A Global Perspective on Extreme Currency Linkages

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Abstract

We apply new methods of extreme value analysis to discuss the size and likelihood of extreme currency returns and particularly of extreme co-movements between currencies. The sample covers the four main industrial country currencies and 10 emerging market currencies from altogether 4 continents between 1980 and 2001. The univariate analysis confirms the conventional wisdom that emerging market country currencies clearly exhibit larger and more frequent extreme returns than the industrial country currencies. However, the bivariate analysis suggests that once a crisis has struck, the breadth of it across currencies is not more severe among emerging markets than among industrial countries. Hence, somewhat surprisingly these results imply that currency contagion is not more severe for emerging economies than for industrial economies, although crisis situations as such are more frequent in the latter group. We also find extreme negative co-movements among East Asian currencies to be much more pronounced than among South Amerian currencies. Finally, we do not find evidence in favour of frequent extreme negative spillovers between industrial country and emerging market currencies.

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1 Introduction

Various financial crises during the 1990s have led policy makers, market participants and academic scholars to make special efforts to better understand the spreading of instability across international capital markets and implement precautions against widespread collapse. On the policy side the international financial institutions (IMF, World Bank, Bank for International Settlements, Financial Stability Forum etc.), central banks and national supervisory bodies spent extra efforts to improve macro-prudential surveillance and regulations of financial institutions (see e.g. Hunter, Kaufman and Krueger, 1999). On the market side, new portfolio risk management and hedging tools are developed and new institutions are built to ensure safer cross-border settlement procedures (see e.g. the Continuous Linked Settlement (CLS) Bank for foreign exchange transactions). Finally, a new theoretical and empirical literature on systemic risk and contagion has emerged in academia and policy research departments, studying the breadth, underlying causes and propagation mechanisms of financial crises (see De Bandt and Hartmann (2000) for a recent survey).

Almost by definition foreign exchange markets are a primary locus of the international transmission of shocks and financial crises. Foreign exchange spot and derivatives markets are the largest financial markets in the world. For the international investor they connect money, bond and stock markets of different countries. Investors' benchmark performance in their respective home currency can change dramatically even if a foreign investment's local performance does not. Even market-oriented economists observe occasionally long-term misalignments of exchange rates, biasing project performance from the perspective of an outside investor, or sudden jumps in exchange rates causing heavy (short-term) losses to financial institutions caught on the wrong side of the market. At least the former can also have important macroeconomic implications for open economies. For these reasons we want to focus on extreme movements observed in global currency markets and particularly the co-movements of extreme exchange rate returns in this paper. We want to ask the question whether certain currencies are more prone to crashes than other currencies and whether certain currency pairs crash together more frequently than others. We quantify the likelihood of extreme currency crashes and co-crashes for a sample of 4 major industrial countries and 10 non-industrial countries, covering 4 continents. We are able to use a sample of almost 22 years of weekly exchange rate returns, extending from 1980 to 2001.

Our methodological approach is extreme value analysis (EVA), the statistical technique for studying the tail behaviour of distributions. This technique is particularly well designed to address the occurrence of financial market crises, which are rare events located far out in the tails of empirical return distributions. In a univariate setting this approach has been used to study the frequency of currency market (Koedijk, Schafgans and de Vries, 1990; Hols and de Vries, 1991), stock market (Jansen and de Vries, 1991; Longin, 1996) and bond market crashes (Hartmann, Straetmans and de Vries, 2001) in industrial countries. Koedijk, Stork and de Vries (1992) study the tail behaviour of 12 South American black market exchange rates. In this paper we also provide a univariate analysis of the fatness of exchange rate tails and the likelihood of currency market crashes. In contrast to the previous literature, however, we also include currencies from Asia and Africa and use a more recent sample period. More importantly, we extend the analysis of extreme exchange rate fluctuations by a bivariate perspective, measuring the co-occurrence of currency market crashes (and booms).

We apply the conditional co-crash measure presented in Straetmans (2000), Embrechts, de Haan and Huang (2000) and Hartmann, Straetmans and de Vries (2001) to industrial country and emerging market exchange rates. This measure specifies, for example, how likely it is that the yen and the mark simultaneously depreciate by more than 10% against the dollar, given that at least one of the two is falling by this magnitude. An advantage of the semi-parametric estimator we use for our co-crash measure is that we do not have to assume a uniform probability law for the very diverse emerging market currency returns. Moreover, the measure easily captures non-linearities, in contrast for example to traditional correlation based analysis. The former aspect may be particularly valuable when many markets are studied and compared, in particular for emerging market currencies, as the case in the present paper. The latter aspect is of course particularly relevant for crisis situations, the focus of this paper.

Bivariate extreme value analysis has recently also been applied to stock market returns by Straetmans (2000) and by Longin and Solnik (2001, who assume a logistic distribution for the joint return process). Ramchand and Susmel (1998) estimate large and small stock market spillovers using a bivariate regime-switching ARCH model. Bae, Karolyi and Stulz (2001) again follow a different line by applying a multinomial logistic regression model to a sample of 17 emerging market stock indices. Hartmann et al. (2001) apply bivariate EVA to stock and government bond markets to also study crises cutting across different asset classes and the "flight to quality" phenomenon.[2]

Our work is also related to the literature on the co-occurrence of speculative currency attacks. Eichengreen, Rose and Wyplosz (1996) estimate a binary probit model for a panel of 20 industrial country currencies to test whether the occurrence of a speculative attack in one country increases the probability of a speculative attack in other countries. An important difference between our approach and theirs is that we consider only effective depreciations whereas their approach also considers unsuccessful currency attacks, by combining exchange rate returns with interest rate differentials and reserve sales in one index of currency crises. They argue that currency crises, defined as an index value of 1.5 standard deviations or more above the sample mean, explain other currency crises beyond macroeconomic fundamentals. Sachs, Tornell and Velasco (1996),

[2] Following the early article by King and Wadhwani (1990), there is now also emerging a small literature addressing financial market contagion phenomena from a micro-theoretical perspective. See e.g. Calvo and Mendoza (2000), Kodres and Prittsker (forthcoming) and Kyle and Xiong (forthcoming). However, these theoretical papers do not explicitly identify crisis situations with very extreme market returns as we do in the present paper, but from an empirical perspective.

however, argue that most of the 1994/95 Latin American "tequila" currency crises can be explained by domestic fundamentals. Studying 5 major currency crisis episodes Glick and Rose (1999) find that currency crises tend to remain regional in scope. They explain this feature with the importance of real trade linkages for the propagation of such crises. Kaminsky and Reinhart (2000) also find that currency crises somewhere in the world have explanatory power for other crises beyond macroeconomic fundamentals, but they pay more attention to extreme outcomes of their crisis index (an outcome 3 standard deviations above the sample mean is regarded as a crisis). Moreover, they add that international financial linkages, such as e.g. a common creditor country, may be more important for the propagation of crises than trade linkages. Van Rijckeghem and Weder (forthcoming) provide a refined analysis of common lender effects in joint currency crises.

Finally, our analysis is related to theoretical models explaining why greater macroconomic fluctuations and boom-bost cycles are more frequent in emerging market countries with an intermediate degree of financial development (Aghion, Bacchetta and Banerjee, 1999) and to third generation currency crisis models that explain the propagation of currency crises across countries (Masson, 1999; Buiter, Corsetti and Pesenti, 1997; Drazen, 1998).

We proceed as follows. The next section briefly recalls the construction of the co-crash indicator and the estimation techniques. We then address the univariate properties of currency returns, inter alia comparing the tail behaviour of emerging market currencies with that of industrial country currencies. Section 4 discusses the joint occurrence of exchange rate crashes (and booms) among industrial countries and section 5 among emerging market countries. Section 6 addresses the extreme linkages between industrial country and emerging market currencies. The final section concludes.

2 A Measure and Estimator of Extreme Currency Linkages

In order to assess the "systemic" breadth of dramatic depreciations or appreciations in foreign exchange markets, we are interested in the probability that an exchange rate e_i changes by a large amount, given that another exchange rate e_j has changed by a large amount. At this stage, we want this conditional probability of a joint currency crisis to be symmetric, i.e. independent of the conditioning and the conditioned currency. Denoting the log first differences of the exchange rates as random variables R_i and R_j and some large conditioning quantile as r this **conditional "co-crash" probability** can be derived from the standard definition of conditional probability as

$$P\{R_i > r \text{ and } R_j > r \mid R_i > r \text{ or } R_j > r\} =$$

$$\frac{P\{R_i > r \text{ and } R_j > r\}}{P\{R_i > r \text{ or } R_j > r\}} =$$

$$\frac{P\{R_i > r\} + P\{R_j > r\} - P\{R_i > r \text{ or } R_j > r\}}{P\{R_i > r \text{ or } R_j > r\}} =$$
$$\frac{P\{R_i > r\} + P\{R_j > r\}}{1 - P\{R_i \leq r, R_j \leq r\}} - 1. \tag{1}$$

Depending on the type of exchange rate regime one could also speak of an "extreme co-devaluation" or "extreme co-depreciation".

Another closely related linkage measure constitutes the **expected number of currency crashes** given that there has been at least one. Let κ stand for the number of currencies that exhibit simultaneous extreme returns beyond r ($\kappa = \sum_{i=1} I(R_i > r)$). The expected number of simultaneous currency crashes is now given by the conditional expectation

$$E[\kappa|\kappa \geq 1, \kappa \in \{1,2\}] =$$
$$\frac{P\{R_i > r \text{ and } R_j \leq r\} + P\{R_i \leq r \text{ and } R_j > r\} + 2P\{R_i > r \text{ and } R_j > r\}}{P\{R_i > r \text{ or } Y > r\}} =$$
$$\frac{P\{R_i > r\} + P\{R_j > r\}}{1 - P\{R_i \leq r \text{ and } R_j \leq r\}}. \tag{2}$$

Trivially, the two extreme linkage measures (1) and (2) are closely related because $E[\kappa|\kappa \geq 1, \kappa \in \{1,2\}] = P\{\kappa = 2|\kappa \geq 1, \kappa \in \{1,2\}\} + 1$. Hence, an alternative interpretation of the extreme linkage indicator (2) is in terms of (1 plus) the conditional probability that both currencies crash given that at least one currency crashes. We report the estimates of the latter measure in this paper. It could be easily generalised to the multivariate case $\kappa > 2$.[3]

The question is how one can estimate (2). Since we want to avoid any strong distributional assumptions on exchange rate returns, we have to think in terms of asymptotic arguments with conditioning quantiles very far out in the tails.[4] It turns out that our asymptotic extreme linkage measure E_{ij} (for two exchange rates i and j) can be derived from the two marginal crash probabilities

[3] Note that $E[\kappa|\kappa \geq 1, \kappa \in \{1,2,3,...,N\}]$ is still equal to the ratio of the sum of the marginal excess probabilities and the joint failure probability. The measure $P\{\kappa = 2|\kappa \geq 1\}$ is however not easily extended to higher dimensions than 2.

[4] We provide only an extremely abridged description of the estimations techniques here. For a full discussion of the asymptotic arguments and derivations of estimators and test statistics, see for example our previous paper (Hartmann, Straetmans and de Vries, 2001).

Within the framework of a parametric probability law, the calculation of (2) would be easy, because it solely required estimating the distributional parameters by maximum likelihood optimization. In this paper we renege from making very specific distributional assumptions for currency returns. If one estimated the linkage measure (2) using the wrong distributional assumptions, the estimates may be biased due to misspecification. Indeed, model risk can be expected to be high because of the large heterogeneity in exchange rate regimes and accompanying shock propagation mechanisms within and between the industrial and emerging market currency blocks. For example, the empirical analysis below underlines that the multivariate normal dramatically underestimates the likelihood of extremal currency spillovers regardless of the forex regime or the currency block considered.

($p_i = P\{R_i > r\}$, $p_j = P\{R_j > r\}$) and the bivariate probability that one or the other market crashes ($p_{ij} = 1 - P\{R_i \leq r \text{ and } R_j \leq r\}$).

$$E_{ij} = \frac{p_i + p_j}{p_{ij}} \tag{3}$$

Therefore E_{ij} is estimated in a univariate step ($\hat{p}_i, \hat{p}_j$) and a bivariate step ($\hat{p}_{ij}$). Following standard procedure in the extreme value theory literature, we estimate the univariate excess probabilities semi-parametrically by inserting the Hill (1975) estimator of the tail index α_i

$$\hat{\alpha}_i = \left[\frac{1}{m_i}\sum_{M_i=0}^{m_i-1}\ln\left(\frac{R_i^{n-M_i,n}}{R_i^{n-m_i,n}}\right)\right]^{-1} \tag{4}$$

in the semi-parametric probability estimator of de Haan, Jansen, Koedijk and de Vries (1994)

$$\hat{p}_i = \frac{m_i}{n}\left(\frac{R_i^{n-m_i,n}}{r}\right)^{\hat{\alpha}_i}. \tag{5}$$

n is the sample size and $R_i^{n-m_i,n}$ the m_i-th largest depreciation in the spot market i.[5] The number of extreme exchange rate returns m_i that enters the estimation is determined optimally by trading off bias and variability. (See e.g. Embrechts et al., 1997.)

We estimate the bivariate excess probabilities non-parametrically. Using Huang's (1992) polar transform, this amounts to

$$\hat{p}_{ij} \approx \frac{1}{k_{ij}}\hat{d}_{ij}\sum_{l=1} I\left(R_i^l > R_i^{n-[k_{ij}\cos\hat{\theta}_{ij}],n} \text{ or } R_j^l > R_j^{n-[k_{ij}\sin\hat{\theta}_{ij}],n}\right), \tag{6}$$

where the angle θ_{ij} and corresponding radius d_{ij} can be consistently estimated by

$$\hat{\theta}_{ij} = \arctan(\hat{p}_i/\hat{p}_j) \text{ and } \hat{d}_{ij} = \sqrt{\hat{p}_i^2 + \hat{p}_j^2}.$$

$\left[k_{ij}\sin\hat{\theta}_{ij}\right]$ denotes the integer value of $k_{ij}\sin\hat{\theta}_{ij}$ and I the indicator function. Analogous to m_i and m_j in the univariate step, k_{ij} determines the optimal number of extreme observations that enter the bivariate step (trading off bias and variability). So, loosely speaking, this estimator simply counts the number of instances at which one or both bilateral foreign exchange markets experience an extreme return (beyond r).

[5] So the one (weak) structural assumption we are making is that the tails of exchange rate return distributions exhibit the property of "regular variation at infinity". This means that, up to a first order approximation, the rate of decline of the distributions towards the left and right extremes follows a power law. In other words, we are constraining the picture to Fréchet laws, a large class of distributions exhibiting "fat tails", which should be uncontroversial.

3 Extreme Currency Movements

We now discuss first the univariate properties of extreme currency movements, looking at the largest positive and negative returns, the size of estimated left and right tail indices α and the univariate probabilities of extreme currency returns. We use weekly log returns of nominal exchange rates for 6 bilateral spot markets for industrial country currencies and 10 bilateral spot markets of emerging market currencies against the US dollar. The sample extends from early 1980 to mid 2001, giving about 1100 observations.[6] Industrial country currencies were chosen with an eye on their size in global foreign exchange trading, including US dollar (USD), Deutsche mark (DEM), Japanese yen (JPY) and British pound (GBP).[7] The choice of emerging market currencies covered was determined by geographical coverage, data availability and data reliability. From South America the Chilean peso (CLP), the Colombian peso (COP) and the Venezuelan bolivar (VEB) are covered and from Africa the South African rand (ZAR).[8] Asia is represented by the Indonesian rupiah (IDR), the Indian rupee (INR), the Thailand baht (THB), the Philippine peso (PHP), the Malaysian ringgit (MYR) and the Pakistan rupee (PKR). We are particularly interested in the comparison of the size and likelihood of extreme exchange rate returns in industrial country currency markets as compared to emerging market country currency markets.

Table 1 displays the three largest positive and negative exchange rate returns for all markets considered. We first concentrate on the historical minima ($R^{1,n}$) and maxima ($R^{n,n}$) across exchange rates. The largest weekly industrial country returns vary between 4.8% (the largest appreciation of the pound against the mark in the last 22 year, happening in October 1992) and 13.7% (the largest appreciation of the yen against the mark, happening in October 1998). The former event relates to the pound's rebounce after it had been forced out of the European Monetary System in September 1992 and the latter to the extreme financial market volatility observed in the aftermath of the Russian and LTCM crises in Fall 1998. Our data show very clearly that the dramatic yen appreciation during this episode was a very broad foreign exchange market phenomenon. The three largest industrial country currency returns in our sample all occurred in that week, all yen appreciations (against USD, DEM and GBP). Emerging market extremes range from 6.1% for the Indian rupeeh to 109.9% for the Venezuelan bolivar. Whereas "on average" the minimum emerging market returns (largest appreciations against the dollar) do not seem to be very far out

[6] All the data were downloaded from Datastream, daily WM/Reuters exchange rate series. Weekly returns are calculated Monday to Monday.

[7] After 1 January 1999 the DEM, as all the other European currencies joining the third stage of EMU, is completely fixed to the euro (EUR). Therefore, from that date on extreme DEM and EUR returns are identical.

[8] Unfortunately, the Argentinean and Brazilian currencies are not included. Data quality for the exchange rates of the currencies for the two largest South American economies was so low that we had to eliminate them from our sample. Also the Argentinean currency board made the peso exchange rate virtually constant against the dollar for an extended period of time.

of line with industrial country currency returns, the maximum returns (largest depreciations against the dollar) are (with the exception of Pakistan) strictly larger than industrial country returns. This is first evidence that speculative attacks and currency crises are more severe for emerging market currencies than for industrial country currencies.

[TABLE 1 ABOUT HERE]

Generally, one may observe that only a few of the minimal and maximal currency returns occurred at the dates of one of the recent well-known financial crises. Two or three extremes occurred in Fall 1998 (Russia, LTCM) and another two or three in September 1992 (EMS crisis). At this stage of the analysis it seems that extreme currency returns do not necessarily cluster massively around the well-known recent crisis times. In particular, non of the most extreme emerging market currency returns occurred during the Asian financial crisis of 1997.

The second and third largest currency returns, also shown in table 1, somewhat qualify the impression from the pure maximima and minima, since a few more extremes emerge for the well-known crisis times. For example, during the 1998 Russia-LTCM turrmoil the Japanese yen experienced its second largest depreciation both against the dollar and against the pound, but also its second largest appreciation against the dollar, illustrating the volatile character of this episode. However, among the emerging market currencies covered only the Indonesian rupiah experienced its second largest appreciation during this time. The 1997 Asian financial crisis is also more visible from these secondary extremes. Between October and December 1997 the Thai baht experienced its second largest appreciation and depreciation against the dollar over the last 20 years. The Pakistan rupee exhibited its second largest depreciation and the Indonesian rupiah and the Philippine peso its third largest depreciation. During the 1992 EMS crisis the mark showed its second largest depreciation against the dollar and the Japanese yen its second largest appreciation against the pound sterling. Finally, we can observe that many extremes also occurred during 1985, the year in which the dollar reached a historical high and then started a long slide against most other industrial country currencies. In particular, around September 1985 the dollar showed extreme downward corrections against the pound, the yen and the mark. (Among the emerging market currencies, only the rand showed extreme - two-sided - volatility during this year.)

Looking at the tail indexes (α) introduced in the previous section in (4), gives a more general picture than just looking at the few largest extremes. From table 2 it turns out that all emerging market currency tail indexes (ranging from 1.2 for Indonesian rupiah depreciations to 2.9 for Pakistan rupee depreciations, as shown in panel B) are smaller than industrial country currency tail indexes (ranging from 3.0 for yen appreciations against the dollar to 5.2 for yen depreciations against the mark, see panel A). In other words, when the whole left and right tails of extreme returns are considered, then extreme appreciations as well as extreme depreciations tend to be more frequent in emerging markets. Therefore, our univariate analysis confirms the conventional wisdom that emerging market currencies are much more risky than industrial country currencies.[9] For example, Aghion et al. (1999) advance a macroeconomic argument explaining boom-bust cycles in emerging market countries with their intermediate degree of financial development.

[TABLE 2 ABOUT HERE]

Our emerging market tail indexes are fairly similar to those found by Koedijk, Stork and de Vries (1992) for monthly returns of a partly overlapping sample of South and Middle American currencies. They explained the thinner tails of industrial country currency return distributions with stabilising market forces under floating exchange rates. Maybe a different way to make a similar point is to infer that fixed (but adjustable) exchange rates are associated with occasional attacks and currency crises that apparently lead to larger extreme exchange rate fluctuations than the case under floating. This point is also underlined by Koedijk et al.'s tables 3 and 4, which show that EMS tail indexes indicate higher extreme returns than floating industrial country currency indexes. Notice that this property of many fixed exchange rate regimes does not mean that currency volatility is generally higher. Usually extreme volatility is somewhat higher, due to occasional crises and realignments, but regular volatility - more towards the interior of the return distribution - is lower.

Table 2 also provides the probabilities associated with the univariate tail behaviour for different extreme quantiles (5% and 10% for industrial country currency returns in panel A and 10% nd 20% for emerging market currency returns in panel B). For example, there is a 0.5% probability that a 10% weekly depreciation of the mark against the dollar happens in a given year (row DEM/USD, culomn right tail, $r = 10\%$). In contrast, for emerging market currencies this probability varies between 5.3% (India) and 61.0% (Indonesia). By inverting the figures in the table, we can derive the number of years it takes historically to have a currency crash (or boom) of a given extreme size. For example, a 10% slump of the mark against the dollar is estimated to happen every 214 years ($\approx 1/0.004678$), whereas to the yen that would happen every 45 years ($\approx 1/0.02236$). In contrast, such currency crashes are much more regular for emerging markets, happening every three and a half years for the Chilean peso, every 7 years for the Thai baht and every 15 years for the Pakistan rupee (the emerging market currency with the lowest crash probability at the 10% return level). Hence, table 2 illustrates more forcefully that extreme currency returns are much more frequent among emerging market currencies than among industrial country currencies, particularly regarding extreme depreciations against the dollar. Compare these estimates to a normal distribution based estimate which predicts weekly depreciations in e.g. Chilean peso against dollar of 10% or more to happen only once per 7.58×10^{16} years! Needless to say that a normal distribution based analysis would, as for other financial markets, dramatically underestimate the likelihood extreme currency returns.

By juxtaposing tail indexes and quantile probabilities in table 2 here with

[9] We should caution, however, that the differences in tail indexes are in many cases not statistically significant at the usual levels.

those in tables 1 and 2 in our previous paper (Hartmann, Straetmans and de Vries, 2001), one can see that the frequency of extreme currency returns for industrial countries are more comparable to the frequency of extreme stock market returns in the same countries than to extreme government bond market returns. Left tail stock market returns still tend to be more frequent than currency returns but not right tail stock market returns. This greater symmetry of currency market extremes is not very surprising, given that each foreign exchange market determines the price of one currency with respect to another, so the gain of one is the loss of the other. Although there are a few exceptions to the rule, the results therefore suggests that from the perspective of univariate extremes, industrial country currencies are a fairly risky asset class, almost as risky as broad industrial country stocks indexes. Many emerging market currencies are of course even more risky than industrial country stocks.

4 Extreme Linkages between Industrial Country Currencies

We now turn to the bivariate results for extreme co-movements between currencies. In this section we concentrate on the co-movements between industrial country currencies and in the next section on the co-movements between emerging market currencies. Finally, section 6 looks at the co-movements between industrial country and emerging market currrencies.

We first want to use our extreme currency linkage indicator E_{ij} to estimate the probability that for any two bilateral foreign exchange markets between industrial country currencies both exchange rates exhibit an extreme positive return, given that one of the two exhibits an extreme positive return (first quadrant). Table 4 displays our results for 10%, 20% and 25% conditioning quantiles. Exchange rate returns are calculated as log first differences of the exchange rates indicated, where the exchange rates are expressed as the number of units in the first currency one has to pay for one unit of the second currency. In other words, a positive return corresponds to a depreciation of the first currency with respect to the second. Hence, the estimates in the table refer to the conditional probabilities of joint depreciations of the two first currencies in each row. It also contains the regular correlation coefficient ρ (for the whole return distribution) and the value of k, determining how many observations entered the estimator E_{ij}. The table is organised in five panels, where in each of the first four one currency is the common denominator whereas the last panel covers mixed pairs.

[TABLE 3 ABOUT HERE]

The first observation from table 3 is that extreme co-movements between industrial country currencies can be quite different depending on which currency pair one is looking at and which base currency is used. For example, every third crash of the dollar or the mark against the yen is a joint crash, whereas less than every 20th crash of the yen or the pound against the mark is a joint crash. Overall, however, co-crash probabilities among industrial countries are quite high, varying for most currency pairs and base currencies between 10 and 30% (almost irrespective of the conditioning quantile). These orders of magnitude are again reminiscent of the conditional probabilities of joint crashes in G-5 stock markets, as found in Hartmann, Straetmans and de Vries (2001), but larger than for joint government bond market crashes or joint stock-bond crashes. We can also see that extreme co-movements are quite different for different base currencies. This leads us to the following interpretations of the results from a risk management perspective: For a yen-based investor holding a portfolio of dollar and yen positions is extremely risky, providing hardly any diversification benefits in a crisis situation. Perhaps less surprisingly, the same applies to joint positions in dollar and pound for mark-based investors. Naturally, the probabilities are lower and also more difficult to interpret for the mixed exchange rate pairs, where the number of country factors is increased from 3 to 4.

Table 4 contains the same information for the third quadrant, i.e. for joint extreme appreciations of the first currencies vis-a-vis the respective base currency. The table confirms that conditional co-boom probabilities vary a lot across currency pairs but most tend to be quite high and that base currencies tend to matter a lot. The interesting new information in table 4 is that whereas in some cases, the left-tail joint probabilities and the right-tail joint probabilities are quite similar, there are several important cases in which they differ substantially. For example, whereas the probability of a joint extreme depreciation of dollar and mark against the yen is very large (about one third), the probability of a joint extreme appreciation of dollar and mark against the yen is markedly lower (2 to 4%). The reversed phenomenon occurs for mark and yen against the dollar. In other words, in contrast to the univariate exchange rate tails described in table 2, bivariate exchange rate tail behaviour can exhibit substantial asymmetries. This suggests that the importance of country factors in extreme exchange rate returns is not uniform.

[TABLE 4 ABOUT HERE]

The relevance of extreme co-movements in industrial country currency markets is further underlined by the simple observation that the conditional probability of experiencing an extreme exchange rate appreciation or depreciation in one market, given that there was one in another market, is substantially larger than the univariate (unconditional) probability of having such an extreme return in the former market. Moreover, similar as for univariate extreme quantile probabilities an assessment of extreme co-movements on the basis of the bivariate normal distribution (using the sample means, variances and covariances) would lead to a tremendous under-estimation of spillover probabilities.[10] This is, however, a distinct point from the better known observation that financial market return distributions have fat tails, since the statistical concepts of tail dependence and tail fatness are not necessarily linked. Finally, tables 3 and 4 make clear that simple correlations are unreliable measures of the degree of dependence in the tails of exchange rate return distributions. These three points

[10] This is not too surprising knowing that the multivariate normal distribution by construction exhibits asymptotic independence far out in the tails, even if $\rho \neq 0$.

are qualitatively quite similar to the results we found earlier for stock and government bond markets.

We also calculated similar tables for the second and fourth quadrants of extreme exchange rate returns, which describe extreme opposite movements in different currencies and may therefore be indicative of flight movements from one currency to another. We only report here that the related probabilities turned out to be much lower than the joined booms or crashes discussed before. For most currency pairs and base currencies the probabilities were 1 to 2% or even much lower. Apparently, contagion phenomena and joint crashes are much more frequent during crises within foreign exchange markets than flight phenomena from one currency to another.[11] To interested readers the detailed results are available from the authors on request.

Summing up this section it can be retained that, despite differences across currencies, there are quite some co-movements among industrial country spot foreign exchange markets in critical times. For many exchange rates they are comparable to the extreme dependence among industrial country stock markets. These findings complement the univariate results of the preceeding section, which already indicated currencies as a relatively risky asset class.

5 Extreme Linkages between Emerging Market Currencies

We now want to advance to the results for emerging market currencies and compare them to the results for industrial country currencies discussed above. Table 5 shows our extreme linkage indicator estimates for the 10 emerging market countries and three conditioning quantiles (20% and 30%), as well as regular correlation coefficients ρ and the parameter k. The upper part of the table concentrates on the co-movements between South American dollar rates and between those and the other Asian and African dollar rates. The lower part focuses on the remaining pairs between Asian and African currencies against the dollar.

The first and perhaps most important observation from the tables is that emerging market currency extreme co-movements are not more pronounced than industrial country currency extreme co-movements. Actually, many of the non-East Asian currency pairs rather tend to be less interlinked in critical situations like 20% weekly depreciations than industrial country currencies (compare table 5 to tables 3 and 4).

[TABLE 5 ABOUT HERE]

[11] On the surface that may be read as a difference to the relatively high likelihood for flight to quality from stocks into government bonds that we documented in our earlier paper (Hartmann et al., 2001, table 4). In that paper we found flight to quality was not less frequent than joint crashes between stocks and bonds. However, the two analyses are not really comparable, since here we are looking at flight phenomena within the same asset class, whereas in the other paper we stressed flight phenomena across different asset classes.

The second important observation from comparing the upper part of the table with the lower part is that emerging market currency extreme co-movements within South America seem rather weak, the probability of experiencing a joint crash between any two pairs of the three South American currencies given one experienced a crash varies between 3.5 and 7.0%. The same figures for the four East Asian currencies (INR, MYR, PHP, THB) range between 4% and 27%, with most being above 13%. Hence, with few exceptions currency crisis linkages between the countries most affected by the Asian crisis of 1997 seem to be much stronger than the crisis linkages between Latin American countries. The Asian "flu" seems to be much more severe and recurrent than "tequila" effects. It is interesting to remark in this context that in a recent IMF working paper Loayza, Lopez and Ubide (1999) observed that regular (non-crisis) fluctuations in real value added GDP in Latin America between 1970 and 1994 was mainly characterised by country specific components, whereas in East Asia common factors (or rapid cross-country propagation) were much more important, potentially related to a more homogenous industrial structure in these countries. Our data (which do not cover exactly the same sample period) suggest that a similar pattern also characterises the two regions' respective currency returns during crisis situations.

Cross-continental extreme currency linkages between South America, South Africa and Asia seem to be of a weaker nature (with few exceptions, such as the extreme linkages of Thailand with both South Africa and Colombia).

The conclusion is that whereas emerging market currencies have fatter tails and therefore have a higher likelihood of individual crashes and currency attacks than industrial country currencies, the evidence does not allow for a generalisation of this result to the multivariate case. Excluding East Asian currencies, the degree of crisis co-movements among emerging market currencies may well be lower than among industrial country currencies. This means that whereas currency crashes of a given extreme size are less frequent in industrial countries than in emerging markets, once an extreme movement has occurred in an exchange rate, the occurrence of further extreme movements cannot be expected to be less likely across industrial countries. Or in other words, once a currency crisis has struck there is no systematic difference between their breadth in emerging and industrial countries. The economic interpretation of this finding is that whereas currency crises are more frequent and more severe for emerging markets than for industrial countries, for the reasons discussed above, their propagation mechanisms can be quite similar, irrespective of the precise characteristics of the underlying economy.

6 Extreme Linkages between Industrial Country and Emerging Market Currencies

Finally, we also have a short look at the extreme currency linkages between industrial and emerging market countries. The results are summarised in table

6. It turns out that industrial country-emerging market currency linkages are generally very low. (A few exceptions include pound sterling/Indian rupeeh, perhaps not too surprisingly for the political and economic links between the UK and India, or Japanese yen/Indian rupeeh.) This suggests that during our sample period and across our country cross-section only very little currency contagion seems to have been taken place either from the industrial country currencies to the emerging market currencies or vice versa. This may not bee too surprising, since in an emerging market crisis the "hot money" will usually flow back from the currencies in crisis to the industrial country currencies.

[TABLE 6 ABOUT HERE]

7 Conclusions

Extreme exchange rate depreciations and appreciations can be an important element in international financial instability. They are one primary locus of the international transmission of financial shocks and in the form of currency crises they are often related to severe domestic macroeconomic instability. In this article we try to make an advance by not only addressing the historical frequency of extreme currency returns but also by assessing the breadth of extremely large exchange rate fluctuations across the foreign exchange market. Applying newly available techniques of multivariate extreme value theory to a broad data set of industrial country and emerging market currencies, we first discuss the size and probability of critically large exchange rate movements univariately and then we address the likelihood of extreme exchange rate spillovers among industrial country currencies, among emerging market currencies and between industrial country and emerging market currencies.

Our most important result and perhaps also the most surprising one is that the likelihood of extreme co-movements between industrial country exchange rates is not lower than for emerging market exchange rates. For example for most industrial country currency pairs and for most base currencies the probability of having an extreme currency depreciation in two spot markets, given there was one in at least one of the two, varies between 10 and 30%. This spillover likelihood is comparable in magnitude to the one historically observed for industrial country stock markets, underlining the riskiness of currency positions. Further we observe some asymmetry in bivariate extreme co-movements between currencies in that the probability of joint extreme appreciations of two currencies may be quite different from the probability of joint extreme depreciations of the same currencies.

For emerging market exchange rates we find some regional differences in that currency co-crashes tend to be more likely among East Asian currencies than among Latin American currencies. Since Asia seems also characterised by stronger macroeconomic interdependence in normal times, the reasons for these more pronounced crisis linkages may also be related to greater integration and more similar industrial structures in this region compared to Latin America. However, we generally find cross-continental emerging market currency linkages to be relatively weak. Similarly, we find hardly any evidence of significant currency crisis spillovers between emerging market countries and industrial countries.

Going back to the univariate probabilities of exchange rate returns, we confirm the conventional wisdom that emerging market exchange rates experience more frequent and more dramatic extreme movements. This somewhat qualifies the high crisis linkages between industrial country currencies mentioned above, since crises as such are much less frequent among those countries. However, the general relevance of contagion and joint crash phenomena is underlined by the fact that these univariate (unconditional) probabilities are much lower than the conditional probabilities of spillovers. This also corresponds to results we found in earlier work on extreme co-movements in stock and government bond markets. So, joint crises or contagion are relevant phenomena in international financial markets, in particular within the same asset class. Whereas it is well known that the frequency of market crises is greatly underestimated when applying the univariate normal distribution, we make the distinct point that the application of the multivariate normal distribution to financial market returns involves also a dramatic underestimation of crisis co-movements far out in the tails. Another interesting finding of the univariate analysis is that several of the most extreme exchange rate movements in our sample do not seem to be directly associated with any of the widely publicised major crises.

Our results have implications for policies to preserve the stability of the international financial system and for the management of currency portfolio risk. They locate the historical "hot spots" of extreme exchange rate volatility and they describe the propensity of currency crises and attacks to propagate across markets. Although the probabilities of joint crises and contagion are not very large in absolute terms, they do not suggest that in present efforts to reform the international financial architecture currency relationships between industrial countries are a completely benign issue for financial stability. As regards risk management implications, we can conclude somewhat surprisingly - at least on the basis of the available historical experience - that portfolios composed of a larger number of emerging market currencies (outside East Asia) should be fairly well diversified in a crisis situation. However, portfolios concentrated in industrial country exposures or in East Asian currency exposures should exhibit a relatively large value at risk.

Table 1: Historical extremes of weekly industrial country and emerging market currency returns, 1980 to 2001

	Extreme currency returns					
	Highest			Lowest		
Rates	$R^{n,n}$	$R^{n-1,n}$	$R^{n-2,n}$	$R^{1,n}$	$R^{2,n}$	$R^{3,n}$
(Cross)	Panel A: Developed country currencies					
GBP/USD	10.02	7.04	5.85	-6.35	-6.07	-5.71
	(21/9/92)	(1/2/93)	(8/6/81)	(15/4/85)	(23/9/85)	(25/3/85)
JPY/USD	5.57	5.44	4.71	-12.80	-6.97	-6.84
	(21/6/93)	(9/11/98)	(12/6/89)	(12/10/98)	(7/9/98)	(30/9/85)
DEM/USD	5.84	5.80	5.32	-6.77	-6.11	-5.42
	(15/5/95)	(14/9/92)	(22/4/91)	(21/9/81)	(23/2/81)	(23/9/85)
JPY/DEM	6.62	5.13	5.00	-13.69	-6.06	-5.70
	(23/2/81)	(4/12/00)	(18/1/99)	(12/10/98)	(10/4/95)	(10/8/81)
GBP/DEM	10.29	6.62	5.33	-4.79	-4.17	-3.77
	(21/9/92)	(23/2/81)	(22/11/82)	(12/10/92)	(30/5/83)	(20/10/80)
JPY/GBP	5.16	4.93	4.82	-12.62	-10.42	-8.11
	(18/1/99)	(9/11/98)	(15/4/85)	(12/10/98)	(21/9/92)	(30/9/85)
(Dollar)	Panel B: Emerging market currencies (USD numeraire)					
Chile	28.18	22.49	22.30	-14.06	-12.81	-12.73
	(16/8/82)	(19/5/80)	(24/9/84)	(24/3/80)	(3/3/80)	(2/6/80)
Colombia	25.10	9.83	9.59	-9.86	-8.57	-8.32
	(30/11/92)	(5/12/88)	(16/12/91)	(23/12/91)	(28/11/88)	(28/10/91)
Venezuela	109.90	67.01	16.05	-19.10	-16.46	-14.36
	(10/10/83)	(4/12/95)	(30/5/94)	(23/6/86)	(15/12/86)	(11/7/94)
South Africa	15.54	14.30	12.04	-13.10	-7.76	-7.70
	(9/9/85)	(19/8/85)	(25/2/85)	(2/9/85)	-13/1/86	28/1/85
Indonesia	37.34	35.62	33.11	-35.37	-16.64	-13.87
	(15/9/86)	(26/1/98)	(15/12/97)	(2/2/98)	(12/10/98)	(25/5/98)
India	17.66	6.31	6.19	-6.14	-5.94	-5.23
	(8/7/91)	(1/3/93)	(1/8/88)	(8/8/88)	(10/7/89)	(29/5/89)
Thailand	15.58	13.41	12.77	-10.49	-9.24	-7.10
	(5/11/84)	(15/12/97)	(12/1/98)	(16/3/98)	(10/11/97)	((2/2/98)
Philippines	24.98	24.33	12.94	-9.48	-7.96	-7.55
	(10/10/83)	(11/6/84)	(15/12/97)	(16/6/86)	(6/7/87)	(10/3/86)
Malaysia	35.69	11.25	10.27	-13.38	-11.83	-11.08
	(2/11/98)	(12/1/98)	(9/3/98)	(5/4/99)	(31/5/99)	(19/1/98)
Pakistan	11.07	8.35	8.18	-10.24	-6.19	-6.11
	(27/7/92)	(20/10/97)	(28/10/96)	(29/6/92)	(18/5/92)	(6/7/87)

Table 2: Univariate tail index and crash probability estimates for weekly industrial country and emerging market currency returns

Panel A: Industrial country currencies

	Left tail			Right tail		
	$\hat{\alpha}$	$\hat{p} = \hat{P}\{X < r\}$		$\hat{\alpha}$	$\hat{p} = \hat{P}\{X > r\}$	
Exchange rate		r =-5%	r =-10%		r =5%	r =10%
GBP/USD	4.39	0.13540	0.00648	3.59	0.23660	0.019670
JPY/USD	4.12	0.41160	0.02367	3.21	0.20690	0.022360
DEM/USD	4.23	0.22430	0.01194	5.00	0.14920	0.004678
JPY/DEM	4.07	0.35390	0.02104	5.22	0.08058	0.002156
GBP/DEM	3.77	0.04949	0.00362	3.28	0.15600	0.016090
JPY/USD	2.96	0.56553	0.07288	4.04	0.15737	0.009550

Panel B: Emerging market currencies

	Left tail			Right tail		
	$\hat{\alpha}$	$\hat{p} = \hat{P}\{X < r\}$		$\hat{\alpha}$	$\hat{p} = \hat{P}\{X > r\}$	
		r =-10%	r =-20%		r =10%	r =20%
Chile	1.61	0.10807	0.03540	1.40	0.29091	0.11022
Colombia	1.70	0.07199	0.02221	2.21	0.09573	0.02069
Venezuela	1.67	0.22622	0.07108	2.11	0.43866	0.10169
South Africa	1.56	0.20264	0.06854	2.20	0.15552	0.03385
Indonesia	1.27	0.38337	0.15875	1.16	0.61049	0.27271
India	2.78	0.02069	0.00301	2.40	0.05305	0.01005
Thailand	2.28	0.05875	0.01206	1.75	0.13524	0.04010
Philippines	2.30	0.08497	0.01723	2.08	0.17106	0.04053
Malaysia	1.37	0.14229	0.05503	1.48	0.13698	0.04894
Pakistan	1.99	0.09229	0.02328	2.92	0.06158	0.00811

Table 3: Extreme linkages between industrial country currencies (1rst quadrant)

Exchange rate pairs	k	$\hat{\rho}$	$\hat{E}$ $r = 10\%$	$\hat{E}$ $r = 20\%$
USD numéraire				
DEM/USD-JPY/USD	200	0.536	1.111	1.033
DEM/USD-GBP/USD	150	0.711	1.212	1.085
JPY/USD-GBP/USD	100	0.412	1.138	1.129
DEM numéraire				
USD/DEM-JPY/DEM	200	0.451	1.112	1.065
USD/DEM-GBP/DEM	300	0.460	1.291	1.215
JPY/DEM-GBP/DEM	125	0.249	1.048	1.026
JPY numéraire				
USD/JPY-DEM/JPY	200	0.512	1.313	1.314
USD/JPY-GBP/JPY	180	0.612	1.200	1.121
DEM/JPY-GBP/JPY	200	0.746	1.238	1.135
GBP numéraire				
USD/GBP-DEM/GBP	150	0.298	1.092	1.102
USD/GBP-JPY/GBP	150	0.468	1.170	1.173
DEM/GBP-JPY/GBP	150	0.459	1.118	1.135
Mixed pairs				
DEM/USD-JPY/GBP	175	-0.096	1.031	1.035
GBP/USD-JPY/DEM	150	-0.287	1.003	1.008
JPY/USD-GBP/DEM	150	-0.207	1.031	1.032

Table 4: Extreme linkages between industrial country currencies (3rd quadrant)

Exchange rate pairs	k	$\hat{E}$ $r = -10\%$	$\hat{E}$ $r = -20\%$
USD numéraire			
DEM/USD-JPY/USD	300	1.308	1.282
DEM/USD-GBP/USD	300	1.365	1.346
JPY/USD-GBP/USD	100	1.087	1.078
DEM numéraire			
USD/DEM-JPY/DEM	50	1.147	1.088
USD/DEM-GBP/DEM	150	1.176	1.152
JPY/DEM-GBP/DEM	120	1.058	1.069
JPY numéraire			
USD/JPY-DEM/JPY	120	1.039	1.015
USD/JPY-GBP/JPY	150	1.193	1.137
DEM/JPY-GBP/JPY	100	1.161	1.073
GBP numéraire			
USD/GBP-DEM/GBP	140	1.176	1.184
USD/GBP-JPY/GBP	250	1.171	1.126
DEM/GBP-JPY/GBP	200	1.141	1.119
Mixed pairs			
DEM/USD-JPY/GBP	100	1.017	1.014
GBP/USD-JPY/DEM	100	1.024	1.017
JPY/USD-GBP/DEM	50	1.028	1.029

Table 5: Extreme linkages between emerging market currencies

	k	$\hat{\rho}$	$\hat{E}$	$\hat{E}$
Exchange rate pairs			$r = 20\%$	$r = 30\%$
Chile-Colombia	150	0.053	1.061	1.035
Chile-Venezuela	150	0.015	1.071	1.070
Chile-South Africa	150	0.027	1.053	1.059
Chile-Indonesia	200	0.030	1.085	1.078
Chile-India	200	0.019	1.025	1.008
Chile-Thailand	125	0.066	1.061	1.045
Chile-Philippines	40	0.047	1.027	1.027
Chile-Malaysia	200	0.057	1.082	1.085
Chile-Pakistan	300	0.058	1.036	1.022
Colombia-Venezuela	250	0.034	1.057	1.055
Colombia-South Africa	120	0.024	1.058	1.057
Colombia-Indonesia	180	0.045	1.016	1.020
Colombia-India	90	0.042	1.019	1.017
Colombia-Thailand	225	0.096	1.102	1.098
Colombia-Philippines	30	0.032	1.035	1.002
Colombia-Malaysia	70	0.004	1.019	1.021
Colombia-Pakistan	100	0.046	1.037	1.052
Venezuela-South Africa	175	-0.003	1.059	1.063
Venezuela-Indonesia	250	0.012	1.051	1.044
Venezuela-India	250	-0.000	1.036	1.026
Venezuela-Thailand	60	0.034	1.024	1.032
Venezuela-Philippines	225	0.278	1.071	1.073
Venezuela-Malaysia	250	0.002	1.076	1.089
Venezuela-Pakistan	25	0.019	1.076	1.056
South Africa-Indonesia	150	0.038	1.027	1.017
South Africa-India	75	0.153	1.036	1.035

	k	$\hat{\rho}$	$\hat{E}$	$\hat{E}$
Exchange rate pairs			$r = 20\%$	$r = 30\%$
South Africa-Thailand	200	0.091	1.132	1.133
South Africa-Philippines	175	0.061	1.081	1.083
South Africa-Malaysia	40	0.117	1.070	1.057
South Africa-Pakistan	80	0.106	1.048	1.020
Indonesia-India	70	0.033	1.022	1.022
Indonesia-Thailand	250	0.362	1.071	1.054
Indonesia-Philippines	140	0.241	1.053	1.038
Indonesia-Malaysia	120	0.365	1.151	1.134
Indonesia-Pakistan	300	0.035	1.022	1.008
India-Thailand	175	0.158	1.072	1.046
India-Philippines	200	0.181	1.106	1.092
India-Malaysia	250	0.081	1.070	1.039
India-Pakistan	280	0.304	1.270	1.262
Thailand-Philippines	190	0.319	1.210	1.203
Thailand-Malaysia	150	0.263	1.179	1.178
Thailand-Pakistan	250	0.147	1.052	1.038
Philippines-Malaysia	250	0.154	1.158	1.157
Philippines-Pakistan	250	0.235	1.074	1.063
Malaysia-Pakistan	250	0.064	1.038	1.026

Table 6: Extreme linkages between industrial country and emerging market currencies

	k	$\hat{\rho}$	$\hat{E}$	$\hat{E}$
Exchange rate pairs			r = 20%	r = 30%
GBP/USD,Colombia	150	0.041	1.021	1.024
GBP/USD, Venezuela	150	-0.011	1.016	1.009
GBP/USD, S.Africa	100	0.379	1.037	1.017
GBP/USD, Indonesia	150	0.056	1.013	1.009
GBP/USD, India	100	0.299	1.072	1.063
GBP/USD, Malaysia	150	0.164	1.026	1.014
GBP/USD, Philippines	150	0.011	1.012	1.008
GBP/USD, Thailand	100	0.151	1.020	1.019
GBP/USD, Chile	70	0.043	1.015	1.021
GBP/USD, Pakistan	150	0.071	1.033	1.031
JPY/USD, Colombia	80	0.026	1.020	1.023
JPY/USD, Venezuela	100	-0.016	1.013	1.015
JPY/USD, S. Africa	50	0.259	1.048	1.026
JPY/USD, Indonesia	150	0.124	1.016	1.011
JPY/USD, India	125	0.203	1.062	1.047
JPY/USD, Malaysia	150	0.168	1.034	1.024
JPY/USD, Philippines	100	0.067	1.017	1.017
JPY/USD, Thailand	100	0.206	1.008	1.013
JPY/USD, Chile	70	0.048	1.036	1.025
JPY/USD, Pakistan	100	0.093	1.020	1.011
DEM/USD, Colombia	150	-0.006	1.007	1.009
DEM/USD, Venezuela	150	-0.018	1.008	1.007
DEM/USD, S.Africa	140	0.371	1.012	1.009
DEM/USD, Indonesia	125	0.019	1.009	1.008
DEM/USD, India	80	0.247	1.014	1.018
DEM/USD, Malaysia	250	0.154	1.007	1.005

	k	$\hat{\rho}$	$\hat{E}$	$\hat{E}$
Exchange rate pairs				
DEM/USD, Philippines	110	0.020	1.013	1.010
DEM/USD, Thailand	70	0.133	1.018	1.015
DEM/USD, Chile	150	0.010	1.008	1.007
DEM/USD, Pakistan	190	0.081	1.013	1.008
JPY/DEM, Colombia	100	0.034	1.013	1.001
JPY/DEM, Venezuela	100	0.002	1.001	1.010
JPY/DEM, S.Africa	50	-0.103	1.022	1.021
JPY/DEM, Indonesia	150	0.112	1.007	1.007
JPY/DEM, India	100	-0.036	1.016	1.012
JPY/DEM, Malaysia	100	0.021	1.011	1.010
JPY/DEM, Philippines	100	0.050	1.012	1.011
JPY/DEM, Thailand	150	0.082	1.008	1.007
JPY/DEM, Chile	125	0.041	1.009	1.008
JPY/DEM, Pakistan	70	0.016	1.022	1.017
GBP/DEM, Colombia	150	0.060	1.029	1.030
GBP/DEM, Venezuela	70	0.011	1.016	1.025
GBP/DEM, S.Africa	90	-0.025	1.014	1.020
GBP/DEM, Indonesia	70	0.046	1.021	1.017
GBP/DEM, India	100	0.042	1.045	1.026
GBP/DEM, Malaysia	150	-0.002	1.006	1.010
GBP/DEM, Philippines	160	-0.014	1.009	1.006
GBP/DEM, Thailand	150	0.010	1.020	1.015
GBP/DEM, Chile	100	0.041	1.025	1.017
GBP/DEM, Pakistan	100	-0.019	1.035	1.017

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