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DETERMINANTS OF THE MOVEMENTS IN THE EURO-DOLLAR EXCHANGE RATE DURING THE SOVEREIGN DEBT CRISIS

by Alessio Anzuini*, Martina Cecioni* and Stefano Neri*

Abstract

We identify the drivers of the movements in the euro-dollar exchange rate during the sovereign debt crisis. In particular, we show that the announcement of outright monetary transactions (OMT) by the Governing Council of the ECB during the summer of 2012 played a major role in the euro's subsequent appreciation. OMT and the reform efforts undertaken by governments at national and European level saw off the risk of a euro-area break up and prompted net capital inflows. We estimate two models. The first is a reduced-form high-frequency model, in which the exchange rate is explained by the differentials between interest rates in euros and dollars at both short- and long-term horizons, the sovereign spread in euro-area countries and an index of volatility. The second is a vector autoregressive (VAR) model including GDP growth differentials, short-term nominal interest rate differentials and inflation differentials between the euro area and the U.S., an average of the sovereign spreads of selected euro-area countries, the bilateral trade balance and the euro-dollar nominal exchange rate. Both approaches suggest that the evolution of the sovereign spread supported the value of the euro following the announcement of OMT in the summer of 2012.

JEL Classification: F31, C32.
Keywords: exchange rates, sovereign spreads, vector autoregression.

Contents

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1. Introduction

During the sovereign debt crisis in the euro area the exchange rate of the euro against many currencies was extremely volatile. During the most acute phase of the crisis, between the summer of 2011 and 2012, the euro depreciated sharply vis-à-vis the US dollar, reflecting a lack of confidence in the institutional setup of the common currency and market skepticism about its future. This trend was reversed after President Draghi's speech, in late July, at the Global Investment Conference in London where he pledged to do 'whatever it takes' to preserve the euro, and the subsequent announcement, in early August, of outright monetary transactions (OMT) by the ECB Governing Council. This paper describes the analytical tools we used to study the determinants of the nominal euro-dollar exchange rate during the sovereign debt crisis, focusing on its most acute phase. In this period the interest rate differential between the euro area and U.S., which in general accounts for most of the volatility of the euro-dollar exchange rate, was found to be insufficiently informative for the currency movements. The models were accordingly augmented to include other factors that were likely to have played a role.

Assessing the determinants of exchange rates is, generally speaking, a difficult task, as the theoretical predictions of most macroeconomic models, for example the uncovered interest rate model, have been found to be at odds with the data (Meese and Rogoff, 1983). Surveys and econometric analyses have shown that exchange rate traders pay attention to different macroeconomic indicators over time. Market participants, in search of a rational explanation for observed exchange rate fluctuations, may attach excessive weight to an individual macro variable, which then becomes a natural scapegoat, influencing trading strategies and eventually the exchange rate itself. Therefore when econometricians try to recover the relationship between exchange rate movements and fundamentals ex post the estimated parameters tend to display instability.

Bacchetta and van Wincoop (2004) have rationalized this parameter instability by suggesting that the weight given by traders to some variables during certain periods may be 'excessive' (*scapegoat theory*). Evidence for the sovereign debt crisis shows that the exchange rate of the euro reacted not only to the economic fundamentals, but also to public controversy among policymakers about the crisis and the proposed solutions (Ehrmann et al., 2013).

In this paper we identify different driving forces behind the euro-dollar exchange rate during the acute phase of the sovereign debt crisis based on two empirical models. The first is a reduced-form high-frequency model in which the exchange rate is explained by the differentials between interest rates in the euro and dollar at both short- and long-term horizons, the sovereign spread in euro-area

countries, as a proxy of market confidence in the institutional setup of the euro area, and an index of market volatility. The second is a structural vector autoregressive (VAR) model that identifies both financial and real factors behind euro-dollar exchange rate developments at lower frequency.

We found that the large currency appreciation between mid-2012 and mid-2014 was mostly attributable to the return of confidence in the euro area following the announcement of OMT in the summer of 2012 and that the higher short-term real interest rate in the euro area relative to the U.S. contributed to keeping the euro strong during the same period. The trade balance surplus of the euro area also helped to strengthen the euro, though only from late 2013 onwards.

The rest of the paper is organized as follows. Section 2 describes developments in key explanatory variables. Sections 3 and 4 illustrate the reduced-form high-frequency model and the VAR analysis respectively. Box 1 in Section 4 shows, as an example of a policy-relevant application of the VAR model and using historical decomposition, the contribution of each identified shock to the deviations of the exchange rate from the estimated baseline between January 2007 and March 2013. Section 5 concludes.

2. Recent developments in key explanatory variables

Since the relationship between exchange rates and macroeconomic fundamentals is highly unstable (Bacchetta and Van Wincoop, 2004) we examine the (unconditional) correlations between the euro-dollar exchange rate and their potential determinants over the recent period in a preliminary analysis of the data. The variables are selected drawing both on economic theory and anecdotal evidence.

Interest rate differentials

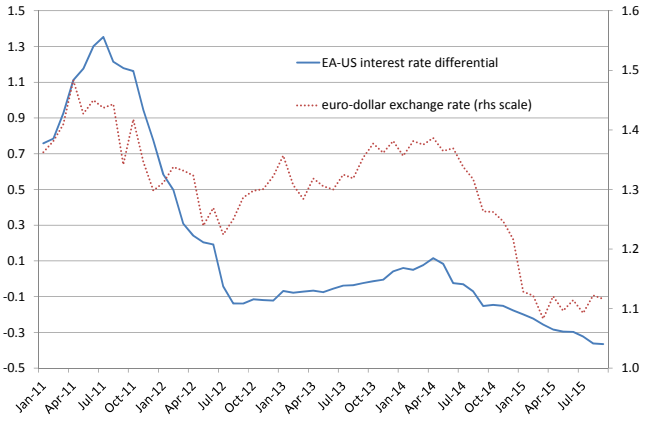
According to the Uncovered Interest Parity (UIP) condition, the interest rate differential between two countries is equal to the expected change in the exchange rate between the two countries' currencies. While widely used in international macroeconomic models, its empirical validity is still subject to intense debate. In fact, it is often the case that currencies with high interest rates tend to appreciate vis-à-vis currencies with low interest rates, contrary to the UIP prediction. In our sample, in fact, the short-term interest rate differential between the euro area and the U.S. is positively correlated with the level of the euro-dollar exchange rate (Figure 1, panel A). This is a common result usually motivated by the presence of a foreign exchange risk premium, i.e. the fact that high yielding currencies are riskier than low yielding ones (Lewis, 1995). The same arbitrage

condition applies to long-term yields. However, the correlation between the long-term yield differential and the exchange rate has been unstable since the sovereign debt crisis (Figure 1, panel B). Between the summer of 2013 and mid-2014, the decline in the long-term interest rate differential was mirrored by an appreciation of the euro; the correlation reversed after the ECB Governing Council announced in spring 2014 that it would provide further monetary policy accommodation in the euro area. The reduction in the pace of asset purchases by the Federal Reserve (*tapering*) had no significant effects on the euro.[1]

Figure 1 – Interest rate differentials and the exchange rate

(monthly data; percentage points)

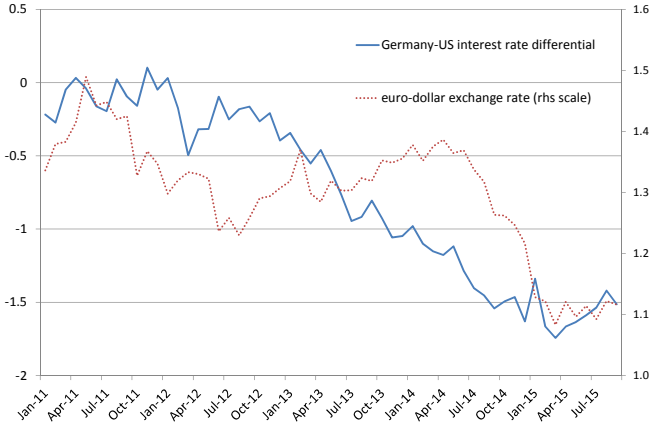
A. Short-term interest rates



Note: The short-term interest rate is the 3-month Euribor for the area and the 3-month Libor for the U.S.

Source: Datastream.

B. Long-term interest rates



Note: The long-term interest rates are the 10-year yields on German and U.S. benchmark government bonds.

Source: Bloomberg.

Euro break-up risk, portfolio investment flows and sovereign spread

One of the major driving forces behind developments in the euro during the most acute phase of the sovereign debt crisis was the fear of a break-up of the euro area, as a result of which international investors shied away from financial assets issued by some member countries, thus contributing to the single currency's depreciation. Although not directly measurable, this risk weighed on the most volatile components of capital flows and on the prices of the euro-denominated assets issued in the countries hit by the sovereign debt crisis. As a proxy for the break-up risk, we focus on portfolio investment flows and sovereign spreads.[2] After the announcement of

[1] The dollar, though, appreciated vis-à-vis the currencies of some emerging market economies.

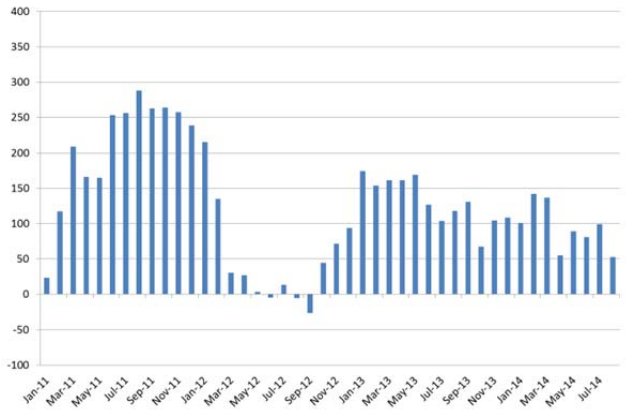
[2] Empirical evidence shows that portfolio flows, more than foreign direct investment flows, can track the movements in exchange rates. See Brooks et al. (2001).

OMT, portfolio capital flows into the area turned positive and sovereign spreads fell markedly. This suggests that the elimination of the break-up risk of the monetary union renewed investors' confidence, thus supporting the euro (Figure 2).

Figure 2 – Proxies of the euro break-up risk

A. Net flows of portfolio investments

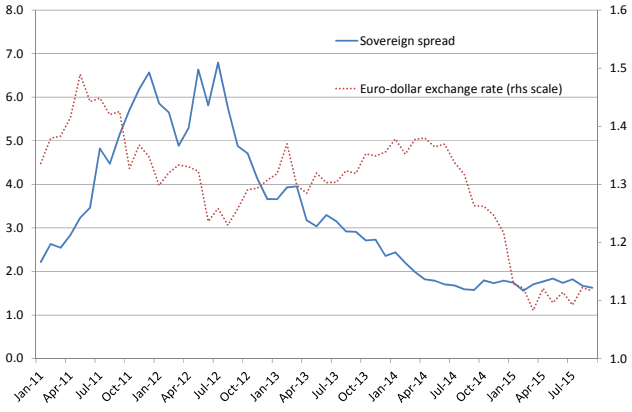
(12-month cumulated flows; € bln)



Source: ECB.

B. Sovereign spreads

(percentage points)



Source: Bloomberg. The sovereign spread is the GDP-weighted average of the 10-year sovereign spreads of Italy, Spain, Greece, Portugal and Ireland with respect to the Bund.

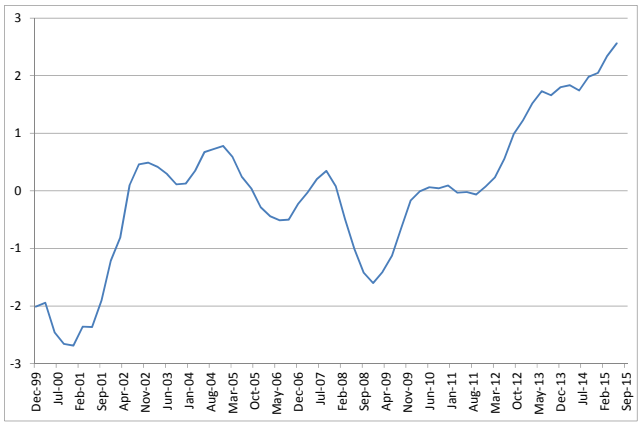
Current account and trade balance

A current account surplus in the euro area implies stronger demand for euros from foreigners to purchase goods and services produced in the area. This is expected to reinforce the euro against the dollar. The external balance of the euro area turned positive at the end of 2011 and registered the highest surplus since 1999 in the second quarter of 2015 (2.6% of GDP; Figure 3, panel A). The current account of the U.S. has been steadily improving since the global financial crisis, but remains negative (-2.4% of GDP in 2015Q2; Figure 3, panel B). Moreover, the bilateral trade position of the euro area vis-à-vis the U.S. is positive and has been increasing over time, supporting the euro (Figure 4).

Figure 3 – Current account

(% of GDP; quarterly data)

A. Euro area



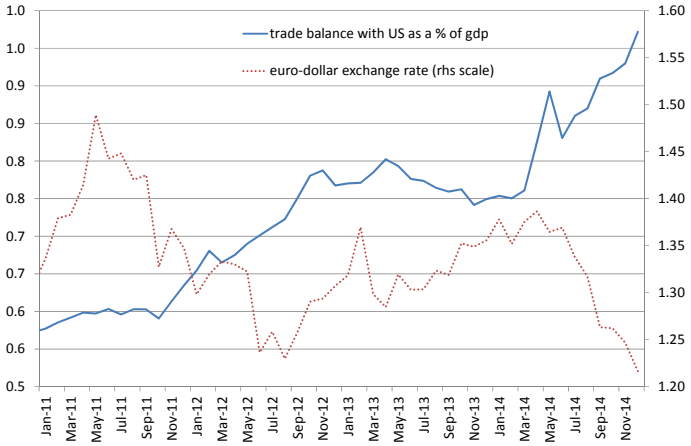
Source: ECB.

B. United States

Source: BEA.

Figure 4 - Trade balance of the euro area vis-à-vis the U.S. and the exchange rate

(% of euro-area nominal GDP)



Source: Eurostat.

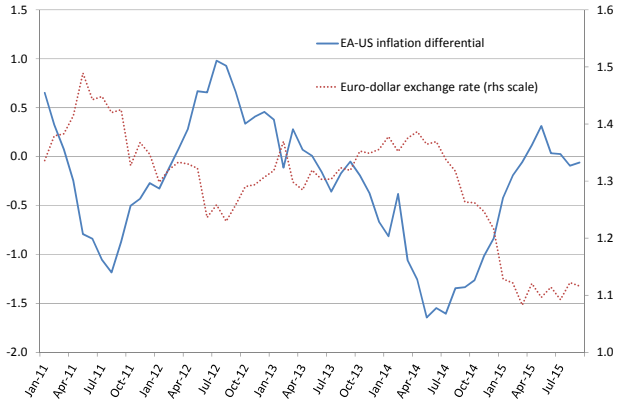
Inflation differential

The relationship between the inflation differential and the exchange rate is not straightforward from a theoretical point of view. While their unconditional correlation tends to be negative, causality can run in both directions. Following an appreciation of the exchange rate and a consequent decrease in the prices of imported goods, consumer price inflation (CPI) falls; at the same time, lower inflation relative to trading partners will put upward pressure on the exchange rate

through the purchasing power parity (PPP). Indeed, if the real exchange rate is stationary (that is, if PPP holds), the bilateral nominal exchange rate should offset any inflation differential: a decrease of inflation in the euro area relative to that in the U.S. means that goods produced in the euro area are cheaper. As a consequence, demand for them will increase and so will demand for euros in the foreign exchange market. The euro would thus appreciate. Figure 5 shows that in the last years the correlation between the inflation differential and the exchange rate has been negative, suggesting that the widening, negative inflation differential between the euro area and the U.S., observed between mid-2012 and mid-2014, may have contributed to the appreciation of the euro.

Figure 5 – Inflation differential and the exchange rate

(annual growth rate; percentage points)



Sources: Eurostat and Bureau of Labor Statistics. The differential is computed using consumer price indices.

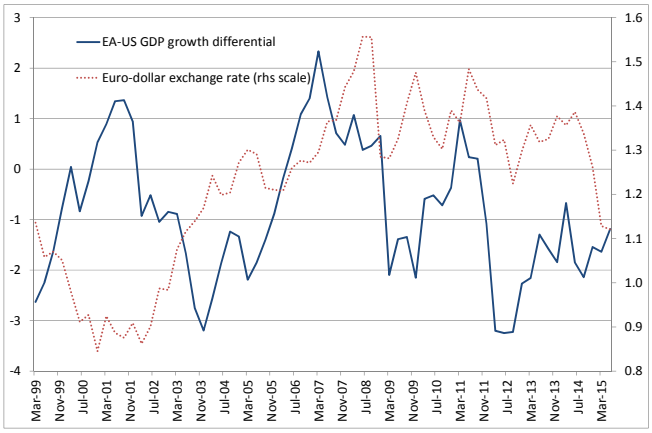
Growth differentials

The relationship between growth differentials and exchange rates is not straightforward either. When economic activity in a country accelerates relative to its trading partners, the impact on the exchange rate depends on the underlying shock. An increase in growth differentials due to a relative demand shock may lead to an appreciation in the exchange rate if it generates expectations of interest rates hike. An increase in the relative growth due to a technology shock may appreciate or depreciate the exchange rate depending on the elasticity of substitution between domestic and foreign goods, see Corsetti et al. (2008). For the VAR analysis in Section 4, growth differentials are useful for controlling for the different cyclical positions of the two economies when the current account is shocked. Indeed, an increase in the current account position exerts strong upward pressure on the exchange rate only when it stems from a structural as opposed to a cyclical improvement. Moreover, growth differentials also help in the interpretation of shocks to interest

rate differentials: after controlling for price and growth differentials, an interest rate shock come closer to a monetary policy shock. After 2012 the cyclical positions of the two areas were different: the euro area was in recession in 2012 and started recovering at the end of 2013, while the U.S. real GDP growth rate was more stable at an annual rate of around 2.2% per quarter (Figure 6). Notwithstanding the different cyclical positions though, the euro remained surprisingly strong till mid-2014.

Figure 6 – Real GDP growth differentials and the exchange rate

(annual growth rate; percentage points)



Sources: Eurostat and BEA.

3. High-frequency reduced-form analysis

This section presents our high-frequency model that relates the movements in the euro-dollar exchange rate to short- and long-term interest rate differentials, to the sovereign spreads of some euro-area countries and to financial market uncertainty. As explained above, the sovereign spreads help to capture the effects of capital inflows and outflows on the exchange rate, as data on these flows are available only at a monthly frequency. The equation is:

$$e_t = \bar{e} + \beta_1(i_t^{€} - i_t^{\$}) + \beta_2(i\_10y_t^{DE} - i\_10y_t^{\$}) + \beta_3\, Sov\_spread_t + \beta_4\, \sigma_t + \varepsilon_t$$

where e_t is the bilateral \$/€ exchange rate; $i_t^{\$}$ and $i_t^{€}$ are the 3-month forward interest rates, 9 months ahead, on deposits in dollars and in euros, respectively; $i\_10y_t^{\$}$ is the 10-year U.S. Treasury bond yield and $i\_10y_t^{DE}$ is the yield on German Bunds; Sov_spread_t is the GDP-weighted average of the ten-year sovereign spreads of the euro-area countries under financial stress with respect to the Bund; σ_t is the option-implied volatility of the S&P 500 index; ε_t is the error term. The equation is estimated over two periods: between 2005 and mid-2011 and from March 2012 to November 2013.

Including the period from June to December 2011 generates instability in the coefficients of the equation; this may be related to the intensification of the sovereign crisis that followed the announcement of private sector involvement (PSI) in the solution to the Greek crisis. To account for the endogeneity of the regressors, the equation is estimated using the one-week lagged values of these variables as instruments. The equation tracks the daily movements of the exchange rate reasonably well, with the exception of some periods in which the errors are quite persistent (Table 1 and Figure 6).

Table 1 – Estimates of the regression

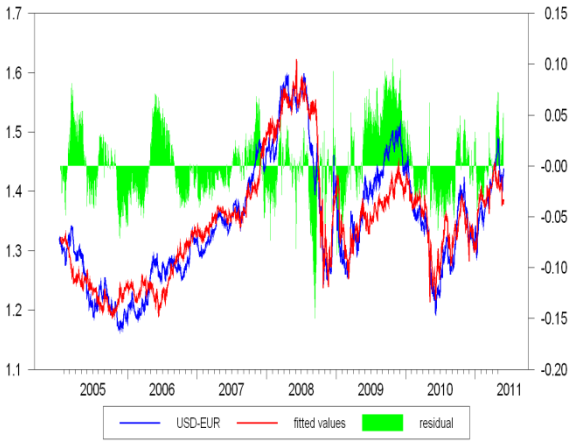
Parameter		January 2005 – May 2011	March 2012 – November 2013
$\bar{e}$	*Constant*	1.427**	1.435**
		(0.008)	(0.023)
β_1	*Short-term interest rate differential*	0.091**	0.194**
		(0.008)	(0.022)
β_2	*Long-term interest rate differential*	0.042*	0.020*
		(0.019)	(0.010)
β_3	*Sovereign spread*	-0.090**	-0.039**
		(0.008)	(0.005)
β_4	*Volatility index*	-0.004**	0.000
		(0.000)	(0.001)
Nobs		1662	456
R^2		0.87	0.83

Note: Standard errors (in parentheses) are corrected for heteroskedasticity and autocorrelation of the residuals; ** and * denote statistical significance at, respectively, the 1% and 5% level.

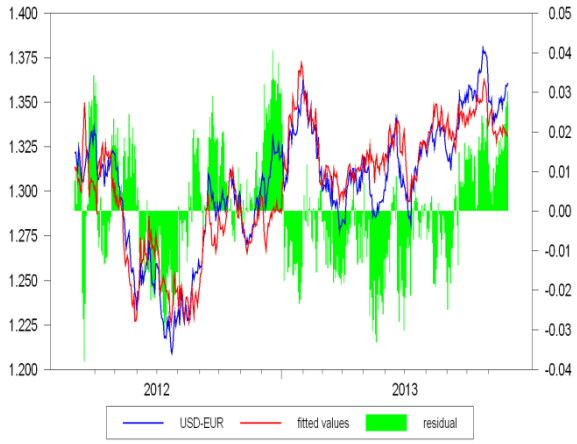
Figure 6 – Fit of the regression

(*daily data*)

(a) January 2005 – May 2011



(b) March 2012 – November 2013

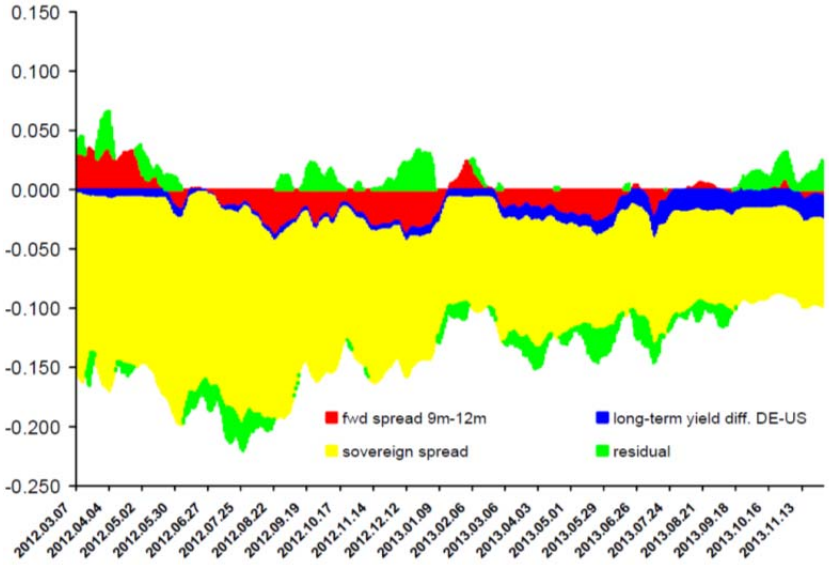


Note: The residual (green shades) are measured on the right-hand scale.

This model has been especially useful to figure out the determinants of the appreciation of the euro vis-à-vis the dollar since mid-2012. Figure 7 shows the contribution of the regressors to the exchange rate, excluding the measure of volatility which is not significant in the second period. The analysis shows that the appreciation of the euro since mid-2012 mainly reflects the decline in sovereign spreads (red area). The contribution of the spread between the yields on German and U.S. 10-year government bonds (green area) has gradually increased since last summer, possibly reflecting the uncertainty of the tapering by the Federal Reserve which raised U.S. yields. The contribution of the forward rate differential has become almost nil since the summer of 2013. The contribution of the residuals is given by the green area.

Figure 7 – Decomposing the euro-dollar exchange rate

(*March 2012 – November 2013, daily data; deviation from estimated constant – 1.4*3)



4. The VAR analysis

Our lower-frequency model is a VAR estimated using monthly data from January 1999 up to March 2014. The VAR generates conditional movements of the exchange rate which are consistent with economic theory. Using variance and historical decomposition, we assess the relative contribution of the different driving forces behind the recent euro-dollar exchange rate dynamics.

As widely documented in the literature, the relationship between exchange rates and macroeconomic fundamentals is highly unstable. Survey and econometric evidence have shown that exchange rate traders pay attention to different macro indicators across time; Bacchetta and van Wincoop (2004) have rationalized this parameter instability suggesting that the weight given by

traders to some variables during certain periods may be 'excessive' (*scapegoat theory*). Given that the focus of the analysis is on the developments of the euro since mid-2012, in order to specify our model we select the variables with the highest correlation with the exchange rate after that date. The variables are: the differentials between euro area and U.S. GDP annual growth rates,[3] the 3-month nominal interest rate differential, the annual inflation differential, the spread between the average yield of 10-year government bonds in the euro-area countries most affected by the sovereign debt crisis and the yield on the Bund and bilateral trade balance.[4]

Our estimated VAR is the following

$$y_t = B(L)\, y_t + \varepsilon_t$$

where y_t includes the variables selected above, L is the lag operator and ε_t is the vector of our reduced-form residuals. We decompose the variance-covariance matrix of the reduced form residuals using a Cholesky factorization with the following order: GDP growth rate differential, short-term interest rates differential, inflation differential, sovereign spread, trade balance and the euro-dollar exchange rate; changing the order of the variables does not affect the results. A lag length of 2 is selected by the Akaike information criteria.

4.1 Impulse response functions

The impulse response functions to the shocks identified by the Cholesky factorization generate conditional correlations among the variables that are in line with predictions of a large class of models, though the identified shocks cannot be given a structural interpretation (Figure 8). Following an unexpected increase in growth differentials the exchange rate tends to appreciate and the trade balance worsens, so that, in our model, it seems reasonable to interpret this shock as a relative demand shock. The euro-dollar exchange rate appreciates on impact also after a shock that increases the short-term interest rate differential of the area relative to the U.S. one. An improvement in the euro-area trade balance strengthens the euro, but only in the medium term,[5] while a widening of the intra-area sovereign spread depreciates it. In accordance with PPP, an increase in euro area inflation relative to the U.S. one generates a persistent depreciation of the euro against the dollar. All shocks are equal to one standard deviation: an increase of 30 basis points in

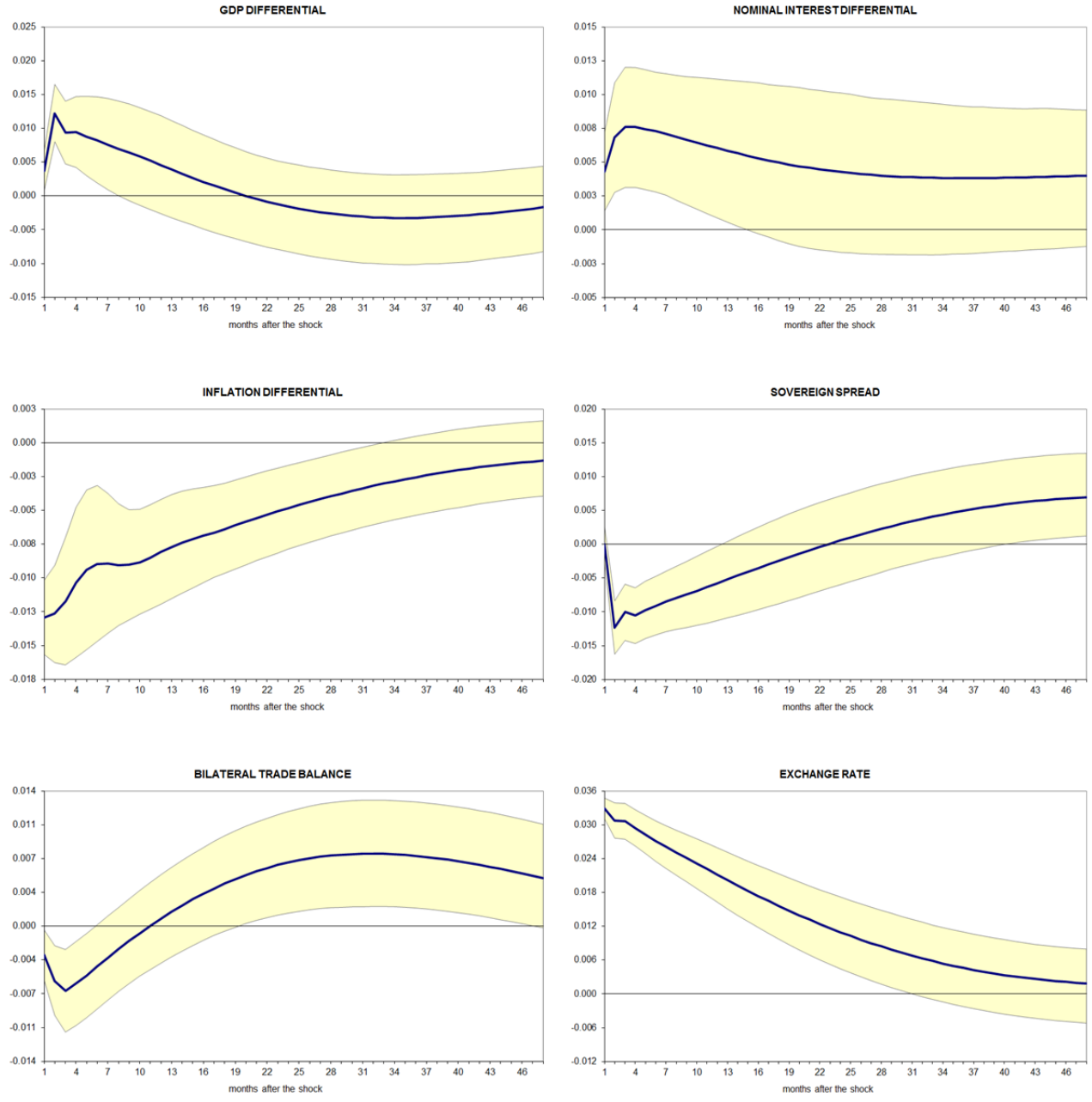
[3] We interpolated the quarterly series of real GDP in the two areas using the monthly growth rates of industrial production.

[4] As discussed previously, we consider the sovereign spread as a proxy for the capital inflows in the euro area. The sovereign spread is computed as the differential between the average of the yields of Italian, Spanish, Portuguese, Irish and Greek bonds, weighted by their real GDP in 2012, and the German Bund yield.

[5] This would be consistent with a permanent productivity shock, generating a positive comovement of current accounts and the exchange rate in the long run (see Lee and Chinn, 2006).

the spread generates a depreciation of the euro equal to 1 cent after two months (for instance, given an exchange rate of 1.30, such a shock would bring it to 1.31 after two months).[6]

Figure 8 – Responses of the euro-dollar exchange rate to different shocks



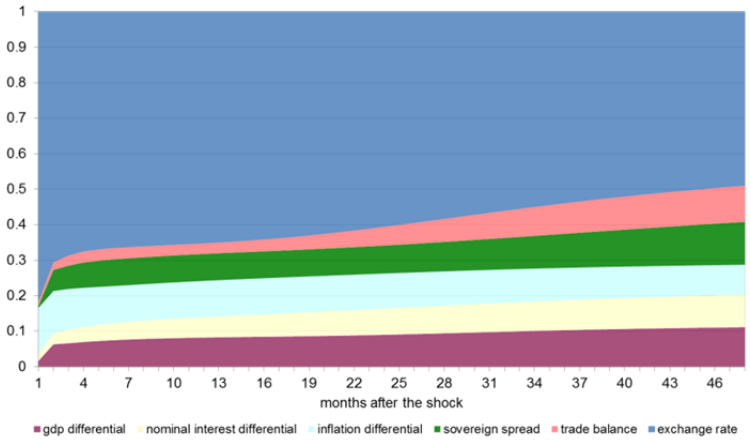
Note: Blue solid line: point estimates; yellow shaded area: 68% confidence bands.

[6] Following the order of the variables in the system the size of the other shocks is equal respectively to: 1.5%, 20 basis points, 1%, 30 basis points, 0.01%, 3 cents. The last shock is a shock to the exchange rate itself.

4.2 Variance decomposition

The variance decomposition indicates the average contribution of each shock to the variability of the euro-dollar exchange rate over the sample. In the short term, the variance of the exchange rate is explained almost exclusively by the shock on the exchange rate itself, one month after the shock the sum of the contributions of all fundamentals to exchange rate movements is less than 20%; the difficulty of structural models in predicting the short-term dynamics of the exchange rate is commonly reported in the empirical literature (Meese and Rogoff, 1983). However, over the medium-term (after 24 months), about 40% of the variability of the exchange rate is driven by our selected macroeconomic fundamentals (Figure 9).

Figure 9 – Variance decomposition of the euro-dollar exchange rate



Over this longer horizon, GDP growth and CPI inflation differentials together account for 20% of the variability of the exchange rate; the sovereign spread for 8%. Differentials in short-term nominal interest rates contribute in the amount of about 7%.[7] The contribution of the trade balance shocks to the exchange rate increases over time, reaching about 5% after 24 months and 10% after 48 months.

[7] Scholl and Uhlig (2008) consistently estimated that the fraction of exchange rate variability attributed to monetary policy shocks is equal to roughly 10%.

Box 1 – Decomposing the appreciation of the euro-dollar exchange rate from mid-2012 to mid-2014

The historical decomposition of the exchange rate quantifies the contribution of each (past and current) shock to the deviations of the exchange rate from the estimated baseline in each period (Figure 10).[8] This exercise answers the following question: had the exchange rate been hit only by a single shock, what would have been its level?

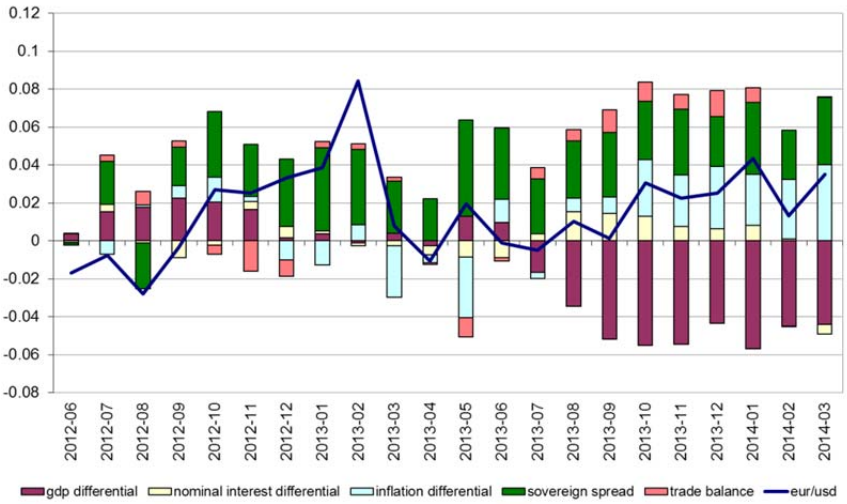
In Figure 9 the zero line corresponds to a zero deviation from the baseline value which was, for example, equal to 1.34 dollars per euro in March 2014. The actual value of the exchange rate was 1.38 and can be decomposed into two components: the baseline, which is obtained as a projection of the estimated VAR, assuming that no shock hit the economy, and the sum of the effects of past and current structural shocks. Each bar in the figure represents the contribution to the deviations from the baseline of a single shock in terms of dollar cents. For example, the three main contributions in March 2014 came from the negative GDP growth differential (-4.4 cents), the negative inflation differential (4 cents) and the sovereign spread (3.6 cents).

Between June 2012 and March 2014 the euro-dollar exchange rate was above the estimated baseline, mainly reflecting low inflation and increased confidence in the euro area, which was partly offset by weaker growth. As far as the GDP growth differential is concerned, the euro was over-appreciated: had this been the only shock, in March 2014 the exchange rate level would have stood at 1.30, well below the actual value of 1.38 and the baseline (1.34). However, other shocks more than offset the difference in the cyclical positions. The evolution of the sovereign spread supported the value of the euro after OMT was announced in the summer of 2012. Another important contribution to the strength of the euro at that time came from the negative inflation differential between the euro area and the U.S., following the fall of 2013. Finally, the short-term interest rate differential and the trade balance both provided a positive, though small, contribution between July 2013 and January 2014.

[8] Historical decompositions are computed using point estimates of the parameters and do not explicitly account for the considerable sampling uncertainty; thus, they should be considered as only suggestive. To avoid an increasing trend in the baseline and focus on the more recent period, the historical decomposition is obtained estimating the VAR from January 2007.

Figure 10 – Historical decomposition of the euro-dollar exchange rate

(contributions to deviations from the baseline)



Note*:* Blue solid line: the baseline, that is the euro-dollar exchange rate obtained from the estimated VAR assuming that no shocks hit the economy. Vertical bars: contribution of a single shock (indicated in the legend) to deviations from the baseline.

5. Conclusions

Explaining exchange rate movements is a difficult task. It is very likely that fundamentals play a role which is not time invariant and the size and direction of this time variation is difficult to predict. Ex-post though, some light can be shed on important determinants of exchange rates in certain periods. Our analysis shows that the OMT announcement supported the external value of the euro by removing the break-up risk until late 2013. Then in the second half of 2014 a path of depreciation emerged. While explaining the latest development in the euro-dollar exchange rate is beyond the scope of this work, the recent weakness is an equilibrium phenomenon linked to the decoupling of monetary policies in the U.S. and the euro area and the launch of the Asset Purchase Programme by the ECB Governing Council.

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