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Sylvester C. W. Eijffinger*

How Much Inevitable US-Euro Area Interdependence Is There in Monetary Policy?

Against the backdrop of the present international financial and economic crisis this article looks into the issue of the interdependence of US monetary policy and monetary policy in the euro area. Is there a significant interdependence? If so, what is the nature and intensity of this interdependence? Has the ECB been influenced by the Fed or vice versa and to what degree? Has the relationship changed in recent years, and if so, in what direction?

With a monetary policy across the Atlantic recently very different from that of the euro zone and with increasing pressure to comment on the transatlantic interest rate differential, President Jean-Claude Trichet of the European Central Bank (ECB) has repeatedly stated that the euro area and the United States remain two totally different policy areas, reflecting the partly very different fundamentals and the different situations of the real economies (and housing markets). As a logical consequence, ECB monetary policy should be evaluated only in the light of developments in the euro area and independent of the actions of the Federal Reserve System (Fed).

While this statement implicitly claims an absence of interdependence between monetary policymaking on both sides of the Atlantic, it may not be entirely credible. It is evident that there are differences in both the mandates of the two central banks and in the underlying problems. However, this as such is not sufficient to imply the absence of interdependence, unintended as this dependence may be. In order to validate Mr Trichet's claim of independent policy decisions for the euro area, it would be interesting to look at some of the existing research on transatlantic interdependence in monetary policy, and to evaluate this in the light of the present policy challenges. The following questions are interesting in this regard:

1. Is there significant interdependence in the first place? What is the nature and intensity of that interdependence (e.g. interest rate levels, exchange rates, liquidity provision, communications and announcements etc.)? To what extent can these be quantified?
2. Direction of (inter)dependence: has the ECB been influenced in its decision-making by the Fed or vice-versa and to what degree? Are the two central banks equals in their interaction or is there a leader-follower relationship? Has the relationship changed in the past year/years, and if so, in what direction?
3. What has been the effect of monetary policy announcements on one side of the Atlantic on the other side of the Atlantic? What has been the (evolving) effect of Economic and Monetary Union (EMU), i.e. has the US markets' understanding and anticipation of monetary policy decisions in the euro area improved over time?

These questions will be investigated in this paper, followed by our own empirical analysis of the interdependence of ECB and Fed monetary policy decision-making, focusing on the Granger causality and the cointegration relationship between short-term and long-term nominal daily interest rates in the euro area and the USA during the last decade. From both the Granger causality and cointegration analysis, we may conclude that there is a significant interdependence between the USA and the euro area, which runs through both the short-term money market and the long-term bond market. The paper concludes that there may be decoupling in the short run but not in the long run.

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Evidence of US-Euro Area Interdependence and Its Direction¹

One of the most recent manifestations of monetary policy interdependence is of course the concerted liquidity intervention of 12 December 2007 by the ECB, Fed, Bank of Canada, Bank of England and the Swiss National Bank. This was called the Term Auction Facility (TAF) and it was followed by the Term Securities Lending Facility (TSLF) on 11 March 2008.² The liquidity crisis has tested the institutional setup of both the ECB and the Fed and their cooperation capacities, but has also highlighted the issue of monetary policy interdependence. Several authors have investigated the degree of interdependence between the euro area and the USA, in terms of interest rates, exchange rates, bond markets and equity markets.

Ehrmann and Fratzscher,³ and Ehrmann and Fratzscher⁴ took US, German and euro area macroeconomic news and monetary policy announcements to gauge the interdependence between the euro area and the United States. Their sample period runs from 1993 to 2003, where they have taken Germany and the Deutsche Bundesbank as proxies for the euro area until 1999. They have modelled the process of interest rate changes in a weighted least squares (WLS) framework, to take into account negative skewness, excess kurtosis, non-normality and serial correlation. In their regressions, the authors include past interest rates in both currency areas, monetary policy surprises and day-of-the-week effects. The results indicate that the euro area and the US money markets have increasingly become more interdependent over time, where spillovers go both ways. This effect has become stronger with the advent of EMU, as structural break tests indicate. Nevertheless, the euro area reacts more strongly to US macroeconomic news than vice versa; this effect has also become significant only after the formation of EMU in 1999. Additionally, the authors try to explain why these results hold true. Their conclusion is that US macroeconomic news announcements have become

good leading indicators for euro area economic developments, and euro area macroeconomic announcements and expectations are highly correlated with the US announcements. The overall conclusion is that US and euro area money markets have become more interdependent since 1999, which is attributable to the increased real integration between the two areas.

Ullrich⁵ sets up reaction functions for both the ECB and the Fed to analyse interdependence. She splits the sample period to gauge the effect of EMU and ends up with the periods 1995:1 to 1998:12 and 1999:1 to 2002:8. The conclusion is that the average European interest rate reacts mainly to inflation before 1999, while the ECB focuses more on the output gap and money growth. Ullrich also finds that there is an influence of the Fed on the ECB in policymaking, especially from 1999 on. This does not hold the other way around. Also, these results have to be assessed with caution because of the small sample period.

Goldberg and Leonard⁶ compare US and German bond markets and the effect of US, German and euro area macroeconomic news on the yields in these markets. This news contains information about variables such as GDP, the labour market, unemployment, prices, business confidence and industrial production. They measure the difference between the actual numbers in the news releases and market expectations, to determine the real news (surprise) component of the announcement. Then, the authors gauge the effect of these surprises on both the US and German bond yields, at two-year and ten-year maturities. US announcements are found to have an effect on German yields within an hour of their release, which confirms the very high degree of interdependence between the US and euro area markets. Some of these announcements had an even greater effect than German releases. In contrast, German and euro area announcements influence US Treasury yields much less. The authors find three explanations for this. First, the USA is increasingly perceived as the engine of global economic growth, and business cycles across major industrialised countries have become more synchronised. Second, linkages between the USA and the euro area suggest that US and European yields respond to similar macroeconomic conditions. Third, US data

¹ For a more general analysis and description of the ECB and its policies cf. J. de Haan, S. Eijffinger and S. Waller: *The European Central Bank: Credibility, Transparency, and Centralization*, Cambridge MA, 2005, MIT Press.

² R. Guttman: *Central Banking in a Debt-deflation crisis: a comparison of the Fed and ECB*, www.univ-paris13.fr/CEPN/texte_guttman_210308.pdf, 2008.

³ M. Ehrmann, M. Fratzscher: *Interdependence between the euro area and the US: What role for EMU?*, Working Paper Series, No. 200, European Central Bank, 2002.

⁴ M. Ehrmann, M. Fratzscher: *Equal Size, Equal Role? Interest Rate Interdependence Between the Euro Area and the United States*, in: *The Economic Journal*, Vol. 115, No. 506, October 2005, pp. 928-948.

⁵ K. Ullrich: *A Comparison Between the Fed and the ECB: Taylor Rules*, ZEW Discussion Papers 03-19, ZEW - Zentrum für Europäische Wirtschaftsforschung (Center for European Economic Research), 2003.

⁶ L. Goldberg, D. Leonard: *What moves sovereign bond markets? The effects of economic news on U.S. and German yields: Current Issues in Economics and Finance*, Federal Reserve Bank of New York, September 2003.

releases have typically come out earlier than releases from individual euro area countries.

Andersson et al.⁷ extend this methodology using French and Italian news announcements. They analyse the effect of US, German, French, Italian and aggregate euro area news on German bond yields. German yields can be used as a reliable proxy, since spreads have been small and relatively stable since the introduction of EMU in 1999. They use five-minute prices of long-term German government bond futures, from the beginning of 1999 to December 2005. They use a GARCH model to capture changes in returns as well as volatility. Their results indicate that US announcements influence German bonds more than euro area and national news. Additionally, this effect has increased over time. The authors provide three reasons for this, which are similar to the reasons that Goldberg and Leonard have provided.⁸ First, aggregate euro area data releases are published after national announcements. Second, national releases may not be perceived to provide timely and complete information about the euro area. Thirdly, as in Goldberg and Leonard, the results may suggest that investors perceive the USA as an engine for global economic growth.⁹

Janssen and de Haan¹⁰ have focused on exchange rate reactions on ECB announcements. They investigate statements by ECB officials from 4 January 1999 to 17 May 2002, and relate these statements to the daily euro/dollar exchange rate. Their results suggest that the effects on the level of the exchange rate are small, but that ECB statements have had considerable impact on the volatility of the exchange rate. This is logical, since statements bring news and will thus induce price adjustment. Furthermore, the authors find that some statements on monetary policy have influenced the level of the exchange rate, where in most cases there is a negative relationship between interest rates and exchange rates, and between inflation and the exchange rate.

Other authors have specifically aimed research at the direction of the interdependence of monetary

policy. Monticini and Vaciago¹¹ have investigated the impact of monetary policy announcements by the ECB, Fed and Bank of England on domestic interest rates and the money market rates in foreign markets. To measure this, they use money market futures contracts on the Euribor, USD LIBOR and LIBOR, all for one month and one year maturities in a sample ranging from January 1999 to December 2003. They find that there is no relevant impact of ECB decisions on the US money market. However, the Fed decisions spill over to the European money market, showing that the European (futures) money market takes into account Fed policy decisions, but that this relation does not hold the other way around.

Chinn and Frankel¹² analyse the behaviour of world interest rates, focusing on the formation of EMU. To this end, they use monthly data from 1973-03 to 2004-09, divided into two subsamples, 1973:03 to 1995:12 and 1996:01 to 2004:09, where they use Germany as a proxy for the euro area until 1999. A vector error correction model is specified, imposing long-run cointegration between the nominal and real rates of interest. In the early sample, US rates seem to affect European long-term rates, while the opposite is not true. The results are more ambiguous in the later sample, where US long-term real rates seem to move closer to European rates. For short-term rates, the same result holds. The authors conclude that, although financial integration has increased a lot, the direction of the effects runs predominantly from the USA to the euro area. The introduction of EMU has not alleviated this asymmetry.

Ehrmann et al.¹³ have analysed the degree of transmission between money, bond and equity markets and exchange rates within and between the United States and the euro area. Using an empirical methodology that identifies financial shocks by heteroskedasticity, they can determine different regimes to pin down the direction of financial transmission. The results, from a sample from the period 1989-2004, indicate the importance of international spillovers, within asset classes and across different markets. US short-term interest rates, for instance, have a significant influence on euro area bond yields and equity markets; they explain as much as 10% of the movements. However, this effect also runs in the opposite direction. Overall, US finan-

⁷ M. Andersson, L. Hansen, S. Sebastyén: Which news moves the euro area bond market?, Working Paper Series, No. 631, European Central Bank, 2006.

⁸ L. Goldberg, D. Leonard: What moves sovereign bond markets? The effects of economic news on U.S. and German yields, Current Issues in Economics and Finance, Federal Reserve Bank of New York, September 2003.

⁹ Ibid.

¹⁰ D. Janssen, J. de Haan: Talking heads: The effects of ECB statements on the euro-dollar exchange rate, in: Journal of International Money and Finance, Vol. 24, No. 2, March 2005, pp. 343-361.

¹¹ A. Monticini, G. Vaciago: Are Europe's Interest Rates led by FED Announcements?, Macroeconomics 0507022, EconWPA, 2005.

¹² M. Chinn, J. Frankel: The Euro Area and World Interest Rates, Santa Cruz Center for International Economics, Working Paper Series, No. 1016, Center for International Economics, UC Santa Cruz 2005.

¹³ M. Ehrmann, M. Fratzscher: Equal Size, Equal Role? op. cit.

Relevant Studies on the Issue of US-Euro Area Monetary Policy Interdependence

Ehrmann and Fratzscher (2002, 2005)	The authors study news effects of monetary policy announcements and macroeconomic news on daily interest rates in the USA and the euro area. Their innovation is the establishment of a link between domestic assets and foreign news, while they also assess why this interdependence occurs. Additionally, they focus on volatility. Their method has the disadvantages that it involves a lot of meticulous data collection, and that there may be confounding events, such as a business cycle slowdown in all G7 countries.
Ullrich (2003)	The author uses Taylor-type reaction functions to gauge interdependence. The innovation is that these incorporate monetary policy decisions from abroad. Additionally, it is a transparent approach as it just compares the reaction functions. The disadvantages are that there is not much data, only for the period 1999-2002, and that the ECB generally does not follow Taylor-type rules, as also follows from the paper.
Goldberg and Leonard (2003)	This announcement study focuses on the effects on long-term interest rates. It takes into account a broad range of economic news, and it focuses on the surprise component. However, it does not take into account monetary policy decisions, or that US economic announcements are more coordinated than EMU-wide announcements (which makes comparison more difficult); and many yield changes appear not to depend on any news.
Andersson et al. (2006)	This paper examines the effects of macroeconomic data releases and ECB monetary policy statements on the German long-term bond yield. It incorporates news for the USA, Italy, France, Germany and the euro area, using a GARCH model which also takes volatility into account. The disadvantages are that the research does not incorporate Fed decisions and that it uses only the German yield instead of a synthetic euro area-wide yield, which is available.
Jansen and de Haan (2005)	These authors study the reaction of the euro-dollar exchange rate to announcements by ECB officials. They distinguish between mean and volatility, and take into account a broad range of statements, including monetary policy talk. Also, they use high-frequency data. On the other hand, they do not incorporate Fed announcements, they have only 3 years of data and the ECB generally does not focus on the exchange rate, which makes it likely that ECB announcements have a minor effect on the exchange rate.
Monticini and Vaciago (2004)	This research investigates interlinkages in monetary policy between the USA, the euro area and the UK. They incorporate decisions by the Fed, ECB and Bank of England and use futures prices to determine interest rate expectations. Moreover, they explicitly focus on spillover effects across the areas. However, they do not mention anything about volatility and do not take outliers into account. Additionally, ECB and BoE meetings are often on the same day, which may create a confounding effect.
Chinn and Frankel (2005)	This paper focuses on world interest rates and the influence of EMU and the USA, using a cointegration framework. This approach is transparent and gives unambiguous results. Also, the authors use a relatively long time horizon, including short-term as well as real long-term rates for the whole euro area. On the other hand, for the short-term interest rate they only use German rates as a proxy, and their method does not yield very detailed results.
Ehrmann et al. (2005)	The authors investigate financial shock transmission between money, bond and equity markets and exchange rates within and between the USA and the euro area. They set up a new framework consisting of structural form equations, in which they exploit the heteroskedasticity in asset prices to identify financial shocks. Although very complete, it is a relatively less transparent method and the authors have made several strong assumptions including parameter stability and several sign and exclusion restrictions.
Belke and Gros (2005)	Using a Granger causality test, this study aims to characterise the relationship between the ECB and the Fed in monetary policy-making. Using this method, it is also possible to gauge the direction of the interdependence. Also, they proxy the ECB rates by those of the German Bundesbank, which creates a longer time-series. This makes it possible to split up the sample and see if there is a structural break. On the other hand, it is hard to find a clear reason for the interdependence. Moreover, Granger causality is designed for continuous variables, while interest rate changes are discrete.
Neri and Nobili (2006)	By means of a structural VAR approach the authors study the transmission of monetary policy shocks from the USA to the euro area. This is a comprehensive, transparent method, which uses restrictions that come from modern macroeconomic theory. They also use a long sample period, from 1982 to 2005. However, coming from theory, the restrictions are imposed rather than derived from the data. Furthermore, they do not test for the presence of a structural break in the data (i.e. around 1999), and they do not incorporate the effect of ECB decisions on the USA.
Dees et al. (2005)	This paper looks at the financial transmission of shocks in the world using a global VAR methodology which uses 26 economies, including the euro area as a whole. This solves econometric issues concerning the single exchange rate and short-term interest rate since 1999. They include a broad range of variables, such as output, inflation, equity prices, and long and short-term interest rates. On the other hand, this is a relatively complex method and requires quite a few theoretical assumptions. Additionally, they only use 4 years of data from the EMU period.
Ehrmann and Fratzscher (2003)	This study focuses on money market reactions to monetary policy announcements by the Fed, Bundesbank and the ECB. They only take into account the surprise component of the data, and allow explicitly for spillover effects across the USA, Germany and the euro area (since 1999). They also look at the development of these spillovers over time, especially before and after EMU. Yet they have not obtained their expectations data from futures prices but by surveys which were conducted some days before the announcement.
Berger et al. (2006)	The authors try to assess the forecast accuracy of the ECB in 24 countries throughout the world, using surveys conducted by Reuters. This method yields comprehensive measures of forecast accuracy, explicitly allowing for differences in macroeconomic conditions, central bank independence and geography. However, their data is also obtained from surveys and not futures prices, and they do not include economic growth as a macroeconomic measure.

cial markets explain (on average) more than 25% of the movements in euro area financial markets, while euro area markets only explain 8% of the US asset price variance. Additionally, the authors find that direct transmission of financial shocks within asset classes is magnified by as much as 50% by indirect spillovers coming from other markets.

Finally, Belke and Gros¹⁴ have investigated the following question: Does the ECB follow the Fed? This seems to be “conventional wisdom”, but the authors try to give a more documented answer to this question. They do this by executing Granger causality tests on interest rates, which are daily realisations of different maturities of money market rates. Their results indicate that the relationship between the Fed and the ECB changes over time. There is a significant structural break around the formation of EMU in terms of the relationship of short-term interest rates. By splitting the sample, the authors find that there has not been an asymmetry in this relationship, especially not since the advent of EMU. Only for a short time after September 2001 and around the turn-of-year 2000/2001 is there a significant influence of the USA on the euro area, with little in the other direction. However, the sample period for this study is too small to give significant results. The authors explain the ECB following the Fed in situations with higher global uncertainty by the inflexibility of the euro area economy. This waiting for interest rate changes may be valuable in situations with a large degree of uncertainty.

As an overview, the International Monetary Fund (IMF) has devoted a chapter in its 2007 World Economic Outlook to the question whether the world can decouple from the USA. The general answer of the IMF is “no”, since the world has become increasingly integrated. This has been analysed by Eurointelligence,¹⁵ which has come up with a number of positive and negative points from this report. As can also be seen above, the main linkage between the euro area and the USA is the financial market. This also implies that the euro area will be mostly hit by a financial downturn, more than by an economic downturn. Unfortunately, this is what has happened. However, as Eurointelligence says: there is good news and bad news. The euro area has become more resistant to shocks for three reasons. First, the size effect says that a large and increasingly integrated monetary union is less

prone to external shocks. Second, an improved monetary policy assures an anti-cyclical policy response if the euro area is hit by a symmetric shock. Third, the Stability and Growth Pact (SGP) has introduced a counter-cyclical fiscal policy in many countries, with automatic stabilisers to cushion the effect of external shocks. However, the bad news is that financial distress easily spills over to the euro area, as is documented in the IMF report in a special box. It concludes that asset markets in the euro area are driven more by US shocks than by domestic shocks, which is bad news if we look at the events surrounding the credit crisis. These financial linkages are the reason why Europe cannot decouple from the USA.

Effect of Monetary Policy Announcements by the ECB and the Fed

Neri and Nobili¹⁶ have studied the transmission of monetary policy from the USA to the euro area using a two-country structural VAR, with a dataset ranging from 1982:3 to 2005:2. The analysis shows that a monetary contraction in the USA has a short-run positive effect on output in the euro area, which is not persistent. In the medium run, there is a more persistent and negative effect. The euro depreciates on impact, and then slowly appreciates back to fulfill the uncovered interest rate parity condition. Pass-through of this change into consumer prices is incomplete. Also, the short-term nominal interest rate increase does not compensate the hike in prices and thus the real short-term interest rate declines. This explains the initial expansion in output, which disappears in the medium run. Finally, the authors find that the trade balance plays a negligible role in transmission, which suggests that other channels, like financial markets, play a bigger role in transmitting US monetary policy to the euro area.

Dees et al.¹⁷ use a Global Vector Autoregression (GVAR) analysis to gauge the effects of a US monetary policy shock on euro area markets. They find that US financial shocks travel rapidly towards the euro area, and often get amplified when they cross the Atlantic. Their effect is mainly on equity and bond markets, while the effects on euro area output and inflation are lagging, limited and not highly significant. The model also highlights second round effects, which is especially interesting in the light of the current events.

¹⁴ A. Belke, D. Gros: Asymmetries in Transatlantic Monetary Policy-making: Does the ECB Follow the Fed?, in: *Journal of Common Market Studies*, Vol. 43, No. 5, December 2005, pp. 921-946.

¹⁵ Eurointelligence: ECB Watch: Some thoughts on decoupling from a European perspective, 11-04-2007, <http://www.eurointelligence.com/Article3.1018+M5cb25163573.0.html>.

¹⁶ A. Nobili, S. Neri: The transmission of monetary policy shocks from the US to the euro area, *Termi di Discussione*, No. 606, Banca d'Italia 2006.

¹⁷ S. Dees, F. di Mauro, M. H. Pesaran, L. V. Smith: Exploring the International Linkages of the Euro Area: a Global VAR Analysis, *Computing in Economics and Finance*, No. 47, Society for Computational Economics, 2006.

Shocks in the USA are amplified through the return impacts of shocks to output and inflation in the euro area. Also, the euro area will react to the US shocks transmitted via their trading partners. Additionally, the transmission of shocks takes place via financial variables that have significant spillover effects on real variables.

Ehrmann and Fratzscher¹⁸ take into account monetary policy announcements on both sides of the Atlantic. They first define three channels through which foreign announcements may affect domestic markets. First, foreign news may be domestically relevant if the exchange rate is a key variable. Second, global spillover effects may occur through integrated financial markets. Third, real integration of economies may play a role if foreign monetary policy decisions change domestic macroeconomic decisions. The authors investigate the degree of dependence by measuring the daily reaction of money market interest rates to monetary policy announcements on both sides of the Atlantic. They use data for the USA and Germany until 1999, and data for the USA and the euro area from 1999 on, to arrive at a dataset that comprises January 1993 until February 2002. They focus on the surprise component as the difference between market expectations and the actual announcement, as markets react merely to surprise news. Then they use an exponential GARCH (EGARCH) framework to determine the conditional mean and volatility of interest rates and their reaction to policy announcements. Their results point to general market linkages across the Atlantic, an interdependence that has grown larger since EMU. First, spillovers in the mean of interest rates have become larger over time, mainly from the USA to the euro area. Second, volatility spillovers from each market to the other have increased, in both directions. Regarding foreign monetary policy surprises, spillover effects to money markets are restricted to low maturities, both for the USA and Germany in the period 1993-1998. However, since EMU this effect has strengthened: responses become larger, are significantly different and extend also to higher maturities. Notably, this effect comes on top of the general market linkages as described above. Finally, the volatility of money markets seems to be largely unaffected by monetary policy announcements in recent years. This holds for the Fed as well as the ECB. These findings suggest that the markets' understanding and anticipation of monetary policy decisions by the Fed and the ECB have increased over time, which

is indicated by the lower uncertainty and volatility in markets around policy decisions.

Berger et al.¹⁹ provide a different view of this story: according to their research, forecasting and understanding ECB monetary policy is still a matter of geography. Using a worldwide sample of professional financial analysts' forecasts, they find that differences in forecast accuracy are substantial, and that the forecast error increases with the distance from informational hubs such as Frankfurt or London. Additionally, they find that national macroeconomic conditions tend to influence forecast accuracy. This means that predictions of ECB policies become less reliable when the forecaster operates from a country with inflation or unemployment relative to the euro area average. As the USA and the euro area have become more integrated and interdependent, forecasts of ECB policies by US analysts may be more precise. Also, analysts operating in countries with a history of high central bank independence are more likely to make good forecasts of ECB actions, which is a finding in favour of the USA. Furthermore, the observed heterogeneity in forecasts is systematic. Therefore, the above-mentioned findings can be persistent although some of them have declined due to a learning process. Policy implications of these findings are that this heterogeneity may be problematic, since agents have yet to converge on a common expectation-formation process for monetary policy. This holds for agents within the euro area, as well as for US forecasters.

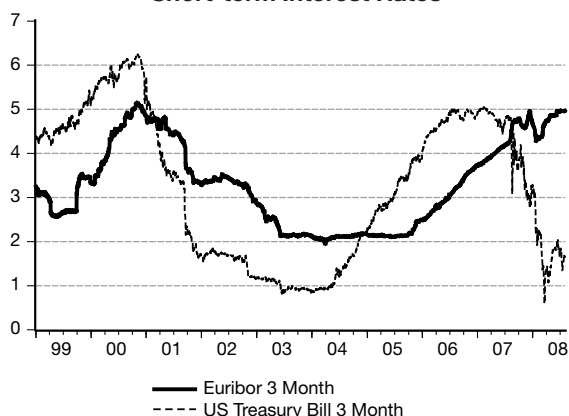
Testing for US-Euro Area Interdependence with Interest Rate Data

The existing literature shows that there is an increasing interdependence between the USA and the euro area. This still appears to be asymmetric, as the USA mostly affects the euro area and not the other way around. However, recent studies use quite outdated data, containing only a few years of the euro's existence. With the 10th anniversary of the euro nearing on 1 January 2009, we have a lot more short-term and long-term interest rate data at our disposal to perform an analysis of the interdependence between the euro area and the USA. This will allow us to more thoroughly gauge the effect of the USA in the euro area, and the other way around. Let us take a first look at Figures 1 and 2, which display the nominal short-term and long-term interest rates from 1 January 1999 until 31 July 2008 in the USA and the euro area.

¹⁸ M. Ehrmann, M. Fratzscher: Monetary Policy Announcements and Money Markets: A Transatlantic Perspective, in: *International Finance*, Vol. 6, No. 3, Winter 2003, pp. 309-328.

¹⁹ H. Berger, M. Ehrmann, M. Fratzscher: Forecasting ECB monetary policy - accuracy is (still) a matter of geography, Working Paper Series, No. 578, European Central Bank, 2006.

Figure 1
Short-term Interest Rates



Note: Daily data, in percentages.
Source: Datastream, Federal Reserve System

Figure 2
Long-term Interest Rates



Note: Daily data, in percentages.
Source: Datastream

Both the short-term and the long-term nominal interest rates move closely together until the middle of 2007. The moving together of the long-term interest rates continues to apply also after the middle of 2007. According to the expectations theory of the term structure, long-term interest rates reflect the expected short-term interest rates during the terms to maturity. If we assume that the expected real interest rates are rather sticky in the short run (from month to month), long-term interest rates reflect the inflationary expectations during the terms to maturity. It is interesting to see, for instance, that during the course of 2007 the European short-term interest rate stayed at approximately the same level, while the US short-term interest rate dropped tremendously with the advent of the credit crisis. The US real short-term interest rate is now strongly negative and the European real interest rate is becoming close to zero by the increasing expected inflation.

Comparison of the European and US nominal interest rates poses the question whether the ECB follows the Fed or the other way around. To address this question, we shall perform two tests. We shall first apply the test for Granger causality on both interest rate series and maturities, as in Belke and Gros.²⁰ Then, we shall impose a long-run cointegrating relationship upon the interest rates as done by Chinn and Frankel.²¹

The reasons for choosing these empirical methods as the basis of our study are linked to the policy relevance of these methods. To begin with, we can use high-frequency data that are available from 1999 un-

til now. This allows us to assess the effect over the whole EMU period. Moreover, both methods are very transparent and unambiguous in their results, as we can read the results from a single coefficient. This also provides us with a comprehensive measure to guide policy decisions. Furthermore, we cannot only assess whether there is interdependence, but using the same measure we can also see in which direction this interdependence runs throughout roughly the first ten years of EMU.

Granger Causality Tests

As in Belke and Gros²², we try to capture the responsiveness of the euro area and the USA to each other's monetary policies by estimating Granger Causality (GC) equations. We shall do this for different lags, to see if the effect is lasting. The result of this empirical exercise is shown in Table 1, where each cell reports the p-value of the GC test. The heading of each column states the null hypothesis of the test.

From this table it follows that the causal relationship between the short-term interest rates in the euro area and in the USA is very strong. Even when we consider a three-month period (60 trading days), both short-term interest rates Granger cause each other. The relationship goes both ways, so we cannot say that one currency area follows the other. For the long-term interest rate, this relationship is more one-sided. When considering lags of a few days, we see that the US long-term interest rate Granger causes the European long-term interest rate, but not the other way around. Also for longer lags we see that the p-values are often

²⁰ A. Belke, D. Gros, *op. cit.*

²¹ M. Chinn, J. Frankel, *op. cit.*

²² A. Belke, D. Gros, *op. cit.*

Table 1
Results of the Granger Causality Test

Short-term interest rates			Long-term interest rates		
Lag in days	US does not GC EMU	EMU does not GC US	Lag in days	EMU does not GC US	US does not GC EMU
1	0.0000	0.0000	1	0.0966	0.0002
2	0.0000	0.0000	2	0.2690	0.0002
3	0.0000	0.0000	3	0.0661	0.0000
4	0.0000	0.0000	4	0.0123	0.0000
5	0.0000	0.0000	5	0.0048	0.0000
10	0.0000	0.0000	10	0.0603	0.0000
15	0.0001	0.0000	15	0.0422	0.0000
20	0.0008	0.0000	20	0.0966	0.0000
30	0.0014	0.0000	30	0.0229	0.0000
60	0.0394	0.0015	60	0.2325	0.0000

Note: the Granger Causality relationship is considered significant if the p-value is smaller than 0.05.

larger than 0.05. Therefore, the US long-term interest rate Granger causes the European long-term interest rate when looking at the 10-years maturities.

Cointegration Tests

Following Chinn and Frankel²³ we impose a long-run cointegrating relationship upon both the short-term and long-term interest rates. This is done by using the following vector error correction specification, where *i* refers to the short-term nominal interest rate and the long-term nominal interest rate respectively:

$$\Delta i_t^{US} = \alpha_1 + \varphi_1(i_{t-1}^{US} - i_{t-1}^{EU}) + \sum_{k=1}^j \beta_{1k} \Delta i_{t-k-1}^{US} + \sum_{k=1}^j \theta_{1k} \Delta i_{t-k-1}^{EU} + \varepsilon_{1t}$$

$$\Delta i_t^{EU} = \alpha_2 + \varphi_2(i_{t-1}^{EU} - i_{t-1}^{US}) + \sum_{k=1}^j \beta_{2k} \Delta i_{t-k-1}^{EU} + \sum_{k=1}^j \theta_{2k} \Delta i_{t-k-1}^{US} + \varepsilon_{2t}$$

The number of lags for this specification is determined by use of the Schwarz Information Criterion, a lag exclusion test and a test for autocorrelation. We arrive at three lags for both the short-term and long-term interest rates. This already tells us that the reaction of the European and US interest rates to their transatlantic counterpart, if there is any, will be very quick. The results of the estimation are reported in Table 2, where ϕ denotes the error correction coefficient in the equations mentioned above.

As we can see, for both the short-term and the long-term interest rate, the cointegrating relationship runs from the USA to the euro area. This means that the United States interest rates react negatively to a

Table 2
Cointegration Relation Estimates

	Euribor	US T-bill	Euro 10 yr bond	US 10 yr bond
ϕ	-0.00021	-0.00608***	0.0001	-0.00043**
Lags	3	3	3	3
N	2496	2496	2496	2496
Adj. R	0.074	0.04	0.17	0.006

,* denote significance at the 5% and 10% level respectively.

positive interest rate gap between the USA and the euro area, which means that US interest rates move to close this gap and equalise interest rates. This reaction is small, since we use daily data, but it is nicely significant. It is interesting to see that, during the EMU period, the USA seems to react to an interest rate differential between the two currency areas, while the European interest rates do not react to this interest rate gap. When separating the analysis for short and long-term interest rates, we can draw two conclusions. First, the negative reaction of US rates to a positive interest rate gap is larger for short-term interest rates than for long-term ones. This indicates that the interest rate relation between the United States and the euro area mainly runs through the money market, as would be expected when the interdependence concerns monetary policy. Second, the US reaction is also statistically more significant for short than for long-term interest rates, which confirms the above conjecture.

From both this analysis and the Granger causality analysis, we may conclude that there is a significant interdependence between the USA and euro area, which runs through both the short-term money market and the long-term bond market.

Conclusion

The literature on the evidence of US-euro area interdependence and its direction and our own empirical analysis seems to support the conclusion that there is interdependence between the USA and the euro area in the long run and the direction is from the USA to the euro area rather than the other way around. Of course, the ECB and the Fed have distinct mandates for monetary policymaking, which explains the transatlantic interest rate differential in the short run. Nevertheless, empirical evidence shows that it is hard to state that the euro area and the USA remain “two totally different policy areas” in the long run. Given the increasing globalisation of inflation and monetary policy, it will become even harder for the ECB not to be influenced in its decision-making by the Fed or vice versa.

²³ M. Chinn, J. Frankel, op. cit.