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Exchange rates and global volatility: implications for Asia-Pacific currencies[1]

At times of heightened global equity and bond market volatility, high-yielding currencies tend to depreciate while low-yielding ones tend to serve as a "safe haven". The whole spectrum of sensitivity to global volatility is represented among Asia-Pacific currencies.

JEL classification: F3, G1.

Emerging market and industrial currencies offering relatively high yields tended to appreciate in 2006 against lower-yielding currencies, except during the sell-off in May and June. Among Asia-Pacific currencies, the Indonesian rupiah, the Philippine peso and even the Australian dollar offer examples of this pattern. Thus, much of the year's trading added to the increasing body of findings (once considered anomalous) that higher-yielding currencies tend to appreciate against lower-yielding currencies (Hodrick (1987), Froot and Thaler (1990), Lewis (1995), Engel (1996), Remolona and Schrijvers (2003)). The sell-off of high-yielding currencies in May 2006, by contrast, supported Irving Fisher's earlier thesis that the higher-yielding currency would tend to depreciate, over time, against the lower-yielding currency, offsetting the yield advantage.

This alternating currency performance forms part of a broader pattern in which a spectrum of high-yielding currencies tend at times to be stable or firming and at other times to depreciate against their low-yielding counterparts. Kumar and Persaud (2002) used these alternating phases of currency returns to define states of low or high risk aversion. Others have since constructed indicators of risk aversion directly from interest rate spreads or capital market volatility (Tarashev et al (2003); see Illing and Aaron (2005) for a survey). Most large international banks now publish risk/volatility or risk aversion indicators for their clients. Currency strategists like Davies (2005) have often related currency returns to such risk indicators in their daily work.

This special feature investigates the relationship between exchange rates and global capital market volatility, and draws some implications thereof for Asia-Pacific currencies. It first reports patterns of exchange rate responses

[1] Our thanks go to Eric Chan for research assistance and members of the EMEAP Forum for discussion. All errors remain the responsibility of the authors. The views expressed are those of the authors and not necessarily those of the BIS.

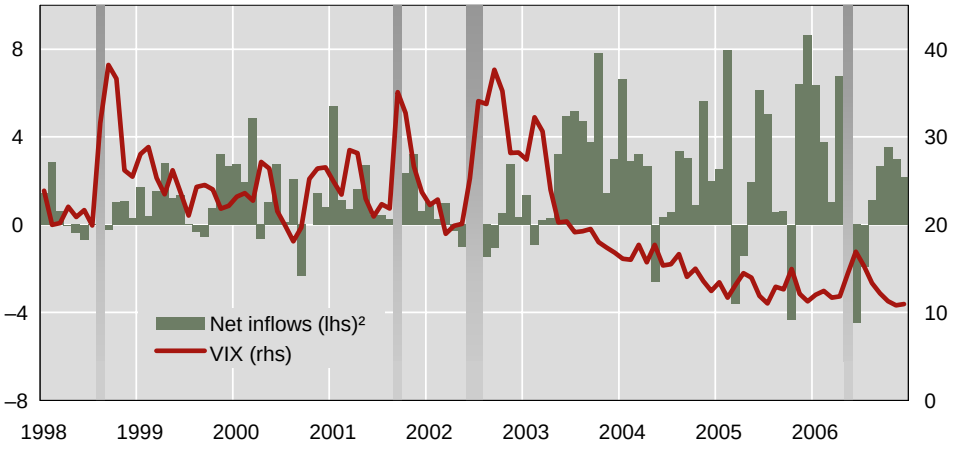
among a broad range of currencies during specific recent episodes of heightened volatility. It then considers exchange rate sensitivity to volatility more generally by relating weekly changes in these currencies to the corresponding weekly changes in capital market volatility over the period 2000–06 as a whole. These two analyses find that certain currencies tend to be stable or to appreciate as volatility rises, while others tend to weaken at such times. The third part of this article relates the differences in currency responses to certain country characteristics. This cross-sectional analysis finds that economies offering higher short-term interest rates tend to see their currencies depreciate against lower-yielding currencies in periods of rising capital market volatility. This regularity poses challenges to Asian exchange rate stability that are discussed in the conclusion.

Exchange rate movements in episodes of higher volatility

In four episodes of high global volatility …

Is there any discernible pattern across currencies in their responses to bouts of rising volatility? Looking back over the past decade, there were several notable episodes of heightened global volatility, as indicated by sharp spikes in indicators such as the widely used VIX index (Graph 1).[2] These episodes occurred in August 1998, September 2001, June–July 2002 and May

Global volatility and Asian net equity inflows[1]



Note: The shaded areas refer to four episodes of rising volatility; see footnote 3 in the main text.

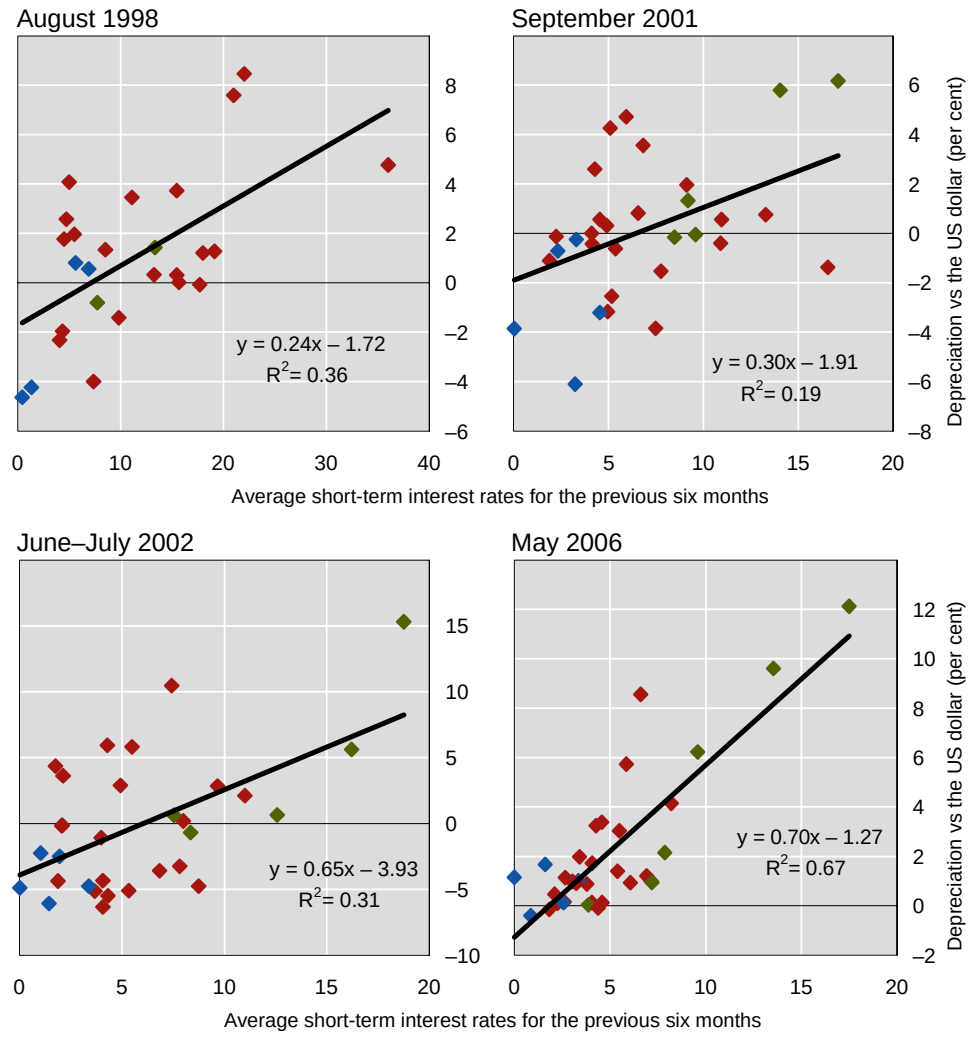
[1] Net foreign purchases of equities in India (data start in 1999), Indonesia, Korea, the Philippines, Taiwan (China) and Thailand. [2] In billions of US dollars.

Sources: Bloomberg; CEIC; Korean Stock Exchange; Philippines Stock Exchange; BIS calculations.

Graph 1

[2] The Chicago Board Options Exchange Volatility Index (VIX) is a measure of market expectations of near-term volatility, as conveyed by S&P 500 stock index option prices. VIX has been used by many as a barometer of investor sentiment and market volatility since its introduction in 1993.

Currency depreciation and interest rates in volatile periods



Note: Blue markers represent generally low-yielding currencies (JPY, CHF, SGD, TWD and EUR), while green markers represent relatively high-yielding ones (TRY, IDR, BRL, RUB, PHP and INR). Currencies with interest rates above 40% and those fixed to the USD are excluded. The HKD 12-month forward and CNY 12-month NDF are used to represent HKD and CNY respectively. For August 1998, the inclusion of RUB, IDR, TRY, ARS and BRL results in a slope of 0.1266 and R^2 of 0.0393. For September 2001, the inclusion of TRY, ARS and MYR results in a slope of 0.1201 and R^2 of 0.2390. For June–July 2002, the inclusion of TRY, ARS and MYR results in slope of 0.2399 and R^2 of 0.2735. Interest rates are either money market rates (60b) or treasury bill rates (60c) from the IMF.

Sources: IMF, *International Financial Statistics*; Bloomberg; BIS calculations. Graph 2

2006.[3] This last episode did not show up as an especially sharp spike in absolute terms, but it nonetheless represented a larger than normal rise in the volatility index relative to the low levels prevailing at the time.[4] In emerging

[3] The episodes are defined as starting with either a discrete event (eg the Russian default, the 11 September terrorist attacks) or when the VIX index first deviated by more than one standard deviation from its three-month moving average. The episodes are defined as ending with the first peak of the VIX index. The four episodes are thus dated: 17–31 August 1998 (Russian default), 10–20 September 2001 (terrorist attacks), 3 June–23 July 2002 (multiple factors, including geopolitical tensions and the WorldCom accounting scandal and bankruptcy) and 11–23 May 2006 (multi-market sell-off).

[4] The May 2006 episode saw only a 5.8 point increase in the VIX, compared to the 12.4, 11.9 and 21.6 point rises in the three earlier episodes.

Asia, the May 2006 episode also saw heavier net sales of equities by non-residents than in the earlier episodes.

… high-yielding currencies tended to depreciate …

During these four episodes, currencies performed in a manner qualitatively consistent with Irving Fisher's hypothesis. Relatively low-yielding currencies such as the Swiss franc (traditionally a "safe haven" currency), the yen and the euro generally appreciated against the US dollar (Graph 2), while higher-yielding currencies such as the Russian rouble, Brazilian real and Turkish lira tended to depreciate. The responses of Asia-Pacific currencies in these episodes offer some further evidence in support of this global dichotomy: low-yielding currencies such as the New Taiwan dollar and the Singapore dollar depreciated relatively little or appreciated in some cases, while higher-yielding ones such as the Indonesian rupiah and the Philippine peso weakened in most episodes. The moderately high-yielding Australian and New Zealand dollars also tended to depreciate. However, the pattern among other currencies is not as clear-cut. For instance, the Indian rupee and the Korean won reacted in a mixed fashion across episodes.

… especially in May 2006

Looking across the episodes, the link between currency performance and average interest rate levels prior to the episode was the tightest during the relatively mild (in terms of the point increase in the VIX) May 2006 episode. Along the least-squares line, currency depreciation over eight business days cost investors about eight months of interest rate premium. Admittedly, industrial economy currencies tended to rise less against the US dollar compared to the experience in the three earlier episodes. In particular, the weakness of the yen against the dollar in May 2006 left emerging Asian currencies especially exposed to the rise in global volatility, given these currencies' tendency to co-move with the US dollar/yen rate (Kawai (2002), Ho et al (2005)).

Regression analysis of volatility and currency performance

Weekly changes in bilateral and effective exchange rates show …

Stepping back from specific episodes, how does currency performance relate to changes in global volatility in general? To assess a currency's overall sensitivity, we regress the percentage change in the currency's exchange rate on the change in global volatility. To control for the regular response of the currency to the movements among the major currencies, the percentage changes in the yen and the euro against the US dollar are included as additional explanatory variables. 34 currencies, including 13 Asia-Pacific currencies, are included in the analysis.[5] Both the bilateral US dollar exchange rates of these currencies and their nominal effective exchange rates (NEERs) were assessed. Two different volatility indicators are considered: the VIX and a

[5] These economies' currencies are covered: Argentina (ARS), Australia (AUD), Brazil (BRL), Canada (CAD), Chile (CLP), China (CNY), Colombia (COP), the Czech Republic (CZK), Denmark (DKK), Hong Kong SAR (HKD), Hungary (HUF), India (INR), Indonesia (IDR), Israel (ILS), Japan (JPY), Korea (KRW), Malaysia (MYR), Mexico (MXN), New Zealand (NZD), Norway (NOK), the Philippines (PHP), Poland (PLN), Russia (RUB), Singapore (SGD), Slovakia (SKK), South Africa (ZAR), Sweden (SEK), Switzerland (CHF), Taiwan, China (TWD), Thailand (THB), Turkey (TRY), the United Kingdom (GBP), the United States (USD) and the euro area (EUR).

composite implied volatility index ("composite index"). While the VIX is derived from US stock market volatility only, the composite index is a more global indicator averaging eight measures of equity and bond market volatility in four major economies.[6] The regressions were performed on weekly changes (Wednesday to Wednesday) over the period January 2000 to December 2006.

Table 1 reports the two sets of estimated coefficients, which indicate the percentage change in the bilateral US dollar exchange rate that is associated with a 1 point change in the two volatility indicators, controlling for changes in the euro's and yen's value against the US dollar.[7] For instance, the estimated sensitivity of the Indonesian rupiah towards the VIX of 0.112 means that, on average, the currency would depreciate by 0.56% in the presence of a 5 point rise in the VIX. Unsurprisingly, this period average result is an order of magnitude smaller than the rupiah's actual movement in May 2006, when the VIX rose by about 5 points.

Regression coefficients relating volatility to US dollar exchange rates

Currency	VIX	Composite	Currency	VIX	Composite	Currency	VIX	Composite
ARS	0.065	0.074	HKD F	0.005	0.011*	PHP	**0.054****	0.085*
AUD	0.140***	**0.347*****	HUF	**0.053****	0.050	PHP NDF	0.035	0.097
BRL	0.144**	**0.307*****	IDR	**0.112*****	0.219***	PLN	0.138***	0.299***
CAD	**0.069*****	0.177***	IDR NDF	0.159***	0.281***	RUB	–0.004	0.024
CHF	–0.057***	–0.114***	ILS	0.059***	0.121***	SEK	0.089***	0.211***
CLP	0.155***	0.298***	INR	0.020**	0.041**	SGD	0.014	0.024
CNY	0.005	0.042	INR NDF	0.045***	0.099***	SKK	0.045***	0.108***
CNY NDF	0.004	0.029*	JPY	0.002	–0.068	THB	0.010	0.056*
COP	0.087***	0.186***	KRW	0.092***	0.182***	TRY	0.285***	0.614***
CZK	0.014	0.071**	KRW NDF	0.033*	0.128***	TWD	0.031**	0.056**
DKK	0.000	0.003	MXN	0.065**	0.116**	TWD NDF	0.020	0.054*
EUR	–0.046	–0.121*	MYR	–0.015	0.029	ZAR	0.044	0.236**
GBP	0.004	–0.016	NOK	–0.000	0.080**	PAIF	0.019**	0.059***
HKD	–0.001	0.000	NZD	0.076**	0.204***	ADXY	0.016**	0.053***

Note: The coefficients indicate the percentage change in the corresponding currency associated with a 1 percentage point change in the volatility index. * Significant at the 10% level. ** Significant at the 5% level. *** Significant at the 1% level. NDFs are three-month rates except for CNY NDF (12-month). HKD F is the 12-month forward rate. PAIF and ADXY are composite Asian currency indices. The sample period is 2000–06, except ARS (from June 2003) and spot CNY, HKD and MYR (from 22 July 2005). Exchange rates and volatility indicators are New York closes. Spot rates that trade only in Asian hours (CNY, IDR, INR, KRW, MYR, PHP and TWD) enter the regressions with a one-day lead. For the EUR and JPY regressions, only the volatility indicator is used as explanatory variable. A full version of this table including the estimated coefficients on JPY and EUR changes is available upon request.

Sources: Bloomberg; BIS calculations. Table 1

[6] The composite index is the simple average of the equity and 10-year swap implied volatilities for each of the United States, the United Kingdom, the euro area and Japan, ie eight series in total, with the VDAX serving as the equity volatility for the euro area. Here no attempt is made, as in Tarashev et al (2003), to decompose investors' risk aversion from the level of risk per se. Regression analysis of currency changes against their monthly index of risk aversion produced similar results.

[7] In terms of direction, a positive coefficient on the volatility indicator means the currency tends to depreciate when the volatility indicator rises in value (ie more risk or risk aversion).

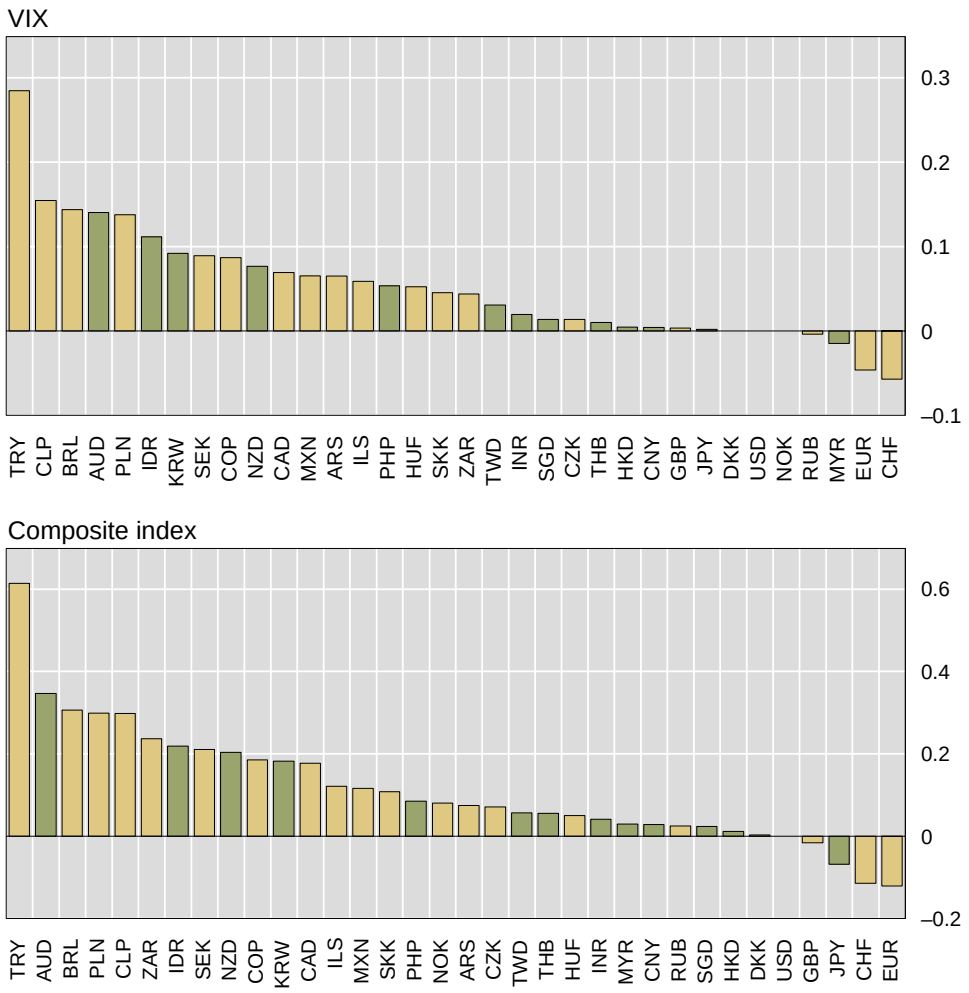
There are several notable observations. First, even when the often significant influences of yen and euro movements are controlled for, most of the currencies still exhibit significant sensitivity towards at least one of the two volatility indicators. Estimated sensitivities to the composite index tend to be more statistically significant than those to the more volatile VIX. However, the differences between the two sets of estimated sensitivity should not be overstated – the correlation between the two is 0.96 while the Spearman rank correlation is 0.91.

… patterns of significant responses of currencies …

Second, the regression results are generally in line with observations from the episodic analysis above. The Swiss franc, the euro and to some degree the yen tend to have negative sensitivities towards the volatility indicators, meaning that they tend to strengthen against the dollar when volatility rises (Graph 3).[8] By contrast, emerging market currencies generally depreciate in an environment of elevated volatility. Overall, the Turkish lira stands out for its

… in line with experience during specific episodes

US dollar exchange rate sensitivity to global volatility, 2000–06



Note: HKD is the HKD 12-month forward, while CNY is the CNY 12-month NDF.

Source: See Table 1.

Graph 3

[8] Including the euro and yen as controls in the non-major currency equations leaves their ranking of estimated sensitivities invariant to the choice of numeraire.

high sensitivity. Among the Asia-Pacific currencies, the Australian, Indonesian, Korean, New Zealand and Philippine currencies show relatively high sensitivities to changes in global volatility.

Mixed evidence of exchange rate management constraining sensitivity

Third, there is some, albeit mixed, evidence that currency management constrains exchange rate responses to changes in global capital market volatility. If exchange rate management by the authorities, as in much of Asia for example, constrains the response of the spot exchange rate, it is potentially informative to try to measure the response of forward rates or offshore non-deliverable forward (NDF) rates. Ma et al (2004) show that, owing to capital restrictions, Asian NDFs are generally not tightly bound by arbitrage to the more controlled spot exchange rates. Consequently, NDF volatilities tend to be higher than spot rate volatilities. Accordingly, the Indian rupee and Indonesian rupiah NDFs have higher estimated sensitivities than the respective spot rates (Table 1). Even for the Hong Kong dollar, whose pegged spot rate hardly responds to changes in volatility, the more volatile one-year forward rate shows a small but statistically significant sensitivity to the composite indicator. However, stronger responses are not obtained for the NDFs of the Chinese renminbi, the New Taiwan dollar and the Philippine peso, for which spot market intervention is generally thought to be quite frequent and capital controls still effective.

Bilateral dollar and effective exchange rates results are consistent

Finally, the effective exchange rates of most currencies tend to be less sensitive to volatility than their bilateral rates, owing to the collective weight of trading partners' currencies that also depreciate when volatility rises. For the same reason, currencies with low or negative bilateral exchange rate sensitivities to volatility tend to have effective exchange rates that appreciate even more than their bilateral dollar rates for a given rise in the volatility indicator. The US dollar depreciates very slightly in effective terms in response to rises in the VIX or composite index. Overall, the results using the bilateral US dollar exchange rates and the effective exchange rates are quite similar.[9]

The determinants of currency sensitivity to global volatility

Out of 11 factors tested …

What factors underlie these measured sensitivities to global volatility? As seen already in the episodic analysis, currency reactions seem to relate to the prevailing short-term interest rate levels. To answer this question more systematically, we perform a strictly cross-sectional analysis, relating the estimated sensitivities to various economic characteristics over the entire 2000–06 period.[10]

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[9] The bilateral-NEER correlation is 0.92 in the case of the VIX and 0.96 in the case of the composite indicator. The Spearman rank correlation coefficients are very close at 0.91 and 0.95, respectively.

[10] The estimated sensitivities for 33 currencies are included in this analysis (MYR is excluded). For Hong Kong SAR and China the 12-month forward rate and 12-month NDF respectively are used. Short-term interest rates are money market rates as defined by the IMF *International Financial Statistics*. IMF data are used for current account as a percentage of GDP (2000–06 average), GDP per capita (in USD terms at market exchange rates) and inflation. The net international investment position (NIIP) as a percentage of GDP (2000–06 average) is from Lane and Milesi-Ferretti (2006). 2004 data are used for 2005 and 2006. Foreign exchange

These variables are chosen to capture four broad types of factors that could potentially affect currency sensitivity to changes in global volatility: "carry" (relative interest rates), depreciation and credit risks, external financing requirements and liquidity. For "carry", both short-term interest rates and the inflation rate are included to determine whether international investors are attracted by nominal or real returns.[11] Depreciation risk is proxied by the ratio of reserves to imports, while creditworthiness is proxied by the credit rating and GDP per capita. Financing requirements are captured on a stock basis by the net international investment position (NIIP) and on a flow basis by the current account.[12] Liquidity is represented by each currency's turnover, both in US dollar terms and in relation to trade, to non-resident portfolio investment and to non-resident equity portfolio investment.[13]

Some high bivariate correlations between these economic variables and the estimated currency sensitivities are observed. The short-term interest rate variable shows the strongest correlation (over 0.75), followed by inflation (over 0.6) and NIIP as a ratio to GDP (stronger than –0.44). The credit rating, GDP per capita, current account balance and FX market liquidity show correlations between 0.25 and 0.4 in absolute value.

When these variables showing strong bilateral correlations are made to compete against each other in a multiple regression framework, a remarkably parsimonious empirical account of the sensitivities emerges (Table 2).[14] Two findings stand out.

… short-term interest rates dominate …

First, even after controlling for other economic variables, the short-term interest rate dominates, showing a very significant positive association with currency sensitivity. One way of reading this finding is that investment strategies that target high-yielding currencies (eg carry trades) are vulnerable to rises in global volatility. Inflation, which is highly correlated with the level of interest rates across countries, seems to play no independent role.

Admittedly, high-inflation and high-interest-rate currencies in the sample (the Brazilian real and the Turkish lira) contribute to this strong cross-sectional relationship between interest rate level and currency sensitivity. But even if

(FX) market liquidity is proxied by the FX turnover of each currency from the 2004 triennial survey (BIS (2005)).

[11] It might seem that interest rate spreads, rather than levels, would be the appropriate regressor. However, the correct base currency for calculating the spread would have to be fine-tuned currency by currency, taking into account the "betas" with respect to the yen and the euro. Recall that the regression analysis in effect works on the difference between each currency's interest rate and the sample average. If our not fine-tuning each currency's spread is considered an error in the variable, then the usual analysis applies: the coefficient on short-term interest rates would be biased towards zero.

[12] See IMF (2006, p 14) for the relationship between emerging market currency performance in May–June 2006 and the current account deficit.

[13] IMF (2006, p 13) suggests a variant of the latter two variables that includes only investment in local currency bonds and equities as an operationalisation of the notion of "crowded trade", that is, a position with potentially large reversals in relation to the liquidity of one of the underlying markets.

[14] The remaining four variables with low bilateral correlations were tested and found to be jointly insignificant.

US dollar exchange rate sensitivity and macroeconomic variables: estimation results								
	VIX				Composite index			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Intercept	0.008	–0.017	0.055	0.011	–0.051	–0.041	–0.110	0.025
	(0.916)	(0.790)	(0.188)	(0.310)	(0.769)	(0.778)	(0.250)	(0.297)
Short-term interest rate	0.008***	0.006***	0.006***	0.007***	0.018***	0.014***	0.014***	0.014***
	(0.002)	(0.000)	(0.000)	(0.000)	(0.003)	(0.000)	(0.000)	(0.000)
Inflation	–0.003	-	-	-	–0.005	-	-	-
	(0.369)	-	-	-	(0.517)	-	-	-
Credit rating (log)	–0.010	-	-	-	0.040	-	-	-
	(0.751)	-	-	-	(0.581)	-	-	-
GDP per capita (log)	0.013	0.013	-	-	0.019	0.028	-	-
	(0.216)	(0.150)	-	-	(0.435)	(0.188)	-	-
NIIP/GDP	–0.025	–0.023*	–0.019	–0.022*	–0.059	–0.046	–0.037	–0.042
	(0.208)	(0.060)	(0.120)	(0.073)	(0.193)	(0.105)	(0.185)	(0.124)
Current account/GDP	0.000	-	-	-	0.002	-	-	-
	(0.986)	-	-	-	(0.735)	-	-	-
FX market liquidity (log)	–0.009	–0.010*	–0.004	-	–0.021	–0.019	–0.009	-
	(0.117)	(0.077)	(0.271)	-	(0.119)	(0.120)	(0.357)	-
Adjusted R^2	0.591	0.621	0.605	0.602	0.550	0.578	0.566	0.568

Note: Specifications (2) – (4) exclude variables with the highest p-values in the previous specification.

Sources: Lane et el (2006); IMF, *International Financial Statistics*; Bloomberg; BIS (2005); BIS calculations. Table 2

these extreme observations are removed from the sample, the positive relationship still holds, indeed, to the exclusion of the other surviving variable in the full-sample case (Graph 4).

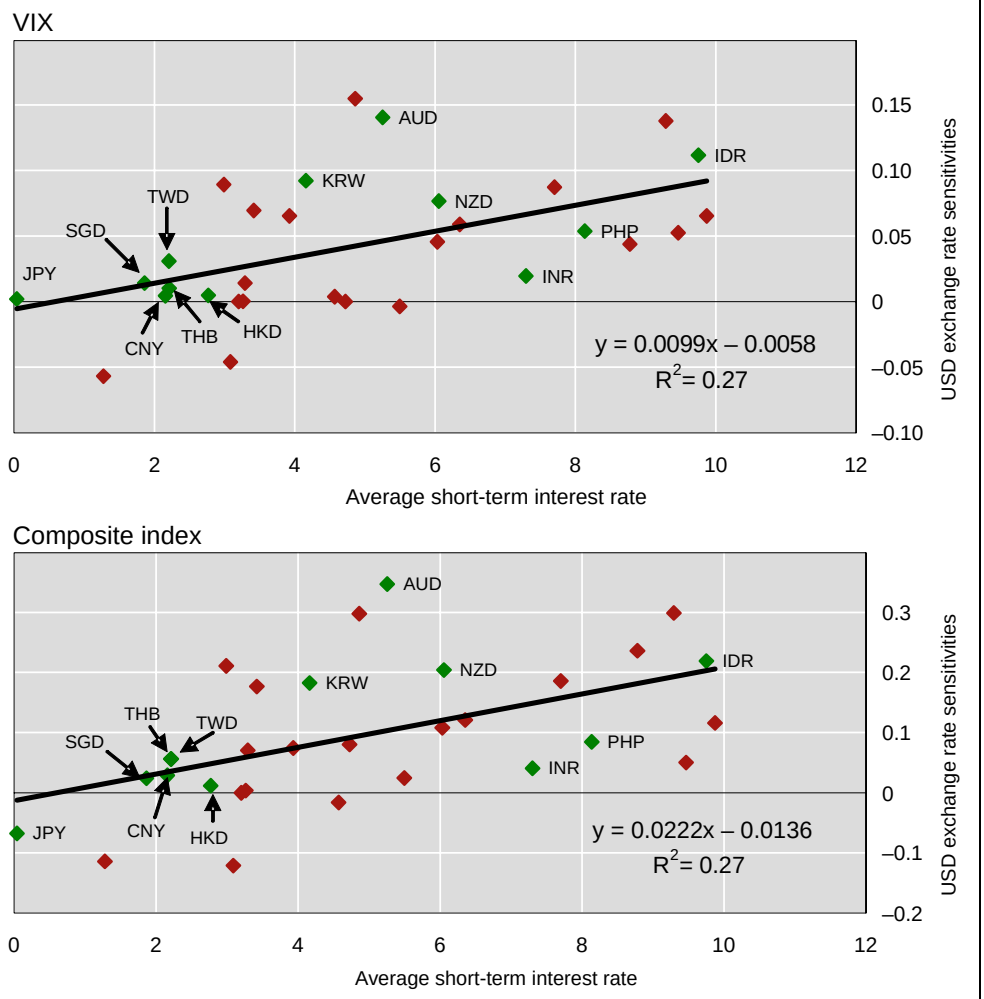
… while external financing also matters

Second, balance of payments fundamentals are found to have some, but less consistent, influence over currency sensitivity. The NIIP in relation to GDP (though not the current account) survives the multiple regression analysis of sensitivity to the VIX. The larger an economy's net international liabilities, the more prone its currency is to depreciation in volatile times. This result lends some support to the widespread view that long currency positions tend to be cut back in periods of rising global volatility, leading to potentially larger declines in currencies with heavier debt burdens to roll over.

The two main findings above help to make sense of the different sensitivities among Asia-Pacific currencies. The Australian and New Zealand dollars, with relatively high interest rates and large external liability positions, are hit hard by upsurges in global volatility. In contrast, even though interest rates are also high in Indonesia and the Philippines, the influence of rising global volatility may be offset to some extent by the ongoing contribution of the two economies' current account surpluses to their external positions. In the rest of Asia, generally lower interest rates and external surpluses tend to limit currency sensitivity to changes in global volatility.

Currency sensitivities and interest rate levels

2000–06; sample excluding Brazilian real and Turkish lira



Note: The p-value on the interest rate is 0.0026 in the case of the VIX and 0.0027 in the case of the composite index.

Sources: IMF, *International Financial Statistics*; Bloomberg; BIS calculations. Graph 4

Caveats may apply

Still, the statistical link traced above between interest rate levels and balance of payments fundamentals, on the one hand, and currency sensitivity, on the other, may not represent the final word. For instance, threshold effects and non-linearities may play an unexplored role. Moreover, differences in the style and intensity of exchange rate management by the authorities have not been formally accounted for in the cross-sectional analysis. To some extent, the currencies that respond to volatility may be the ones that are allowed to do so. One approach to account for exchange rate management would be to include a measure of exchange rate flexibility as an explanatory variable. However, such measures (eg realised currency volatility) could approximate the currency sensitivities that are to be explained, so that their use would risk circularity. The mixed results above from comparing NDF and spot rate sensitivities suggest that our omission of exchange rate management may not be too harmful. Still, caution in interpreting these results is called for.

Conclusions

Both episodic and regression analysis of the years 2000–06 provides evidence of a systematic pattern of sensitivities of various currencies to changes in global capital market volatility. Much of this pattern of currency sensitivities can be accounted for by the level of short-term interest rates and, to a lesser extent, the scale of net international liabilities.

Looking across the Asian currencies, there is some prospect for them to respond more similarly to changes in global volatility. Thus far in this century, the higher interest rate currencies, the Indonesian rupiah and the Philippine peso, have been somewhat sheltered from changes in global volatility by their responsiveness to the yen. Nevertheless, shifts in global volatility tend to strain cross rates between such currencies and lower-yielding Asian currencies. Going forward, the convergence of inflation rates in the region would tend to reduce interest rate differentials. This would in turn tend to narrow the current differences in the response of various currencies in the region to a change in global volatility.

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