THE KOREAN ECONOMIC REVIEW
Volume 18, Number 1, Summer 2002

THE FINANCIAL DEVELOPMENT, MACROECONOMIC STABILITY, AND EXCHANGE RATE VOLATILITY

SANG-YONG JOO* · HAN-GWANG CHOO** · DO-SUN HONG***

We investigated the connection between the exchange rate volatility and the underlying fundamental volatility, and found that the two volatilities are correlated. This finding indicates that a flexible exchange rate need not be an unstable exchange rates and domestic macroeconomic stabilization policy aimed at reducing exchange rate volatility is still valid and important. For institutional factors reducing the fundamentals volatility associated with exchange rate fluctuations, we found the importance of two factors: the financial development and the reduction in exchange and capital controls. Various indices of them are found to affect macroeconomic stability. There seems to exist some underlying driving force between financial underdevelopment, macroeconomic instability, and exchange rate volatility all at the same time.

JEL Classification: E42, E44, F33
Keywords: Financial Development, Macroeconomic Stability, Exchange Rate Volatility

I. INTRODUCTION

The choice between fixed and flexible exchange rates has long been one of the most fundamental issues in international finance. This issue has been more hotly debated than ever after experiencing frequent financial crises in 1990s. Both fixed and flexible regimes are found to be subject to crises. While only a small number of fixed exchange rates survived the past several years, the

Received for publication: Nov. 1, 2001. *Revision accepted:* Feb. 7, 2002.
* The 1st author, Associate Professor, Department of Economics, Sejong University, Gunja-Dong 98, Guangjin-Gu, Seoul, Korea. Email) joosy@sejong.ac.kr.
** The 2nd author, Associate Professor, Department of Economics, Sejong University, Email) choo-hg@hanmail.net.
*** The 2nd author, Graduate Student, Department of Economics, Sejong University, Email) algenon@korea.com
This work was supported by the Brain Korea 21 Project. Seung-In Hong and sungkeun shin provided valuable research assistance. We also thank two anonymous referees for helpful comments. All remaining errors are ours.

darkest time for the Asian crises came after moving to flexible exchange rate regime.[1]

Those who favor fixed exchange rates emphasize that exchange rates are too volatile and sometimes become misaligned with fundamentals. Exchange rate volatility is costly, since it may discourage trade and investment. Furthermore, when capital wants to leave the country, the floating rate regime would not be particularly helpful. Thus the free floating regime is not immune to currency crisis.

However, the fixed exchange rate regime (including currency board) is not a panacea. Many recent efforts to peg ,exchange rates have ended in spectacular debacles. Evasion has become much easier as international interdependence has grown, together with giant global capital markets. Hence, for most countries today, the choice between fixed and flexible exchange rates has been increasingly difficult.

Then where should we go? It would not be easy to turn back the clock and adopt again the postwar system of fixed exchange rates which already collapsed 30 years ago. We go back to the traditional issue on the exchange rate volatility. Whether the driving force for the volatility is its underlying fundamentals or the noiseness inherent in foreign exchange markets, has important implications for the choice of exchange regime and preventive policies for currency crisis.

Since the seminal article by Meese and Rogoff(1983), many empirical studies have searched for the explanatory power of exchange rate models based on macroeconomic fundamentals. A broad range of empirical studies observe that in the floating-rate era exchange rates are extremely volatile, and unrelated to fundamentals. The focus, however, was mainly on the determination of exchange rate returns itself, not its volatility. Notable exceptions are Flood and Rose(1999, 1995), and Rose(1996). They investigated the connection between the exchange rate volatility and the underlying fundamentals volatility, and found that, for major industrial countries, the two volatilities are unrelated.[2]

These findings have important implications for the exchange rate stabilization policy. If there is little systematic relationship between exchange rate volatility and macroeconomic phenomena, any domestic macroeconomic stabilization policy aimed at reducing exchange rate volatility is doomed to be a failure. Since the macroeconomic stability is fruitless, alternatives would be found in reforming measures of the international financial system. Fixing exchange rates or imposing bands are candidates among them.[3] Monetary independence should be abandoned.

In this article, we reexamine the relationship between the exchange rate

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[1] Eichengreen(1998) argues that there is no simple correlation between the exchange rate regime and the prevalence of banking crisis.

[2] Rose(1996) used a panel of data for twenty-two OECD countries and Flood and Rose(1995) considered eight industrial countries.

[3] Rose(1996) found exchange rate volatility is significantly correlated with the width of the declared exchange rate band.

volatility and the macroeconomic fundamentals volatility. We use the recent period's, cross-country data set which is not restricted to developed nations. Using cross-sectional analysis, contrary to the findings of Flood and Rose, we found that greater volatility of underlying monetary and macroeconomic fundamentals tends to be associated with greater exchange rate volatility. This finding casts doubts on the robustness of the results of Flood and Rose.

Also, this result indicates a flexible exchange rate need not be an unstable exchange rates. Friedman(1953) argued that, if exchange rates are unstable, it is primarily because there is underlying instability in the economic conditions. The floating rate regime itself is not to blame. Further, we investigate what are the underlying forces driving instability of economic conditions associated with exchange rate instability.

Here, as a candidate for contributing to the stability of macroeconomic conditions, we consider the role of financial development. Recently, many authors begin to emphasize the role of financial sectors as a source of macroeconomic instability(Aghion, Banerjee and Piketty, 1999, Bacchetta, Aghion and Banerjee, 1999, and Bernanke, Gertler and Gilchrist, 1998). With respect to macroeconomic maladies of emerging economies such as Latin America, Caballero(2000) argues that underdeveloped financial markets limit the smoothing of shocks over time and are themselves a source of shocks, creating excessive volatility of the real economy.[4]

Our concern on the role of domestic financial development in explaining the macroeconomic volatility associated with the exchange rate volatility, arise from following two main reasons. First, since financial markets are characterized by asymmetric information and agency problems, underdeveloped financial markets can reduce the efficiency of the process of matching lenders and potential borrowers, thereby expanding endogenous fluctuations in macroeconomy. Second, since foreign exchange markets are closely linked to the domestic capital markets, inefficiencies in the domestic capital markets can also generate malfunctions in the foreign exchange markets.

Thus we conjecture the stability of macroeconomic fundamentals associated with the determination of exchange rates could also be traced in part to the degree of financial development. We found that various measures of domestic financial market development are negatively linked to macroeconomic volatility. We also found that exchange and capital controls, as another indicator of financial development, increase instability of macro-monetary fundamentals. These findings show the importance of the development of domestic financial market as an underlying stabilizer of foreign exchange markets as well as macroeconomy. The next section lays out basic connection between exchange rate and

[4] Blanchard(2000) points out that identifying the role of institutions, including labor or financial market institutions, in generating differences in macroeconomic evolutions is likely to be an important topic of research in the future.

macroeconomic volatility. In section Ⅲ and Ⅳ, the empirical results follow. The paper ends with brief conclusion.

II. EXCHANGE RATE AND MACROECONOMIC VOLATILITY

To explore the relation between exchange rate and macroeconomic volatility, we begin with standard monetary model of exchange rate.[5] The monetary exchange rate model consists of a structural money market equilibrium condition in logarithms as:

$$m_t - p_t = \alpha y_t - \beta i_t + \varepsilon_t, \tag{1}$$

where m_t denotes the logarithm of the stock of money at time t; p denotes the price level; y denotes real income; i denotes the nominal interest rate; ε denotes a shock to money market; and α and β are structural parameters indicating income and interest rate elasticities, respectively. There is a comparable equation with the notation of $*$ for the foreign country.

If we assume that prices are perfectly flexible, purchasing power parity(PPP) holds at least with a disturbance:

$$p_t - p_t^* = e_t + u_t, \tag{2}$$

where e denotes the domestic price of unit of foreign exchange; and u is a stationary disturbance.

If we assume that domestic and foreign elasticities in each country's money market are equal, then subtraction of foreign analogue from (1) and solving for the exchange rate gives:

$$e_t = (m_t - m_t^*) - \alpha(y_t - y_t^*) + \beta(i_t - i_t^*) - (\varepsilon_t - \varepsilon_t^*) - u_t, \tag{3}$$

For simplicity, we introduce the notation

$$f_t = (m_t - m_t^*) - \alpha(y_t - y_t^*) + \beta(i_t - i_t^*),\ v_t = -(\varepsilon_t - \varepsilon_t^*) - u_t,$$

then we get:

$$e_t = f_t + v_t. \tag{4}$$

which expresses the exchange rate as a function of macroeconomic fundamentals, namely differentials of money, output, interest rates and shocks.

To get an expression for exchange rate changes, we transform the above structural exchange rate equations by taking first differences:

$$\Delta e_t = \Delta f_t + \Delta v_t, \tag{5}$$

[5] The derivation here is similar to Rose(1996).

Since our focus lies on the relation between the exchange rate and macroeconomic volatility, we then transform the equation by moving from first to second moments. If we assume that all variables are stationary with finite second moments and the covariance between the changes in fundamentals, Δf and disturbances, Δv, are zero:

$$\sigma^2(\Delta e) = \sigma^2(\Delta f) + \sigma^2(\Delta v), \tag{6}$$

which states that exchange rate volatility equals fundamental volatility and the variance of some forms of noises.[6] Equation (6) implies that the volatility of macroeconomic or monetary fundamentals is reflected proportionately in the exchange rate volatility. That is, the (in)stability of exchange rates is a symptom of (in)stability in the underlying macroeconomic conditions.

The left-hand side of equation (6) is observable, but the first term of the right-hand side of this equation is not. Given data on money, output, and interest rate, however, it can be measured with the addition of two structural parameters, α and β. A number of authors argue that long-run money demand is stable, with an income elasticity near one and an interest (semi) elasticitiy near -0.1(Lucas, 1988; Stock and Watson, 1993). The reasonable choice on α might be one. However, Ball(2001) argues that α is approximately 0.5 for the M1 demand in the United States when extending the data through the mid-1990s. The interest elasticity, β, is much less certain. Rose(1996) suggests two alternative values of β, 0.1 and 0.5. In the following analysis, therefore, we use four alternative combination of (α, β), which are (1.0, 0.1), (1.0, 0.5), (0.5, 0.1), (0.5, 0.5).

The data is taken from the International Financial Statistics. To measure macroeconomic fundamentals with the structural parameters, we use narrow(M1) money indices(IFS line 34i), industrial indices for the measure of output(line 66), and short interest rates(line 60b). Our data are transformed by natural logarithms except interest rates which are annual % returns divided by 100. The quarterly frequency sample starts from 1994 ending in near 2000 depending on countries. Bilateral American dollar exchange rates for the same sample period are used and the United States is always considered as the foreign country(IFS mnemonic rf). We consider 33 countries adopting (managed) floating exchange rate regime including wide range of developed and underdeveloped nations. The reason for the choice of countries is mentioned further below.

The first five columns in Table 3 lay out exchange rate volatility measured as standard deviation of quarterly nominal exchange rate changes, and four different fundamentals volatility defined as standard deviation of quarterly Δf defined in equation (6) with corresponding structural parameters. With this data

[6] Throughout the paper, the term $\sigma^2(\Delta f)$ or $\sigma(\Delta f)$ is interpreted as indicating fundamentals volatility, macroeconomic volatility, monetary or macroeconomic divergence, all having the same meaning.

set, we first examine whether countries with volatile exchange rates also have high macroeconomic volatility. Table 1 shows correlations among exchange rate volatility and macroeconomic volatilities. The STDEX is the standard deviation of exchange rates and the SF1, SF2, SF3, and SF4 correspond to standard deviations of macroeconomic fundamentals in equation (3) defined using (α, β) being equal to (1.0, 0.1), (1.0, 0.5), (0.5, 0.1), and (0.5, 0.5), respectively.

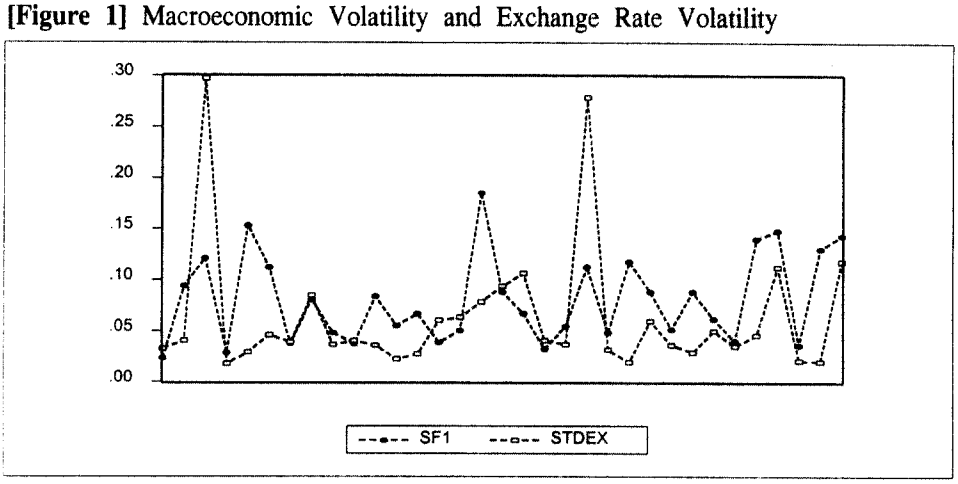
[Table 1] Correlations among Exchange Rate Volatility and Macroeconomic Volatilities

	STDEX	SF1	SF2	SF3	SF4
STDEX	1.000	-	-	-	-
SF1	0.355	1.000	-	-	-
SF2	0.237	0.802	1.000	-	-
SF3	0.238	0.721	0.984	1.000	-
SF4	0.422	0.942	0.846	0.818	1.000

The STDEX is the standard deviation of exchange rates and the SF1, SF2, SF3, and SF4 correspond to standard deviations of macroeconomic fundamentals in equation (3) defined using (α, β) being equal to (1.0, 0.1), (1.0, 0.5), (0.5, 0.1), and (0.5, 0.5), respectively.

The correlations range from 0.24 to 0.42 depending on measures of macroeconomic volatility. Figure 1 also shows clearly that there are similar movements in volatilities of exchange rate and macroeconomic fundamentals. The simple regression analysis presented in Table 2 corroborates the impression left by Table 1 and Figure 1, namely that exchange rate volatility is positively linked to the volatility of macroeconomic fundamentals.

[Figure 1] Macroeconomic Volatility and Exchange Rate Volatility



The STDEX is the standard deviation of exchange rates and the SF1 is standard deviation of macroeconomic fundamentals in equation (3) defined using (α, β) being equal to (1.0, 0.5).

The estimated slopes are all positive, implying that macroeconomic volatility tend to raise exchange rate volatility. The regression coefficients look all significantly different from zero. Using SF2 and SF3 give weaker results, but main findings seem not so sensitive to the choice of fundamentals. The R^2 is not very high. However, considering the nature of small sample, cross-sectional simple regression analysis, it shows reasonably high goodness of fit.

[Table 2] Exchange Rate Volatility and Different Measures of Macroeconomic Volatility

explanatory variable	parameter estimated (θ_1)	standard errors	p-value	R^2
SF1	0.528	0.232	0.030	0.126
SF2	0.221	0.105	0.043	0.056
SF3	0.221	0.109	0.052	0.056
SF4	0.695	0.298	0.026	0.178

The STDEX, SF1, SF2, SF3, and SF4 are defined as in Table 1. The results are based on the regression form; $(STDEX)_i = \theta_0 + \theta_1 (SF_j)_i + \eta_i, j=1, \cdots, 4, i=1, \cdots, N$, where N is the sample size. Standard Errors are White-consistent.

III. MACROECONOMIC VOLATILITY: EFFECTS OF FINANCIAL DEVELOPMENT AND EXCHANGE-CAPITAL CONTROLS

The above simple analysis provides an evidence showing that exchange rate volatility is a manifestation of economic volatility. This result has direct implications on the importance of appropriate macroeconomic stabilization to insure exchange rates stability. A flexible exchange rate need not be an unstable exchange rates if the underlying economic conditions are healthy and stable. Then what makes the underlying fundamental conditions health and stable, other than macroeconomic stabilization? Which factors are related to the (in)stability of macroeconomic fundamentals? This section considers the role of financial development as candidate for contributing to the stability of macroeconomic conditions.[7] We also examine the effect of exchange and capital control on the stability of macro-monetary fundamentals.[8]

The linkages between financial development and macroeconomic stability are

[7] A growing literature, including King and Levin(1993), Rajan and Zingales(1996), and Levine and Zervos(1998), examines the consequences of developed financial markets for economic growth. For example, King and Levin(1993) found that the financial system promote economic growth, using data on 80 countries over the 1960-1989 period.

[8] We do not consider here the direct linkage between exchange rate volatility and financial development, since their relations are not yet established theoretically. Empirically, the two variables seem uncorrelated, after taking the fundamental volatility into account. Actually, in the regression analysis of our own based on the sample of this paper, various measures of financial development turned out having no additional explanatory power on the exchange rate volatility when the fundamental volatility is included.

not yet well established. However, recent studies such as Aghion, Banerjee, and Piketty(1999), and Bacchetta, Aghion, and Banerjee(1999) begin to emphasize the role of capital markets as a source of macroeconomic instability. They show that capital market imperfections together with unequal access to investment opportunities can generate endogenous and permanent fluctuations in macroeconomy. Here, in the spirit of these studies, we conjecture the stability of macroeconomic fundamentals associated with the determination of exchange rates is also traced in part to the degree of financial development.

Also, in the literature of international finance, the role of exchange and capital controls has long been an important issue. And their effectiveness as proper policy measures to remedy various illnesses of open economy has always been controversial. To mention an article closely related with our study, Rose(1996) found the evidence, with most european countries, that exchange rate volatility is only loosely linked to the degree of capital mobility. However, our focus differs slightly from Rose(1996). We examine the effect of degrees of exchange and capital controls, together with the financial development, on the macroeconomic volatility.

We use the data on measures of financial development and exchange and capital controls taken from existing literatures. For the indicators of financial development, we use the data set of La Porta, Lopez-de-Silanes, Shleifer, and Vishny(1997), henceforth LLSV(1997).[9] They constructed various indicators of the effectiveness of financial system for 49 countries, and the data set focuses on external finance: debt and equity.[10]

The data on debt finance consists of the total bank debt of the private sector and the total face value of non-financial corporate bonds in each country. The aggregate of these two variables relative to the GNP is a plausible measure of the overall ability of the private sector to access debt finance. We denote this aggregate value to GNP in 1994 as DEBT in the following analysis. We also take three different measures of equity finance from LLSV(1997). The first variable is the ratio of stock market capitalization to GNP in 1994. Instead of using just the ratio of stock market valuation to GNP, LLSV(1997) corrected this ratio by excluding large shares of insiders. The share of equity held by true outsiders will reflect the ability to raise external funds. The second measure of the extent of equity finance is the number of listed domestic firms in each country relative to its population in 1994(FIRMS). The third is the number of initial public offerings of shares in each country between mid-1995 and

[9] With the various measures of financial development carefully redesigned, LLSV(1997) focused on its determinants, not its consequences, and found the legal environment such as investor protections has large effects on the size and breadth of capital markets across countries.

[10] Our sample of 33 countries chosen are subset of the LLSV(1997)'s data set. Among their 49 countries, those with (near) fixed exchange rate regime such as Hong Kong and Argentina, for example, are excluded. Our choice of sample seems rather ad hoc at first glance, but that is to use the existing, better measures of financial development.

mid-1996(IPO). Since the last two variables reflect the stock and the flow of new companies obtaining equity finance, those will serve as good proxies for the breadth of external finance.

The data on the extent of national exchange and capital controls are also taken from an exiting study. Tamirisa(1999) constructed three indices of controls on current payments and transfers(CCI), capital controls(KCI), and exchange and capital controls in their entirety(ECI). Each index ranges from zero(the lowest extent) and to one(the hight extent). CCI measures the extent of controls on current payments and transfers, KCI reflects the pervasiveness of controls on capital movement. ECI, as the average of CCI and KCI, reflects the overall extent of exchange and capital controls.

Table 3 shows the three indices of exchange and capital controls and four indicators of the breadth of external finance, together with volatilities of exchange rates and macroeconomic fundamentals. Table 4 presents correlations of the variables with the four macroeconomic volatility indices. Among measures of financial development, DEBT, FIRMS, and IPO are negatively correlated with all four indices of macroeconomic volatility. However, CAP shows negative, but weak correlation with macroeconomic volatility measures. The three indices of exchange and capital controls are strongly positively linked to the fundamental macroeconomic volatility. Figure 2 and Figure 3 show those relationships graphically.

The econometric analysis presented in Table 5 corroborates the impressions left by Table 4, Figure 2, and Figure 3, namely that fundamental volatility is negatively linked to financial development indicators, and positively linked to the indices of exchange and capital controls. The results are based on the regression form; $(SF_j)_i = \varphi_0 + \varphi_1$ (Financial Development Measures)$_i + \varphi_2$ (ECI)$_i + \xi_i, j=1, \cdots, 4, \ i = 1, \cdots, N$, where N is the sample size.

When SF1 is used as a dependent variable and the financial development measures are entered individually as a regressor, regression coefficients on DEBT, FIRMS, and IPO are all different from zero at conventional significance levels of 1% to 10%, implying that financial developments tend to reduce macroeconomic volatility. When financial development measures are entered jointly with the measure of exchange and capital controls(ECI), all four coefficients turned out significant. The goodness of fit is very high, considering the nature of small sample and cross-sectional analysis. Exchange and capital controls measured as ECI tend to increase macroeconomic volatility. This result is robust to the choice of fundamentals and measures of financial development.

[Table 3] Countries and Variables

Country	STDEX	SF1	SF2	SF3	SF4	DEBT	CAP	FIRMS	IPO	CCI	KCI	ECI
Australia	.032	.023	.039	.040	.024	.76	.49	63.5	NA	.036	.195	.116
Austria	.040	.094	.096	.055	.044	.79	.06	13.8	.25	NA	NA	NA
Brazil	.296	.121	.186	.182	.120	.39	.18	3.4	.00	.313	.603	.458
Canada	.017	.028	.068	.068	.028	.72	.39	40.8	4.93	.089	.055	.072
Chile	.029	.149	.215	.219	.152	.63	.80	19.9	.35	.221	.889	.555
Colombia	.045	.095	.113	.116	.101	.19	.14	3.1	.05	NA	NA	NA
Denmark	.038	.037	.061	.054	.031	.34	.21	50.4	1.80	.016	.074	.045
Ecuador	.084	.077	.095	.100	.085	NA	NA	13.1	.09	NA	NA	NA
France	.036	.048	.076	.074	.045	.96	.23	8.0	.17	.043	.157	.100
Germany	.040	.037	.058	.055	.034	1.12	.13	5.1	.08	.036	.066	.051
Greece	.036	.071	.076	.073	.069	.23	.07	21.6	.30	.057	.055	.056
India	.022	.055	.200	.206	.052	.29	.31	7.7	1.24	.221	.868	.545
Israel	.027	.061	.086	.084	.058	.66	.25	127.6	1.80	.160	.538	.349
Italy	.060	.038	.059	.056	.035	.55	.08	3.9	.31	.095	.056	.076
Japan	.063	.050	.173	.173	.049	1.22	.62	17.7	.26	.088	.159	.124
Kenya	.078	.171	.203	.145	.110	NA	NA	2.2	NA	.045	.167	.106
Korea	.093	.069	.068	.064	.070	.74	.44	15.8	.02	.103	.703	.403
Mexco	.106	.067	.177	.178	.070	.47	.22	2.2	.03	.053	.364	.209
Netherland	.040	.032	.055	.055	.031	1.08	.52	21.1	.66	.045	.010	.027
Newzealand	.036	.040	.049	.049	.038	.90	.28	69.0	0.66	.016	.092	.054
Nigeria	.278	.112	.131	.126	.104	NA	.27	1.6	NA	NA	NA	NA
Norway	.031	.048	.094	.094	.043	.64	.22	33.0	4.50	.008	.047	.027
Peru	.019	.115	.150	.131	.095	.27	.40	9.4	.13	NA	NA	NA
Philippine	.059	.084	.129	.117	.069	.10	.10	2.9	.27	.164	.473	.318
Portugal	.036	.051	.063	.054	.039	.64	.08	19.5	.50	NA	NA	NA
Singapore	.029	.088	.142	.128	.060	.60	1.18	80.0	5.67	NA	NA	NA
Southafrica	.050	.062	.094	.090	.056	.93	1.45	16.0	.05	.290	.563	.426
Sweden	.035	.040	.062	.056	.033	.55	.51	12.6	1.66	NA	NA	NA
Switzerland	.046	.091	.107	.083	.065	NA	.62	33.8	NA	NA	NA	NA
Turkey	.112	.148	.189	.160	.125	.15	.18	2.9	.05	.160	.364	.262
Uk	.020	.036	.063	.061	.035	1.13	1.00	35.6	2.01	.025	.065	.045
Uruguay	.020	.130	.146	.127	.111	.26	NA	7.0	.00	.086	.131	.108
Venezuela	.118	.136	.166	.175	.146	.10	.08	4.2	.00	NA	NA	NA

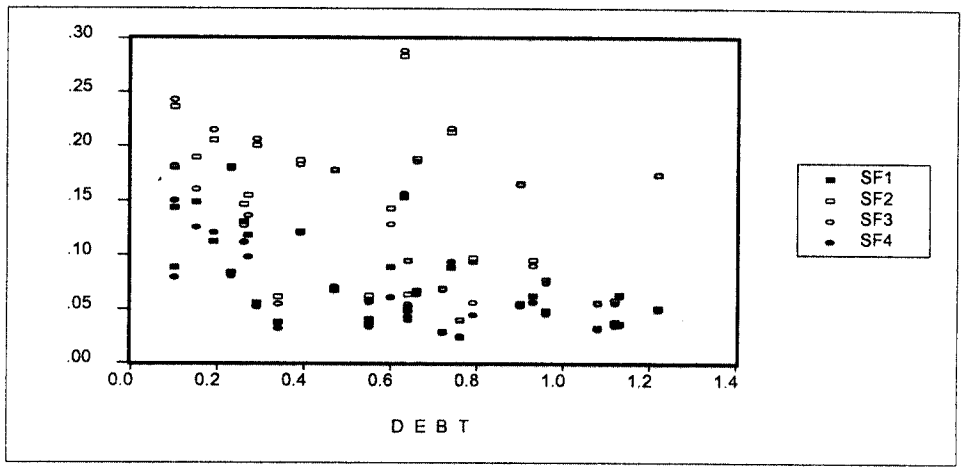
The STDEX, SF1, SF2, SF3, and SF4 are defined as in Table 1. The DEBT is the ratio of the sum of bank debt of the private sector and the total face value of non-financial corporate bonds to GNP in 1994. The CAP is the ratio of stock market capitalization held by minorities to GNP in 1994. The FIRMS is the number of listed domestic firms in each country relative to its population in 1994. The IPO is the number of initial public offerings of shares between mid-1995 and mid-1996. The CCI, KCI and ECI are indices of controls on current payments and transfers, capital controls, and exchange and capital controls in their entirety in 1996, respectively.

[Table 4] Correlations of the Variables with Macroeconomic Volatility Indices

	DEBT	CAP	FIRMS	IPO	CCI	KCI	ECI
SF1	-0.605	-0.055	-0.311	-0.351	0.379	0.402	0.412
SF2	-0.480	-0.050	-0.131	-0.294	0.407	0.624	0.595
SF3	-0.448	-0.045	-0.116	-0.280	0.430	0.677	0.642
SF4	-0.591	-0.070	-0.329	-0.402	0.471	0.527	0.534

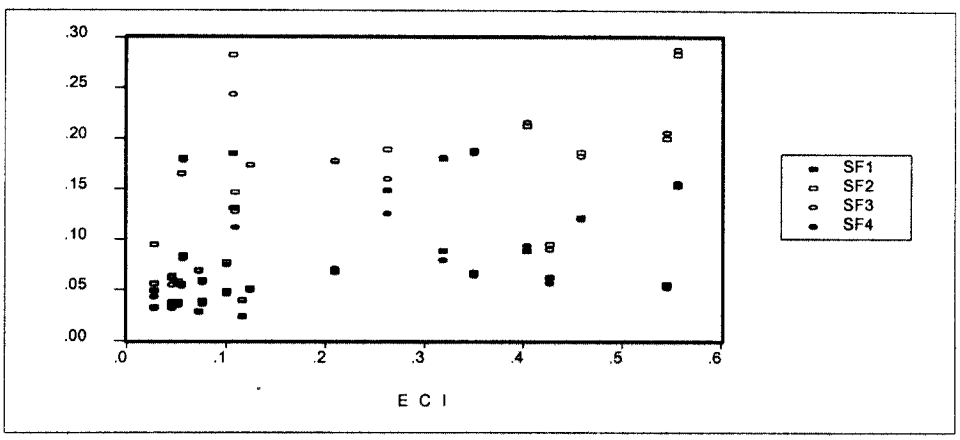
The variables are defined as in Table 3.

[Figure 2] Financial Development and Fundamentals Volatility



The DEBT is the ratio of the sum of bank debt of the private sector and the total outstanding value of non-financial corporate bonds to GNP. The fundamentals volatility, SF1, SF2, SF3, and SF4 are defined as in Table 1.

[Figure 3] Exchange and Capital Controls and Fundamentals Volatility



The ECI is the index of exchange and capital controls. The fundamentals volatility, SF1, SF2, SF3, and SF4 are defined as in Table 1.

[Table 5] Fundamental Volatilities, Financial Development, and Exchange-Capital Controls

	DEBT	CAP	FIRMS	IPO	ECI	R^2	no. of obs
SF1	-0.0715**					0.366	29
		-0.0064				0.003	30
			-0.0004*			0.096	33
				-0.0086#		0.123	29
					0.1051*	0.170	23
	-0.0468*				0.0944#	0.475	22
		-0.0237#			0.1439**	0.475	21
			-0.0004#		0.0972#	0.260	23
				-0.0079#	0.0989*	0.393	21
SF2	-0.0971**					0.230	29
		-0.0098				0.002	30
			-0.0003			0.017	33
				-0.0123*		0.086	29
					0.2474**	0.354	23
	-0.0433				0.2448**	0.550	22
		-0.0544#			0.3014**	0.588	21
			-0.0002		0.2438**	0.361	23
				-0.0070	0.2445**	0.537	21
SF3	-0.0948**					0.201	29
		-0.0091				0.002	30
			-0.0002			0.013	33
				-0.0123*		0.078	29
					0.2594**	0.412	23
	-0.0334				0.2580**	0.547	22
		-0.0524			0.3055**	0.587	21
			-0.0001		0.2573**	0.415	23
				-0.0056	0.2556**	0.542	21
SF4	-0.0686**					0.350	29
		-0.0079				0.004	30
			-0.0004*			0.108	33
				-0.0098**		0.161	29
					0.1153*	0.285	23
	-0.0360*				0.1043*	0.487	22
		-0.0204			0.1438**	0.508	21
			-0.0003*		0.1093*	0.359	23
				-0.0072*	0.1047*	0.453	21

The variables are defined as in Table 3. The results are based on the regression form; $(SF_j)_i = \varphi_0 + \varphi_1$ (Financial Development Measures)$_i + \varphi_2$ (ECI)$_i + \xi_i, j=1, \cdots, 4, i = 1, \cdots, N$, where N is the sample size. The notations located on the upper-right of parameter estimates; #, *, and ** indicate significance level of 10%, 5%, and 1%, respectively. Standard errors are White-consistent.

VI. SOME ROBUSTNESS RESULTS

Now we check how much the above results depend on the choice of fundamentals. We already used four measures of fundamental volatilities, from SF1 to SF4, based on the standard monetary model. We use the simplest type of the model without interest rates, to which the money demand is inelastic. This is to set β equal to zero in equation (6). For income elasticities, we still try two alternative values; 1 and 0.5. That is, we use two alternative combination of (α, β), which are (1.0, 0.0) and (0.5, 0.0). The measures of fundamental volatilities constructed in this way are named SF5 and SF6, consecutively.

First of all, exchange rate volatility still turns out positively linked to these alternative volatilities.

$$\underset{}{\text{STDEX}} = \underset{(0.011)}{0.015} + \underset{(0.263)}{0.632}\ \text{SF5} + \text{e}, \quad R^2 = 0.16,$$

$$\underset{}{\text{STDEX}} = \underset{(0.014)}{0.006} + \underset{(0.339)}{0.834}\ \text{SF6} + \text{e}, \quad R^2 = 0.23.$$

White-consistent standard errors are in parentheses.

The estimation results are quite similar to the cases where the SF1 through SF4 are used. That means the basic correlations between exchange rate volatility and fundamental volatility are unaffected by excluding interest rate differentials.

Next we examine if the relationship between the fundamental volatility and financial development is changed to the choice of fundamentals. Again, we use simple regression analysis using SF5 or SF6 as a dependent variable. In both cases where the financial development measures are entered individually as a regressor and are entered jointly with the measures of exchange and capital controls, regression coefficients on DEBT, FIRMS, and IPO (again except for CAP) are all different from zero at conventional significance levels of 1% to 10%. The results in Table 6 are very similar to those in Table 5. Single entrance of the measures of exchange-capital controls also maintains explanatory power. These results show that the basic correlations among the fundamental volatility and the two institutional factors; financial development and exchange-capital controls, are strong and insensitive to the inclusion of interest rate differentials into the definition of the macro-monetary divergence.

[Table 6] Fundamental Volatilities(without interest rates), Financial Development, and Exchange-Capital Controls

	DEBT	CAP	FIRMS	IPO	ECI	R2	no. of obs
SF5	-0.0714**					0.372	29
		-0.0097				0.007	30
			-0.0005*			0.120	36
				-0.0077#		0.101	29
					0.0986*	0.162	23
	-0.0512*				0.0831#	0.463	22
		-0.0243*			0.1355**	0.426	21
			-0.0004*		0.0902#	0.270	23
				-0.0076#	0.0913*	0.343	21
SF6	-0.0683**					0.359	29
		-0.0127				0.011	30
			-0.0004*			0.126	33
				-0.0090*		0.139	29
					0.1042*	0.250	23
	-0.0407*				0.0875#	0.435	22
		-0.0204			0.1297*	0.416	21
			-0.0003*		0.0980*	0.334	23
				-0.0073*	0.0908#	0.370	21

The variables are defined as in Table 3. The results are based on the regression form; $(SF_i)_i = \varphi_0 + \varphi_1$ (Financial Development Measures)$_i + \varphi_2 (ECI)_i + \xi_i, j=1, \cdots, 4, i = 1, \cdots, N$, where N is the sample size. The notations located on the upper-right of parameter estimates; #, * , and ** indicate significance level of 10%, 5%, and 1%, respectively. Standard errors are White-consistent.

Finally, we consider the issue of estimation method. The results thus far indicate that the fundamental volatility is correlated with the financial development and the exchange rate volatility, as well. We started with the causal relationship between the exchange rate volatility and the fundamental volatility using the standard monetary model. Next, we confirmed that the fundamental volatility is linked to the financial development (including exchange-capital controls). These relationships raise simultaneity issue. In the analyses thus far, to highlight the importance of each relations, we estimated the regression forms; $STDEX = \theta_0 + \theta_1 SF + \eta$, and $SF = \delta_0 + \delta_1 Z + \omega$, where Z represents financial development indicators, individually.

Now, to correct the simultaneity problem, when regressing the exchange rate volatility(STDEX) against the fundamental volatility(SF), we instrument it with the financial development indicators. The DEBT, FIRMS, IPO, and ECI, individually, is used as a instrumental variable.[11] Table 7 shows estimation

[11] Among instrumental variables, the CAP is excluded. As the ratio of equity market capitalization to GDP, it is presumably a good indicator of financial development. In the analyses thus far, however, it is not found to be correlated with the fundamental volatility. This may reflect the fact that it is sensitive to fluctuations in valuations.

results.

[Table 7] Exchange Rate Volatility and Macroeconomic Volatility: Estimation with Instrumental Variables

explanatory variable	parameter estimated (θ_1) using the instrumental variables:			
	DEBT	FIRMS	IPO	ECI
SF1	0.541 (0.066)	1.633 (0.026)	1.319 (0.039)	1.099 (0.246)
SF2	0.398 (0.074)	2.435 (0.403)	0.924 (0.030)	0.467 (0.278)
SF3	0.407 (0.080)	2.723 (0.449)	0.921 (0.023)	0.445 (0.282)
SF4	0.564 (0.059)	1.708 (0.011)	1.158 (0.006)	1.002 (0.241)
SF5	0.541 (0.064)	1.553 (0.019)	1.460 (0.062)	1.172 (0.249)
SF6	0.566 (0.053)	1.665 (0.006)	1.260 (0.009)	1.109 (0.242)
no. of obs	29	33	29	23

The STDEX, SF1 through SF6, DEBT, FIRMS, IPO, and ECI are defined as in previous tables. The results are based on the regression form; $(\text{STDEX})_i = \theta_0 + \theta_1 (\text{SF}_j)_i + \eta_i, j=1, \cdots, 6$, and $(\text{SF}_j)_i = \delta_0 + \delta_1 Z_i + \omega_i, Z=$ DEBT, FIRMS, IPO, and ECI, respectively, $i = 1, \cdots, N$, where N is the sample size. P-values are in parentheses and White-consistent.

The parameter estimates, representing the effect of the fundamental volatility on the exchange rate volatility, range from 0.4 to 1.7, depending on the fundamental volatility indicators and instrumental variables used. As expected, standard errors increase and look dependent on the sample size. When DEBT is used as instrument, the effect of SF on STDEX is statistically significant at 10% level. Using FIRMS gives mixed results. While having imprecise estimates for SF2 and SF3, it gives much lower p-values for other fundamentals volatility indicators. When IPO is used, the effect remains statistically significant for all indicators. When ECI is used as instrument, however, the effect turns out statistically insignificant. This result may result from the shortage of sample size or the wrong choice of instrument.

Overall, the basic findings on the relation between the fundamental volatility and the exchange rate volatility look unchanged even when simultaneity problem is accounted for. The financial development indicators such as DEBT, FIRMS, and IPO, which are highly (negatively) correlated with the fundamental volatility, serve as good instruments. There might exist causal chains running from the macroeconomic volatility to the exchange rate volatility. Also, the financial development, the underlying economic structure, has at least indirect effect on the exchange rate volatility via its effect on the macroeconomic volatility.

V. CONCLUSION

We investigated the connection between the exchange rate volatility and the underlying fundamentals volatility, and found that the two volatilities are correlated. This result is in contrast to the findings of Flood and Rose(1995) and Rose(1996), which relied on a set of data consisting of major industrial countries. Using more recent periods and extending sample including underdeveloped and developing countries give different results. This finding casts doubts on the robustness of the results of Flood and Rose, who advocated for fixing rather than floating exchange rate regime based on their findings.[12] Our findings indicate a flexible exchange rate need not be an unstable exchange rates. It also means that the domestic macroeconomic stabilization policy aimed at reducing exchange rate volatility is still valid and important.

Besides macroeconomic policy under the floating regime, then, which institutional factors matters for the reduced fundamentals volatility associated with exchange rate fluctuations? We found the importance of two factors: the financial development and the reduction in exchange and capital controls. Various indices of financial development and exchange-capital controls are found to affect macroeconomic volatility.

The following interpretation could be given to the collection of facts we found here. There is some fundamental driving force between financial underdevelopment, macroeconomic instability, and exchange rate volatility all at the same time.[13] The financial underdevelopment tends to worsen information and monitoring problems, and limits prompt reallocation and proper aggregation of resources, creating excessive fluctuations in macroeconomy and foreign exchange markets as well. Exchange and capital controls, found to increase macroeconomic volatility, also raise the issue of the development of financial markets, both domestically and in their integration to international financial markets.

Fixing exchange rates or imposing bands are popular candidates reducing instability of exchange rates. However, it is impossible to pursue the following three policies together: fixed exchange rate, free capital mobility, and independent monetary policy. Our results indicate a more promising approach to reduce exchange rate volatility is to reduce macro and monetary divergence. Specifically, reducing domestic inflation and the instability it causes should be emphasized since exchange rates basically reflect differentials of prices. First of all, low credibility and unstable money supply (expectations) should be avoided. In this respect, efforts to reform monetary institutions should focus directly on restrain-

[12] The issues on the optimal choice of exchange rate system are very complex. They require serious and massive empirical analysis, much of which are not yet established.

[13] Concerning the link between financial structure and macroeconomic stability, Cecchetti and Krause(2001) found that, macroeconomic stability has been accompanied by changes in financial structure, especially, declines in the level of bank assets owned by the government, which enhanced the efficiency of monetary policy.

ing domestic inflation. The inflation targeting or having genuinely independent central bank with conservative principles could help mitigate both inflation and inflationary expectations.

Besides the stabilization policy, some structural measures to reduce domestic financial market imperfections and foreign exchange market restrictions could help reduce macroeconomic instability, even though they would take time. The financial development in the sense of alleviating information problems, is now believed to mitigate the endogenous propagation and amplification of shocks to macroeconomy. The financial development has another important aspect. Although financial markets often respond with delay and overreact, in general they impose a strong discipline on governments and central banks to adopt better economic policies, thereby reducing wasteful fluctuations of the economy.

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