdom, BISAD refers to all-currency

We include GDP per capita (in PPP units) as an extra control variable. This is intended as a general check for potential omitted variable bias, since external finance may systematically vary with the level of development and so may just proxy for other economic and institutional developments associated with a rising per capita income. *Trade*, *Cycle* and *Extfin* are potentially endogenous to exchange rate volatility. For this reason, we report instrumental-variables estimates in subsection 4.2 below.

Section 4: Empirical Results

4.1 OLS Estimation

We begin with a basic specification in Table 4, with *Extfin=Alld*. The full sample is included in column (1); the IND subsample in column (2); and the DEV subsample in column (3). Further splits of the DEV subsample are considered in columns (4)-(6): only observations vis-à-vis the major currencies (US, UK, Japan, France, Germany) are included in columns (4)-(6); observations with *Alld*=0 are further excluded in columns (5)-(6); observations with mean bilateral depreciation rates above 3 percent are yet further excluded in column (6).

Across columns (1)-(6), the standard OCA variables work reasonably well: in particular, *Trade* and *Size* have the expected signs. The latter is always significant but the former does not reach standard significance levels for some of the DEV country subsamples in columns (4)-(5). For the IND sample, *Cycle* has the expected sign and is quite significant; for the FULL and DEV samples, it is actually significantly negative.[18]

debt, since this country does not separately report the domestic-currency component. The data should be reasonably uniform, since these are based on information from BIS-reporting banks.

[18] The simple correlation between *Cycle* and *Vol* is quite positive at 0.43, 0.47, 0.41 for the FULL, IND and DEV samples respectively, suggesting that the negative sign for the FULL and DEV sample regressions is the result of collinearity with the other regressors.

For the IND sample, *Finance* enters with a significantly positive coefficient: more financially sophisticated industrial countries are able to tolerate a higher level of exchange rate volatility, all else equal. However, *Finance* is actually significantly negative for the FULL and DEV samples. Among the developing countries, this suggests that domestic financial development helps to stabilize the exchange rate, for instance by facilitating intertemporal smoothing by households and firms or adding liquidity to financial markets (including the foreign exchange market).

A sharp difference between the IND and DEV countries is also evident for the *Extfin* variable. For the FULL and DEV samples, *Extfin* has a significantly negative association with exchange rate volatility. In contrast, *Extfin* is actually significantly positive for the IND countries. This pattern in fact broadly matches our theoretical priors. Financial frictions are more important in developing countries than in the industrial nations and, as in our theoretical model, the former group will do more to minimize exchange rate fluctuations, the greater the reliance on external finance. That *Extfin* is positive for the IND sample is consistent with the idea that industrial countries most active in international asset trade are best placed to absorb a more volatile exchange rate.

The behavior of the interaction term *Extfin**Finance* provides further supporting evidence. The interaction term is significantly positive for the FULL and DEV samples: the greater is domestic financial depth (the smaller are financial frictions), the less important is external financial dependence in determining the appropriate exchange rate policy. The interaction term is actually negative for the IND sample, suggesting again an underlying nonlinearity in the relation.

With respect to economic magnitude of the impact of external financial dependence on bilateral exchange rate volatility, we take the point estimates for the direct and interaction effects in column (6) of Table 4 for illustrative purposes. Taking a country-pair with a level of bilateral exchange rate volatility equal to the subsample mean of 4 percent, a five percentage point increase in the ratio of external liabilities of country j vis-a-vis country i (as a fraction of GDP) implies a decline in volatility to 2.86 percent if *Finance*=0.25 but an increase in volatility to 4.79 percent if *Finance*=0.75.[19] This is an intuitive partition: for developing countries with weak domestic financial systems, higher external liabilities is associated with lower exchange rate volatility. For countries with stronger financial systems, the relation even turns positive.

Additional explanatory power is provided by *GDP per capita* for the FULL and DEV samples: richer countries tend to have more stable exchange rates. Again, this effect is not important if we confine attention to the IND sample. Finally, we note that the overall explanatory power is relatively poorer for the developing country subsample than for the industrial nations.

Table 5 repeats the analysis for the second measure of external financial dependence: *Extfin=Bisad*. As noted, more observations are available for this measure and it also permits the inclusion of Germany among the creditor countries. The downside is now that only bank liabilities are considered. However, in contrast to the portfolio debt data, at least we know that these bank liabilities are denominated in the currency of the

[19] The turning-point in the relation between external finance and bilateral volatility is at *Finance*=0.55. (The subsample median value of *Finance* is 0.35.) The turning point when we use the alternative measure of external finance (EXTFIN=BISAD) is 0.68 (column (6) of Table 5). The IV estimates in Tables 7-8 for the sample specifications give turning points of 0.52 and 0.71.

creditor country.[20] This is closer to the type of financial liability that should matter for currency behavior, according to our theoretical model. The results are very similar to Table 4. The main exceptions are that *Trade* is now significant for the DEV subsamples (at the 5 or 10 percent levels) and *Cycle* is no longer significant for these subsamples.

4.2 IV Estimation

As noted earlier, the OLS results may not be reliable if some of the regressors are endogenously determined by the level of bilateral exchange rate volatility. We consider four variables to be potentially affected by this problem: *Trade*, *Cycle*, *Extfin* and the interaction term *Extfin*Finance*. Our instruments for these three variables are: log(distance) and its square; a common language dummy; a colonial dummy; a regional trade agreement dummy; log(GDP) and its square for home and partner countries; and log(GDP per capita) for home and partner countries. Bayoumi and Eichengreen (1998) use a similar list in instrumenting for *Trade* and *Cycle* --- the recent literature on 'gravity and capital flows' suggest that these are also good instruments for *Extfin*.[21]

As a prelude to the instrumental-variables estimation, Table 5 investigates the relevance of the instrument list. Shea (1997) provides a methodology for investigating relevance when there are multiple potentially endogenous regressors.[22] Following this approach, we regress each regressor X_1 on the instrument vector *Z*. We calculate $\hat{X}_1$ as the fitted value. We also regress each X_1 on the other regressors , *X* to form the residual $\tilde{X}_1$. We next regress $\hat{X}_1$ on $\hat{X}$, where $\hat{X}$ are the fitted values for the other regressors, to

[20] With the exception of the United Kingdom, as already noted.
[21] On the determinants of bilateral financial relations, see Buch (2001), Ghosh and Wolf (2001), Honohan and Lane (2000), Kawai and Liu (2001), Portes and Rey (2001) and Warnock and Mason (2001).

form the residual $\bar{X}$. We report the partial R2 from a regression of $\tilde{X}_1$ on $\bar{X}_1$ and an F-test for the significance of $\bar{X}_1$ in explaining $\tilde{X}_1$.

The results in Table 6 show that the F-tests are always significant for the four endogenous regressors across the various samples, even if the partial R2 values are relatively low in a number of cases. Across the subsamples, the partial R2 values are typically highest for *Trade* and lowest for *Cycle*. Shea (1997) does not provide a formal methodology for establishing a threshold level of acceptability for the partial R2 value. However, the low values in some cases suggest the need to improve the identification of the endogenous regressors, to better establish lines of causality. This mixed evidence on instrument relevance indicates that the IV results should be interpreted with due caution.

The IV results are given in Tables 7-8. Estimation is by GMM with White-corrected standard errors. The J-statistics are typically insignificant, implying that the overidentifying restrictions tests are not rejected.[23] At a qualitative level, the results are broadly similar to those in Tables 4-5. Given our focus, we note that magnitude of the coefficient estimates for *Extfin* is increased for the developing country subsample in columns (3) - (6).[24] The results in Table 8 are of particular interest. Comparing columns (3) with (4), we find that for IND countries, exchange rate volatility is determined by conventional OCA variables alone. But for DEV countries, both *Finance* and *Extfin* play a critical role in explaining exchange rate volatility, in addition to the OCA variables

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[22] When there is a single endogenous regressor, instrument relevance can be shown by reporting the R2 or F-test for the first-stage regression. For each of our candidate endogenous regressors, these first-stage regressions have quite strong explanatory power.

[23] The only exception is for the IND country sample in column (2) of Table 8. Our primary focus is on the DEV subsamples.

[24] That the IV result for EXTFIN is stronger than the OLS estimate is indeed consistent with a reverse causality channel running from the level of exchange rate volatility to the degree of international asset trade. A similar point applies for the increased coefficient estimate for TRADE.

Trade and *Size*. Again, as suggested by the theory, volatility is negatively significantly negatively related to *Extfin.*

Overall, the results support the contention that both financial factors and OCA variable play a role in determining bilateral exchange rate volatility. Moreover, financial dependence matters for the emerging market economies but not for the rich economies that have stronger balance sheets and are able to issue debt in domestic currency.

Section 5. Conclusions

Rather than repeating our results, here we emphasize some of the outstanding questions raised by our analysis. We have stressed some of the limitations of the empirical results arising from the lack of data. For instance, as emphasized in footnotes 8 and 10, we must attribute at least part of observed bilateral exchange rate volatility to policy decisions. In addition, we must remain concerned about endogeneity in explanatory variables. In future work, it would be useful to further investigate the link between international financial linkages and exchange rate behavior. In this regard, examining the role of finance in determining exchange rate regime decisions (de jure and de facto) and considering alternative measures of volatility would be interesting. Data permitting, it would also be desirable to examine volatility over longer time spans, and to find better instruments for bilateral financial trade in order to minimize endogeneity concerns. Related to this point, the forthcoming publication of the second IMF Portfolio Survey will provide new financial data that may permit a panel estimation approach. Although our empirical results are preliminary, the findings so far suggest that economists may have to extend the list of variables important for understanding bilateral exchange rate volatility beyond those suggest by traditional optimal currency area theory.

Data Appendix

Nominal Exchange Rate Volatility: Standard deviation of the log first difference of the bilateral exchange rate over 1995.1-2000.9. Source: IMF's *International Financial Statistics* CD-ROM.

Trade: Ratio of bilateral exports and imports relative to host country j's GDP in 1997. Source: IMF's *Direction of Trade Statistics* CD-ROM.

Cycle: Standard deviation of $GROWTH_{it} - GROWTH_{jt}$, where output growth is the log first difference of GDP (in PPP terms) over 1990-1998. Source: World Bank's *World Development Indicators* CD-ROM.

Size: $Log(GDP_i * GDP_j)$ in constant US dollars in 1995. Source: World Bank's *World Development Indicators* CD-ROM.

Finance: Ratio of liquid liabilities to GDP in host country j in 1995. Source: Beck, and Levine (2001) dataset. Available online from World Bank website.

BISAD: Own-currency bank claims of country i on country j, in constant dollars over 1995.1 to 2000.4. Augmented by all-currency bank claims of the United Kingdom on country j. Expressed as a ratio to host country j's GDP. Source: Bank of International Settlements, by permission.

PD: Long-term debt securities of country j held by country i, at end 1997. Expressed as a ratio to host country j's GDP. Source: IMF's *Results of the 1997 Coordinated Portfolio Investment Survey*.

ALLD: Sum of BISAD and PD.

GDP per capita: GDP per capita, in PPP terms for 1995. Source: World Bank's *World Development Indicators* CD-ROM.

DIST: Log of bilateral distance. Source: http://www.haas.berkeley.edu/~arose

COMLANG: Common language dummy. Source: http://www.haas.berkeley.edu/~arose, augmented by CIA World Factbook.

COLONIAL: Dummy for colonial relationship. Source: http://www.haas.berkeley.edu/~arose, augmented by CIA World Factbook.

RTA: Dummy for common membership of a regional trade agreement. Source: http://www.haas.berkeley.edu/~arose, augmented by data on WTO website.

References

Aghion, P., Bacchetta, P., Banerjee, A., 2001. Currency Crises and Monetary Policy in an Economy with Credit Constraints. European Economic Review 47, 1121-1150.

Alesina, A., Barro, R., 2002. Currency Unions. *Quarterly Journal of Economics*, forthcoming.

Bayoumi, T., Eichengreen, B., 1998. Exchange Rate Volatility and Intervention: Implications of the Theory of Optimum Currency Areas. Journal of International Economics 45, 191-209.

Benigno, P., 2000. Optimal Monetary Policy in a Currency Area. Mimeo, Federal Reserve Bank of New York.

Benigno, P., 2000. Optimal Monetary Policy in a Currency Area. Mimeo, Federal Reserve Bank of New York.

Bernanke, B., Gertler, M., Gilchrist, S., 1999. The Financial Accelerator in a Quantitative Business Cycle Model. in John Taylor and Michael Woodford, eds, *Handbook of Macroeconomics*, Volume 1c, Amsterdam: North Holland, 1341-1393.

Buch, C.M., 2001. Distance and International Banking. Kiel Institute of World Economics Working Paper No. 1043.

Caballero, R., Krishnamurty, A., 2001. A “Vertical” Analysis of Crises and Intervention: Fear of Floating and Ex-Ante Problems. NBER Discussion Paper 8428.

Calvo, G., Reinhart, C., 2002. Fear of Floating. Quarterly Journal, forthcoming.

______ 2000b. Fixing for your Life. NBER Discussion Paper 8006.

Cespedes, L.F., Chang, R., Velasco, A., 2000. Balance Sheets and Exchange Rate Policy. NBER Discussion Paper 7840.

Cespedes, L.F., Chang, R., Velasco, A., 2001b. Dollarization of Liabilities, Net Worth Effects and Optimal Monetary Policy. Mimeo, Harvard University.

Cook, D., 2000. Liability Dollarization and Stability Monetary Policy and Foreign Currency Debt. Mimeo, Hong Kong University of Science and Technology.

Devereux, M.B., Lane, P.R., 2001. Exchange Rates and Monetary Policy for Emerging Market Economies. CEPR Discussion Paper No. 2874.

Eichengreen, B., 2002. When to Dollarize. Journal of Money, Credit and Banking 34, 1-24.

Eichengreen, B., Hausmann, R., 1999. Exchange Rates and Financial Fragility. NBER Working Paper No. 7418.

Engel, C., Rose, A.K., 2000. Currency Unions and International Integration. NBER Working Paper No. 7872.

Frankel, J.A., Rose, A.K., 1996a. The Endogeneity of the Optimum Currency Area Criteria. NBER Working Paper No.5700.

Gertler, M., Gilchrist, S., Natalucci, F., 2001. External Constraints on Monetary Policy and The Financial Accelerator. Mimeo, New York University.

Ghosh, S., Wolf, H., 2001. Spatial Effects and Capital Flows, mimeo, IMF.

Hausmann, R., Panizza, U., Stein, E., 2001. Why Do Countries Float the Way They Float? Journal of Development Economics, XXX.

Honohan, P., Lane, P.R., 1999. Pegging to the Dollar and the Euro. International Finance 2, 379-410.

Honohan, P., Lane, P.R., 2000. Where Do the Irish Invest? Irish Banking Review, Autumn 2000, 12-23.

International Monetary Fund, 1999. Results of the 1997 Coordinated Portfolio Investment Survey. Washington DC.

Kawai, M., Liu, L.G., 2001. Determinants of International Commercial Bank Loans to Developing Countries. Mimeo, University of Tokyo and Asian Development Bank Institute.

Krugman, P., 1999. Balance Sheets, The Transfer Problem and Financial Crises. International Tax and Public Finance 6, 459-472.

Lane, P., 2001. The New Open Economy Macroeconomics: A Survey. Journal of International Economics 54, 235-266.

Larrain, F.B., Tavares, J., 2000. Regional Currencies versus Dollarization: Assessing the Options for Asia and the Americas. Mimeo, Universidade Nova.

Levy, Y., Sturzennegger, F., 2002. Classifying Exchange Rate Regimes: Deeds versus Words. Mimeo, Universidad Torcuato di Tella.

Meese, R., Rogoff, K., 1983. Empirical Exchange Rate Models of the Seventies: Do They Fit out of Sample. Journal of International Economics 14, 3-24.

Mundell, R.A., 1961. A Theory of Optimum Currency Areas. American Economic Review 51, 657-665.

Obstfeld, M., Rogoff, K., 1995. Exchange Rate Economics: Redux. Journal of Political Economy, 103, 624-60.

--------------, 2000. New Directions for Stochastic Open Economy Model. Journal of International Economics, 50, 117-53.

Poirson, H., 2001. How Do Countries Choose Their Exchange Rate Regime?. International Monetary Fund Working Paper WP/01/46.

Portes, R., Rey, H., 2001. Cross-Border Equity Flows. Mimeo, London Business School and Princeton University.

Reinhart, C., Rogoff, K., 2002. The Modern History of Exchange Rate Arrangements. Mimeo, IMF.

Shea, J., 1997. Instrument Relevance in Multivariate Linear Models: A Simple Measure. Review of Economics and Statistics 79, 348-352.

Stock, J.H., Wright, J., Yogo, M., 2002. GMM, Weak Instruments and Weak Identification. Journal of Business and Economic Statistics, forthcoming.

Van Rijckeghem, C., Weder, B., 2001. Spillovers through Banking Centers: A Panel Data Analysis of Bank Flows. Mimeo, University of Mainz.

Woodford, M., 1999. Interest and Prices. Manuscript, Princeton University, Portes.

Figure 1 Optimal Exchange Rate Response

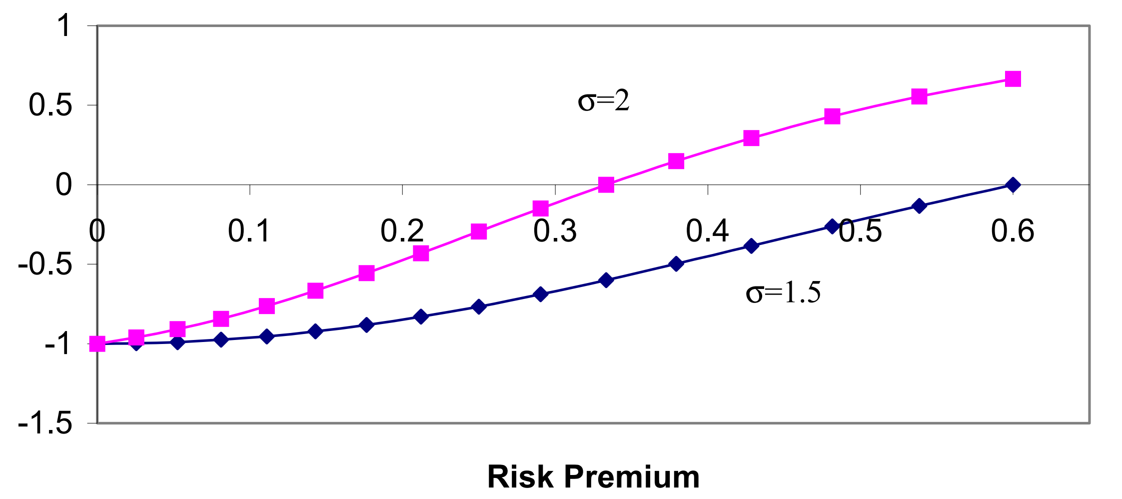

Table 1. Exchange Rate Volatility: Summary Statistics			
	FULL	IND	DEV
Mean	4.21	2.04	4.59
St. Dev	5.99	1.06	45.4
N	3026	442	2584

Exchange rate volatility is measured as the standard deviation of the log first difference of the bilateral exchange rate over 1995.1-2000.9. The IND countries are the OECD members: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Switzerland, Sweden, United Kingdom, United States. Source: IMF's *International Financial Statistics* CD-ROM.

Table 2. List of Creditor Countries
United States, United Kingdom, Japan, France, Germany, Austria, Belgium, Ireland, Italy, Netherlands, Spain, Sweden, Switzerland, Finland, Hong Kong
Portfolio debt data missing for Germany, Hong Kong.

Table 3. List of Debtor Countries

DEBTOR COUNTRIES

UNITED STATES	SPAIN	URUGUAY	SAUDI ARABIA
UNITED KINGDOM	TURKEY	VENEZUELA	SYRIA
AUSTRIA	AUSTRALIA	BARBADOS	UAE
DENMARK	NEW ZEALAND	DOMINICA	EGYPT
FRANCE	SOUTH AFRICA	GRENADA	AFGHANISTAN
GERMANY	BOLIVIA	GUYANA	BANGLADESH
SAN MARINO	BRAZIL	BELIZE	BHUTAN
ITALY	CHILE	JAMAICA	BRUNEI DAR.
NETHERLANDS	COLOMBIA	ST. LUCIA	MYANMAR
NORWAY	COSTA RICA	ST. VINCENT	CAMBODIA
SWEDEN	DOMINICAN REP.	SURINAME	SRI LANKA
SWITZERLAND	ECUADOR	TRIN.&TOBAGO	TAIWAN
CANADA	EL SALVADOR	CYPRUS	INDIA
JAPAN	GUATEMALA	IRAN	INDONESIA
FINLAND	HAITI	IRAQ	KOREA
GREECE	HONDURAS	ISRAEL	LAOS
ICELAND	MEXICO	JORDAN	MALAYSIA
IRELAND	NICARAGUA	KUWAIT	MALDIVES
MALTA	PARAGUAY	OMAN	NEPAL
PORTUGAL	PERU	QATAR	PAKISTAN

PHILIPPINES	GHANA	SIERRA LEONE	TAJIKISTAN
THAILAND	GUINEA-BISSAU	SUDAN	CHINA
VIETNAM	GUINEA	SWAZILAND	TURKMENISTAN
DJIBOUTI	COTE D IVOIRE	TANZANIA	UKRAINE
ALGERIA	KENYA	TOGO	UZBEKISTAN
ANGOLA	LESOTHO	TUNISIA	CZECH REPUBLIC
BOTSWANA	LIBYA	UGANDA	SLOVAK REPUBLI
BURUNDI	MADAGASCAR	BURKINA FASO	ESTONIA
CAMEROON	MALI	ZAMBIA	LATVIA
CAPE VERDE	MAURITANIA	SOLOMON ISL	HUNGARY
CENT. AFR. REP.	MAURITIUS	FIJI	LITHUANIA
CHAD	MOROCCO	KIRIBATI	MONGOLIA
COMOROS	MOZAMBIQUE	PAPUA NG	CROATIA
CONGO, REP.	NIGER	ARMENIA	SLOVENIA
CONGO, DEM. REP	NIGERIA	ALBANIA	MACEDONIA
BENIN	ZIMBABWE	GEORGIA	BOSNIA&HERZ.
EQ. GUINEA	RWANDA	KAZAKHSTAN	POLAND
ETHIOPIA	SAO TOME	KYRGYZ REPUBLIC	ROMANIA
GABON	SEYCHELLES	BULGARIA	
GAMBIA, THE	SENEGAL	RUSSIA	

Table 4. Volatility Regressions I. OLS Estimation.

	(1)	(2)	(3)	(4)	(5)	(6)
C	-0.1 (5.7)***	-0.12 (4.6)***	-0.14 (6.4)***	-0.14 (3.11)***	-0.15 (2.97)***	-0.18 (3.1)***
Trade	-0.2 (4.04)***	-0.22 (4.14)***	-0.2 (3.74)***	-0.22 (1.36)	-0.3 (1.52)	-0.38 (1.83)*
Cycle	-0.05 (2.33)**	0.49 (5.41)***	-0.09 (4.1)***	-0.09 (1.99)**	-0.11 (2.23)**	-0.15 (2.84)***
Size	0.41 (9.9)***	0.27 (7.8)***	0.45 (9.45)***	0.44 (4.11)***	0.48 (4.17)***	0.55 (3.93)***
Finance	-0.018 (6.39)***	0.004 (2.7)***	-0.026 (6.11)***	-0.034 (3.52)***	-0.038 (3.48)***	-0.004 (3.1)***
Extfin	-0.26 (3.16)***	0.14 (2.25)**	-0.37 (3.43)***	-0.4 (3.02)***	-0.44 (3.07)***	-0.42 (2.88)***
Extfin *Finance	0.24 (2.24)**	-0.1 (1.42)	0.5 (2.64)***	0.63 (2.73)***	0.76 (2.97)***	0.77 (2.84)***
GDP per capita	-0.85 (7.73)***	-0.35 (1.29)	-0.53 (4.01)***	-0.45 (1.71)*	-0.64 (1.92)*	-0.67 (1.82)*
R2	0.15	0.43	0.14	0.15	0.16	0.17
N	1087	198	889	250	209	186

Note: EXTFIN=ALLD. OLS estimation, with White-corrected standard errors. t-statistics in parentheses. Full sample in column (1); Rich country sample in column (2); Developing country sample in columns (3)-(6). Only observations vis-à-vis the major currencies (US, UK, Japan, France, Germany) included in columns (4)-(6);observations with EXTFIN=0 further excluded in columns (5)-(6); observations with mean depreciation rates above 3 percent further excluded in column (6). ***, **, * denote 1%, 5% and 10% levels of significance.

Table 5. Volatility Regressions II. OLS Estimation.

	(1)	(2)	(3)	(4)	(5)	(6)
C	-0.1 (6.5)***	-0.09 (3.5)***	-0.14 (7.3)***	-0.15 (4.7)***	-0.17 (4.5)***	-0.19 (4.5)***
Trade	-0.23 (5.3)***	-0.22 (5.3)***	-0.22 (4.6)***	-0.21 (1.8)*	-0.24 (1.8)*	-0.29 (2.1)**
Cycle	-0.04 (2.42)***	0.37 (5.7)***	-0.08 (4.4)***	-0.04 (1.4)	-0.03 (1.0)	-0.04 (1.2)
Size	0.39 (11.4)***	0.25 (7.9)***	0.45 (10.9)***	0.46 (6.0)***	0.53 (5.8)***	0.58 (5.6)***
Finance	-0.017 (7.3)***	0.003 (2.4)**	-0.024 (7.1)***	-0.025 (4.2)***	-0.029 (4.2)***	-0.028 (3.9)***
Extfin	-0.18 (3.0)***	0.035 (1.3)	-0.26 (3.1)***	-0.26 (2.8)***	-0.28 (2.8)***	-0.27 (2.7)***
Extfin *Finance	0.2 (3.3)***	0.5 (0.2)	0.32 (3.0)***	0.31 (2.85)***	0.39 (2.8)***	0.4 (2.7)***
GDP per capita	-0.86 (9.2)***	-0.41 (1.8)*	-0.58 (5.2)***	-0.55 (2.7)***	-0.75 (3.1)***	-0.82 (3.1)***
R2	0.14	0.36	0.13	0.13	0.14	0.15
N	1560	279	1281	443	377	349

Note: EXTFIN=BISAD. OLS estimation, with White-corrected standard errors. t-statistics in parentheses. Full sample in column (1); Rich country sample in column (2); Developing country sample in columns (3)-(6). Only observations vis-à-vis the major currencies (US, UK, Japan, France, Germany) included in columns (4)-(6);observations with EXTFIN=0 further excluded in columns (5)-(6); observations with mean depreciation rates above 3 percent further excluded in column (6). ***, **, * denote 1%, 5% and 10% levels of significance.

Table 6. Relevance of the Instrumental Variables

		(1)	(2)	(3)	(4)
		TRADE	CYCLE	EXTFIN	EXTFIN*FIN
ALLDY,FULL	Partial R2	0.29	0.06	0.06	0.05
	F-statistic	364.2	56.1	45.6	55.5
ALLDY,DEV	Partial R2	0.32	0.03	0.12	0.13
	F-statistic	340.4	97.5	104.7	19.0
BISADY,FULL	Partial R2	0.11	0.02	0.02	0.01
	F-statistic	165.1	24.9	11.2	29.9
BISADY,DEV	Partial R2	0.24	0.02	0.03	0.02
	F-statistic	219.0	32.9	20.0	17.3

Note: Following Shea (1997), we regress each regressor X_1 on the instrument vector Z. We calculate $\hat{X}_1$ as the fitted value. We also regress each X_1 on the other regressors X, to form the residual $\tilde{X}_1$. We next regress $\hat{X}_1$ on $\hat{X}$, where $\hat{X}$ are the fitted values for the other regressors, to form the residual $\overline{X}_1$. We report the partial R2 from a regression of $\tilde{X}_1$ on $\overline{X}_1$ and an F-test for the significance of $\overline{X}_1$ in explaining $\tilde{X}_1$.

Table 7. Volatility Regressions III. IV Estimation.

	(1)	(2)	(3)	(4)	(5)	(6)
C	-0.28 (6.5)***	-0.08 (1.0)	-0.33 (6.74)***	-0.18 (2.8)***	-0.16 (2.2)**	-0.15 (1.63)
Trade	-0.27 (2.1)**	-0.49 (1.3)	-0.49 (3.49)***	-0.38 (0.72)	-0.39 (0.62)	-0.64 (0.9)
Cycle	0.81 (4.6)***	-0.1 (0.2)	0.63 (2.45)**	0.23 (0.85)	0.116 (0.29)	-0.39 (0.51)
Size	0.63 (9.2)***	0.17 (0.91)	0.74 (8.72)***	0.44 (3.39)***	0.46 (3.26)***	0.48 (2.88)***
Finance	-0.031 (3.92)***	0.04 (2.1)**	-0.039 (4.12)***	-0.059 (2.99)***	-0.071 (2.9)***	-0.083 (2.48)**
Extfin	-1.9 (3.41)***	4.1 (2.45)**	-2.0 (3.55)***	-1.16 (2.46)***	-1.39 (2.63)**	-1.39 (2.63)***
Extfin *Finance	2.91 (3.26)***	-5.12 (2.21)**	3.82 (3.1)***	2.05 (2.35)**	2.51 (2.43)**	2.66 (2.32)**
GDP per capita	-0.49 (2.56)**	-0.48 (0.78)	-0.58 (3.21)***	-0.07 (0.23)	-0.35 (0.81)	-0.34 (0.70)
J-statistic	8.83 (0.64)	7.57 (0.67)	5.44 (0.91)	8.44 (0.49)	9.86 (0.36)	9.02 (0.44)
N	901	194	707	222	186	164

Note: EXTFIN=ALLD. IV-GMM estimation, with White-corrected standard errors. t-statistics in parentheses. J-statistic is test of overidentifying restrictions (p-values in parentheses). Full sample in column (1); Rich country sample in column (2); Developing country sample in columns (3)-(6). Only observations vis-à-vis the major currencies (US, UK, Japan, France, Germany) included in columns (4)-(6);observations with EXTFIN=0 further excluded in columns (5)-(6); observations with mean depreciation rates above 3 percent further excluded in column (6). ***, **, * denote 1%, 5% and 10% levels of significance.

Table 8. Volatility Regressions III. IV Estimation.

	(1)	(2)	(3)	(4)	(5)	(6)
C	-0.24 (4.1)***	-0.17 (3.3)***	-0.29 (6.1)***	-0.2 (3.49)***	-0.2 (3.0)***	-0.21 (3.0)***
Trade	-0.23 (1.04)	-0.57 (1.9)*	-0.43 (2.0)**	-0.55 (1.72)*	-0.27 (0.71)	-0.36 (0.94)
Cycle	0.56 (2.55)**	0.93 (5.28)***	0.48 (1.6)	0.21 (0.86)	0.14 (0.44)	0.025 (0.07)
Size	0.6 (6.54)***	0.41 (5.48)***	0.7 (8.45)***	0.48 (4.18)***	0.58 (3.76)***	0.58 (3.4)***
Finance	-0.03 (2.44)**	-0.013 (1.58)	-0.048 (3.66)***	-0.051 (2.58)**	-0.072 (2.74)***	-0.066 (2.13)**
Extfin	-2.03 (2.51)**	-0.13 (0.25)	-2.49 (3.06)***	-1.03 (1.76)*	-1.67 (2.35)**	-1.48 (1.99)**
Extfin *Finance	2.83 (1.7)*	0.81 (0.89)	4.63 (2.19)**	1.55 (1.51)	2.44 (1.89)*	2.07 (1.52)
GDP per capita	-0.61 (4.22)***	-0.82 (1.76)*	-0.68 (4.12)***	-0.27 (1.01)	-0.55 (1.52)	-0.50 (1.29)
J-statistic	15.85 (0.15)	26.4 (0.003)	15.69 (0.153)	14.28 (0.161)	13.86 (0.18)	15.76 (0.11)
N	1321	275	1046	386	330	303

Note: EXTFIN=BISAD. IV-GMM estimation, with White-corrected standard errors. t-statistics in parentheses. J-statistic is test of overidentifying restrictions (p-values in parentheses). Full sample in column (1); Rich country sample in column (2); Developing country sample in columns (3)-(6). Only observations vis-à-vis the major currencies (US, UK, Japan, France, Germany) included in columns (4)-(6);observations with EXTFIN=0 further excluded in columns (5)-(6); observations with mean depreciation rates above 3 percent further excluded in column (6). ***, **, * denote 1%, 5% and 10% levels of significance.