Department of
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Exchange Rate Uncertainty and International Portfolio Flows

Guglielmo Maria Caporale[a,b,c*], Faek Menla Ali[a] and Nicola Spagnolo[a,d]

[a]Department of Economics and Finance, Brunel University, London, UK
[b]CESifo, Munich, Germany
[c]DIW Berlin, Germany
[d]Centre for Applied Macroeconomic Analysis (CAMA), Canberra, Australia

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Abstract

This paper examines the impact of exchange rate uncertainty on different components of portfolio flows, namely equity and bond flows, as well as the dynamic linkages between exchange rate volatility and the variability of these two types of flows. Specifically, a bivariate GARCH-BEKK-in-mean model is estimated using bilateral data for the US *vis-à-vis* Australia, the UK, Japan, Canada, the euro area, and Sweden over the period 1988:01-2011:12. The results indicate that the effect of exchange rate uncertainty on equity flows is negative in the euro area, the UK and Sweden, and positive in Australia, whilst it is negative in all countries except Canada (where it is positive) in the case of bond flows. Under the assumption of risk aversion, this suggests that exchange rate uncertainty induces a home bias and causes investors to reduce their financing activities to maximise returns and minimise exposure to uncertainty. Furthermore, since exchange rate volatility and the variability of flows are interlinked, exchange rate or credit controls on these flows can be used to pursue economic and financial stability.

Keywords: Exchange rate uncertainty, Equity flows, Bond flows, Causality-in-variance
JEL Classification: F31, F32, G15

*Corresponding author. Email: Guglielmo-Maria.Caporale@brunel.ac.uk

1. Introduction

The macroeconomic effects of exchange rate uncertainty, especially on trade flows, have attracted considerable attention since the collapse of the Bretton Woods system in 1971 and the adoption of floating exchange rates in March 1973, both in the theoretical and empirical literature (see McKenzie, 1999, for a comprehensive review). By contrast, the

Canada, the euro area, Japan, Sweden, and the UK over the period 1988:01-2011:12. Second, unlike Hau and Rey (2006) who assume that the supply of bonds is infinitely elastic, thereby simplifying the dynamics of bond acquisitions in their model, we examine the impact of exchange rate uncertainty on bond and equity flows (as well as their variability) in turn. In this way, we are able to evaluate the impact of uncertainty on the individual components of portfolio flows across borders. According to Hau and Rey (2006), exchange rate uncertainty should affect equity, but not bond flows; we provide some relevant empirical evidence on this issue.

Third, existing empirical studies on the relationship between exchange rate changes and portfolio flows investigate short-run dynamic interactions only with linear dependence techniques (i.e., first moment analysis). For example, Brooks et al. (2004) and Hau and Rey (2006) use simple correlations and regression analysis for the US vis-à-vis the euro area and Japan, and 17 OECD countries respectively; Siourounis (2004), Chaban (2009), and Kodong and Ojah (2012) estimate VAR models for four developed countries (the UK, Japan, Germany, and Switzerland), three oil-exporting countries (Canada, Australia, and New Zealand), and four African countries (Egypt, Morocco, Nigeria, and South Africa) vis-à-vis the US. Their results are characterised by significant deviations from normality and conditional heteroscedasticity, i.e. volatility clustering or the so-called ARCH effects (see Engle, 1982) that are not captured by their setup. By contrast, we model first and second moments simultaneously to analyse the dynamic interactions between exchange rate changes and portfolio flows, in this way avoiding the potential pitfalls of earlier studies.

Fourth, since volatility is a measure of the information flow (see Ross, 1989), it is of paramount importance to understand how the stochastic information arrivals in the form of simple portfolio investment shifts in bonds and equities are transmitted to the foreign exchange market, and viceversa. Our analysis sheds light on this mechanism and thus provides important information to policy-makers and regulators to formulate appropriate policies based on imposing or relaxing credit controls on these flows depending on the state of the economy, with the aim of achieving economic and financial stability.

The remainder of the paper is organised as follows. Section 2 describes the data and reports some descriptive statistics. Section 3 outlines the econometric model. Section 4 discusses the empirical results, and finally Section 5 concludes.

2. The econometric model

We employ a bivariate VAR-GARCH (1, 1) in the BEKK specification (Engle and Kroner, 1995) allowing for in-mean effects in order to examine the impact of exchange rate uncertainty on equity and bond flows as well as the dynamic linkages in the first and second moments of these variables over the period 1988:01-2011:12. Various lags of exchange rate volatility affecting the conditional mean of equity and bond flows are included in the specification to avoid the potential pitfalls of models allowing only for contemporaneous interactions. The economic interpretation is that it might take some time for the investors' response to exchange rate volatility to be incorporated into their strategies. Therefore the conditional mean equation is specified as follows:

$$y_t \quad \overset{p}{\underset{i\ 1}{}} \ {}_i\, y_{t\ i} \quad \overset{p}{\underset{i\ 1}{}} \ {}_i\, h_{t\ i} \quad {}_t$$

$$\begin{matrix} 1 \\ 2 \end{matrix} \ ; \ {}_i \quad \begin{matrix} {}^{i}_{11} & {}^{i}_{12} \\ {}^{i}_{21} & {}^{i}_{22} \end{matrix} \ ; \ {}_i \quad \begin{matrix} {}^{i}_{11} & {}^{i}_{12} \\ {}^{i}_{21} & {}^{i}_{22} \end{matrix} \ ; \ {}_t \quad \begin{matrix} {}_{1,t} \\ {}_{2,t} \end{matrix} \qquad (1)$$

where =[

available at time *t*-1. Lags are included sequentially in Equ. (1) until serial correlation is removed by employing the Hosking (1981) multivariate *Q*-statistics on the standardised residuals for i = 1, 2.

Note that cointegration tests between exchange rates and net flows have not been carried out as the former appear to be I (1)

$$H_t \quad C C \quad A \quad {}_{t\ 1}\ {}_{t\ 1}A \quad B H_{t\ 1} B \qquad (2)$$

In matrix form, it can be specified as:

$$\begin{matrix} H_{11,t} & H_{12,t} \\ H_{21,t} & H_{22,t} \end{matrix} \quad C C \quad A \quad \begin{matrix} u_{1,t\ 1}^2 & u_{1,t\ 1} u_{2,t\ 1} \\ u_{2,t\ 1} u_{1,t\ 1} & u_{2,t\ 1}^2 \end{matrix} \quad A \quad B \quad \begin{matrix} H_{11,t\ 1} & H_{12,t\ 1} \\ H_{21,t\ 1} & H_{22,t\ 1} \end{matrix} \quad B \qquad (3)$$

(CCF) two-step approach of Cheung and Ng (1996) (see Hafner and Hewartz, 2008). Causality-in-variance is tested using the following likelihood ratio test statistic:

$$LR = \quad 2(L_r \quad L_{ur}) \quad x^2_{df} \tag{4}$$

where L_r and L_{ur} indicate the restricted and unrestricted log-likelihood test statistic; LR follows the chi-squared distribution with degrees of freedom equal to the number of the restricted coefficients (*df*).

Given that, as stated earlier, the innovations are assumed to be normally distributed, the log likelihood function for such a model is given by:

$$L(\quad) \quad \frac{Tn}{2}\ln(2\quad) \quad \frac{1}{2}\,{}^{t}_{t\;1}(\ln|H_t| \quad {}_t H^{1}{}_t \;{}_t) \tag{5}$$

where n is the number of equations, two in our case; T is the number of observations, which is 287; and   is a vector of unknown parameters to be computed. More specifically, we use the Quasi-Maximum Likelihood (QML) method of Bollerslev and Woolbridge (1992) to calculate the standard errors that are robust to deviations from normality.[3] As a final check of the

[3] We use the SIMPLEX free-derivative method, which is useful to improve the initial values, and then the BFGS standard algorithm to obtain the standard errors (see Engle and Kroner, 1995; Kearney and Patton, 2000 among others). This procedure was implemented with a convergence criterion of 0.00001.

adequacy of the estimated model we employ the Hosking (1981) multivariate *Q*-statistic for the standardised squared residuals to evaluate whether or not the ARCH and GARCH dynamics have been appropriately captured in the conditional variance equation, Equ. (3).

3. Data description

We examine the impact of exchange rate uncertainty on different components of portfolio flows, namely equity and bond flows, as well as the dynamic linkages between these flows and exchange rate changes for the US *vis-à-vis* the UK, Japan, Canada, Australia, Sweden, and the euro area. Throughout, the US is considered the domestic or home economy. Since the data on portfolio investment flows, obtained from the US *Treasury International Capital (TIC) System*,[4] are sampled at a monthly frequency, we employ monthly data from 1988:01 to 2011:12 for all series. The reason for selecting this start date is that portfolio flows for the period precedinf1 Tf(inam)or the for selec individual EMU countries (Austria, Belgium-Luxemburg, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal, Spain) to extract cross-border bond and equity flows between the US and this region.

Positive numbers imply net equity and bond inflows (in millions of US dollars) towards the US or outflows from the counterpart countries. Following Brennan and Cao (1997), Hau and Rey (2006), and Chaban (2009) among others, we normalise these flows using the average of their absolute values over the previous 12 months, since without scaling model convergence is difficult to achieve. The exchange rates are end of period data, defined as US dollars per unit of foreign currency; the source is the IMF's *International Financial Statistics (IFS).* Exchange rate changes are calculated as where $P_{E,t}$ represents the log of the exchange rate at time *t*. For the period preceding the inception of the euro, i.e. before 1999, we use US dollar per ECU as the euro area's exchange rate.

Descriptive statistics are displayed in Table 1. The mean of monthly exchange rate changes is positive (US dollar depreciation) for Japan and Canada, and negative (US dollar appreciation) for the rest of the countries. On the other hand, the monthly mean of net equity flows is positive for Sweden and Canada and negative for the remaining countries, indicating equity inflows from Sweden and Canada towards the US and outflows from the US towards the other countries. The monthly mean of net bond flows is negative for Australia and positive for the other countries. This indicates the existence of bond inflows from all countries except Australia (for which there is evidence of bond outflows) vis-à-vis the US.

Exchange rate changes are found to exhibit higher volatility than the two flows. Furthermore, equity flows appear to be characterised by higher volatility than bond flows (although their volume is very small). As for the third and fourth moments, exchange rate changes, net equity flows, and net bond flows all exhibit skewness and excess kurtosis in most cases. The Jarque-Bera (JB) test statistics imply a rejection at the 1% level of the null hypothesis that exchange rate changes and the two flows are normally distributed in all countries in question.

[Insert Table 1 about here]

Fig. 1 shows monthly exchange rate changes, net equity flows and net bond flows for all countries over the period under investigation. Volatility clustering is clearly present in all cases, suggesting that an ARCH model might be required to capture it. The series also appear to be covariance stationary.

[Insert Fig. 1 about here]

4. Empirical results

As can be seen from the Tables, the dynamic interactions between exchange rate changes and net equity and bond flows, captured by , suggest that there exist limited dynamic linkages between the first moments compared to the second ones. The results in the mean equation indicate the existence of mean spillovers between exchange rate changes and net bond flows in Japan, from bond flows to exchange rate changes in Canada and the UK, and from equity flows to exchange rate changes in the euro area.

With regard to the impact of exchange rate uncertainty on equity flows, the results suggest that exchange rate volatility affects equity flows negatively in the euro area, Sweden, and the UK, and positively in Australia, and has no effect in Canada and Japan. Its impact on bond flows, on the other hand, appears to be negative in all countries except Canada for which it is positive.

The observed negative impact on equity as well as bond flows has important implications. First, it indicates that risk averse market participants respond to exchange rate uncertainty by reducing their financing activities, hence favouring domestic rather than foreign securities in their portfolios to reduce their exposure to exchange rate volatility.

Second, in contrast to Hau and Rey (2006) who assume that bonds are usually hedged instruments not affected by exchange rate uncertainty, it appears that uncertainty in fact affects bond as well as equity flows, and the former more widely, since a negative impact is found in five of the six countries considered. This is consistent with the results of Fidora et al.

(2007), who found in a wide set of industrialise

GARCH matrices indicate that shocks to exchange rate changes (net equity flows) affect the conditional variance of net equity flows (exchange rate changes) at the 10% level in the euro area and Japan. The results also show that shocks to exchange rate changes (net bond flows) affect the conditional variance of net bond flows (exchange rate changes) at the 10% level in all cases except Japan.

More specifically, the causality-in-variance (i.e., the information flow) tests based on likelihood ratio test statistics provide evidence of strong causality-in-variance from equity flows to exchange rate changes in the case of the euro area and bidirectional causality-in-variance in the case of Japan. There is also causality-in-variance from bond flows to exchange rate changes in Australia, the euro area, and Sweden, as well as bidirectional causality in Canada and the UK. A possible explanation for the existence of stronger dynamic linkages between exchange rate changes and bond flows rather than equity flows is that foreign exchange dealers usually follow bond yields in their trading behaviour, with such yields, in turn, driving cross-border bond acquisitions, which results in volatile exchange rates. Spillovers from the exchange rates may also be due to the fact that investors adjust their portfolios on the basis of their volatility. Also, the limited linkage between exchange rate changes and bond flows in Japan can be explained by the fact that a high percentage of Japanese debt is financed internally, primarily by Japanese pension funds, hence bilateral

The causality-in-variance analysis suggests the existence of strong spillovers from equity flows to exchange rate changes in the euro area and bidirectional causality-in-variance in Japan. As for the linkages between exchange rate changes and bond flows, causality-in-variance from bond flows to exchange rate changes is found for Australia, the euro area, and Sweden, and bidirectional causality for Canada and the UK. These findings have important policy implications, since they suggest that policy-makers and economic and financial regulators could use exchange rate or credit controls on equity as well as bond flows as instruments to achieve economic and financial stability.

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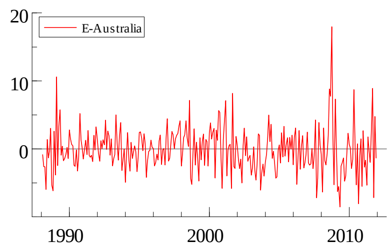
E-Australia
20
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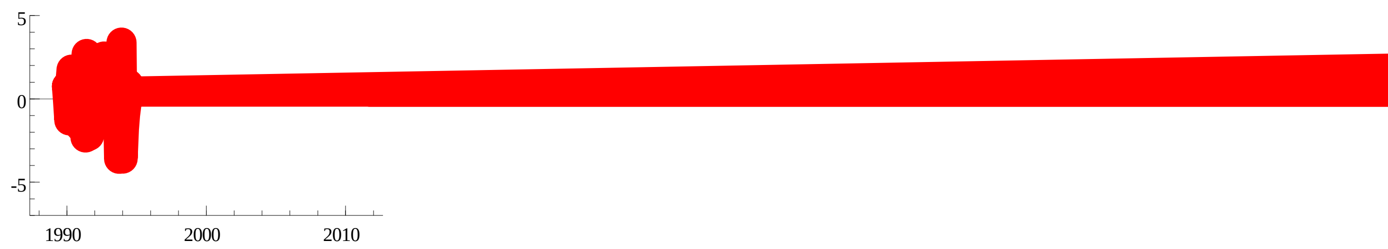
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Table 1

Summary of descriptive statistics for the normalized net portfolio flows and exchange rate changes.

Statistics	Variable	Australia	Canada	Euro area	Japan	Sweden	UK
Mean	E_t						

Table 2

The estimated bivariate GARCH–BEKK–

Table 4

The estimated bivariate GARCH–BEKK–in–mean model for the euro area.

Panel A: Exchange rates (E_t) and equity flows (EF_t)			Panel B: Exchange rates (E_t) and bond flows (BF_t)		
	E_t (i=1)	EF_t (i=2)		E_t (i=1)	BF_t (i=2)
Conditional Mean Equation					
i	0.065 (0.178)	1.818** (0.916)	i	0.023 (0.194)	0.627*** (0.274)
$1i,t\ \ 1$	–	0.229** (0.101)	$2i,t\ \ 1$	–	0.142** (0.058)
$2i,t\ \ 2$					

Table 6

The estimated bivariate GARCH–BEKK–in–mean model for Sweden.

Panel A: Exchange rates (E_t) and equity flows (EF_t)			Panel B: Exchange rates (E_t) and bond flows (BF_t)		
	E_t (i=1)	EF_t (i=2)		E_t (i=1)	BF_t (i=2)
Conditional Mean Equation					
$_{i}$	0.118 (0.179)	0.045 (0.196)	$_{i}$	0.066 (0.165)	0.597*** (0.130)
$_{2i,t\ 1}$	–	0.275*** (0.059)	$_{2i,t}$	0.028*** (0.024)	–
$_{2i,t\ 2}$	–	0.137** (0.069)			
$_{2i,t\ 5}$	0.013* (0.008)	–			
Conditional Variance Equation					
c_{1i}	1.128 (0.810)	0	c_{1i}	1.174*** (0.308)	0
c_{2i}	0.567 (0.757)	1.183*** (0.421)	c_{2i}	0.881*** (0.172)	0.000001 (.382)
$_{1i}$	0.502*** (0.094)	(0.047)			

Table 7

The estimated bivariate GARCH