UNITED NATIONS CONFERENCE ON TRADE AND DEVELOPMENT

UNITED NATIONS

CENTER FOR
INTERNATIONAL
DEVELOPMENT
HARVARD UNIVERSITY

G-24 Discussion Paper Series

The Impact of G-3 Exchange Rate Volatility on Developing Countries

Gerardo Esquivel and Felipe Larraín B.

No. 16, January 2002

UNITED NATIONS CONFERENCE ON
TRADE AND DEVELOPMENT

CENTER FOR INTERNATIONAL DEVELOPMENT
HARVARD UNIVERSITY

G-24 Discussion Paper Series

Research papers for the Intergovernmental Group of Twenty-Four on International Monetary Affairs

UNITED NATIONS
New York and Geneva, January 2002

Note

Symbols of United Nations documents are composed of capital letters combined with figures. Mention of such a symbol indicates a reference to a United Nations document.

*

* *

The views expressed in this Series are those of the authors and do not necessarily reflect the views of the UNCTAD secretariat. The designations employed and the presentation of the material do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries.

*

* *

Material in this publication may be freely quoted; acknowledgement, however, is requested (including reference to the document number). It would be appreciated if a copy of the publication containing the quotation were sent to the Editorial Assistant, Macroeconomic and Development Policies Branch, Division on Globalization and Development Strategies, UNCTAD, Palais des Nations, CH-1211 Geneva 10.

UNCTAD/GDS/MDPB/G24/16

UNITED NATIONS PUBLICATION

Copyright © United Nations, 2002
All rights reserved

PREFACE

The *G-24 Discussion Paper Series* is a collection of research papers prepared under the UNCTAD Project of Technical Support to the Intergovernmental Group of Twenty-Four on International Monetary Affairs (G-24). The G-24 was established in 1971 with a view to increasing the analytical capacity and the negotiating strength of the developing countries in discussions and negotiations in the international financial institutions. The G-24 is the only formal developing-country grouping within the IMF and the World Bank. Its meetings are open to all developing countries.

The G-24 Project, which is administered by UNCTAD's Macroeconomic and Development Policies Branch, aims at enhancing the understanding of policy makers in developing countries of the complex issues in the international monetary and financial system, and at raising awareness outside developing countries of the need to introduce a development dimension into the discussion of international financial and institutional reform.

The research carried out under the project is coordinated by Professor Dani Rodrik, John F. Kennedy School of Government, Harvard University. The research papers are discussed among experts and policy makers at the meetings of the G-24 Technical Group, and provide inputs to the meetings of the G-24 Ministers and Deputies in their preparations for negotiations and discussions in the framework of the IMF's International Monetary and Financial Committee (formerly Interim Committee) and the Joint IMF/IBRD Development Committee, as well as in other forums. Previously, the research papers for the G-24 were published by UNCTAD in the collection *International Monetary and Financial Issues for the 1990s.* Between 1992 and 1999 more than 80 papers were published in 11 volumes of this collection, covering a wide range of monetary and financial issues of major interest to developing countries. Since the beginning of 2000 the studies are published jointly by UNCTAD and the Center for International Development at Harvard University in the *G-24 Discussion Paper Series*.

The Project of Technical Support to the G-24 receives generous financial support from the International Development Research Centre of Canada and the Governments of Denmark and the Netherlands, as well as contributions from the countries participating in the meetings of the G-24.

THE IMPACT OF G-3 EXCHANGE RATE VOLATILITY ON DEVELOPING COUNTRIES

Gerardo Esquivel and Felipe Larraín B.

El Colegio de México

Pontificia Universidad Católica de Chile
and Harvard University

G-24 Discussion Paper No. 16

January 2002

Abstract

This paper describes G-3 exchange rate volatility and evaluates its impact on developing countries. The paper presents empirical evidence showing that G-3 exchange rate volatility has a robust and significantly negative impact on developing countries' exports. A one percentage point increase in G-3 exchange rate volatility decreases real exports of developing countries by about 2 per cent, on average. G-3 exchange rate volatility also appears to have a negative influence on foreign direct investment to certain regions, and increases the probability of occurrence of exchange rate crises in developing countries. These results imply that greater stability in the international exchange rate system would help improve trade and foreign direct investment prospects for developing countries – and would help prevent currency crises.

Table of contents

Preface ..... *iii*

Abstract ..... *vii*

I. Introduction 1

II. Likely impacts of G-3 currency volatility in developing countries 2

A. Trade flows 2
B. Foreign direct investment 3
C. Currency crises 3
D. Debt servicing costs 3

III. G-3 currency volatility 4

A. G-3 exchange rates: stylized facts 4
B. Measure of volatility 4
C. Interest rate volatility versus exchange rate volatility 5
D. G-3 exchange rate changes and multilateral real exchange rates 7

IV. Impact of G-3 currency volatility on trade 10

V. Impact of G-3 currency volatility on foreign direct investment 11

VI. Impact of G-3 currency volatility on currency crises 16

A. Definition of crisis 16
B. Estimation methodology 16
C. Empirical results 16

VII. Conclusions 18

Notes 18

References 19

THE IMPACT OF G-3 EXCHANGE RATE VOLATILITY ON DEVELOPING COUNTRIES

Gerardo Esquivel and Felipe Larraín B.*

I. Introduction

There is a widespread presumption that volatility on the exchange rates of developed countries is one of the main sources of economic instability around the world. For example, an influential group of people which includes, among others, Paul Volcker and George Soros, has recently stated that "… the impact of the global economy on emerging countries is driven significantly by swings among the currencies of the three major economic powers. In recent years these swings have been enormous, volatile and frequently unrelated to underlying economic fundamentals. … The current G-3 authorities intervene on a totally ad hoc and episodic basis, without any clear sense of a sustainable equilibrium. Such intervention typically comes too late to prevent severe currency misalignments. These imbalances, in turn, trigger major economic distortions, protectionist trade pressures, and inevitably sharp currency reversals that generate a second round of large costs." (Allaire et al., 1999).

These criticisms are not new. In fact, the exchange rate arrangement that emerged after the collapse of Bretton-Woods has always been criticized on the grounds that it does not have a mechanism to reduce or regulate excessive exchange rate fluctuations among the major currencies.[1] More recently, it has also been argued that G-3 currency instability[2] may have been at the root of some of the currency and financial crises that have affected several developing countries. A prominent example in this regard is the Asian crisis of 1997 which, for many authors, was partly due to the strong appreciation of the dollar vis-à-vis the yen that took place between mid-1995 and 1998.[3]

As a consequence, there is renewed interest on the debate about whether more stable relationships amongst the G-3 currencies can bring about greater stability to the world economy, in general, and to the

* A previous version of this paper was presented at the G-24 Technical Group Meeting in Washington, DC, 17–18 April 2001. The authors would like to thank the very useful comments of Dani Rodrik and other participants at that meeting, and the excellent research assistance of Francisco Arias, Alejandra Huerta and Pedro Martínez.

developing economies, in particular.[4] Of course, the debate on this issue crucially depends on the nature and magnitude of the impact of G-3 exchange rate volatility on the world economy. Unfortunately, there are no currently available estimates on any of the effects that G-3 exchange rate volatility may have on other economies. This paper will attempt to shed light on this issue by providing the first empirical estimates on the impact of G-3 currency volatility on developing countries.

There is, indeed, a substantial amount of research about the effects of volatility of a country's own real exchange on certain macroeconomic variables. Caballero and Corbo (1989), for example, show that higher volatility of the real exchange rate hurt exports in a large group of developing countries. Many other authors have also attempted to investigate whether exchange rate variability depresses trade flows in different periods and for different countries. This literature has been surveyed by McKenzie (1999), who concludes that empirical results on this matter have so far been inconclusive. Recent and stronger evidence of a negative impact of exchange rate volatility on trade flows can be found in Arize et al. (2000) and Dell'Ariccia (1999).

On the other hand, Larraín and Vergara (1993) show that real exchange rate volatility (measured by its coefficient of variation) hurt the rate of private investment in emerging Asia. Similarly, Dupont and Juan-Ramón (1996) explore the relationship between real exchange-rate variability and commodity prices. They found that the dollar price of a small number of commodities is affected by the parities between the deutsche mark and the dollar and between the yen and the dollar.

In spite of the abundant literature on the effects of exchange rate volatility on macroeconomic variables, there is not a single paper that had attempted to identify the role of third-country exchange rate volatility on domestic macroeconomic variables. This paper attempts to fill this gap by exploring the effects of G-3 currency volatility on developing countries. It begins by discussing the alternative channels through which volatility in the major currencies may exert a negative influence on developing economies. It then describes the stylized facts about G-3 currency volatility since 1973. The next sections present preliminary evidence on the impact of G-3 currency volatility on trade flows, foreign direct investment and on the probability of occurrence of exchange rate crises in developing countries since 1975. The final section presents the authors' conclusions.

II. Likely impacts of G-3 currency volatility in developing countries

There are several channels through which G-3 currency instability may affect developing countries. Some of the variables often mentioned as being influenced by this volatility are: trade flows; foreign direct investment; currency crises; debt servicing costs; portfolio composition; and commodity prices.

Of course, the specific channels and reasons behind each one of these effects may differ across variables. However, the standard argument on the likely impact of G-3 currency instability on developing countries goes as follows: given that most of the international economic transactions take place in dollars, yens or euros, exchange rate instability and/or exchange rate uncertainty among these three currencies, if combined with risk-averse agents, may lead to increased instability in international economic transactions. This, in turn, may provoke distortions, uncertainty and economic fluctuations worldwide which may negatively affect the developing world.

Each of the main channels that have been identified in this discussion is reviewed in greater detail below.

A. Trade flows

The relationship between exchange rate volatility and trade is well established. The basic idea is the following: if commodity traders are risk averse (or even risk neutral), higher exchange rate uncertainty may lead to a reduction in the volume of trade because they may not want to risk their expected profits from trade (Brodsky, 1984). As long as there is uncertainty, economic agents will demand a higher price to cover their exposure to currency risk, and this, in turn, will decrease the volume of trade. Now, since most of the international transactions take place in some of the G-3 currencies, increased exchange rate uncertainty among them may have an effect which is equivalent to a higher uncertainty on the bilateral exchange rate. Therefore, higher G-3 currency volatility may also lead to a lower volume of trade.

However, this is just the direct effect, and there may be other (perhaps more important) indirect effects of G-3 exchange rate volatility on trade. Suppose a country chooses to peg its exchange rate to

one of the main world currencies. If there is instability among the G-3 exchange rates, rapid movements in the real exchange rate among these countries may have an indirect effect on the competitiveness of all the countries that are pegged (explicitly or implicitly) to one of the main currencies. Of course, the effect on trade of movements on G-3 parities depends on whether the anchor currency is appreciating or depreciating vis-à-vis the rest of the world.

B. Foreign direct investment

G-3 currency volatility may also affect developing countries through its effects on foreign direct investment inflows.[5] Two channels have been identified here. To start with, greater exchange rate volatility increases uncertainty over the return of a given investment. Potential investors will invest in a foreign location only as long as the expected returns are high enough to cover for the currency risk. Thus, foreign direct investment will be lower under higher exchange rate volatility.

The second channel works as follows: changes in the bilateral real exchange rates of the major currencies will have an immediate impact on the real wealth of the G-3 countries. Since G-3 countries are among the main sources of FDI, changes in their bilateral real exchange rate affect their real wealth, and this may have a direct impact on the amount and direction of foreign direct investment. This effect, however, is ambiguous. It may increase or decrease foreign direct investment depending on which currencies are appreciating or depreciating. The final effect will also depend on the relevance of FDI on the source countries and on the wealth elasticity of FDI on the different source countries.

C. Currency crises

It has been argued recently that G-3 exchange rate instability may have contributed to the Asian crisis of 1997, mainly based on the observation that during the months that preceded the crises, the dollar had a large and relatively rapid appreciation vis-à-vis the deutsche mark and the yen (see charts 1 and 2). As a result, all the currencies that were then pegged to the dollar also appreciated with respect to the deutsche mark and the yen. This deteriorated the relative price competitiveness of these countries, thus contributing to a deterioration of their external accounts, and may have eventually led to the Asian currency crises.

However, the effects on developing countries are not unambiguous. Countries with exchange rates that were pegged to other currencies (i.e. the deutsche mark and the yen) experienced the opposite effects. In this sense, it is important to emphasize that some arguments against exchange rate volatility usually criticize not the volatility itself, but a continuous change of one currency in certain direction.

D. Debt servicing costs

One of the most important effects of G-3 exchange rate movements on developing countries refers to the external debt burden. Most developing economies are net debtors and, in consequence, changes in the G-3 exchange rates may affect the real cost of servicing their debts. A strong appreciation of the dollar, for example, implies a higher cost of servicing an external debt that is mainly thus denominated. Although this argument is correct, the impact of changes in the G-3 exchange rates on developing countries are not in a single direction. In the example used above, countries with higher share of debt denominated in the yen or the deutsche mark will have lower costs of debt servicing and their balance sheets will improve as a result of a strong appreciation of the dollar.[6]

Summarizing, G-3 exchange rate changes may affect developing countries in different ways depending on their debt denomination and on which of the major currencies they are more closely connected to. Most of these channels, however, are more related to the levels in the G-3 parities than to the volatility or uncertainty associated to them. Exceptions are the trade and foreign direct investment channels which suggest that G-3 real exchange rate volatility may indeed reduce both types of flows to developing countries.

In the following the stylized facts on G-3 exchange-rate volatility will be described, before it will be tested empirically whether these channels have indeed affected developing countries in the recent past, and whether G-3 exchange-rate volatility has had any influence on increasing the probability of currency crises in developing countries.

III. G-3 currency volatility

A. *G-3 exchange rates: stylized facts*

The 1973 collapse of the Bretton-Woods arrangement gave way to a period of floating exchange rates throughout the developed world. Chart 1 shows the historical nominal G-3 exchange rates since that year. The chart illustrates some of the most important swings that have occurred in the past decades amongst the G-3 exchange rates. It makes clear that both the deutsche mark and the yen have tended to appreciate vis-à-vis the dollar since 1973, and that the yen has appreciated with respect to the deutsche mark.

Some periods, though, show a moderate upward-sloping trend, that was soon reversed. To the naked eye, the longest rally in reverse was the appreciation of the dollar with respect to the deutsche mark between 1979 and 1985. This was followed, however, by a period of rapid decline in the dollar.

Chart 2 shows the historical bilateral real exchange rates (deflated by consumer prices) for each one of the G-3 currencies. Following Clarida (1999), the chart also shows a hypothetical PPP bilateral exchange rate, which assumes that real exchange rates were in equilibrium at the time of the Louvre Accord (February, 1987). A simple comparison between charts 1 and 2 confirms that most of the changes in the nominal exchange rates amongst the G-3 currencies have had, at least temporarily, real effects. This chart also shows that PPP estimates of the G-3 currencies suggest a continuous appreciation of the deutsche mark and the yen vis-à-vis the dollar. Similarly, the PPP estimates suggest a relatively stable relationship between the yen and the deutsche mark. The most striking result is that real bilateral exchange rates have departed substantially from the hypothetical PPP exchange rate, particularly during the seventies, mid-eighties and late nineties.

B. *Measure of volatility*

One of the most common measures of exchange rate volatility is the standard deviation of the growth rates of real exchange rates (V).[7] This measure is approximated by a time-varying measure defined as follows:

$$V_{t+m} = \left[\frac{1}{m} \sum_{i=1}^{m} (R_{t+i-1} - R_{t+i-2})^2 \right]^{1/2}$$

Chart 1

G-3 NOMINAL EXCHANGE RATE, JANUARY 1973 – DECEMBER 1998

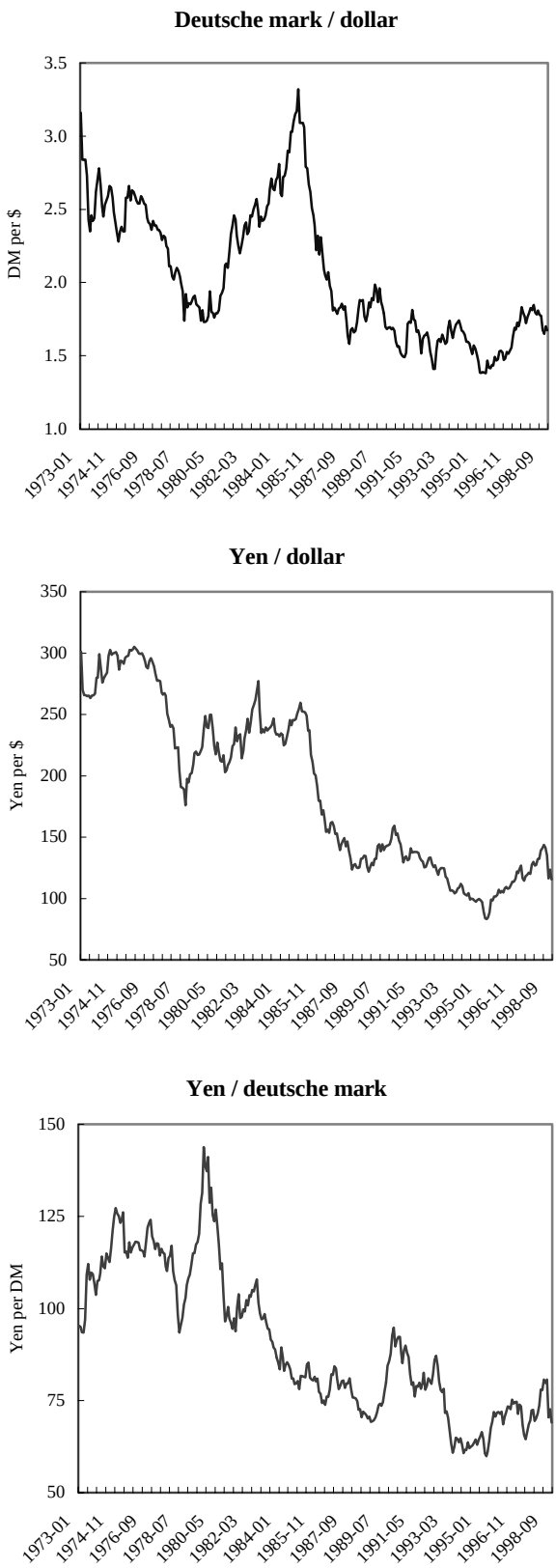
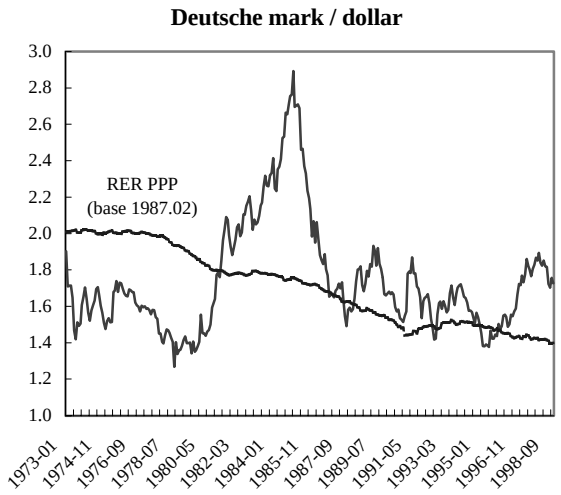
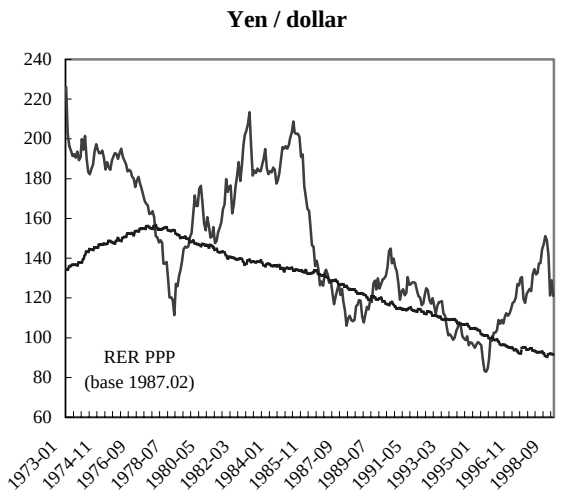


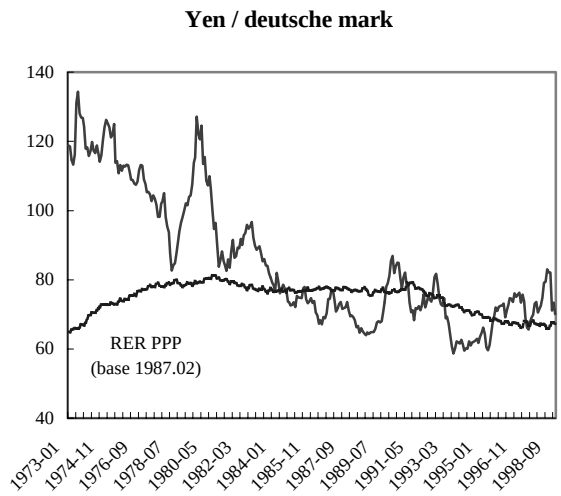
Chart 2

G-3 RELATIVE BILATERAL EXCHANGE RATES, JANUARY 1973 – DECEMBER 1998

(Exchange rate deflated by consumer prices)







where R is the natural log of the bilateral real exchange rate (ε) and m is the order of the moving average.[8]

An alternative measure of exchange rate volatility is defined as the time-varying twelve-month coefficient of variation (CV) of the real exchange rate (this is, in fact, a measure of dispersion of the real exchange rate).

$$CV_{t+m} = \frac{\left[\frac{1}{m}\sum_{i=1}^{m}(\varepsilon_{t+i-1} - \bar{\varepsilon})^2\right]^{1/2}}{\bar{\varepsilon}}$$

where $\bar{\varepsilon}$ is the mean of the bilateral real exchange rate between months t and $t+m-1$.

Charts 3 and 4 show both measures of volatility for the bilateral G-3 exchange rates. A simple comparison between the two measures of exchange rate volatility highlights the main differences between them. For example, while the CV measure indicates a large increase in the dispersion of the G-3 real exchange rates in 1981 and 1986 for the deutsche mark vis-à-vis the dollar; in 1976, 1986 and 1996 for the yen vis-à-vis the dollar, and in the late 1970s for the yen vis-à-vis the deutsche mark, the volatility measure (V) only suggests moderate increases in volatility in the late seventies for the three real exchange rates and in the late nineties for the rate of the yen vis-à-vis the dollar.

A simple inspection of charts 2–4, suggests that the standard measure of volatility (V) misrepresents what is taking place on the bilateral G-3 real exchange rates. It fails to identify periods of rapid but sustained change in the real exchange rate (as occurred, for example, with the deutsche mark against the dollar in 1986). On the other hand, the coefficient of variation measure is successful in capturing these events and, therefore, will be the measure of exchange rate volatility in what follows.[9]

C. Interest rate volatility versus exchange rate volatility

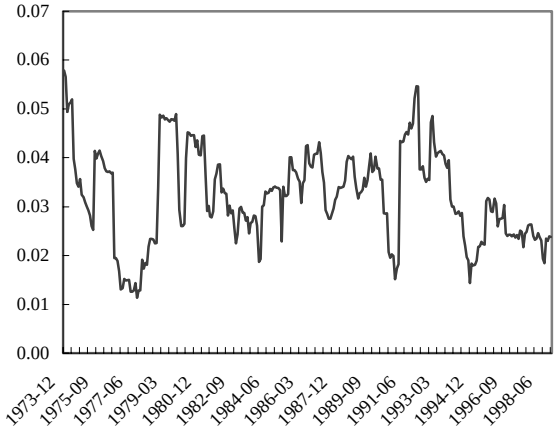
It has been pointed out that reducing G-3 exchange rate volatility may come at the cost of higher interest rate variability, which in turn may translate into higher variability on debt servicing costs for developing countries (Reinhart and Reinhart, 2000a). To investigate whether such a trade-off between in-

Chart 3

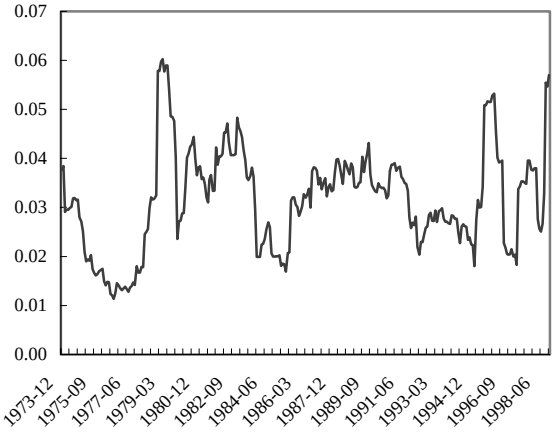
G-3 CURRENCY VOLATILITY: STANDARD DEVIATION

(December 1973 – December 1998)

Deutsche mark / dollar



Yen / dollar



Yen / deutsche mark

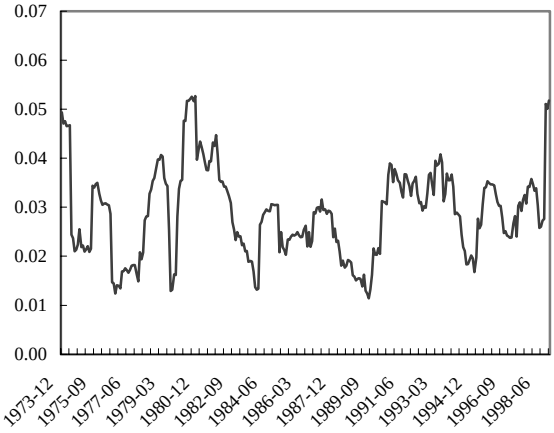
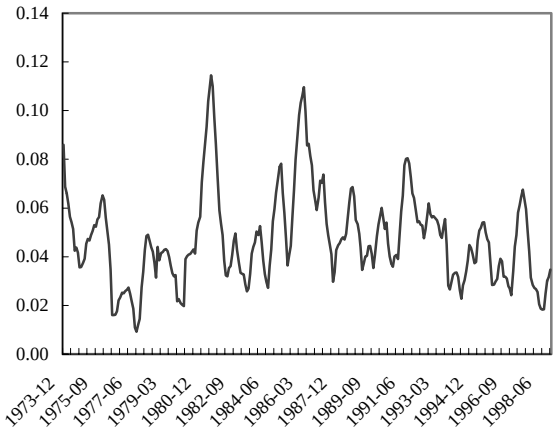


Chart 4

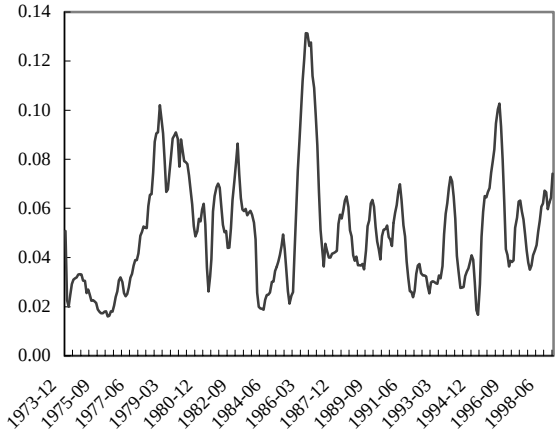
G-3 CURRENCY VOLATILITY: COEFFICIENT OF VARIATION

(December 1973 – December 1998)

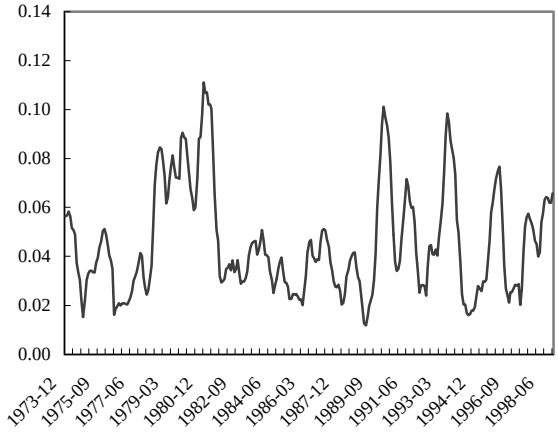
Deutsche mark / dollar



Yen / dollar



Yen / deutsche mark

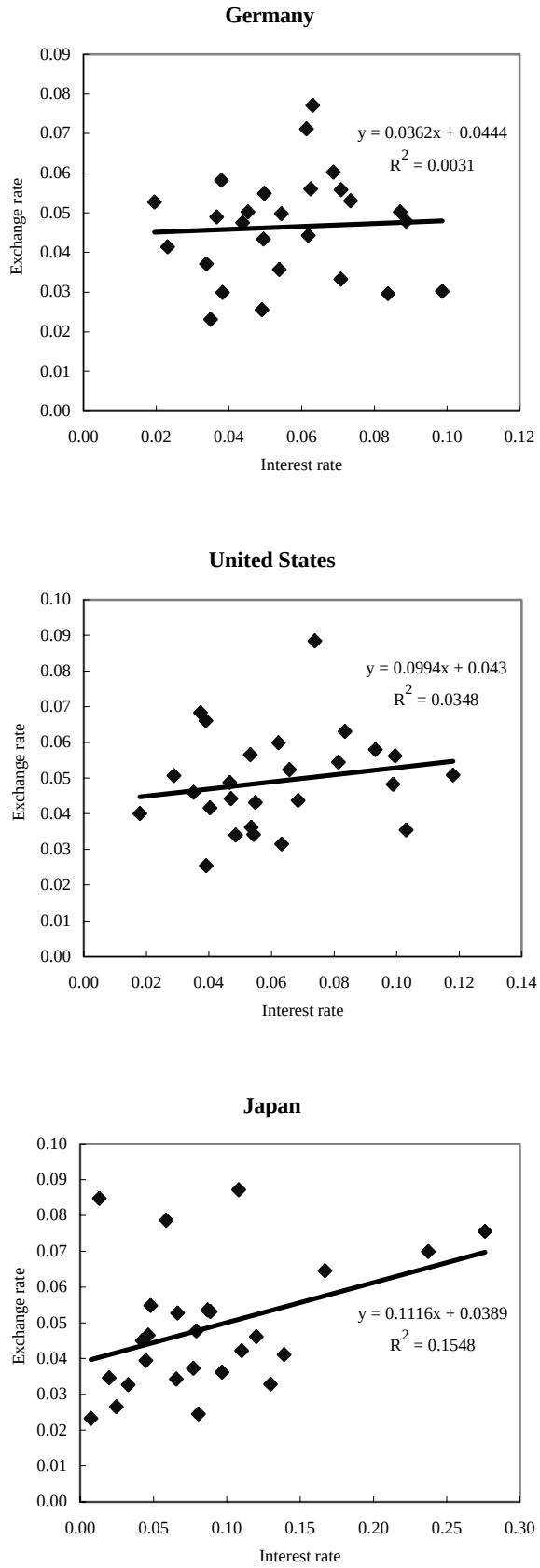


terest rate and exchange rate variability has occurred, annual versions of the CV for these two variables for the G-3 countries between 1973 and 1998 were computed.[10] This approach is undoubtedly simplistic and crude, but might provide an initial approximation to the issue. The results of this exercise are shown in chart 5. Each chart also shows an adjusted linear regression, its corresponding equation and the R^2 of the estimated equation.

The charts show that there is no apparent trade-off between interest rate and exchange rate variability for the G-3 countries. Instead, in Japan and the United States there exists evidence of a positive simple correlation between these two types of variability. Of course, the existence of a trade-off between these two indicators may be hidden as result of movements in other variables that influences any of them. However, it is not clear, based on this preliminary evidence, that lower exchange rate variability will bring about higher interest rate variability.

Chart 5

G-3 INTEREST RATE AND EXCHANGE RATE VARIABILITY



D. G-3 exchange rate changes and multilateral real exchange rates

In this section an attempt is made to identify the contribution of changes in G-3 exchange rates on the effective real exchange rates of developing countries, following Reinhart and Reinhart (2000b) in decomposing changes in the effective real exchange rate of a country into changes in the bilateral dollar exchange rate and all other dollar cross exchange rates.

Consider the following expression of an effective real exchange rate:

$$\varepsilon_t^i = \prod_{j=1}^{k} \left(s_t^{ij}\right)^{\sigma_i}$$

where ε_t^i is the effective real exchange rate, s_t^{ij} are the bilateral real exchange rates between country *i* and country *j*, and the σ_i's are weights.

Given that the σ_i's must add up to one, we can restate the previous equation as:

$$\varepsilon_t^i = \left(s_t^{iUS}\right) \cdot \prod_{j=1}^{k} \left(s_t^{ij} / s_t^{iUS} \right)^{\sigma_i}$$

where s_t^{iUS} is the bilateral real exchange rate of country *i* vis-à-vis the dollar.

Table 1

IMPACT OF G-3 EXCHANGE RATE CHANGES ON REAL EFFECTIVE EXCHANGE RATES, JANUARY 1980 – DECEMBER 1998

Country	*Bilateral real exchange rate*	*Deutsche mark /dollar*	*Yen/dollar*	*Adjusted R-squared*
Latin America and the Caribbean				
Argentina	0.489	-0.094	-0.076	0.635
	(19.87)*	(-0.866)	(-0.750)	
Bolivia	0.962	-0.693	0.046	0.786
	(28.85)*	(-2.340)**	(0.176)***	
Brazil	0.924	-0.154	-0.135	0.796
	(28.57)*	(-3.874)*	(-3.598)*	
Colombia	0.598	-0.328	-0.135	0.680
	(14.05)*	(-9.480)*	(-4.345)*	
Costa Rica	1.000	-0.229	-0.073	0.977
	(95.66)*	(-10.730)*	(-3.840)*	
Chile	0.998	-0.383	-0.119	0.886
	(38.76)*	(-12.629)*	(-4.336)*	
Dominica	0.552	-0.289	-0.082	0.613
	(10.29)*	(-10.253)*	(-3.243)*	
Ecuador	0.517	-0.189	-0.206	0.318
	(9.197)*	(-1.631)***	(-1.991)**	
Mexico	0.953	-0.118	-0.041	0.909
	(47.19)*	(-3.055)*	(-1.138)	
Paraguay	0.491	-0.310	0.075	0.514
	(15.09)*	(-3.217)*	(0.872)	
Peru	0.699	-0.188	-0.089	0.626
	(19.37)*	(-1.491)	(-0.744)	
Uruguay	0.774	-0.413	-0.112	0.800
	(27.56)*	(-6.417)*	(-1.937)***	
Venezuela	0.572	-0.245	-0.150	0.732
	(24.20)*	(-2.908)*	(-1.981)**	
Sub-Saharan Africa				
Côte d'Ivoire	0.992	-0.531	-0.092	0.963
	(74.56)*	(-18.063)*	(-3.887)*	
Gambia	0.939	-0.502	-0.103	0.943
	(61.51)*	(-16.711)*	(-3.965)*	
Nigeria	0.861	-0.574	-0.227	0.656
	(20.12)*	(-3.340)*	(-1.472)	
South Africa	0.975	-0.528	-0.144	0.979
	(102.3)*	(-36.239)*	(-11.34)*	
East Asia and the Pacific				
Fiji	0.836	-0.226	-0.179	0.832
	(33.36)*	(-8.668)*	(-7.501)*	
Indonesia	0.947	-0.138	-0.187	0.954
	(68.89)*	(-4.069)*	(-5.833)*	

/...

Table 1 (concluded)

IMPACT OF G-3 EXCHANGE RATE CHANGES ON REAL EFFECTIVE EXCHANGE RATES, JANUARY 1980 – DECEMBER 1998

Country	*Bilateral real exchange rate*	*Deutsche mark /dollar*	*Yen/dollar*	*Adjusted R-squared*
Philippines	0.774 (19.51)*	-0.140 (-3.296)*	-0.120 (-2.995)*	0.665
Samoa	0.718 (24.56)*	-0.264 (-7.612)*	-0.099 (-3.152)*	0.738
Republic of Korea	0.861 (32.00)*	-0.124 (-4.188)*	-0.168 (-5.987)*	0.827
Malaysia	0.842 (54.11)*	-0.248 (-16.044)*	-0.214 (-15.11)*	0.935
Thailand	0.725 (22.43)*	-0.107 (-3.187)*	-0.174 (-5.529)*	0.702
South Asia				
India	0.779 (16.08)*	-0.285 (-7.248)*	-0.063 (-1.708)***	0.595
Pakistan	0.808 (20.69)*	-0.420 (-16.688)*	-0.146 (-6.531)*	0.809
Middle East and North Africa				
Morocco	0.741 (22.21)*	-0.543 (-18.670)*	-0.045 (-2.470)**	0.704
Europe and Central Asia				
Turkey	0.619 (18.68)*	-0.175 (-3.630)*	-0.008 (-0.189)	0.609

Note: *, ** and *** indicate statistical significance at 1, 5 and 10 per cent level, respectively. Numbers in parentheses are t-statistics.

This expression can be log-differentiated to get:

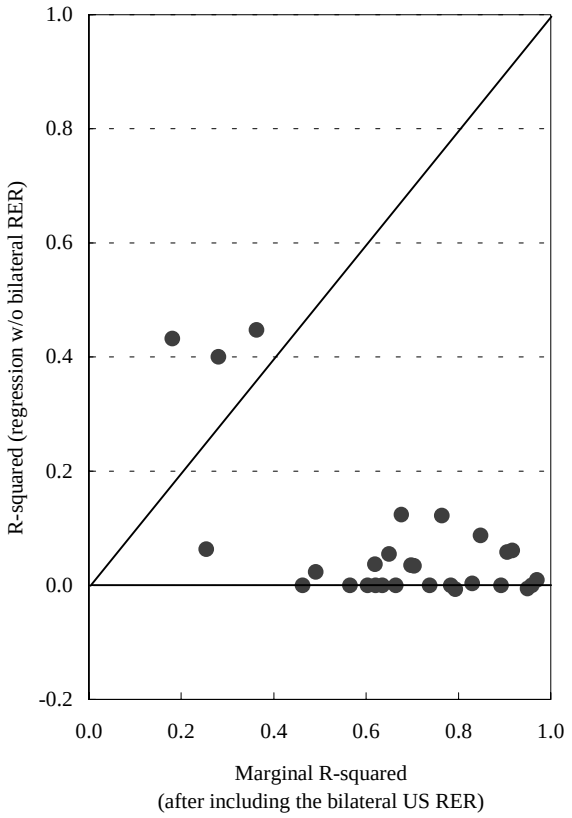
$$\Delta 1\text{n}\,(\varepsilon_t^i) = a_1 + a_2\,\Delta\,1\text{n}\,(s_t^{iUS}) + a_2\,\Delta\,1\text{n}\,(DM/\$) + a_3\,\Delta\,1\text{n}\,(Yen/\$) + \ldots$$

From this expression, the relative contribution of the changes in the G-3 exchange rates to the variability of the multilateral real exchange rate of any country can be separated out. This equation was then estimated for 28 developing countries using monthly log changes in the bilateral real exchange rates for the period 1980–1998.

Table 1 presents the results of these regressions. It shows the prominent role played by the bilateral dollar exchange rate in the determination of changes in the multilateral real exchange rate of all developing countries included in the table. In all the regressions, the coefficients associated to this variable are statistically significant at the 1 per cent level and they usually take values well above 0.5. This means that an important share of the variations in the bilateral real exchange rate translates into changes in the effective real exchange rate of developing countries. On the other hand, many of the coefficients on the G-3/dollar exchange rates are also significant but tend

Chart 6

CONTRIBUTION OF CHANGES IN G-3 EXCHANGE RATES TO MULTILATERAL REAL EXCHANGE RATES OF DEVELOPING COUNTRIES



to be much smaller in magnitude. As expected, most of the coefficients associated to these variables are negative, which means that, for example, when the yen appreciates with respect to the dollar, the domestic currency depreciates with respect to the world.

In order to analyse in more detail the contribution of G-3 exchange rate changes to the effective real exchange rate of developing countries, the following exercise was performed. First, a regression excluding the bilateral real exchange rate against the dollar was estimated. Then the R^2 of this regression was compared against the marginal increase in the R^2 that is obtained when the bilateral exchange rate was added. The objective of this exercise is to compare the explanatory power of the changes in the parities of the dollar vis-à-vis the yen and the deutsche mark against that of the changes in the dollar bilateral exchange rate. The results of this exercise are presented in chart 6. The chart shows quite convincingly that the single most important determinant of changes in the effective real exchange rate of most developing countries is the bilateral dollar real exchange rate.

In conclusion, results in table 1 and chart 6 show that changes in the exchange rates among the three major currencies tend to exert a relatively small influence on the effective real exchange rate of many developing countries.

IV. Impact of G-3 currency volatility on trade

In this section a first approximation on whether G-3 exchange-rate instability has a negative impact on trade flows of developing countries is provided. The basic question of whether a country's own exchange rate volatility has an effect on external trade has a long tradition in economics and there is a vast number of papers addressing the issue.[11] However, as far as is known by the authors, there are no previous empirical attempts to estimate the volatility of third-country exchange rates on the trade flows of developing countries.

As mentioned above, log changes in the multilateral real exchange rate of a given country can be partially explained by changes in both the bilateral real exchange rate vis-à-vis the dollar, and in the bilateral G-3 real exchange rates against the dollar. Therefore, it has to be estimated whether G-3 currency volatility has had a negative effect on the exports of developing countries.

In particular, the interest is in estimating an exports function of the form:

$$X = f \text{ (world demand, bilateral dollar real exchange rate, G-3 currency volatility)}$$

which, in linear form, can be expressed as:

$$\ln(X_t) = a + b \cdot \ln(GDP_w) + c \cdot RER_{US} + d \cdot VOL_{Yen/\$} + e \cdot VOL_{DM/\$} + \varepsilon_t$$

where X are real exports, GDP_w is the real world GDP, RER_{US} is the bilateral real exchange rate with respect to the dollar and the variables VOL are measures of exchange rate volatility.[12]

Tables 2 and 3 show the results obtained after estimating this regression for a group of forty developing countries. Each table uses a different measure of volatility and each regression is estimated using annual data for the 1973–1998 period. Only the coefficients associated to the volatility measures as well as the adjusted coefficients of determination for each regression are reported.

The tables show that several of the coefficients associated to G-3 volatility variables are negative and statistically significant. In particular, when the standard volatility measure (that is, the standard deviation of the log changes of the RER, or *V*), is used, it is found that in nine regressions at least one volatility coefficient is negatively significant. However, when the coefficient of variation is used as the measure of volatility (table 3), G-3 currency volatility reduces developing countries' exports in most cases (23 out of 40 countries). In a few cases an unexpected significant positive effect of volatility on exports was found.

In general, the empirical analysis indicates that higher volatility among the G-3 parities leads to lower exports of developing countries. This result is not only statistically significant but also economically important. On average, the estimated coefficients suggest that a one percentage point increase in the coefficient of variation of the deutsche mark/dollar real exchange rate reduces exports of developing countries in about 2 per cent. For the Asian countries, this effect is even higher (about 3 per cent on average). It is important to note that there have been years in which the coefficient of variation has risen by more than 4 percentage points, thus suggesting a very important negative effect on developing countries' exports in those periods.

V. Impact of G-3 currency volatility on foreign direct investment

As mentioned above, if potential foreign investors are risk averse (or even risk neutral), larger exchange rate volatility may reduce overall foreign direct investment inflows. This section tests whether G-3 exchange rate volatility has had a negative effect on foreign direct investment flows to developing countries.

Tables 4 and 5 show the results of this exercise with annual data for the period 1975–1998. Each table uses a different measure of exchange rate volatility. Also, each one has two panels: the upper part uses as dependent variable, the level of foreign direct investment as a percentage of gross domestic investment, whereas the lower part uses as a dependent variable, the level of FDI as a percentage of gross domestic product. In addition, each panel shows two types of estimates. The first estimates are obtained after controlling for the level of the world interest rate, which in this case is proxied by the United States interest rate, and they also include a trend variable. The second set of estimates only includes a trend variable and the G-3 volatility variables as independent variables.

Instead of running separate regression for each developing country, this section focuses on FDI flows to geographical regions. Accordingly, FDI variables represent regional averages. Table 4 shows the coefficients on the G-3 exchange rate volatilities when the standard measure of volatility (*V*) is used. Only a handful of coefficients are statistically significant and some of them have the wrong sign. The regression for the Middle East and North Africa is the only one that has a negatively significant coefficient. In general, results in this table suggest that G-3 exchange rate volatility has no discernible effect on foreign direct investment flows to developing countries.

Table 5 shows the results obtained when the coefficient of variation is used as a measure of exchange rate volatility. In this case, there is stronger empirical evidence suggesting that G-3 exchange rate volatility may have a negative effect on FDI flows to certain regions. The number of regions that are affected depends on the exact specification chosen (with or without controlling for changes in the United States interest rate) and on the dependent variable being analysed. For example, if FDI is seen as a percentage of gross domestic investment (upper panel), it may be concluded that G-3 currency volatility reduces FDI flows to either two or four regions depending on whether changes in the world interest rate are controlled for or not. In general, it seems that FDI flows to sub-Saharan Africa and to the East Asia and the Pacific are the ones more clearly affected by changes in the G-3 currency volatility. In contrast, FDI flows to the Middle East and Latin America do not seem to be influenced by changes in G-3 currency volatility. The empirical evidence on FDI flows to Eastern Europe and South Asia is mixed. As in the trade regressions, the volatility of the deutsche mark/dollar parity is the G-3 volatility variable that seems to be more significant in this analysis.

Table 2

IMPACT OF G-3 CURRENCY VOLATILITY ON DEVELOPING COUNTRIES' EXPORTS

Measure of volatility: standard deviation of RER growth rates (V)

Country	*Deutsche mark/dollar*	*Yen/dollar*	*Adjusted R-squared*
Africa			
Cameroon	12.357	-2.325	0.57
	(1.884)***	(-0.432)	
Egypt	-0.939	-1.165	0.95
	(-0.544)	(-0.768)	
Gambia	0.527	-2.382	0.52
	(0.151)	(-0.765)	
Ghana	-8.437	9.472	0.42
	(-1.393)	(1.667)***	
Kenya	-1.589	-2.290	0.79
	(-0.571)	(-0.818)	
Madagascar	-0.718	0.146	-0.2
	(-0.166)	(0.038)	
Morocco	-2.413	-1.265	0.89
	(-1.117)	(-0.654)	
Nepal	**-7.615**	6.552	0.90
	(-1.931)***	(1.801)***	
Nigeria	-0.038	-0.766	0.08
	(-0.007)	(-0.166)	
Niger	-2.602	6.697	0.68
	(-0.911)	(2.787)*	
Rwanda	9.458	-7.038	0.49
	(1.568)	(-1.270)	
Senegal	**-5.556**	-2.766	0.63
	(-2.416)**	(-1.492)	
South Africa	-2.721	1.719	0.81
	(-1.544)	(1.116)	
Togo	5.225	8.698	0.46
	(1.767)***	(3.383)*	
Asia			
Philippines	-1.995	1.681	0.95
	(-0.915)	(0.885)	
India	**-4.950**	3.885	0.95
	(-2.015)**	(1.714)***	
Indonesia	-3.686	0.552	0.71
	(-0.868)	(0.143)	
Rep. of Korea	**-3.978**	2.439	0.98
	(-2.163)**	(1.498)	
Malaysia	**-4.367**	-1.036	0.97
	(-1.748)***	(-0.463)	
Pakistan	3.690	**-4.932**	0.95
	(1.384)	(-1.945)***	
Thailand	-1.384	-0.494	0.98
	(-0.602)	(-0.239)	

Country	*Deutsche mark/dollar*	*Yen/dollar*	*Adjusted R-squared*
Western Hemisphere			
Argentina	**-6.364**	5.046	0.92
	(-2.764)*	(2.503)**	
Bolivia	-3.881	0.503	0.73
	(-1.092)	(0.157)	
Brazil	0.887	-1.924	0.97
	(0.459)	(-1.177)	
Chile	0.223	-0.857	0.99
	(0.216)	(-0.957)	
Colombia	1.008	-0.110	0.94
	(0.400)	(-0.050)	
Costa Rica	-2.299	0.599	0.94
	(-0.912)	(0.276)	
Dominican Rep.	-1.671	0.161	0.90
	(-0.555)	(0.063)	
Ecuador	-0.270	-2.830	0.91
	(-0.115)	(-1.378)	
El Salvador	**-10.101**	4.581	0.09
	(-1.794)***	(0.938)	
Guatemala	-5.706	3.104	0.33
	(-1.599)	(0.980)	
Haiti	7.842	-0.400	0.64
	(2.023)**	(-0.116)	
Honduras	0.995	2.006	0.81
	(0.719)	(1.657)***	
Jamaica	1.543	-1.640	0.89
	(0.847)	(-1.060)	
Mexico	-2.606	2.996	0.94
	(-0.759)	(0.989)	
Paraguay	-2.659	0.104	0.93
	(-0.692)	(0.031)	
Peru	-4.584	4.097	0.57
	(-1.610)	(1.626)	
Uruguay	**-2.502**	-1.010	0.97
	(-1.759)***	(-0.792)	
Venezuela	-4.004	-1.625	0.41
	(-0.932)	(-0.400)	
Europe			
Turkey	-2.286	1.475	0.97
	(-1.121)	(0.825)	

Note: *, ** and *** indicate the coefficient is statistically significant at 1, 5 and 10 per cent level, respectively. Coefficients in bold are negatively significant.

Table 3

IMPACT OF G-3 CURRENCY VOLATILITY ON DEVELOPING COUNTRIES' EXPORTS

Measure of volatility: coefficient of variation (CV)

Country	*Deutsche mark/dollar*	*Yen/dollar*	*Adjusted R-squared*
Africa			
Cameroon	12.58	1.713	0.76
	(4.691)*	(0.820)	
Egypt	**-1.739**	-0.498	0.95
	(-1.848)***	(-0.672)	
Gambia	1.549	-1.585	0.54
	(0.706)	(-1.012)	
Ghana	**-10.142**	1.450	0.58
	(-3.295)*	(0.565)	
Kenya	**-3.747**	-0.643	0.83
	(-2.467)**	(-0.536)	
Madagascar	**-4.697**	0.639	0.03
	(-2.108)**	(0.347)	
Morocco	-1.374	-0.429	0.89
	(-0.775)	(-0.419)	
Nepal	**-4.927**	1.163	0.90
	(-2.061)**	(0.629)	
Nigeria	**-5.808**	2.004	0.32
	(-2.341)**	(0.979)	
Niger	**-4.277**	2.586	0.76
	(-3.128)*	(2.321)**	
Rwanda	7.968	-0.596	0.55
	(2.399)**	(-0.218)	
Senegal	**-3.266**	**-2.381**	0.64
	(-2.688)*	(-2.491)**	
South Africa	**-2.599**	0.477	0.84
	(-2.424)**	(0.610)	
Togo	2.616	3.979	0.17
	(1.109)	(2.281)**	
Asia			
Philippines	0.159	-1.165	0.95
	(0.115)	(-1.166)	
India	**-3.867**	0.109	0.95
	(-2.705)**	(0.098)	
Indonesia	**-6.891**	-0.663	0.82
	(-3.575)*	(-0.435)	
Rep. of Korea	**-3.530**	-0.082	0.99
	(-3.359)*	(-0.108)	
Malaysia	**-3.460**	-1.603	0.97
	(-2.520)**	(-1.512)	
Pakistan	1.099	**-2.992**	0.95
	(0.698)	(-2.316)**	
Thailand	**-2.257**	-1.047	0.98
	(-1.689)***	(-1.038)	

Country	*Deutsche mark/dollar*	*Yen/dollar*	*Adjusted R-squared*
Western Hemisphere			
Argentina	**-2.927**	2.189	0.91
	(-2.005)**	(1.982)**	
Bolivia	**-5.763**	**-2.752**	0.82
	(-3.057)*	(-1.850)***	
Brazil	2.606	-1.074	0.97
	(2.066)**	(-1.448)	
Chile	-0.627	-0.010	0.99
	(-0.932)	(-0.022)	
Colombia	-2.051	0.032	0.95
	(-1.538)	(0.031)	
Costa Rica	**-3.154**	-0.865	0.95
	(-2.121)**	(-0.836)	
Dominican Rep.	2.190	-1.375	0.91
	(1.307)	(-1.114)	
Ecuador	-1.561	-1.313	0.91
	(-1.207)	(-1.205)	
El Salvador	**-7.195**	1.236	0.16
	(-2.151)**	(0.496)	
Guatemala	**-6.216**	-0.141	0.55
	(-3.675)*	(-0.100)	
Haiti	1.276	0.549	0.56
	(0.520)	(0.284)	
Honduras	-0.213	1.488	0.83
	(-0.262)	(2.437)**	
Jamaica	-1.133	-0.516	0.89
	(-0.993)	(-0.712)	
Mexico	1.497	0.548	0.94
	(0.739)	(0.340)	
Paraguay	**-5.314**	-0.127	0.95
	(-2.815)**	(-0.085)	
Peru	**-4.215**	0.711	0.62
	(-2.207)**	(0.466)	
Uruguay	-0.729	-0.227	0.96
	(-0.676)	(-0.318)	
Venezuela	**-5.855**	-1.277	0.55
	(-2.822)*	(-0.757)	
Europe			
Turkey	-1.065	-0.762	0.97
	(-0.725)	(-0.809)	

Note: *, ** and *** indicate the coefficient is statistically significant at 1, 5 and 10 per cent level, respectively. Coefficients in bold are negatively significant.

Table 4

IMPACT OF G-3 CURRENCY VOLATILITY ON FOREIGN DIRECT INVESTMENT AS A PERCENTAGE OF GROSS DOMESTIC INVESTMENT

(Measure of volatility: standard deviation of log changes)

	Controlling for the United States interest rate			*Without controlling for the United States interest rate*		
Region	*Deustche mark / dollar*	*Yen / dollar*	*Adjusted R-squared*	*Deustche mark / dollar*	*Yen / dollar*	*Adjusted R-squared*
Sub-Saharan Africa	-6.25 (-0.17)	17.54 (0.529)	0.29	-6.57 (-0.18)	13.55 (0.447)	0.32
South Asia	-14.2 (-1.09)	6.221 (0.519)	0.60	-14.0 (-1.10)	8.238 (0.750)	0.62
Eastern Europe and Central Asia	-107.0 (-1.29)	109.2 (1.427)	0.60	-109. (-1.32)	78.69 (1.091)	0.59
Latin America and the Caribbean	-55.5 (-1.12)	44.09 (0.965)	0.84	-57.6 (-1.12)	17.07 (0.382)	0.83
Middle East and North Africa	150.2 (2.99)*	**-82.2** (-1.76)***	0.27	149.2 (3.000)*	**-95.1** (-2.20)**	0.29
East Asia and the Pacific	-60.7 (-1.49)	42.87 (1.138)	0.79	-62.8 (-1.44)	16.05 (0.424)	0.75

Table 4a

IMPACT OF G-3 CURRENCY VOLATILITY ON FOREIGN DIRECT INVESTMENT AS A PERCENTAGE OF GROSS DOMESTIC PRODUCT

(Measure of volatility: standard deviation of log changes)

	Controlling for the United States interest rate			*Without controlling for the United States interest rate*		
Region	*Deustche mark / dollar*	*Yen / dollar*	*Adjusted R-squared*	*Deustche mark / dollar*	*Yen / dollar*	*Adjusted R-squared*
Sub-Saharan Africa	-17.2 (-0.85)	1.591 (0.085)	0.12	-17.2 (-0.87)	1.792 (0.105)	0.16
South Asia	2.397 (0.481)	1.824 (0.395)	0.73	2.243 (0.446)	-0.13 (-0.03)	0.72
Eastern Europe and Central Asia	-28.2 (-1.44)	29.28 (1.620)	0.56	-28.6 (-1.47)	23.52 (1.397)	0.56
Latin America and the Caribbean	-12.8 (-0.98)	9.749 (0.811)	0.85	-13.1 (-1.01)	5.335 (0.473)	0.85
Middle East and North Africa	25.10 (2.164)**	-12.3 (-1.15)	0.07	24.95 (2.196)**	-14.1 (-1.43)	0.10
East Asia and the Pacific	-10.3 (-0.65)	0.879 (0.059)	0.59	-11.3 (-0.63)	-12.0 (-0.77)	0.49

Note: *, ** and *** indicate the coefficient is statistically significant at 1, 5 and 10 per cent level, respectively. The numbers in parentheses are t-statistics.

Table 5

IMPACT OF G-3 CURRENCY VOLATILITY ON FOREIGN DIRECT INVESTMENT AS A PERCENTAGE OF GROSS DOMESTIC INVESTMENT

(Measure of volatility: coefficient of variation of real exchange rate)

	Controlling for the United States interest rate			*Without controlling for the United States interest rate*		
Region	*Deustche mark / dollar*	*Yen / dollar*	*Adjusted R-squared*	*Deustche mark / dollar*	*Yen / dollar*	*Adjusted R-squared*
Sub-Saharan Africa	**-32.5** (-1.76)***	24.88 (1.670)***	0.47	**-34.04** (-1.941)***	23.21 (1.685)***	0.50
South Asia	**-14.3** (-1.98)**	-0.43 (-0.07)	0.65	**-12.76** (-1.812)***	1.397 (0.252)	0.65
Eastern Europe and Central Asia	-80.1 (-1.62)	-80.1 (0.312)	0.60	**-86.37** (-1.831)***	5.509 (0.148)	0.61
Latin America and the Caribbean	-37.9 (-1.29)	-16.5 (-0.69)	0.84	-44.84 (-1.570)	-24.2 (-1.08)	0.84
Middle East and North Africa	30.12 (0.837)	-16.4 (-0.56)	-0.04	22.678 (0.6524)	-24.8 (-0.90)	-0.03
East Asia and the Pacific	-35.6 (-1.44)	-3.73 (-0.18)	0.78	**-43.85** (-1.778)***	-12.9 (-0.66)	0.77

Table 5a

IMPACT OF G-3 CURRENCY VOLATILITY ON FOREIGN DIRECT INVESTMENT AS A PERCENTAGE OF GROSS DOMESTIC PRODUCT + A9

(Measure of volatility: coefficient of variation of real exchange rate)

	Controlling for the United States interest rate			*Without controlling for the United States interest rate*		
Region	*Deustche mark / dollar*	*Yen / dollar*	*Adjusted R-squared*	*Deustche mark / dollar*	*Yen / dollar*	*Adjusted R-squared*
Sub-Saharan Africa	**-27.54** (-2.672)*	4.565 (0.548)	0.36	**-26.87** (-2.745)*	5.323 (-2.74)*	0.39
South Asia	-2.061 (-0.691)	0.225 (0.093)	0.73	-2.674 (-0.928)	-0.46 (-0.20)	0.73
Eastern Europe and Central Asia	-18.93 (-1.596)	3.955 (0.412)	0.54	**-19.70** (-1.750)***	3.086 (0.348)	0.57
Latin America and the Caribbean	-10.21 (-1.358)	-6.45 (-1.06)	0.86	-10.77 (-1.507)	-7.07 (-1.25)	0.86
Middle East and North Africa	4.3596 (0.5669)	-2.44 (-0.39)	-0.14	3.3566 (0.4569)	-3.56 (-0.61)	-0.10
East Asia and the Pacific	**-14.72** (-1.694)***	-10.2 (-1.45)	0.66	**-18.88** (-2.076)**	**-14.8** (-2.08)**	0.61

Note: *, ** and *** indicate the coefficient is statistically significant at 1, 5 and 10 per cent level, respectively. The numbers in parentheses are t-statistics. Coefficients in bold are negatively significant.

VI. Impact of G-3 currency volatility on currency crises

Several analysts have suggested that higher G-3 currency volatility is partially responsible for the occurrence of exchange rate crises in developing countries that had chosen to peg to a G-3 currency (McKinnon, 1999; Allaire et al, 1999). In this situation, if that G-3 currency appreciates substantially with respect to the rest of the world, so does the currency of the developing country. This, in turn, may lead to external balance problems in the developing country, that could eventually end in a currency crisis. Although the argument does make sense, there is no systematic evidence supporting such presumption. Most of the arguments that have been used in this regard are anecdotic, and are usually confined to very specific situations (for example, Thailand in 1997). This issue is addressed empirically in this section, using an extended version of an empirical model on the determinants of currency crises (Esquivel and Larraín, 2000 and 2001).

A. *Definition of crisis*[13]

In this paper we consider a currency crisis to exist only when there is an important change in the nominal exchange rate. Thus, unlike some of the previous studies on the topic, unsuccessful speculative attacks are excluded from the definition.

For a nominal devaluation to qualify as a currency crisis, two criteria are used. First, the devaluation rate has to be large relative to what is considered standard in a country. Second, the nominal devaluation has to be meaningful, in the sense that it should affect the purchasing power of the domestic currency. Thus, nominal depreciations that simply keep up with inflation differentials are not considered currency crises even if they are fairly large.

Combining these two criteria it can be said that a currency crisis exists only when a nominal devaluation is accompanied by an important change in the real exchange rate (at least in the short run). If it is assumed that the price level reacts slowly to changes in the nominal exchange rate, then, in practical terms, a currency crisis can be detected simply by looking at the changes in the real exchange rate. However, it is also necessary to define how large the real exchange rate movement must be in order to be considered as a crisis. Here, it is considered that a currency crisis has occurred when at least one of the following conditions is met:

Condition A: The accumulated three-month real exchange rate change is 15 per cent or more or,

Condition B: The one-month change in the real exchange rate lies in the upper 0.5 per cent of the distribution for each country (provided that it exceeds 4 per cent).[14]

Condition A guarantees that any large real depreciation is counted as a currency crisis.[15] Condition B, on the other hand, attempts to capture changes in the real exchange rate that are sufficiently large relative to the historical country-specific monthly change of the real exchange rate.

B. *Estimation methodology*

The approach to estimate the determinants of currency crises is as follows: the variable to be explained (y_{it}) is dichotomous, and takes the value of 1 if a currency crisis occurred during year *t;* otherwise it is zero. A *probit model* is estimated of the form:

$$\text{Prob (Crisis}_{it}) = \text{Prob } (y_{it} = 1) = \Phi\ (\beta' x_{it-1})$$

where x_{it-1} is a vector of explanatory variables for country *i* in period *t-1*, β is a vector of coefficients to be estimated, and Φ is the normal cumulative distribution function.

Note that in the estimation there is an implicit assumption that an unobservable or latent variable (y_{it}*) exists which is described by

$$y_{it}^* = \beta' x_{it-1} + u_{it}$$

where x_{it-1} and β are as before, u_{it} is a normally distributed error term with zero mean and unit variance, and the observed variable y_{it} behaves according to $y_{it} = 1$ if $y_{it}^* > 0$, and $y_{it} = 0$ otherwise.[16]

C. *Empirical results*

Table 6 shows the main results of this exercise. The coefficients are adjusted to indicate changes in the probability of the occurrence of a currency crisis. Column (1) shows the basic result when the

Table 6

IMPACT OF G-3 CURRENCY VOLATILITY ON CURRENCY CRISES

	Effects on probability, dF/dx		
	(1)	*(2)*	*(3)*
Variables	*Full sample*	*Developing countries*	
Seigniorage[a]	0.0194*	0.0220*	0.0234*
	(4.00)	(3.32)	(3.58)
Real exchange rate misalignment	0.0031*	0.0043*	0.0046*
	(2.90)	(3.04)	(3.18)
Current account balance[a]	-0.0078**	0.0009	0.0002
	(-2.50)	(0.19)	(0.05)
Log (M2/reserves)	0.0563*	0.0855*	0.0829*
	(3.34)	(3.37)	(3.25)
Terms of trade shock	-0.0041**	-0.0054**	-0.0048***
	(-2.07)	(-2.18)	(-1.92)
Negative growth dummy[b]	0.0511***	0.0194	0.0158
	(1.69)	(0.46)	(0.38)
Contagion effect[c]	0.1110*	0.0938**	0.0894**
	(4.03)	(2.33)	(2.23)
G-3 currency volatility[d]			0.0249***
			(1.78)
Number of observations	713	398	398
Log likelihood	-276.6	-164.1	-162.6
McFadden's R^2	0.131	0.142	0.149

Note: *, ** and *** indicate statistical significance at 1, 5 and 10 per cent level, respectively. All regressions include a constant term. Numbers in parentheses are z-statistics.

a As a percentage of GDP.

b 1 if per capita income growth < 0.

c 1 if at least one country in the region had a crisis.

d Coefficient of variation.

model is estimated on a sample of 34 high and middle-income countries. All the coefficients are statistically significant and they have the expected signs. That is, higher rates of seigniorage, larger real exchange rate misalignment, higher deficits in the current account, lower level of foreign exchange reserves, negative terms of trade shocks, negative per capita income growth and a contagion effect (i.e. being in a region where a neighbour has recently had a currency crises), lead to a higher probability of experiencing a currency crises.

Column (2) shows the results of applying the same specification as in column (1) to developing countries only. By doing this, the sample size is reduced by almost half. In the new regression, five out

of the seven explanatory variables remain highly significant and all of them have coefficients with the expected sign.

Column (3) adds the coefficient of variation of the G-3 exchange rates to the estimation. The new variable enters as a simple average of the *CV* of the real exchange rates between the dollar, on the one hand, and the yen, and the deutsche mark, on the other. Its estimated coefficient is positive and statistically significant at the 10 per cent level.[17] The parameter estimate implies that for every percentage point of increase in the volatility of the G-3 currencies, the probability of a currency crisis rises by around 2.5 percentage points in a given year.

This result means that in periods of increased exchange-rate volatility (i.e. when the measure of volatility has risen by more than 4 percentage points in a single year), the probability of a currency crises in any developing country rises by about 10 percentage points. This effect should not be overlooked. Its order of magnitude is almost equivalent to the increase in the probability of a crisis associated to the contagion effect – being in a region where another country has recently experienced a currency crisis. Of course, it is highly unlikely that G-3 exchange rate volatility by itself will put an otherwise safe country in a risky situation. However, it is clear that an increase in G-3 exchange rate volatility may precipitate a currency crisis in a country that is already vulnerable.

One final comment is in order. It can be argued that G-3 exchange rate volatility influences currency crises not through an overall index of volatility, but through the real exchange-rate misalignment of specific countries. While this argument may be correct, such a result cannot necessarily be attributed to the G-3 exchange-rate system. Instead, this situation may be the result of pegging to the wrong currency or, more generally, it may be the result of following an inappropriate exchange rate policy.[18] On the other hand, the empirical results presented above, which show that changes in the effective real exchange rates of developing countries are mostly driven by changes in the bilateral real exchange rates of the dollar, also suggest that G-3 exchange rate volatility affects developing countries through channels other than its overall competitiveness. In this sense, it seems important to separate the effects of real exchange rate misalignment from those associated to the G-3 exchange rate volatility, as it is done in the estimations reported in table 6.

VII. Conclusions

The empirical evidence analysed in this paper suggests that G-3 exchange rate volatility has certainly played a role in reducing exports from developing countries. The estimates suggest that an increase of one percentage point on G-3 exchange rate volatility depresses real exports from developing countries by about 2 per cent. At the same time, G-3 exchange rate volatility also seems to have a negative effect on foreign direct investment inflows to certain regions, although this evidence is less conclusive.

The results also show that G-3 exchange rate volatility increases the probability of occurrence of an exchange rate crisis in developing countries. This effect is positive and significant, but the magnitude of the associated coefficient suggests that even a large increase in G-3 exchange rate volatility would not be sufficient by itself to push a developing country into a currency crisis. Nonetheless, it may play a role in precipitating a crisis in an otherwise vulnerable country.

All in all, these findings suggest that greater stability in the international exchange rate system may be desirable in order to promote higher volumes of trade and foreign direct investment inflows in developing countries. The results also suggest that an added benefit of lower G-3 currency volatility would be to reduce the occurrence of exchange rate crises in the developing world.

Notes

1 Section 2 in Clarida (1999) presents a summary of the arguments that have been put forth against the post Bretton-Woods exchange rate arrangement (or, the non-system, as their critics like to call it).

2 In the empirical applications of this paper, the G-3 countries are Germany, Japan and the United States. Accordingly, the G-3 currencies are the dollar, the yen and the deutsche mark. Since January 1999, the G-3 encompasses the United States, Japan and the twelve countries the euro region.

3 See, for example, McKinnon (1999).

4 Williamson (1986) and Currie and Wren-Lewis (1990) present an early discussion on the possibility of establishing a target zone among the G-3 currencies with the objective of reducing exchange rate fluctuations. Clarida (1999) surveys five alternative proposals to reduce fluctuations among G-3 currencies.

5 Goldberg and Klein (1998) have shown that changes in G-3 real exchange-rates may have an effect on the inflows of foreign direct investment in some regions.

6 This point has been emphasized by Frankel and Roubini (2000).

7 This measure has been used, among others, by Arize et al. (2000), Kenen and Rodrik (1986), and Chowdhury (1993). See McKenzie (1999) for a review of the alternative measures of volatility that have been used in the literature on exchange-rate volatility and trade flows.

8 It is interesting to note that some authors use this indicator as if it were a measure of the standard deviation of the real exchange rate (and not of its growth rate).

9 Empirical results will be presented, however, using both measures of volatility.

10 Interest rate variability is the CV of the nominal interest rate. Exchange rate variability is defined as the simple average of the CV of each country with respect to the other two G-3 currencies.

11 See McKenzie (1999) for a recent survey. Recent studies along this vein include Dell'Ariccia (1999) and Arize et al. (2000).

12 Notice that only two volatility variables are included in this analysis. This is because it cannot be assumed that the volatility in the three parities is due to the G-3 exchange rate system. Instead, it can be assumed that a developing country's exchange rate may closely follow any of the G-3 currencies, so that only the volatility in the other two G-3 parities is exogenous to that country.

13 This section draws on Esquivel and Larraín (2000). The reader is referred to that work for further details on the methodology.

14 If the distribution of the monthly changes is normal, this condition implies that the one-month change is higher than 2.54 times the country specific standard deviation of the monthly rate of change of the real exchange rate.

15 The threshold value of 15 per cent is somewhat arbitrary, but sensitivity analysis shows that the precise threshold is largely irrelevant for the results.

16 In this regard there is a slight difference to Esquivel and Larrain (2000), where a probit model with random effects was used, but where it was also shown that there are no substantial differences in the results obtained with alternative estimation methods. To simplify the exposition of the results, a more standard econometric methodology has been used here.

17 None of these results changes qualitatively if instead of using a simple average of the CVs, only one of them is used as representative of the exchange-rate system instability.

18 This may be the case of Thailand in 1997 and of Argentina in 2001. These countries had chosen to peg to the dollar, despite the fact that the bulk of their international transactions is with countries other than the United States. The appreciation of the dollar in 1995–1998 and in 2000–2001 clearly affected the international competitiveness of these countries. However, it is hard to say that the United States is to blame for such situations. Instead consideration should be given to whether pegging to the dollar was the best thing to do for these two countries in the first place.

References

Allaire et al. (1999). Dissenting views on target zones for the G-3 currencies. In: *Safeguarding Prosperity in a Global Financial System: The Future International Financial Architecture.* Report of an Independent Task Force of the Council on Foreign Relations. New York.

Arize A, Osang T and Slottje D (2000). Exchange rate volatility and foreign trade: Evidence from thirteen LDC's. *Journal of Business and Economics Statistics*, 18(1).

Brodsky DA (1984). Fixed versus flexible exchange rates and the measurement of exchange rate instability. *Journal of International Economics* 16: 295–306.

Caballero R and Corbo V (1989). The effect of real exchange rate uncertainty on exports: Empirical evidence. *World Bank Economic Review* 3(2): 263–278, May.

Chowdhury AR (1993). Does exchange rate volatility depress trade flows? Evidence from error correction models. *Review of Economics and Statistics* 75: 700–706.

Clarida RH (1999). G-3 exchange rate relationships: A recap of the record and a review of proposals for change. NBER Working Paper 7434, December.

Currie D and Wren-Lewis S (1990). Evaluating the extended target zone proposal for the G-3. *Economic Journal*, March: 105–123.

Dell'Ariccia G (1999). Exchange rate fluctuations and trade flows: Evidence from the European Union. IMF-Staff-Papers: 46(3): 315–334, September–December.

Esquivel G and Larraín F (2000). Determinantes de las crisis cambiarias. *El Trimestre Económico*, LXVII. (266), 191–237, April–June.

Esquivel G and Larraín F (2001). Currency crises in Central America. In: Larraín F, ed. *Economic Development in Central America. Volume I: Growth and Internationalization.* Cambridge, MA, Harvard University Press.

Frankel JA and Roubini N (2000). The role of industrial country policies in emerging market crises. Paper presented at the Conference on Economic and Financial Crises in Emerging Market Economies. Woodstock, VT.

Goldberg L and Klein M (1998). Foreign direct investment, trade and real exchange rate linkages in developing countries. In: Glick R, ed. *Managing Capital Flows and Exchange Rates*. Cambridge, United Kingdom, Cambridge University Press: 73–100.

Kenen PB and Rodrik D (1986). Measuring and analyzing the effects of short term volatility in real exchange rates. *Review of Economics and Statistics* 68: 311–215.

Larraín F and Vergara R (1993). Investment and macroeconomic adjustment: The case of East Asia. In: Servén L and Solimano A, eds. *Striving for Growth After Adjustment: The Role of Capital Formation*. Washington, DC, World Bank: 229–274.

McKenzie MD (1999). The impact of exchange rate volatility on international trade flows. *Journal of Economic Surveys* 13(1): 71–106.

McKinnon R (1999). Euroland and East Asia in a dollar-based international monetary system: Mundell revisited. Stanford, CA, Stanford University Working Paper 99–020.

Reinhart C and Reinhart VR (2000a). What hurts most? G-3 exchange rate or interest rate volatility. Paper presented at the Conference on Management of Currency Crises, NBER Summer Institute, Cambridge, MA, July.

Reinhart C and Reinhart VR (2000b). What does a G-3 target zone mean for emerging-market economies. Mimeo, October.

Rogoff K (1999). Perspectives on exchange rate volatility. In: Feldstein M, ed. *International Capital Flows*. Chicago, NBER and Chicago University Press.

Weber A (1996). Foreign exchange intervention and international policy coordination: comparing the G3 and EMS experience. In: Canzoneri M, Ethier WJ and Grilli V, eds. *The New Transatlantic Economy*. Cambridge, United Kingdom, Cambridge University Press.

G-24 Discussion Paper Series*

Research papers for the Intergovernmental Group of Twenty-Four on International Monetary Affairs

No. 15	December 2001	Peter EVANS and Martha FINNEMORE	Organizational Reform and the Expansion of the South's Voice at the Fund
No. 14	September 2001	Charles WYPLOSZ	How Risky is Financial Liberalization in the Developing Countries?
No. 13	July 2001	José Antonio OCAMPO	Recasting the International Financial Agenda
No. 12	July 2001	Yung Chul PARK and Yunjong WANG	Reform of the International Financial System and Institutions in Light of the Asian Financial Crisis
No. 11	April 2001	Aziz Ali MOHAMMED	The Future Role of the International Monetary Fund
No. 10	March 2001	JOMO K.S.	Growth After the Asian Crisis: What Remains of the East Asian Model?
No. 9	February 2001	Gordon H. HANSON	Should Countries Promote Foreign Direct Investment?
No. 8	January 2001	Ilan GOLDFAJN and Gino OLIVARES	Can Flexible Exchange Rates Still "Work" in Financially Open Economies?
No. 7	December 2000	Andrew CORNFORD	Commentary on the Financial Stability Forum's Report of the Working Group on Capital Flows
No. 6	August 2000	Devesh KAPUR and Richard WEBB	Governance-related Conditionalities of the International Financial Institutions
No. 5	June 2000	Andrés VELASCO	Exchange-rate Policies for Developing Countries: What Have We Learned? What Do We Still Not Know?
No. 4	June 2000	Katharina PISTOR	The Standardization of Law and Its Effect on Developing Economies
No. 3	May 2000	Andrew CORNFORD	The Basle Committee's Proposals for Revised Capital Standards: Rationale, Design and Possible Incidence
No. 2	May 2000	T. Ademola OYEJIDE	Interests and Options of Developing and Least-developed Countries in a New Round of Multilateral Trade Negotiations
No. 1	March 2000	Arvind PANAGARIYA	The Millennium Round and Developing Countries: Negotiating Strategies and Areas of Benefits

* ***G-24 Discussion Paper Series*** are available on the website at: http://www.unctad.org/en/pub/pubframe.htm. Copies of ***G-24 Discussion Paper Series*** may be obtained from the Editorial Assistant, Macroeconomic and Development Policies Branch, Division on Globalization and Development Strategies, United Nations Conference on Trade and Development (UNCTAD), Palais des Nations, CH-1211 Geneva 10, Switzerland; Tel. (+41-22) 907.5926; Fax (+41-22) 907.0274; E-mail: MDPB-Ed.Assistant@unctad.org