EUROPEAN CENTRAL BANK

WORKING PAPER SERIES
NO 706 / DECEMBER 2006

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A VAR-BASED RETURN DECOMPOSITION ANALYSIS

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1 The views expressed in this article are the authors' only and do not necessarily reflect those of the European Central Bank or the European System of Central banks. We are grateful to Lorenzo Cappiello, Peter Christoffersen, Stelios Makrydakis, Tarun Ramadorai, Isabel Vansteenkiste and Tuomo Vuolteenaho for helpful comments and Citigroup N.A. for kindly providing us with the currency options data. All remaining errors are our own.

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ISSN 1561-0810 (print)
ISSN 1725-2806 (online)

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Abstract

We apply the Campbell-Shiller return decomposition to exchange rate returns and fundamentals in a stationary panel vector autoregression framework. The return decomposition is then used to analyse how different investor segments react to news as captured by the different return components. The results suggest that intrinsic value news are dominating for equity investors and speculative money market investors while investors in currency option markets react strongly to expected return news. The equity and speculative money market investors seem able to distinguish between transitory and permanent FX movements while options investors mainly focus on transitory movements. We also find evidence that offsetting impact on the various return components can blur the effect of macroeconomic data releases on aggregate FX excess returns.

Key Words: FX return prediction, investor flows, news surprises, panel estimation, stationary VAR.

JEL Classification: C23, F31, F32, G15.

Executive Summary

Explaining movements in exchange rates is an empirically challenging, if not frustrating, exercise, as most empirical exchange rate literature after Meese and Rogoff (1983) attests. Recently, attempts have been made to "explain" exchange rate movements using investor flows data – this approach has inspired much work in the "FX market microstructure" field pioneered by Evans and Lyons (2002). Although it seems that such order flows are able to "explain" a large part of the overall sample variability of exchange rates (see e.g. Wei and Kim (1997) Evans and Lyons (2003) Evans and Lyons (2004) and Rime (2002)), it is not clear whether the effect of order flows on exchange rate returns is permanent (that is, correlated with "news" that affect the long-term intrinsic value of a currency), or temporary. Froot and Ramadorai (2005) address this question by applying to exchange rates the return decomposition technique originally proposed by Campbell (1991) and Vuolteenaho (2002) for stock returns (see also Cohen, Gompers, and Vuolteenaho (2005)). They find that fundamentals tend to drive the permanent component of shocks to exchange rate returns. In contrast, flows - measured by institutional investors' positions - are related to transitory shocks only. However, the permanent component of the variance of exchange rate returns is found to represent only a small proportion of the total returns variance. Froot and Ramadorai (2005) conclude that large transitory movements blur the relationship between fundamentals and exchange rate returns.

This paper applies a procedure similar to that proposed by Froot and Ramadorai (2005) to various exchange rate pairs. In contrast to their paper, however, we specify our theory model in a way that allows us to avoid using non-stationary panel models. While it is true, as claimed by Froot and Ramadorai (2005), that pooling data from various countries increases the power of unit root tests, very stringent conditions on the covariance structure of the data are required to estimate a VAR with real exchange rates in levels by panel cointegration models. Similar conditions apply for the application of panel unit root tests to real exchange rates. A large and growing literature indicates that such tests (and the corresponding estimators) suffer from massive size distortions in the presence of cross-sectional correlation and common stochastic trends. Indeed, in panels of real exchange rates, the price variable in the numeraire country is obviously a (non-stationary) trend that is common to all countries, making such econometric techniques unsuitable[1].

We also differentiate our work from previous studies by investigating the behaviour of investors in various markets, namely equities, international ("speculative") money markets and currency options. Against that background, the specific questions we ask are the following. Can data on flows from other types of investors than the institutional investors used by Froot and Ramadorai (2005) be found driving the transitory component of exchange rate excess returns? Could such a finding further explain the somewhat inconsistent results in re-

[1] On the distortions of panel unit root tests and panel cointegration estimators, see e.g. Banerjee, Marcellino, and Osbat (2004a), Banerjee, Marcellino, and Osbat (2004b), Lyhagen (2000).

cent literature regarding the ability of financial market variables to forecast exchange rate returns over different horizons? And which investors react to the movements in the permanent component of returns? Finally, we use the decomposed individual return series from the USD/EUR currency-specific VAR to estimate how various macroeconomic news affect the different return components. One would expect such "fundamental" news to be mostly correlated with the intrinsic value news component of FX returns. It turns out that while news releases in some major macroeconomic variables are indeed able to track the intrinsic value component, this is not always the case. Moreover, in some cases simultaneous correlation of the macro news variable with several return components can weaken the impact on aggregate returns. We conclude that it could be useful to make the distinction between the impact on various return components before drawing conclusions on links between macro news and FX returns.

The rest of this paper proceeds as follows. Section 2 sketches out the theory model for the exchange rate return decomposition. Section 3 presents the VAR model and the return decomposition to expected return and intrinsic value components. Section 4 introduces the data. Section 5 discusses the results from the VAR estimation. Section 6 derives currency-specific versions of the VARs and demonstrates the response of various return components to macroeconomic news. Section 7 concludes.

1 Introduction

Explaining movements in exchange rates is an empirically challenging, if not frustrating, exercise, as most empirical exchange rate literature after Meese and Rogoff (1983) attests. Recently, attempts have been made to "explain" exchange rate movements using investor flows data – this approach has inspired much work in the "FX market microstructure" field pioneered by Evans and Lyons (2002). Although it seems that such order flows are able to "explain" a large part of the overall sample variability of exchange rates (see e.g. Wei and Kim (1997) Evans and Lyons (2003) Evans and Lyons (2004) and Rime (2002)), it is not clear whether the effect of order flows on exchange rate returns is permanent (that is, correlated with "news" that affect the long-term intrinsic value of a currency), or temporary. Froot and Ramadorai (2005) address this question by applying to exchange rates the return decomposition technique originally proposed by Campbell (1991) and Vuolteenaho (2002) for stock returns (see also Cohen, Gompers, and Vuolteenaho (2005)). They find that fundamentals tend to drive the permanent component of shocks to exchange rate returns. In contrast, flows - measured by institutional investors' positions - are related to transitory shocks only. However, the permanent component of the variance of exchange rate returns is found to represent only a small proportion of the total returns variance. Froot and Ramadorai (2005) conclude that large transitory movements blur the relationship between fundamentals and exchange rate returns.

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cent literature regarding the ability of financial market variables to forecast exchange rate returns over different horizons? And which investors react to the movements in the permanent component of returns? Finally, we use the decomposed individual return series from the USD/EUR currency-specific VAR to estimate how various macroeconomic news affect the different return components. One would expect such "fundamental" news to be mostly correlated with the intrinsic value news component of FX returns. It turns out that while news releases in some major macroeconomic variables are indeed able to track the intrinsic value component, this is not always the case. Moreover, in some cases simultaneous correlation of the macro news variable with several return components can weaken the impact on aggregate returns. We conclude that it could be useful to make the distinction between the impact on various return components before drawing conclusions on links between macro news and FX returns.

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2 FX Return Decomposition: Theoretical Approach

For our theoretical model, we follow Campbell and Shiller (1988) and Campbell (1991) who introduced the asset return decomposition using the dynamic dividend-discount model on stock prices. Froot and Ramadorai (2005) extended that approach to exchange rates and noted that due to the multiplicative nature of the "dividend" component (the interest rate differential) on FX returns the Taylor series expansion that is required when log-linearising the model provides an exact result. This is different than in stock markets where the additive dividend component implies that the log-linearisation only yields an approximate result.

Following this approach, assume now that the return on a currency investment is given by the following identity:

$$R_{t+1} = \frac{S_{t+1}^{\rho} D_{t+1}^{1-\rho}}{S_t} - 1, \tag{1}$$

where S_t is the real exchange rate, D_t is the real interest rate differential (dividend) defined as $(i_t^* - \pi_{t+1}^*) - (i_t - \pi_{t+1})$, where i (i^*) denotes the domestic (foreign) nominal interest rate and π (π^*) is the domestic (foreign) inflation rate. Parameter ρ measures the relative share of the exchange rate movement in the $t+1$ period return. From an international investor's point of view, ρ

could also reflect the costs of hedging: the higher the share of return originating from the exchange rate movement relative to the change in the interest rate differential, the more value the investor assigns on the option of hedging against the exchange rate risk.

Next, following Campbell, Lo, and MacKinlay (1997), continuously compounded log returns can be expressed as

$$r_{t+1} = \log(1 + R_{t+1}). \tag{2}$$

Substituting (1) into (2) yields

$$r_{t+1} = \log(1 + \frac{S_{t+1}^{\rho} D_{t+1}^{1-\rho}}{S_t} - 1) \tag{3}$$
$$r_{t+1}\rho s_{t+1} + (1-\rho)d_{t+1} - s_t.$$

By solving equation (3) forward and imposing the no-bubble constraint $\lim_{j\to 0} \rho^j s_{t+j} = 0$, we get

$$s_t = \sum_{j=0}^{\infty} \rho^j \left[(1-\rho)d_{t+1+j} - r_{t+1+j}\right]. \tag{4}$$

Taking expectations on (4) gives

$$E_t(s_t) = E_t\left[\sum_{j=0}^{\infty} \rho^j \left[(1-\rho)d_{t+1+j} - r_{t+1+j}\right]\right]. \tag{5}$$

Note that $E_t(s_t) = s_t$ because s_t is known at time t. Campbell (1991) shows that by substituting (5) into (3) it is possible to derive an expression that relates unexpected returns in an asset price to changes in expectations of future fundamentals and real returns. More precisely:

$$r_{t+1} - E_t(r_{t+1}) = (E_{t+1} - E_t)\left[\sum_{j=0}^{\infty} \rho^j \bigtriangleup d_{t+1+j}\right] - (E_{t+1} - E_t)\left[\sum_{j=0}^{\infty} \rho^j r_{t+1+j}\right]. \tag{6}$$

Note that unlike in Froot and Ramadorai (2005), the recognition of the weight ρ in the expression for the exchange rate return allows us to express the "dividend" component in first differences rather than in levels. This will have important repercussions in the way we specify the VAR below. Equation (6) tells us that at any point in time, a surprise appreciation of a currency must be associated with an improvement in expected future dividends (widening of expected future real interest rate differential), or a decrease in required future returns. An alternative interpretation of (6) is that it represents a decomposition of excess currency returns into permanent and transitory components as in Beveridge and Nelson (1981). Changes in future expected excess returns generate temporary fluctuations, as the current impact of a future change creates an equal and opposite movement in the currency.

Put in another way, equation (6) expresses unexpected excess currency returns as the difference between "intrinsic" value news and "expected return" news. Intrinsic value news are defined as the innovation in the expected present value of future interest rate differentials, captured by the term:

$$(E_{t+1} - E_t)\left[\sum_{j=0}^{\infty} \rho^j \bigtriangleup d_{t+1+j}\right]$$

The intrinsic value component can be thought of as the excess currency return that would prevail at a given time if expected future currency returns were held constant. Expected return news, defined as

$$(E_{t+1} - E_t)\left[\sum_{j=0}^{\infty} \rho^j r_{t+1+j}\right],$$

is the innovation in the exchange rate that is attributable to a change in required excess returns, holding intrinsic value constant. Clearly, an increase in future expected returns, given intrinsic value, results in a currency depreciation. For convenience, equation (6) can be written in terms of intrinsic value and expected return news as follows:

$$r_{t+1} - E_t(r_{t+1}) = \nu_{iv,t} - \nu_{er,t}. \tag{7}$$

The decomposition in equation (7) is useful for several purposes. It allows us to compare the relative magnitudes of intrinsic value and expected return shocks in currencies. It also allows us to investigate how changes in flows and intrinsic values interact with currency excess returns. To this end, we specify a vector-autoregression model.

3 The Decomposition of Exchange Rate Excess Returns: Empirical Implementation

The discussion in this section draws on Campbell (1991), Vuolteenaho (2002) and Froot and Ramadorai (2005). We refer to our theoretical model for details on the rationale of the decomposition and concentrate here on its representation in the VAR. The decomposition is the same, irrespective of whether a single-country VAR or a "panel VAR" is estimated, provided that the panel VAR imposes homogeneity restrictions on the coefficients of interest. Here we discuss the panel-VAR setting.

Unlike Froot and Ramadorai (2005), equation 6 allows us to specify the panel VAR in first differences. We can then use a simple panel-VAR with fixed effects, pooling the data from all currencies together. Our choice of avoiding nonstationary panel estimators is rooted in numerous results in the recent literature on panel unit roots and panel cointegration, about the strong distortions arising from the presence of cross-sectional correlation. In a setting where exchange rates are included in the VAR, cross-sectional correlation is unavoidable: see for details Lyhagen (2000), Banerjee, Marcellino, and Osbat (2004b) and Wagner (2005).

Let z_{it} be a $k-$dimensional vector of variables for each currency, the first of which is excess returns on the currency. A "panel VAR(p)" of lag length p can be then represented in companion form as a VAR(1) of dimension $k \times p$:

$$z_{it+1} = \Gamma z_{it} + u_{it+1} \tag{8}$$

where u_{it} is serially uncorrelated, with mean 0 and variance $\Sigma_i = \Sigma$.[3] There are no restrictions on contemporaneous correlation in Σ. Given a selection vector e_1 of appropriate dimensions, the forecast of excess returns is then

$$h_{it+1+j} = e_1 \Gamma^{j+1} z_{it} \tag{9}$$

where j is the forecast horizon. Then:

$$\begin{aligned} E_t \left[h_{it+1+j}\right] &= e_1' \Gamma^{j+1} z_{it} \\ E_{t+1} \left[h_{it+1+j}\right] &= e_1' \Gamma^{j} z_{it+1} \end{aligned} \tag{10}$$

and

$$E_{t+1} \left[h_{it+1+j}\right] - E_t \left[h_{it+1+j}\right] = e_1{}' \Gamma^j z_{it+1} - e_1' \left(\Gamma^j \Gamma\right) z_{it} = e_1' \Gamma^j u_{it+1}. \tag{11}$$

The discounted sum of forecast revisions of returns, assuming a discount factor equal to one, is then given by

$$\left(E_{t+1} - E_t\right) \sum_{j=1}^{\infty} \left[h_{it+1+j}\right] = e_1' \sum_{j=1}^{\infty} \Gamma^j u_{it+1}. \tag{12}$$

If the eigenvalues of the matrix Γ are inside the unit circle, then the (discounted) sum of revisions in forecast returns is given by:

$$\begin{aligned} v_{ert} &= \left(E_{t+1} - E_t\right) \sum_{j=1}^{\infty} \left[h_{it+1+j}\right] = e_1' \Gamma \left(I - \Gamma\right)^{-1} u_{it+1} \\ &= \lambda' u_{it+1} \end{aligned} \tag{13}$$

where $\lambda = e_1' \Gamma \left(I - \Gamma\right)^{-1}$.

Campbell (1991) shows that the unexpected return can be decomposed as the difference between intrinsic value news (v_{ivt}) and expected return news (v_{ert} defined above). In terms of the VAR parameterisation:

$$e_1' u_{it} = v_{ivt} - v_{ert} \tag{14}$$

[3] In order to be able to pool the data, they are first standardised currency by currency.

The "intrinsic value news" (or permanent component) can be written simply as

$$\begin{aligned} v_{ivt} &= e_1' u_{it} + v_{ert} \\ &= e_1' \left(I + \Gamma (I - \Gamma)^{-1} \right) u_{it}. \end{aligned} \tag{15}$$

To construct impulse response functions, Froot and Ramadorai (2005) define the innovation in cumulative expected future currency changes $k > 1$ periods forward as

$$e_1' \Phi (k) u_{it} = e_1' \left(\Gamma - \Gamma^{k+1} \right) (I - \Gamma)^{-1} u_{it} \tag{16}$$

and the total impulse response as the shock itself plus the cumulative sum above:

$$\begin{aligned} e_1' \Psi (k) u_{it} &= e_1' (I + \Phi (k)) u_{it} \\ &= e_1' \left(I + \left(\Gamma - \Gamma^{k+1} \right) (I - \Gamma)^{-1} \right) u_{it} \end{aligned} \tag{17}$$

Now, looking back at the return decomposition, we see that the infinite-horizon total impulse response is equal to the "intrinsic value news", while the infinite-horizon innovation in cumulative expected changes equals the "expected return news".

For practical purposes, the impulse response of returns to an unexpected return, u_{1t}, is calculated by setting the return shock to be equal to 50 basis points while the other elements of the error vector are set equal to their conditional values given that $u_{1t} = 0.50$. To calculate the impulse response of returns to a 50 basis points intrinsic value shock, the normalised sum of squared errors from the VAR is minimised, subject to the constraint that $e_1' \left(I + \Gamma (I - \Gamma)^{-1} \right) u_{it} = 0.50$. Impulse responses of the other variables included in the VAR to shocks in expected return news and intrinsic value news can be derived similarly, using different selection vectors.

In the VAR, we include four equations. Three equations are related to "traditional" models of exchange rate determination: currency excess returns, real interest rate differentials, and the real exchange rate. The fourth equation is meant to capture investor flow determinants of short-term exchange rate dynamics. In particular, we experiment with three alternatives for the fourth equation: equity return differentials, speculative currency flows and risk reversals on currency options.

Our setup can be justified along the following lines. Regarding the "standard" equations in our VAR, there is ample evidence that real exchange rates and interest rate differentials are informative about currency excess returns (see Baxter (1994), Engel and West (2003)). In essence this view boils down to the assumption that PPP, or relative PPP, holds in the long run.[4]

Regarding our chosen options for the "flow" equation, the notion that equity investors' behaviour should help explaining currency excess returns has been put

[4]The long-run PPP hypothesis has recently received renewed empirical support from researchers working on non-linear adjustment models that make a distinction between short-term fluctuations and long-run returns to equilibrium (see Taylor, Peel, and Sarno (2001) and De Grauwe and Grimaldi (2005)).

forward by researchers analysing international financial flows. A recent trigger for such interest has been the observed exchange rate movements at the time of the global stock market boom and bust episode in late 1990s and early 2000s (Brooks, Edison, Kumar, and Sløk (2004), Hau and Rey (2006)). In the absence of sufficiently high-quality data on equity investor flows, work along these lines has focused on the link between changes in relative equity prices between two economic areas and the relevant exchange rate. The relationship has been found to be significant at times, but a general conclusion on the robustness of this empirical connection has thus far not been reached. A possible explanation to this puzzle is that the relative strength of correlation between stock market developments and the various FX return components could be time-varying.

As mentioned above, the links between institutional investor flows and exchange rates have been extensively studied by scholars with exclusive access to large financial institutions' proprietary trading data (Evans and Lyons (2002), Froot and Ramadorai (2005)). The results in this field have been more encouraging: Evans and Lyons (2002) argue that exchange rate movements related to investor order flows could be responsible for the bulk of the observed short-term exchange rate movements, while Froot and Ramadorai (2005) find evidence of close links between investor flows and the transitory component of exchange rate returns. We use the weekly IMM speculative flows data as a proxy for such flows, although we do acknowledge that "speculative" and "institutional" investors could follow different investment strategies.

Finally, implied volatility on currency options has been shown to contain useful information when forecasting exchange rate volatility (Jorion (1995), Christoffersen and Mazzotta (2004)). There is some tentative evidence that risk reversals, a contract that reflects the options market's view of the future directional movements in exchange rate levels, could contain information about future levels of exchange rate changes. We therefore include risk reversals as a proxy for currency options flows in the model.

These three variables are included one by one as the fourth equation in our VAR to investigate whether the decomposition of returns into transitory and permanent components could shed some light on their relative predictive power vis-à-vis exchange rate excess returns.

4 Data issues

The sources of the various data that enter the VAR systems are as follows. The bilateral currency pairs considered are CAD/USD, CHF/USD, EUR/USD, GBP/USD and JPY/USD. These bilateral exchange rates are the most frequently used in international trade and financial transactions. The data for the bilateral US dollar rates are obtained from Datastream. All exchange rates are expressed in log differences, i.e. daily returns. The excess returns in the foreign exchange market are measured by the rate of return in US dollar on an uncovered investment in the money market of currency j that is in excess of the US dollar nominal interest rate. The excess returns are calculated by

$ln(s_{j,t+1}) - ln(s_{j,t}) + 1/365\left[ln(1+i_{j,t}) - ln(1+i_{usd,t})\right]$, where $s_{j,t}$ denotes the price of one unit of foreign currency in US dollar terms, and $i_{j,t}$ and $i_{usd,t}$ are the annualised one month euro-market interest rates of currency j and the US dollar (reference currency), respectively.

Turning to the "fundamental" variables entering the VARs, the long-term interest rates we use are the secondary market 10-year nominal benchmark Treasury bond yields for the euro area, US, UK, Japan, Canada and Switzerland (in the case of Switzerland the maturity is over 7 years), that are available from BIS. The real interest rates and real exchange rates are calculated as differences between nominal variables and the CPI inflation rates taken from the IMF database. The fact that the CPI data are monthly also means that we need to adopt the assumption that CPI changes smoothly throughout the month.

Regarding the variables that are used to measure investor behaviour in the VAR, stock market data consist of local currency-denominated total return indices for the euro area, the US, the UK, Japan, Canada and Switzerland, all obtained from Datastream. Prior to 1999 the euro area index is proxied by the Europe ex-UK index that closely tracks the euro area series. All returns are continuously compounded and expressed in daily percentage changes. Data on the short-term speculative accounts consists of figures on the net positions taken on currency futures at the Chicago International Money Market that are downloaded from Bloomberg. Data on currency options risk reversals are based on OTC trading figures, obtained from Citibank. Overall, our data contains daily observations from January 5 1993 until June 30 2004, thus resulting in a total sample size of 2997 observations over eleven and a half years. The choice of the sample period reflects availability of data which in the case of the macro news (to be introduced below) and currency options were available only from 1993 onwards and in the case of equity return differentials only from 1994 onwards. Prior to 1999 euro exchange rates have been proxied by German data.

The measurement of macroeconomic news that are used in the final part of this paper is a more complicated issue, due to the lower frequency of such data series. In our study, we adopt real-time data instead of vintage data, i.e the final, revised figures that are generally released several months after the period to which the data refers. The real-time data reveal the information that becomes available to the markets every day. However, it can be expected that on the day of the announcement the market reacts only to the unexpected, or "surprise", or "news", component of an announcement. The expected part of the announcement has been absorbed by the market previously. However, the impact of the surprise component is somewhat hard to measure since we cannot determine the exact timing of when this occurred. Consequently, the difference between the actual announcement ($A_{k,t}$) and the market's prior expectations ($E_{k,t}$) – normalised by dividing by the sample standard deviation Ω_k of each announcement k – describes the surprise component ($M_{k,t}$) of the announcement. Normalizing the surprise component allows a comparison of the relative size of the coefficients in the econometric model:

$$M_{k,t} = \frac{(A_{k,t} - E_{k,t})}{\Omega_k}$$

The data for the macroeconomic variables are collected from MMS international. In case of the expectations data ($E_{k,t}$) the median of a survey of around 40 market participants on the Friday prior to each announcement is taken. Due to the fact that announcements for most variables take place on a monthly frequency and given the sample period January 5 1993 to June 30 2004, our data set comprises between 60 and 175 news for each variable.

For many return series considered, particularly the exchange rates and equity indices, the distributions are skewed and leptokurtic which is a clear indication of non-normality. This is confirmed by the Jarque-Bera normality test that for the above mentioned variables strongly rejects the hypothesis of normally distributed returns. On the other hand, the Ljung-Box test statistics reveal that autocorrelation is an issue particularly for the long-term interest rates and risk reversals. Regarding the MMS expectations data, previous work by Ehrmann and Fratzscher (2005) has shown that the survey-based expectations are generally unbiased and efficient. All the data were log-transformed and checked for outliers and missing observations. Obvious outliers were removed and missing observations in the series were closed by linear interpolation.

5 Variance Decomposition and Impulse Responses

We now move on to the empirical results from the VAR estimations. After showing the results from the variance decomposition, we use the impulse responses to illustrate the time profile of the responses of returns to shocks.

5.1 Variance Decomposition

The VAR-based return decomposition allow us to study a number of issues regarding the relationship between currency excess returns, their flow determinants and fundamentals. The additional advantage with the VAR framework is that it can illustrate how these relationships change across different horizons.

Previous literature has not been conclusive on this issue. On equity markets, Campbell (1991) found that for the value-weighted NYSE equity index expected return shocks dominated the innovations in cash flows (intrinsic value innovations in our case). In contrast, Vuolteenaho (2004) analysed firm-level stocks and found cash flow news to be the main driver of firm-level returns. A likely explanation of this divergence in results is that in the process of aggregation, the firm-specific cash flow component tends to get washed away in the index.[5] Consequently, the index is mainly driven by the expected return component that is more likely to reflect systematic, macroeconomic information as opposed to firm-level information that is incorporated in the cash-flow component.

Using a VAR for exchange rates where flows are measured by micro-level data on institutional investor positioning, Froot and Ramadorai (2005) found

[5] Vuolteenaho (2004) constructs an equally-weighted portfolio of the individual firms' stock returns and finds that for the hypothetical portfolio, expected return news dominate cash flow news.

that expected return news, or the transitory component, are the main determinant of currency returns. The investor flow data in particular was shown to be strongly correlated with the transitory return component. They argue that this dominance of expected return shocks blurs any empirical link between exchange rates and fundamentals in short horizons, thus providing a potential explanation to the poor short-horizon performance of models where exchange rates are forecast with fundamentals.

We start with looking at the relative importance of the expected return vs. intrinsic value components in explaining the variance of excess returns. For that purpose, it is useful to express the variance of excess returns as follows

$$\sigma_{fx}^2 = \sigma_{iv}^2 + \sigma_{er}^2 - 2\rho_{iv,er}\sigma_{iv}\sigma_{er} \tag{18}$$

or, equivalently, using the notation above,

$$e_1\prime\Sigma e_1 = e_1'\Psi\Sigma\Psi\prime e_1 + e_1\prime\Phi\Sigma\Phi\prime e_1 - 2e_1\prime\Psi\Sigma\Phi\prime e_1 \tag{19}$$

where $\Psi = \Psi(\infty)$ and $\Phi = \Phi(\infty)$.

The results from the variance decomposition of our three different VARs are summarized in Table 1, where the total variance (σ_{FX}^2) is split into the variance of the intrinsic value component (σ_{IV}^2), the expected return component (σ_{ER}^2) and the correlation between the two components ($\sigma_{IV,\ ER}$).

[Table 1 here]

For the VARs where the flow component is measured by equity returns and speculators' net positions, respectively, intrinsic value shocks are substantially larger than expected return shocks. Indeed, although statistically significant, the variances of the expected return components are economically very small in these cases. For the VAR with currency options data, however, the expected return shocks are almost three times larger than the intrinsic value shocks. Against the background of the economic interpretation of the two return components, these results suggest that currency options investors could react more strongly to common, systemic shocks to the FX markets whereas the investors in the other two market segments react more to news in the individual currency, or country, specific fundamentals. This interpretation looks particularly sensible for cross-border equity investors who are typically found to focus on the equity market risk rather than the exchange rate risk.[6] On the other hand, given the association of the expected return news with the transitory component of currency returns, the behaviour of currency options investors, like the institutional investors analysed by Froot and Ramadorai (2005), could have more power in explaining short-term currency returns.

The correlation term in the VAR variance-decomposition also has an important interpretation. As explicitly derived by Vuolteenaho (2004), a positive

[6]The literature in international CAPM provides similar conclusions: for international equity investors, the own market risk component tends to be more significant than the currency risk in cross border investment. See De Santis and Gérard (1998) and Castrén, Cappiello, and Jääskelä (2003) for a more detailed exposition.

correlation between intrinsic value and expected return news implies that in the long run, the exchange rate under-reacts to positive intrinsic value news. This can be explained by observing that by definition, under-reaction implies that the exchange rate does not move "enough" as a response to intrinsic value news and consequently, expected return news must increase to fill the gap. In our estimations the correlations are positive in all cases. However, although not statistically significant, the correlation coefficient for the VAR that includes risk reversals is around seven times higher than the coefficient for the two other VARs. This is further indication that in the long run, investors in the options markets in particular tend to under-react to fundamental news on currencies.

5.2 Impulse Responses

In the following we illustrate how the returns and flows dynamically react to transitory and permanent return innovations. Chart 1 shows the impulse responses of cumulative excess returns to a 50 basis points intrinsic value (or permanent) and to a 50 basis points expected return (or transitory) shock.

The exchange rate appreciates immediately as a response to good intrinsic value news. However, the appreciation continues thereafter, meaning that it takes time for the market to fully price in the news. For equity investors, for example, the peak is reached around 160 trading days after the shock with the profile of the impulse response functions suggesting short-run overreaction (at the level of around 70 trading days) by the market to positive intrinsic value news. This would imply that it takes for the FX market between one-half and one years to fully incorporate intrinsic value news to prices, which is in line with the results reported by Vuolteenaho (2004) for the US equity markets.

<Chart 1 here>

Turning to the expected return, or transitory, shock, consistent with the theory model a negative expected return shock is required to generate an appreciation of the currency which explains the sign of the other impulse response function (see Chart 2). For the equity and speculative investors, the impact of transitory shocks is rather modest over all horizons. The transitory shocks have, however, considerably stronger impact in the currency options investors. This result tends to confirm what was suggested by the variance decomposition above: investors in currency options react much stronger to transitory shocks than equity investors or speculators, for which the intrinsic value component is the more dominant driver of returns.

<Chart 2 here>

Charts 3 and 4 analyse the flow response to shocks on the different return components. Consider first the flow response to an exchange rate appreciation that is caused by a positive intrinsic value shock. For equity investors and, to a lesser extent, speculators, the shock is followed by inflows over the short (around 50 trading days) horizon. These inflows are then broadly reversed in the longer horizons. The initial inflows are indicative of short-term trend-chasing behaviour among investors. In other words, investors tend to buy the currency, or assets denominated in the currency, soon following a positive permanent return shock and sell over longer horizons. For currency options investors the inflows resulting from intrinsic-value shocks are negligible.

<Charts 3 and 4 here>

Regarding the flow response to an appreciation that is caused by a positive expected return shock, note again that in accordance to the theory model, a decline in expected returns is needed to generate an appreciation. For the options markets an appreciation resulting from a transitory shock is followed by buying/inflows, whereas for equity investors and speculators the opposite happens: an appreciation that is generated by transitory expected return news causes more or less substantial short-term outflows up until 100-150 trading days after the shock. This result suggests that investors in equity and international money markets could be able to distinguish between the origins of the different shocks: in the short run, transitory appreciation that is known to revert in the future triggers selling of the currency whilst permanent appreciation generates buying. Investors in options market are, in contrast, either less sophisticated, or characterized by a much shorter horizon, given that strong buying is triggered by transitory appreciation and practically no buying is followed by permanent appreciation. The behaviour of investors in international equity markets and money market futures could therefore be similar to that of institutional investors that were studied by Froot and Ramadorai (2005). In contrast, options market investors seem to behave differently by essentially ignoring appreciations that are caused by permanent return shocks.

5.3 The Correlations among Excess Returns, Flows and Fundamentals

Next, we report the relationships between flows and returns using tables of correlations among the various components. The first row of Tables 2-4 shows innovations in flows. The second row reports the present value of cumulated flow innovations where flows are computed from the VAR. The third row is the sum of the first two. The three columns in turn report, from left to right, the excess return shock and its components, expected return innovations and the intrinsic value innovations. All entries to Tables 2-4 have been scaled by the product of innovation standard deviations.

<Tables 2-4 here>

Looking first at the "price impact" effects reported in cells (1, 1) indicates that for equities and speculative flows, the correlation is significantly positive at 32% and 17%, respectively. For risk reversals, however, the immediate impact is negative (albeit small). Cells (2, 1) show whether return surprises are capable of predicting changes in expected long-run future flows. For equities and speculative flows, these effects are negative suggesting that in the long run, investors sell home country securities as a response to a transitory home currency appreciation. In the case of risk reversals, in contrast, transitory appreciation generates inflows that almost exactly compensate for the negative price impact. These results are consistent with the impulse responses as reported in Chart 2.

The cells in the second columns measure the co-movement of expected future FX returns with innovations in flows. Cell (1, 2) is statistically significant only for equities. The negative coefficient suggests that over the long horizon, home equity inflows tend to lead to home currency depreciation, which is in line with the results reported by Hau and Rey (2006) and the previously identified long-run under-reaction effects. Cells (2, 2) measure the covariance between long-term expected flows with expected returns and suggest that in all cases this is positive and significant (albeit very small for equities).

The final column summarizes the effects of the first two columns and provides a measure of co-movement between intrinsic value news and flow innovations. In particular, cells (3, 3) provide an infinite-horizon correlation measure between flows and returns. Unlike in Froot and Ramadorai (2005), these correlations are all statistically significant suggesting that decisions by investors do show some long-horizon co-movement with exchange rate returns. In this respect, our findings seem to lend support to Evans and Lyons (2002) who argue that investor flows have a long-horizon (permanent) impact on exchange rate returns.

<Tables 5-7 here>

Tables 5-7 summarize the correlations between currency excess returns and interest rate differentials (our proxy for fundamentals). We focus on the results from the VAR with speculative flows only but the other two provide broadly similar conclusions. First, the price impact shows a positive, but insignificant contemporaneous correlation between shocks to interest rate differentials and shocks to returns. Cell (2, 1) shows that surprise currency appreciations positively anticipate future increases in real interest rate differentials. Cell (1, 2) in turn suggests that the evidence on the link between innovations in interest rate differentials and expected future returns is inconclusive, although cell (2, 2) indicates that innovations in real interest rate differentials do have some positive forecasting power for expected short-term currency movements. More importantly, however, regarding the third column, the coefficients suggest that there is a rather strong, positive relationship between interest rate differentials and permanent exchange rate shocks which is in line with the findings of the "mainstream" literature in currency forecasting: over long horizons, changes in macroeconomic fundamentals are related with permanent movements in exchange rates.

6 Exchange rate returns and news on macroeconomic fundamentals

The decomposition of FX excess returns into intrinsic value and expected return news above yielded several interesting results. However, from a practitioner's perspective, intrinsic values that are linked with exchange rate "fundamentals" must be measured using some observable variables that do not depend on a complex estimation of an approximated return generation process. In the literature a large number of variables have been proposed as measuring such "fundamentals" of exchange rates returns, including interest rates, current account variables, monetary aggregates, fiscal variables and various macroeconomic factors (GDP, inflation, and their indicators variables). The question then arises to what extent such "fundamentals", or in the current context "intrinsic value proxies", actually can explain the intrinsic value news component of the FX excess returns. The return decomposition procedure could shed some light on that issue.

Earlier studies looking at the relationships between short-term FX returns and various macroeconomic fundamentals are typically based on static versions of underlying theory models. We recall that in the context of our theory model that is derived from the dynamic dividend-discount model, a static model would treat the expected returns as constant, and therefore would not allow for a decomposition of the total returns into time varying news on intrinsic values and future expected returns. Consequently, studies that use static models effectively look at whether fundamentals can explain total excess returns whereas the impact should actually be measured on the intrinsic value news component of the excess returns.

However, as recently suggested by Hecht and Vuolteenhao (2006) in their study using US equity market data, the dynamic dividend-discount model provides a context that allows one to investigate whether the explanatory power of macro fundamentals as "intrinsic-value proxies" actually arises from the correlation of these proxies with one-period expected returns, intrinsic-value news, or expected return news. More specifically, if expected return variation rather than intrinsic value variation is responsible for the high explanatory power of a regression of aggregate excess return on macro fundamentals, one should not interpret such a result as evidence of intrinsic-value news driving the relationship. Similarly, if expected return news is highly variable and positively correlated with intrinsic value news, the low explanatory power in regressions of total FX excess returns on macro fundamentals does not necessarily imply that macro fundamentals are a noisy measure of the exchange rate return. Even in the case where macro fundamentals actually work as a clear signal of intrinsic value news, simultaneous expected return effects can blur the relationship between fundamentals and total excess returns.

We use the currency return decomposition framework above to split the regression of total excess FX returns on various "intrinsic-value proxies" into three separate regressions, each corresponding to one component of return. We thus arrive at equations for total excess return and its three approximate components:

$$\begin{aligned} r_t &= X_t(\eta_T)\beta + \varepsilon_t \\ E_{t-1}r_t &= X_t(\eta_T)\beta_{E_{t-1}r_t} + \varepsilon_{E_{t-1}r_t} \\ \upsilon_{iv,t} &= X_t(\eta_T)\beta_{\upsilon_{iv,t}} + \varepsilon_{iv,t} \\ \upsilon_{r,t} &= X_t(\eta_T)\beta_{-\upsilon_{r,t}} + \varepsilon_{-iv_r,t} \end{aligned}$$

The regressions as specified above explain FX returns with "intrinsic-value proxies" $X_t(\eta_T)$, where η_T denotes the information set at the end of the world allowing for the possibility that some of the variables may not be known at the end of the return period. In particular, relative to r_t, X_t can contain contemporaneous and future relationships.

To illustrate the difference that return decomposition can make compared to the regressions based on static models, we use the series of real-time macroeconomic news surprises for the US, the euro area and Germany as calculated above in section 4 as "intrinsic-value proxies". We include news surprises on altogether 25 different macro data releases one-by-one as the right-hand side variables of the above regressions.[7] Because we limit ourselves to macro news from the named economic areas only, we also restrict the estimated VAR that is the source of the various left-hand side variables to include data on the USD/EUR exchange rate only. We also drop the fourth ("flow") equation from the VAR and thus include only the excess returns on the USD/EUR, the real interest rate differential between the US and the euro area, and the real USD/EUR exchange rate in the model.

Table 8 reports the results from the estimations. When regressing all three excess return components one-by-one on the various macro fundamentals, many of the estimated coefficients come out as statistically insignificant. For those coefficients that are statistically significant, data releases for the US advanced GDP, the German IFO index, the FOMC policy decisions, the euro area business conditions index and the US retail sales did have a significant impact on the intrinsic-value news component. However, the last two variables (the euro area business condition index and the US retail sales) also track the level of expected returns which distorts the relationship between these variables and the total FX excess returns. In other words, simultaneous relationship of the "intrinsic value proxies" with both intrinsic value news and the level of expected returns partially cancel each other, leaving the aggregate excess return specification with a lower explanatory power. For the US trade balance we find, somewhat surprisingly, a simultaneous relationship with expected return news and the level of expected returns that likewise distorts the relationship between this macro news variable and the total USD/EUR excess returns. Quantitatively, these results are in line with those obtained by Hecht and Vuolteenhao (2006) for a large sample of US non-financial firms. All in all, this exercise shows that caution is needed when drawing inference from the "ability" of macro news variables to explain fundamental FX movements as the potentially conflicting impacts of the various return components that can be extracted using the dynamic model can lead to misleading conclusions.

[Table 8 here]

[7] The macroeconomic news variables included in the investigation were for the euro area: CPI, purchasing managers' index, GDP, industrial production, unemployment rate, retail trade, trade balance, business confidence and ECB interest rate announcements. For Germany: IFO index, CPI, unemployment rate, industrial production, retail sales and GDP. For the US: Advance GDP, unemployment rate, NAPM survey, non-farm payrolls, consumer confidence, industrial production, retail sales, CPI, trade balance and FOMC rate announcements.

7 Conclusions

In this paper we apply the asset price return decomposition techniques to analyse the driving forces of major exchange rate excess returns. Using a panel of five bilateral US dollar exchange rates and an advanced VAR model that accounts for non-stationarity among the endogenous variables we study the interactions between exchange rates, fundamentals and investor flows with data on three different investor categories: international equities, currency options and international money market speculators.

It turns out that the behaviour of investors in the different asset categories can differ quite substantially from each other, and also from the behaviour of institutional investors that have been considered in the earlier literature. While we find that in the long run, all investors tend to under-react to positive intrinsic value news, intrinsic value news are relatively more important for equity market and speculative investors. For currency options investors, in contrast, expected return news are the main driver of flows. This suggests that while country and/or currency specific fundamental news seem to matter for equity and speculative investors, the decisions by currency options investors are more likely to be driven by systemic FX market shocks. The dominance of expected return (transitory) news over intrinsic value (permanent) news for options investors also suggests that options prices could exhibit some forecasting power for short-horizon exchange rate returns.

We also found that, in line with institutional investors analysed in earlier literature, equity and speculative investors seem to be able to distinguish between currency movements that are generated by transitory vs. permanent shocks. Indeed, we found that over short horizons, these investors tend to respond to positive permanent return shocks by buying and to positive transitory return shocks by selling the currency. Currency options investors, in turn, do not seem to react to the intrinsic value news whilst they respond to positive expected return news by buying the currency. This seemingly naïve behaviour could have rational foundations if the investment horizon among these investors is particularly short; alternatively, the positive relationship could simply result from the use of options as a hedging instrument against precisely such short-term exchange rate fluctuations.

Froot and Ramadorai (2005) find that over long horizons investor flows are unrelated to currency movements that are generated by permanent return components. This leads them to conclude that flows only can explain returns over short horizons and adopt a "weak flow-centric view" for exchange rate determination. Our results suggest, in contrast, that for all investor categories considered there is a long-horizon positive relationship between the flows and intrinsic value news which provides some support for the more "strong flow-centric view" advocated by Evans and Lyons (2002).

All in all, our findings shed some further light on the long-standing puzzle of forecasting exchange rate returns over various horizons. In particular, the ability of equity investors to distinguish between transitory vs. permanent appreciations could provide an explanation to the findings in the literature that have shown conflicting results regarding the correlation between relative equity prices and exchange rate returns. In so far as those analyses have reported a negative relationship (such as in Hau and Rey (2006)) they are more likely to have captured the investors' responses either to transitory, or to longer-horizon permanent shocks. Over the short horizons, however, the price impact and the continuing buying into the positive intrinsic value news is likely to dominate, thereby contributing to a positive empirical relationship between relative equity market developments and exchange rates as was reported by Brooks and al (2004) and several authors using daily data frequency. This result suggests that in order to draw conclusions from the impact of macroeconomic news variables on exchange rate returns it could be important to first identify the intrinsic value and expected return components. By looking at the ability of a set of macro news variables to explain the different FX return components we are able to unearth additional justifications for the importance of return decomposition. It turns out that while there are several macro news variables (or "intrinsic value proxies") that are able to track the intrinsic value news component, in some cases this does not translate to a significant relationship between the macro news variable and the aggregate FX excess return. This is because the intrinsic value proxy variable can show simultaneous "disturbing" correlation with other return components.

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	FX	*IV*	*ER*	*IV,ER*
Equities	0.965	1.007	0.022	0.064
(60 lags)	-0.018	-0.02	-0.007	-0.013
Risk reversals	0.968	0.418	1.01	0.46
(60 lags)	-0.017	-0.19	-0.194	-0.383
Speculative flows	0.967	0.991	0.042	0.066
(10 lags)	-0.038	-0.038	-0.007	-0.014

Table 1: Variance decomposition

Excess returns *	*Unexp. innovation*	*Exp. innovation*	*Intr. value innov.*
Flows **	e_1'u	e_1'$\Phi 2$'	e_1'$\Psi 2$'
Unexp. innovation	0.319	-0.039	0.28
e_2'u	-0.01	-0.001	-0.01
Exp. innovation	-0.021	0.006	-0.015
e_2'Φu	-0.001	-0.005	-0.01
Tot. flow innov.	0.297	-0.032	0.265
e_2'Ψu	-0.01	-0.01	-0.011

Table 2: Correlations between excess returns and flows; equities

Excess returns *	*Unexp. innovation*	*Exp. innovation*	*Intr. value innov.*
Flows **	*e1'u*	*e1'Fe2'*	*e1'Ye2'*
Unexp. innovation	-0.084	0.501	0.417
e2'u	-0.011	-0.378	-0.388
Exp. innovation	0.083	4.085	4.168
e2'Fu	-0.017	-0.903	-1.815
Tot. flow innov.	-0.001	4.586	4.585
e2'Yu	-0.903	-1.679	-0.841

Table 3: Correlations between excess returns and flows; risk reversals

Excess returns *	*Unexp. innovation*	*Exp. innovation*	*Intr. value innov.*
Flows **	$e_1'u$	$e_1'\Phi 2'$	$e_1'\Psi 2'$
Unexp. innovation	0.172	0.105	0.277
$e_2'u$	-0.018	-0.177	-0.184
Exp. innovation	-0.12	0.865	0.745
$e_2'\Phi u$	-0.005	-0.293	-0.581
Tot. flow innov.	0.052	0.97	1.022
$e_2'\Psi u$	-0.019	-0.621	-0.313

Table 4: Correlations between excess returns and flows; speculative flows

Excess returns *	*Unexp. innovation*	*Exp. innovation*	*Intr. value innov.*
Int. rate diff. **	$e_1'u$	$e_1'\Phi 2'$	$e_1'\Psi 2'$
Unexp. innovation	-0.012	0.033	0.021
$e_2'u$	-0.01	-0.004	-0.007
Exp. innovation	-0.08	0.038	-0.043
$e_2'\Phi u$	-0.002	-0.007	-0.013
Tot. int. diff. innov.	-0.092	0.071	-0.021
$e_2'\Psi u$	-0.01	-0.016	-0.01

Table 5: Correlations between excess returns and interest rate differentials; equities

Excess returns *	*Unexp. innovation*	*Exp. innovation*	*Intr. value innov.*
Int. rate diff. **	*e1'u*	*e1'Fe2'*	*e1'Ye2'*
Unexp. innovation	0.013	-92.43	-92.417
e2'u	-0.009	-2.997	-3.002
Exp. innovation	0.362	222.476	222.838
e2'Fu	-0.077	-51.244	-102.637
Tot. int. diff. innov.	0.376	130.046	130.422
e2'Yu	-0.075	-104.512	-52.329

Table 6: Correlations between excess returns and interest rate differentials; risk reversals

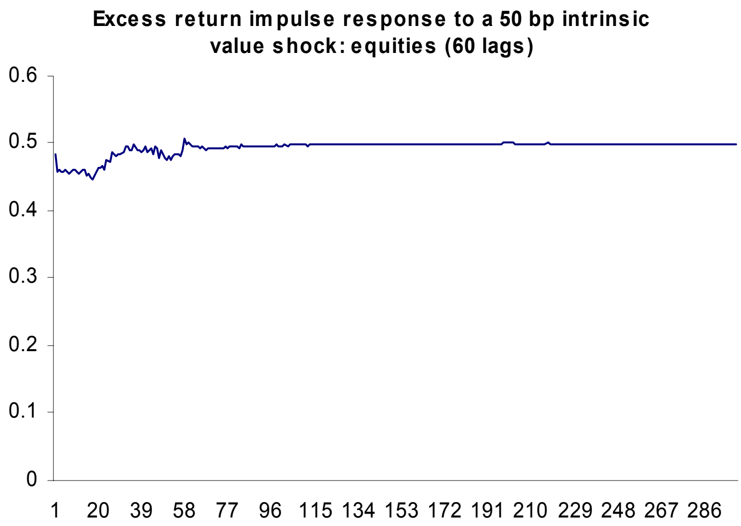
Excess returns *	*Unexp. innovation*	*Exp. innovation*	*Intr. value innov.*
Int. rate diff. **	e_1'u	e_1'$\Phi 2$'	e_1'$\Psi 2$'
Unexp. innovation	-0.012	0.033	0.021
e_2'u	-0.01	-0.004	-0.007
Exp. innovation	-0.08	0.038	-0.043
e_2'Φu	-0.002	-0.007	-0.013
Tot. int. diff. innov.	-0.092	0.071	-0.021
e_2'Ψu	-0.01	-0.016	-0.01

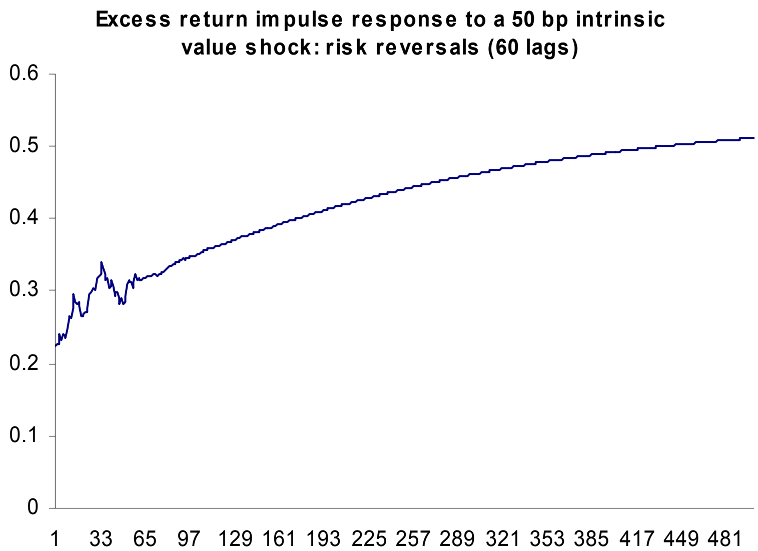
Table 7: Correlations between excess returns and interest rate differentials; speculative flows

RHS/LHS	***rt***	***Et-1rt***	***Niv,t***	***Nr,t***
EUCPI	0.3 *(4.34)*	-	-	-
EUPMI	0.7 *(2.54)*	-	-	-
GECPI	0.7 *(2.59)*	-	-	-
GEIFO	0.45 *(4.22)*	-	0.33 *(4.35)*	-
USAGDP	0.58 *(2.02)*	-	0.7 *(2.54)*	-
FOMC	0.23 *(1.95)*	-	0.27 *(2.84)*	-
EUBCI	-	0.28 *(2.35)*	0.45 *(2.27)*	-
USRS	-	0.27 *(2.35)*	0.45 *(2.27)*	-
USTB	-	0.06 *(2.02)*	-	0.23 *(1.95)*

Table 8: Results from regressions of various FX return components on macroeconomic news variables. T-values in parentheses

CHART 1


Excess return impulse response to a 50 bp intrinsic value shock: equities (60 lags)
0.6
0.5
0.4
0.3
0.2
0.1
0
1 20 39 58 77 96 115 134 153 172 191 210 229 248 267 286


Excess return impulse response to a 50 bp intrinsic value shock: risk reversals (60 lags)
0.6
0.5
0.4
0.3
0.2
0.1
0
1 33 65 97 129 161 193 225 257 289 321 353 385 417 449 481

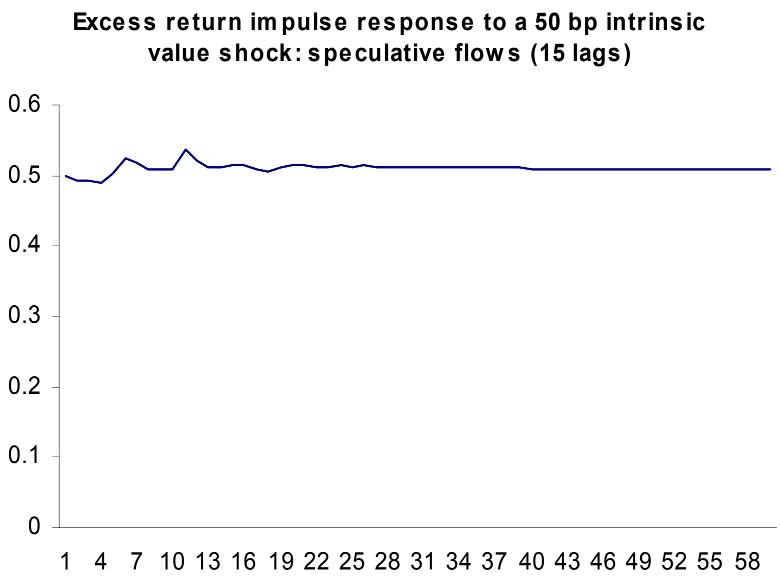
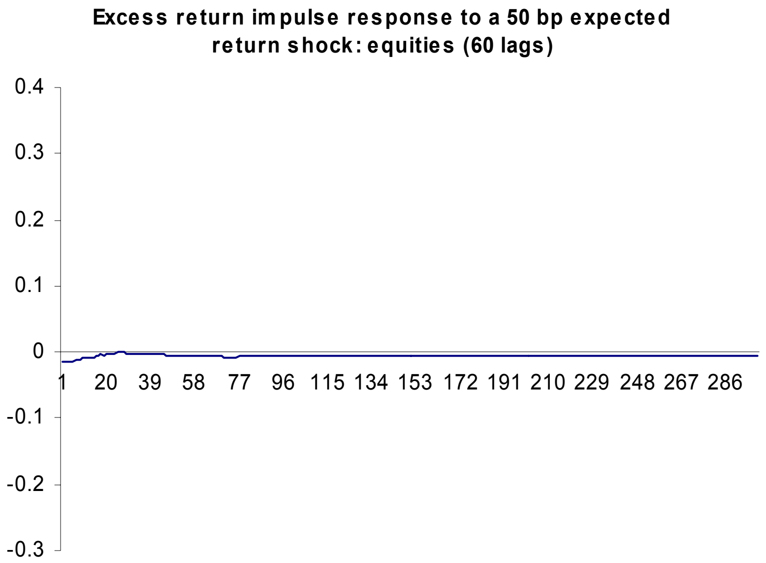
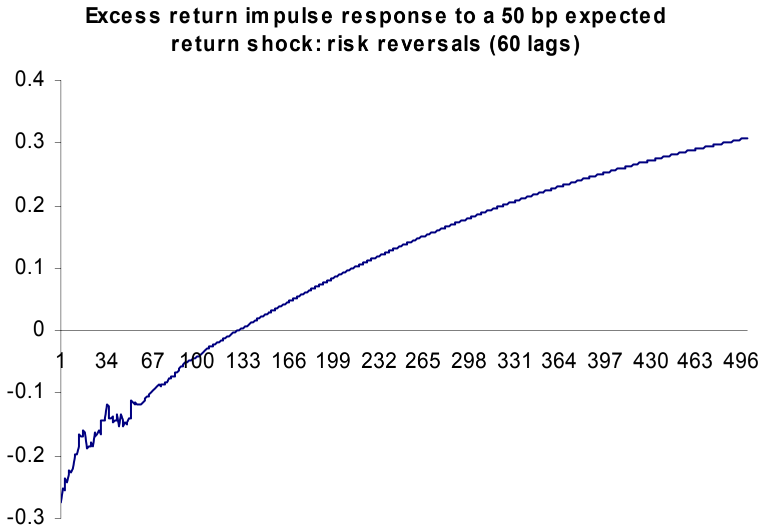

Excess return impulse response to a 50 bp intrinsic value shock: speculative flows (15 lags)
0.6
0.5
0.4
0.3
0.2
0.1
0
1 4 7 10 13 16 19 22 25 28 31 34 37 40 43 46 49 52 55 58

CHART 2


Excess return impulse response to a 50 bp expected return shock: equities (60 lags)
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
1 20 39 58 77 96 115 134 153 172 191 210 229 248 267 286


Excess return impulse response to a 50 bp expected return shock: risk reversals (60 lags)
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
1 34 67 100 133 166 199 232 265 298 331 364 397 430 463 496

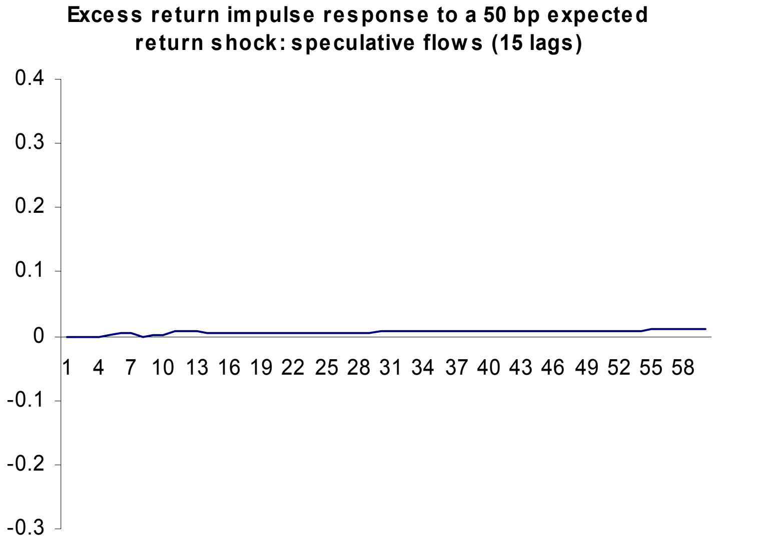
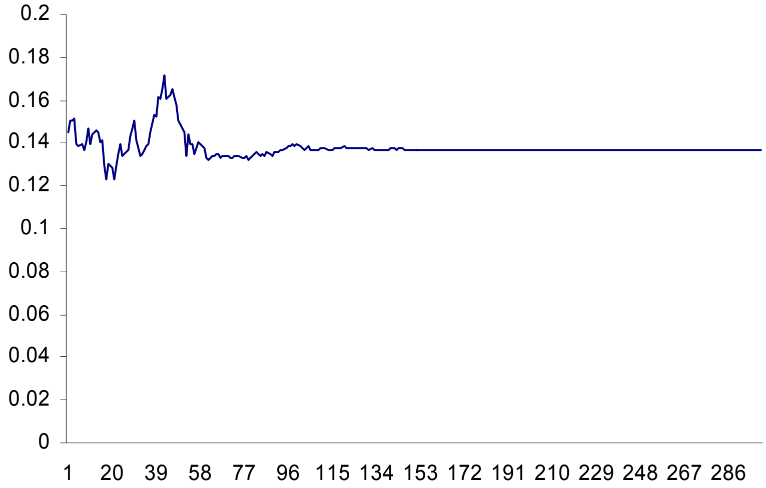
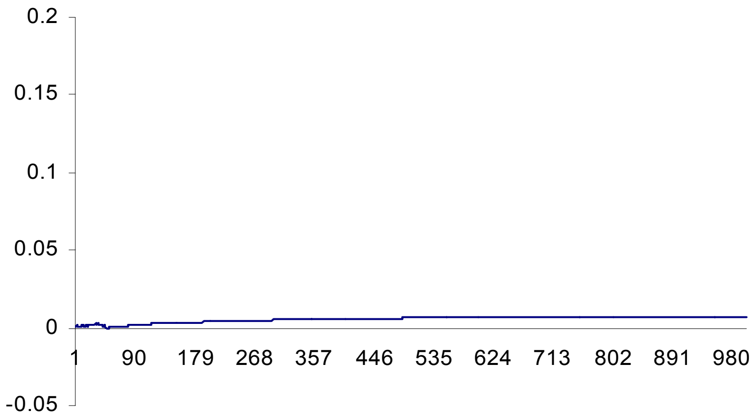

Excess return impulse response to a 50 bp expected return shock: speculative flows (15 lags)
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
1 4 7 10 13 16 19 22 25 28 31 34 37 40 43 46 49 52 55 58

CHART 3

Flow impulse response to a 50 bp intrinsic value shock: equities (60 lags)



Flow impulse response to a 50 bp intrinsic value shock: risk reversals (60 lags)



Flow impulse response to a 50 bp intrinsic value shock: speculative flows (60 lags)

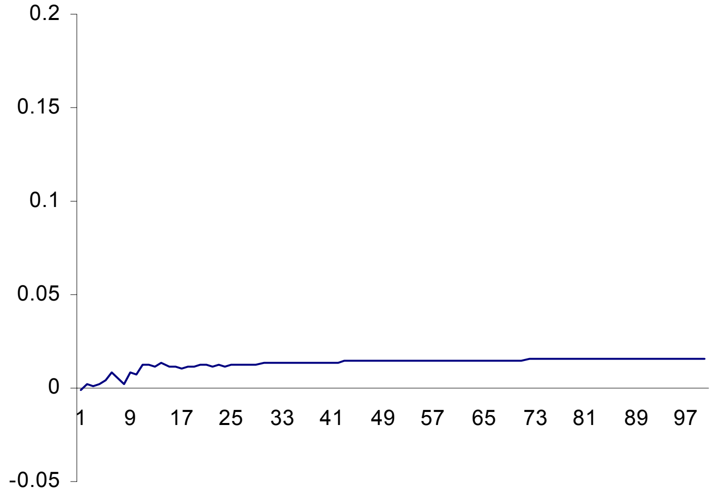
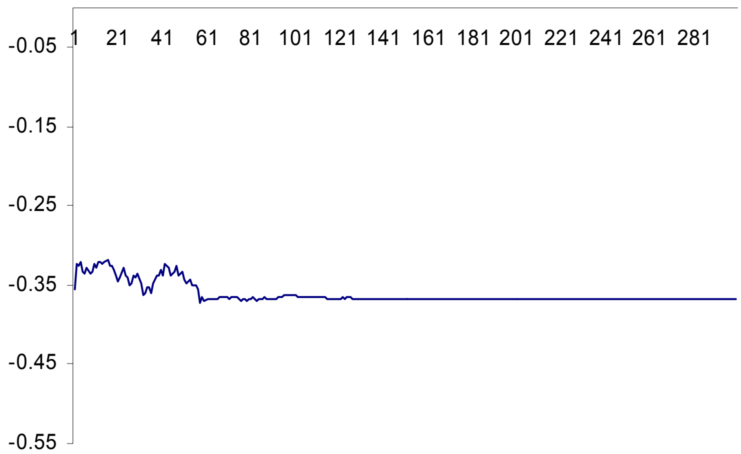
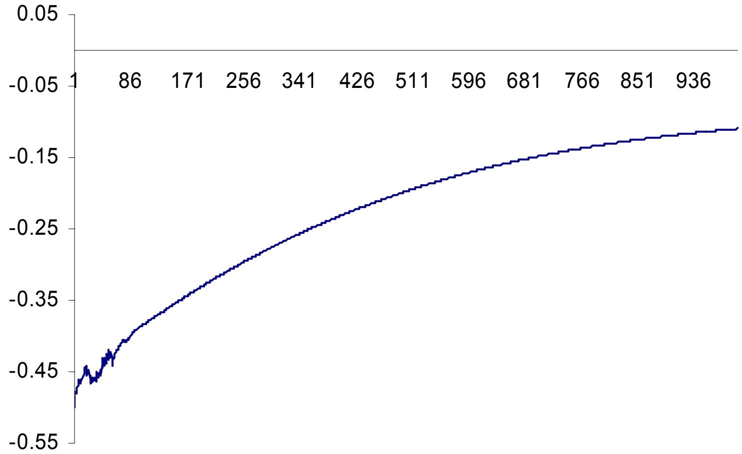


CHART 4

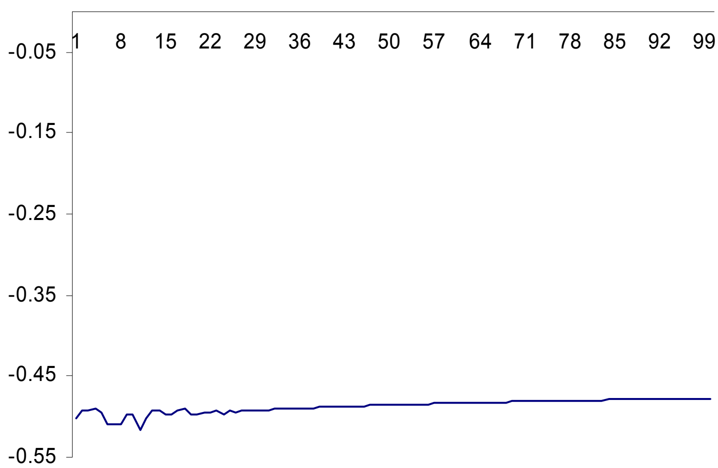
Flow impulse response to a 50 bp expected return shock: equities (60 lags)



Flow impulse response to a 50 bp excess return shock: risk reversals (60 lags)



Flow impulse response to a 50 bp expected return shock: speculative flows (15 lags)



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