

THE IMPACT OF ECB'S MONETARY POLICY ON EURO'S EXCHANGE RATE

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Abstract

The study of *foreign exchange* is relevant thanks to the impact it may have at different levels. Moreover, the recent economic programs influence exchange rates in a free floating *international monetary arrangement*, which has caused several minor international incidents.

Thus, the study topic of this work is the indirect influence of the *European Central Bank (ECB)* on *EUR/USD exchange rate*. This study seems to be pertinent due to the scarce literature available on the subject, its complexity and its current relevance. We have focused on *central banks and their policies*, mainly the Federal Reserve System (Fed) and the ECB, and particularly on the ECB's *monetary policy*.

We have chosen the mixed methods approach, in order to make both a qualitative and quantitative analysis. The study begins with an approach to central banking and moves to contextualizing the ECB's scope of action within the *Eurozone*, as well as analyzing its monetary policy, that, through the transmission mechanism, affects *money supply* and *credit*. Afterwards, we focus on exchange rates and closely examine the EUR/USD exchange rate in different periods, particularly during the *non-conventional monetary policy* period. Lastly, we use statistics to support the argument that non-conventional monetary policy influences exchange rates.

We conclude that the ECB's non-conventional monetary policy puts downward pressure on the EUR/USD exchange rate and the contrary happens with Fed's policy. Several aspects, including behavioral ones, may affect exchange rates particularly in a turbulent economic/financial situation, but very high correlations proving the main arguments of the study, lead us to believe in the primary relation of monetary base and exchange rate.

Keywords: European Central Bank (ECB); EUR/USD exchange rate; Eurozone; non-conventional monetary policy

JEL Classifications: E51 - Money Supply, Credit, Money Multipliers; E52 – Monetary Policy; E58 – Central Banks and their Policies; F31 – Foreign Exchange; F33 – International Monetary Arrangements and Institutions

Resumo

As operações cambiais são muito relevantes devido ao impacto destas a diferentes níveis. Os recentes programas de estímulo económico influenciam as taxas de câmbio, num *sistema monetário internacional* de livre flutuação das moedas, tendo já causando conflitos internacionais menores.

Assim, o tema deste trabalho é a influência, ainda que indirecta, do *Banco Central Europeu (BCE)* na *taxa de câmbio EUR/USD*, estudo que é pertinente devido à escassa literatura sobre o tópico, à sua complexidade, contemporaneidade e relevância. Focámo-nos nos *bancos centrais e nas suas políticas*, neste caso na Reserva Federal Americana (Fed) e no BCE, e particularmente na *política monetária* do último.

Para esta análise recorreremos a uma abordagem mista permitindo assim utilizar tanto uma análise qualitativa como quantitativa. Começámos por descrever o conceito e importância dos bancos centrais e passámos para uma contextualização da actividade do BCE na *Zona Euro* analisando também a sua política monetária que através do mecanismo de transmissão afecta a *massa monetária* e o *crédito*. Depois focámo-nos nas taxas de câmbio e analisámos a taxa EUR/USD em diferentes períodos. Por fim, utilizámos uma análise estatística que sustenta o argumento de que a *política monetária não convencional* afecta a taxa de câmbio.

Concluimos que a política não convencional do BCE influencia a desvalorização da taxa EUR/USD e o contrário acontece com a política da Fed. Vários aspectos, incluindo aspectos comportamentais, afectam as taxas de câmbio particularmente num ambiente de turbulência. Contudo, correlações elevadas, que provam os argumentos deste trabalho, consolidam a relação primordial entre massa monetária e taxas de câmbio.

Keywords: Banco Central Europeu (BCE); taxa de câmbio EUR/USD; Zona Euro; política monetária não convencional

Classificações JEL: E51 - Money Supply, Credit, Money Multipliers; E52 – Monetary Policy; E58 – Central Banks and their Policies; F31 – Foreign Exchange; F33 – International Monetary Arrangements and Institutions

Sumário Executivo

A função dos bancos centrais é cada vez mais assumida como essencial para a obtenção de um sistema económico e financeiro estável. Essa importância dada aos bancos centrais torna-se ainda mais relevante depois da crise financeira de 2007/08 quando uma solução por parte destes era pedida. A recente criação da zona euro e da moeda única sob o controlo exclusivo do Banco Central Europeu (BCE), constituiu um marco de extrema importância na história europeia. O BCE constituiu como único objectivo a obtenção de uma taxa de inflação perto mas abaixo dos 2% pois acredita ser este o valor que permite a obtenção de um ambiente económico saudável. Para isso, tem ao seu dispor diversas ferramentas que lhe permitem através do mecanismo de transmissão influenciar a liquidez no mercado e por sua vez controlar a inflação de modo a obter a taxa pretendida.

O BCE não tem um objectivo em relação à taxa de câmbio do euro embora esta taxa possa ter influencia a diversos níveis, focando-nos neste trabalho no nível dos estados (nível macroeconómico). Dessa forma e estando integrada num sistema monetário internacional onde o valor das moedas flutua livremente, o valor do euro flutua influenciado por inúmeros factores. Não obstante, a política monetária tem efeitos ainda que indirectos na taxa de câmbio. Esses efeitos tornaram-se ainda mais evidentes com a crise financeira de 2007/08 que levou a uma mudança de políticas monetárias devido às várias medidas dos bancos centrais para tentar controlar os efeitos da referida crise. Enquanto a Reserva Federal Americana (Fed) adoptou desde cedo um programa de Quantitative Easing (QE) caracterizado pela expansão do seu balanço com compra de activos para proporcionar liquidez, harmonizar o preço dos activos e proporcionar estabilidade, o BCE optou por diversas operações extraordinárias para proporcionar liquidez mas dentro dos padrões das que já aplicava, ou seja, todas estas operações eram esterilizadas embora os seus efeitos expansionistas se verificassem durante algum tempo.

Dada a ainda escassa literatura sobre estes temas, a sua contemporaneidade, complexidade e relevância, focámos o nosso estudo nos impactos que a política monetária do BCE tem na taxa de câmbio EUR/USD, não podendo esquecer a influência americana sendo que uma moeda é sempre cotada contra outra. Assim, a nossa pergunta de partida resume os grandes tópicos abordados neste trabalho: *How does the ECB's monetary policy, particularly non-conventional monetary policy applied since 2007/08 financial crisis, affect the EUR/USD exchange rate?*

Neste trabalho focamo-nos na política monetária não convencional, assim, focamo-nos nos diversos programas americanos de QE e nas diversas operações de liquidez do BCE

incluindo o programa de QE europeu. Em consequência, argumentamos que existe uma relação entre expansão da massa monetária dos EUA e da zona euro (maior consequência da política monetária não convencional) e a desvalorização da moeda nacional. Assim, analisamos recorrendo a gráficos a taxa de câmbio EUR/USD, em períodos concretos, comparando-a com as variações na massa monetária dos EUA e da zona euro. Através desta análise concluímos que no período pós-crise financeira de 2007/08, a valorização do euro contra o dólar ocorria em simultâneo com um aumento da massa monetária nos EUA e a desvalorização do euro face ao dólar ocorria com a expansão da massa monetária na zona euro.

Assim, calculámos correlações (r), regressões (y) e coeficientes de determinação (R^2) entre variáveis (massas monetárias e EUR/USD) em períodos de tempo específicos. No período 2000-2007 caracterizado por um aumento controlado da massa monetária e por políticas monetárias convencionais obtivemos uma correlação positiva expressiva entre o aumento da massa monetária dos EUA e a taxa EUR/USD. Já no ano de 2009 em que a crise financeira se instalara, ambos os bancos centrais recorreram a medidas extraordinárias que tiveram efeitos de expansão da massa monetária. Assim, em 2009 verificam-se correlações expressivas sendo a correlação entre a massa monetária dos EUA e a taxa EUR/USD positiva e a correlação entre a massa monetária da zona euro e a taxa EUR/USD negativa. Nos anos de 2010-2011 estas relações não se verificam devido à simultaneidade de políticas monetárias expansionistas que se anulam mutuamente e devido a vários outros factores como crises da dívida soberana e o início dos programas de ajustamento. O CBPP2 do BCE é iniciado no final de 2011 e tem os efeitos expectáveis de expansão da massa monetária em 2012 ocorrendo este num período de estagnação do crescimento da massa monetária nos EUA. Em consequência, o euro verifica uma tendência de desvalorização em relação ao dólar e tal como esperado a correlação entre esta taxa e o aumento da massa monetária é negativa e muito expressiva. O contrário ocorre nos anos de 2013-2014 onde a Fed expande a sua massa monetária devido ao QE3 ao mesmo tempo que os efeitos do CBPP2 são esterilizados. Verifica-se neste período uma correlação positiva entre o aumento da massa monetária dos EUA e a taxa EUR/USD. O ano de 2015 é caracterizado pelo fim do QE3 e por variações da massa monetária americana controladas e dentro de limites específicos parecendo ser o começo de um regresso à normalidade. Pelo contrário na zona euro é iniciado o primeiro programa de QE o que leva a um grande aumento da massa monetária. Assim, era esperado que as correlações para este ano corroborassem o anteriormente dito. Contudo, isto não acontece devido à fase ainda incipiente do QE Europeu, a várias pressões externas e devido ao

comportamento da taxa EUR/USD que tem desvalorizado e que recentemente estabilizou flutuando entre valores historicamente baixos.

Concluimos assim que as abordagens do BCE e da Fed são descoordenadas e algo díspares no período pós-crise onde o segundo opta por medidas não convencionais desde cedo e o primeiro opta por estender as medidas já existentes e esterilizar os seus efeitos até 2015. Concluimos também que quando as massas monetárias aumentam a taxa de câmbio EUR/USD valoriza com um aumento da massa monetária nos EUA e desvaloriza com um aumento da mesma na zona euro. Esta expansão da massa monetária constitui a principal consequência das políticas monetárias não convencionais configurando o seu efeito mais duradouro, que por sua vez influencia as taxas de câmbio.

Glossary

<i>Central Banking</i>	
BOE Bank of England	Fed Federal Reserve System
BOJ Bank of Japan	EMU European Monetary Union
ECB European Central Bank	NCB National Central Bank
<i>Currencies</i>	
AUD Australian Dollar	GBP British Pound
CAD Canadian Dollar	JPY Japanese Yen
CHF Swiss Franc	NZD New Zealand Dollar
EUR Euro	USD US Dollar
<i>Macroeconomic Analysis</i>	
GDP Gross Domestic Product	
HICP Harmonized Index of Consumer Price	
<i>Monetary Policy</i>	
ABSPP Asset-backed Securities Purchase Program	MRO Main Refinancing Operation
CBPP Covered Bond Purchase Program	OMT Outright Monetary Transactions
FTO Fine Tuning Operation	QE Quantitative Easing
LTRO Long-term Refinancing Operation	SMP Securities Markets Program
<i>Statistical Analysis</i>	
(<i>r</i>) Correlation	
(<i>Y'</i>) Regression	
(<i>R</i>²) R-squared	

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1. Introduction

The “art of central banking” (Hawtrey, 1934) has now a long history. Central banks, which started as private institutions, provide a public service in modern western economies and have a strong set of principles to follow and a mission to accomplish. As explored further, we will focus our attention on the study of the European Central Bank (ECB) and specifically on the impact of its actions on the euro's exchange rate.

The study topic of the current work is inherent to monetary policy and may influence it and be influenced by it strongly, namely as far as the euro's exchange rate is concerned. Particularly, the ECB's monetary policy and its success depend chiefly on the exchange rate, even though it does not constitute the ECB's main target or a policy tool. The mission of the ECB is to control inflation, in order to obtain price stability, which should lead to an inflation rate lower, but close to 2%. The ECB's influence in prices is based on the idea that the banking system needs the money issued by the central bank and that through a transmission mechanism ultimately the actions of the central bank will ultimately influence the prices. The intervention of the ECB is done recurring to open market operations, and through them the central bank can expand or diminish liquidity in the market (Scheller, 2006, pp. 87-89). As stated, the euro's exchange rate does not constitute a policy tool of the ECB and, thus, the central bank does not have an objective to achieve in terms of exchange rates. Besides, the ECB should not intervene in the foreign exchange markets, unless the intervention aims at influencing price stability. This was the argument for the ECB's intervention in the foreign exchange markets in September and November 2000, when the free floating euro was very weak against reference currencies (US dollar, British pound, yen, and Canadian dollar).

Though the ECB does not use the euro's exchange rate as a monetary policy tool, it has indeed a strong importance. Focusing on what is described further as the *state level* that is the focus of the current study, exchange rates may strongly influence economic growth. In a modern, market oriented economy, the strong impact of exchange rates is felt on the imports and exports. A lower home currency's exchange rate hampers imports and favors exports, because the former become expensive and the national products become cheaper in international markets, which increases the demand for them. Besides, a low exchange rate favors inflation, once it may enhance economic growth. On the other hand, a low exchange rate has also negative impacts. Concerning sovereign debt paid in foreign currency, a strong national currency would favor the debtor. Similarly, in case of intervention in foreign exchange markets, a strong national currency would ease the operation. Bearing this in mind,

it is the challenge of a central bank to balance these situations and adopt the best policy to cool or to boost economic growth with its expected consequences.

Europe, the ECB and the euro currency are some of the most recurring topics in the world financial, economic and political press. After a period of low economic growth accompanied by low inflation and even periods of deflation, in 2015 the ECB launched the European Quantitative Easing (QE) program, in order to boost the European economy through the purchase of sovereign debt and by expanding liquidity in the markets. This action was taken days before the Greek election of a government which strongly contests the policies applied in Greece and supported by the ECB, and now poses obstacles to the expansion of the QE program to Greece. These events have a clear effect on the euro's exchange rate and put a strong pressure on the ECB, which could behaviorally affect the random walk of the euro's exchange rate.

Along the following pages we propose to analyze all the topics mentioned above, having a specific focus on the euro's exchange rate and particularly on its evolution recalling the impact of the ECB's monetary policy on it. We will also come to understand what other events influence the euro's exchange rate and conclude whether the events mentioned above that put a huge pressure on the ECB also influence the euro's quotation against the US dollar.

2. Methodology

According to (Creswell, 2013, pp. 3-23) there are three main research approaches to follow when developing a study, that is, the quantitative approach, the qualitative approach and the mixed methods approach. Having in mind the study's topic we selected the mixed methods approach, allowing the use of both qualitative and quantitative approaches. Thus, we started by a qualitative analysis followed by a quantitative analysis, aimed at proving the first. We may summarize the study methodology as follows:

*Literature review – collection of data (raw data) – application of theory to data collected
(graphs) – statistical analysis to prove theory (hard data)*

Hence, we started by reviewing literature on the subject ranging from theoretical books to case studies, giving special emphasis on readings specifically about the subject, to be precise the ECB's monetary policy and its impact on exchange rates. An example of the latter, are the several ECB's publications on the history of the institution, its functions, objectives and scope of action and its monetary policy instruments. These literature examples allow us to deeply understand the Eurosystem functioning. The theory associated with these readings is of paramount importance, because it is the premise under which the ECB works, for instance, to perform this type of work we may understand theoretical foundations and concepts that will be the basis to perfectly understand empirical knowledge. One may take as an example the transmission mechanism accepted by the ECB. In order to understand liquidity providing operations, as well as extraordinary liquidity providing operations in a very low key interest rates environment, we must understand the path accepted by the ECB through which these measures affect the general economy (transmission mechanism). Also very important are the case studies on, for instance, non-conventional monetary policy, namely, the Quantitative Easing programs in the USA and historical low and negative key interest rates. Because of the current lack of theory and empirical studies on the matter, particularly about the Eurozone reality, these case studies are of high importance.

After getting in touch with theory and reality, we collected raw data applied later. The data collected are primary data, directly collected from Bloomberg® Terminal concerning exchange rates (mainly EUR/USD), monetary base (Eurozone and USA) and macroeconomic indicators (GDP, unemployment, inflation and sovereign bond yields). These data were collected in a monthly average basis, since it is the timeframe allowing better comparisons among variables and it avoids daily and intraday fluctuations.

After raw data collection we made meaningful knowledge of it by transforming the raw data in graphs, recurring to Bloomberg[®] Terminal, which allows a much more easy and comprehensive reading. We then used these graphs to explore the theory and the arguments already existent about the subject and collected before in the literature review. For instance, we used a Eurozone monetary base graph to prove that the several liquidity providing operations were not completely sterilized. Furthermore, we also used these graphs in order to, together with economic theoretical principles, prove our approach. In this case, for instance, we used a comparative graph of Eurozone monetary base and the EUR/USD exchange rate to prove that one variable influences the other.

2.1 Statistical analysis

After all this previous analysis done we recurred to statistics to prove our main argument, specifically, the influence of the USA and the Eurozone monetary bases expansion as a consequence of the unconventional monetary policy on the euro's exchange rate against the dollar. We run several correlations (r), regressions (Y') and R-squared (R^2) among the variables through the following formulas:

$$r = \frac{\sum(x - \bar{x}) \cdot (y - \bar{y})}{\sqrt{\sum(x - \bar{x})^2} \cdot \sqrt{\sum(y - \bar{y})^2}} \quad (=) \quad r = \frac{\sum x * y - n * \bar{x} * \bar{y}}{\sqrt{\sum x^2 - n * \bar{x}^2} \cdot \sqrt{\sum y^2 - n * \bar{y}^2}}$$

$$b = \frac{n \sum x * y - \sum x * \sum y}{n \sum x^2 - (\sum x)^2}$$

$$Y' = a + b \cdot x$$

$$a = \bar{y} - b \cdot \bar{x}$$

Correlations prove the connection strength between the independent variable (monetary base) and dependent variable (EUR/USD exchange rate). Besides, regressions were computed with two objectives: first, obtain a regression function which could give us possible future values for the dependent variable in a given context; second, prove that the correlations are correct. Concerning correlations, they were computed as percentage change from the previous year. This methodology was adopted because it is easier and more perceptible for the reader to see percentage change values with a closer scale instead of a wide range of values with very different axis scaling and mainly because this approach will avoid a spurious correlation

which will happen if total values were to be compared. Accordingly, artificial values would be found and will exacerbate the correlations results.

We selected three variables on a weekly basis from January, 1999 until September, 2015: USA monetary base published on every Wednesday; Eurozone monetary base published every Thursday; EUR/USD exchange rate as Fridays' average value. The variable monetary base is obtained by the formula (*Monetary base=Current accounts + Currency in circulation*). In order to obtain weekly values for the Eurozone monetary base we obtained the data for current accounts (composed by commercial banks' reserves at the ECB and so liabilities of the latter) and added them to the values for banknotes in circulation missing only a few and irrelevant part for the analysis, the quantity of coins in circulation. The data for the statistical analysis were collected from official databases: Eurozone data from Statistical Data Warehouse (E.C.B., Statistical Data Warehouse); USA data from FRED (Federal Reserve Bank of St. Louis) as well as the data on the EUR/USD exchange rate.

2.2 Research question

Bearing in mind the objective of the study and the methodology used to conduct it, it is important to clearly state the research question. This question directs the study towards a very specific objective and narrows down the topics studied. The current work is directed at understanding the monetary policy actions of the ECB and how they influenced the EUR/USD exchange rate. Although the focus of the work is on the ECB, one may keep in mind that the exchange rate is always quoted against another currency and one might not forget and should analyze external impacts as a result of another central bank's policy, in this case the Fed. Consequently, the research question is the following:

How does the ECB's monetary policy, particularly non-conventional monetary policy applied since 2007/08 financial crisis, affect the EUR/USD exchange rate?

2.3 Chapters division

Chapters division is in line with the described methodology. We will start by a general approach to central banking in chapter 3 and we will narrow the approach within the same chapter to better understand how the ECB and the Eurosystem work. Within the same chapter we will analyze the ECB's monetary policy and the monetary policy tools it has available.

On chapter 4 we will focus our attention on the euro's exchange rate starting by a broader approach to the international monetary system and the explanation of how exchange rates

operate and how important they are. Thereafter, we will analyze the EUR/USD exchange rate first on a historical perspective and after divide it into several periods that ease the analysis and may clearly show the impacts monetary policy had on this rate.

Furthermore, on chapter 5 we prove through statistical analysis the main arguments of the study and support them with correlation tables and graphs and several regressions and R-squared calculations.

3. The European Central Bank

3.1 Brief Central Banking History

The banking history is a fascinating and vast topic as well as the history of central banking. The Bank of England (BoE), founded in 1694, might be considered the first central bank in history. In the beginning it was a regular bank but with a special right, the right of issuing shares. With time BoE became the most powerful bank in England with the power to destroy any of the other small banks. Nonetheless, it opted not to do it and forced all the other banks to hold deposits in BoE's safes. With these reserves on its own safes, the BoE assured that it would help the banks in trouble when needed. In the end of the day the private Bank of England provided a public service; it guaranteed the stability of the British banking system.

Guaranteeing the stability of the financial system and providing liquidity are two of the functions of the modern central banks. Creating more stability and predictability in the financial system, specifically by avoiding periods of excessive liquidity or restriction (Mehrling, 2011), was the fundamental mission of the Federal Reserve System (Fed) in the United States of America founded in 1913. The Fed replaced the National Banking System and in the beginning incurred in avoidable mistakes (Meltzer, 2003) leading some to argue that the expansionary policy pursued after the I World War ultimately “...*fired the stock market bubble...*” (Mehrling, 2011). Still, the Fed passed through and influenced all the international monetary system arrangements starting in the 1870's with the gold standard (Moffett, Stonehill, & Eiteman, 2009, p. 60) and has now more than a century of experience. Therefore, many of the founding principles of central banking are still important today but despite the considerable history and experience of central banks they still face hard challenges. The most recent central banks had an easier task defining their scope of action or studying the impact of some of their policies though it does not make their job easy.

3.2 The European Central Bank and the Eurosystem

Recently founded in 1998 as a consequence of the last phase of the European Monetary Union (EMU), the ECB has indeed less experience than other central banks. On the other hand, it took advantage of all the work done by its predecessors regarding the role of central banking and monetary policy but this does not make it a lot easier for the ECB. As Huntington would put it, Europe is united by common strong values which distinguish it from other continents (Huntington, 2009). Nevertheless, the process of integration in the European Union was never easy and the hard task of convincing the national states to give up some

sovereignty to a supranational institution as the ECB is the most preeminent example. This is also a huge challenge for the European bankers' bank.

While the idea of creating a supranational central bank in Europe was not new because it started in the 1960s, the founding process of the ECB took time and passed through different stages (Scheller, 2006, pp. 21-28). Nowadays the role and the scope of action of the ECB are well defined by the treaties. The ECB is the head of the European System of Central Banks (ESCB) and is obviously even more important for the Eurosystem member countries which share the euro as their common currency. The ECB is the sole responsible for the Eurosystem monetary policy, as stated by the treaties, being it “...a specialized, independent organization [responsible] for conducting monetary policy and performing related functions...” (Scheller, 2006, p. 43). On the other hand, the National Central Banks (NCBs) are the ECB's shareholders and provide the central bank with capital and foreign reserve assets. The NCBs play a crucial role on the ESCB and particularly on the Eurosystem. In addition, the NCBs share responsibilities with the ECB and ultimately is through them that the monetary policy is put into practice, for instance, when the ECB decides the amount of money that should be in circulation, are the NCBs who print the great majority of euro banknotes, put them in circulation and are obliged to accept them no matter in which NCB they were them printed. Besides, the ECB can guarantee the application of its monetary policy through three legally binding acts directed to the Eurosystem NCBs: guidelines, instructions and internal decisions. In accordance to what was said, we conclude that the decision making process concerning monetary policy in the Eurosystem is a centralized process with decentralized application.

3.3 The European Central Bank's Role and Principles (modern central banking)

Nowadays, the role and importance of central banks are well defined as are the principles that should guide their actions. The widespread principles that should guide the actions of central banks may be summed up in three which the ECB adopts completely: independence, accountability and transparency. The political cycles (election periods) differ significantly from economic cycles and thus, may go against the policy that central banks should pursue making crucial the principle of independence of central banks from governments and political institutions. The ECB works in close cooperation with Community institutions but operates independently, fact that led some to argue that the ECB is one of the most independent central banks (Mishkin, 2004, pp. 350-351). Concerning accountability, the ECB is mainly accountable to the European citizens to whom it should explain and justify monetary policies. The ECB has input legitimacy because the national states took the sovereign decision to

transfer to the ECB the responsibility of their monetary policies. The ECB could also achieve output legitimacy if it performs its tasks successfully. Output legitimacy is more difficult to measure and achieve mainly because monetary policy is thought as a long term policy and its results may be fruitful and bring stability in the future but being mild in the present time (Scheller, 2006, p. 127). At the end of the day, the ECB is also accountable to the European Court of Justice (ECJ) which, by initiative of others, may analyze and decide on the acts of the ECB. Transparency is also taken as an important value to follow in central banking and the disclosure of monetary policy and central bank's actions is a paramount topic (Settlements, 2009, p. 144). Once more, the ECB adopted this principle and its actions and policies are widely spread through official communications and through a wide range of publications.

Especially after the financial crisis of 2007/2008 the role and actions of central banks came into the spotlight. The discussion became even more relevant when the Fed expanded its function of lender of last resort (Mehrling, 2011) and the ECB decided not to adopt a Quantitative Easing (QE) strategy until a much later phase, situation that distinguished the approaches of both central banks to the same problem. It is widely accepted that the paramount role of a modern central bank is to maintain financial stability. However, the concept of financial stability is too wide and hard to quantify and so few central banks clearly define it as their main role (Settlements, 2009, pp. 25-28). Taking the example of the ECB we conclude that financial stability is crucial in its approach. The central bank defines price stability as its priority but price stability may be understood as economic and financial stability. By having a quantitative definition of price stability and setting the objective of having a steady inflation less but close to 2% (Scheller, 2006, p. 80) the ECB is introducing, alongside with stability, the concept of predictability by making the future less uncertain. Another aspect of financial stability and predictability is the influence that central banks have in short term interest rates which will by its turn influence long term interest rates and therefore the interest rates charged and paid by private banks. Central banks do this mainly through managing liquidity and they have special mechanisms to use, for instance, through open market operations and acting as lender of last resort. Central banks are usually also responsible for an exchange rate policy because it has a strong impact on the financial sector and on the real economy. This is not exactly the case of the ECB because exchange rate policy is not its main priority neither a policy tool (explored later in this section). Lastly, central banks have an important role in creating stability, predictability and trustworthiness in the payment system. One may cleverly recall the example of Trans-European Automated

Real-time Gross settlement Express Transfer system (TARGET) in Europe (E.C.B., 2010, pp. 178-180) and the function of settlement agents shared by the ECB and NCBs and the depositary function still fulfilled by some NCBs.

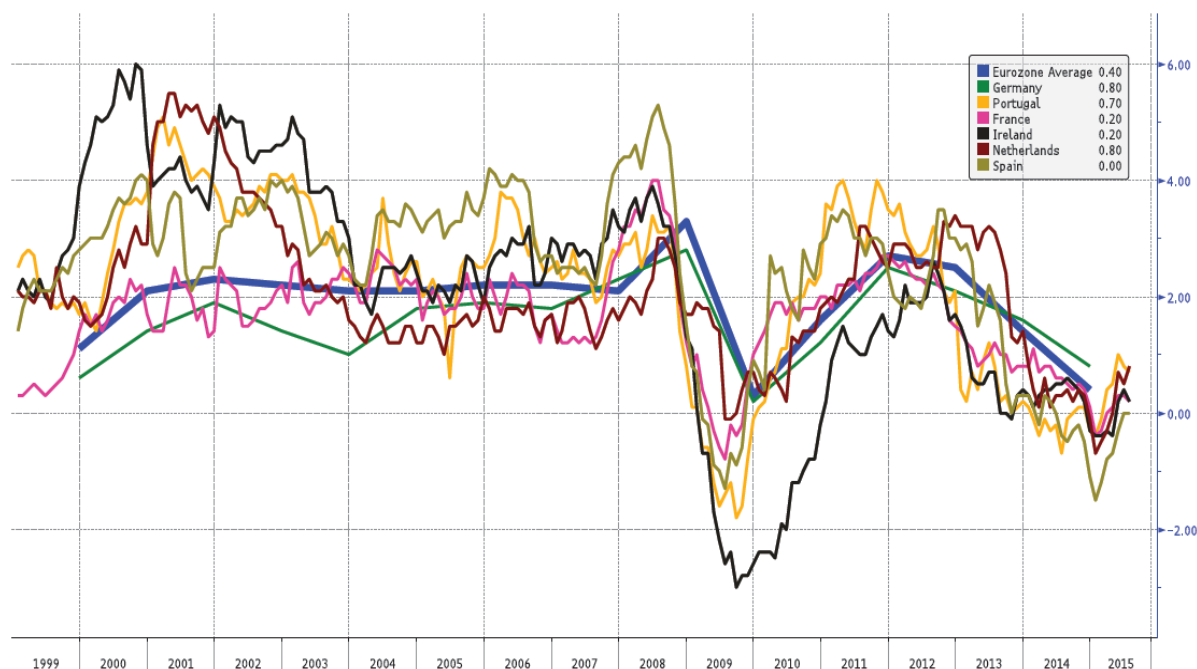


Chart 1- Monthly Harmonized Consumer Index Prices (HICP) for six Eurozone countries compared with the Eurozone average in the period 1999 to 2015. Source: Bloomberg ®

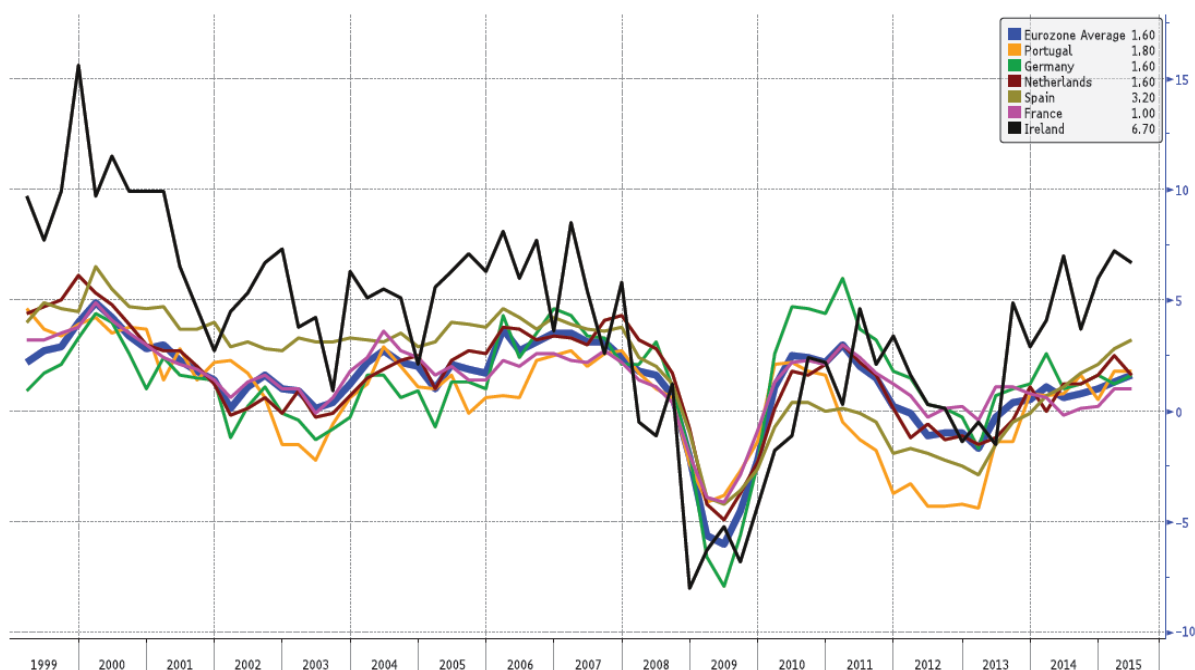


Chart 2- Quarterly real GDP growth for six Eurozone countries compared with the Eurozone average in the period 1999 to 2015. Source: Bloomberg ®

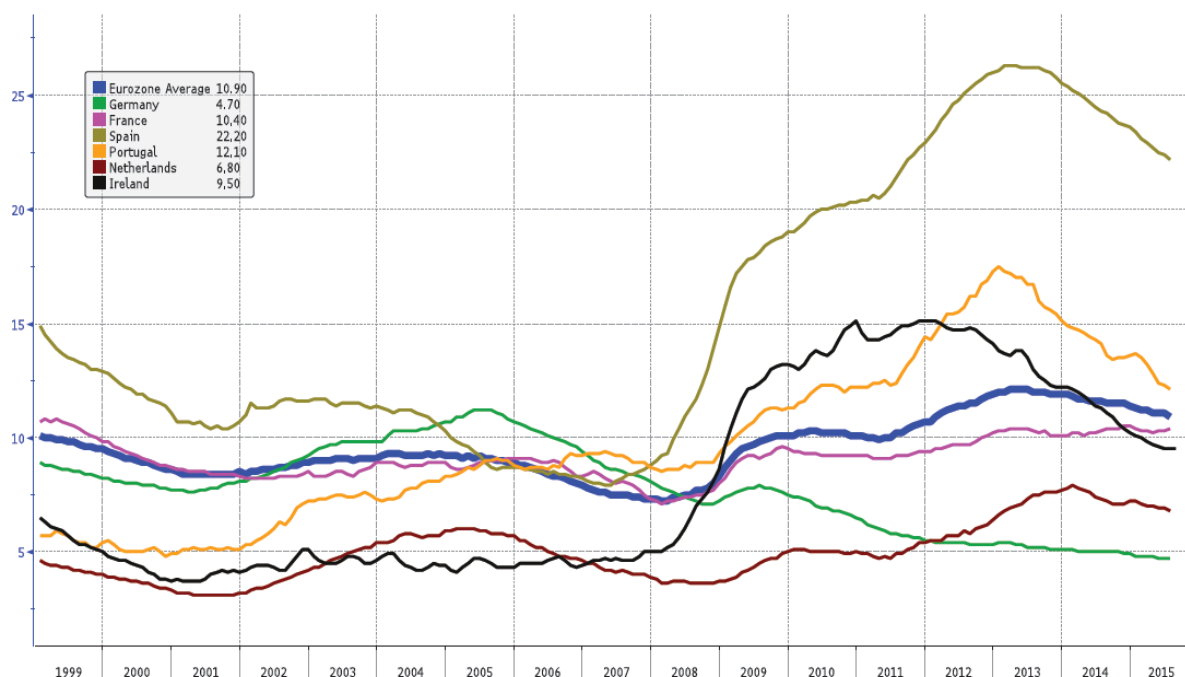


Chart 3- Monthly unemployment rate for six Eurozone countries compared with the Eurozone average in the period 1999 to 2015. Source: Bloomberg ®

In fact, the ECB's role is clearly defined and it follows the principles that should guide modern central banks, though we believe that the integration process is still an ongoing process that can go much beyond of what it is now as it is proved by the following examples. The ECB has a sole monetary policy directed to the entire European Union though the realities of its members differ significantly (charts 1, 2 and 3). For instance, the inflation rates differ among the EU's countries and when the ECB directs a sole policy to all of them it may cause some harm (chart 1). The fact is that the audience of the ECB "*...is not genuinely European, but rather multinational...*" (Scheller, 2006, p. 128). As price stability is the main stated objective of the ECB it should maintain inflation stable for a long period. Nevertheless, Europe is currently going through a period of very low inflation (even period of deflation) and poor economic growth. This poses a threat to the ECB's legitimacy and a challenge to the ECB's decision makers which must come out with a solution. Part of this solution might be the recently announced European Quantitative Easing (QE) program that proposes expanding market liquidity and buying sovereign bonds (Randow, 2015). The ECB is expanding its role of lender of last resort until now only fulfilled through the so called standing facilities. The problem here is that the ECB is prohibited by the treaties to favor or facilitate credit to governments including the purchase of debt instruments (Scheller, 2006, p. 73) but now is exactly what it is proposed. The challenge is to accept more integration leading the ECB to

become closer the Fed's policy of "dealer of last resort" (Mehrling, 2011) or to hamper this new impetus of the European Central Bank. If the challenge is succeeded through more integration it would be a remarkable event.

3.4. The European Central Bank's Monetary Policy

Along with the process of European integration and as a natural evolution of the mentioned process, an essential element of sovereignty was given to the European Central Bank, that is, monetary policy. Monetary policy was the way individual National Central Banks used to try to control and influence economic developments through managing the money supply. They did this with close cooperation with national governments. Currently, the NCBs have no more control over the money supply in the economy and cannot take monetary policy measures alone. The ECB is the sole responsible for economic policy guidelines which are executed through the NCBs in their respective member state.

Instead of different monetary policy decisions taken by the individual member states, the European Union has now a single orientation towards monetary policy. As a consequence, when a measure in this field is taken, it influences all the EU's members and it is not adapted to the different realities. This creates clear advantages such as a strong sole monetary policy and a strong common currency which both make the European bloc much stronger but may have also some flaws as the lack of adaptability to different needs as EU's members are not always at the same stage of development and may also be at different stages as far as economic cycles are concerned.

The ECB has strict monetary policy guidelines to follow and to fulfill its paramount objective has also clear instruments. After several years of the ECB's foundation the European bankers' bank was able to expand its role and cleverly surpass some imposed limitations in order to have a deeper and stronger influence, for instance, as a consequence of the 2007/2008 financial crisis which was followed in Europe by a sovereign debt crisis and economic downturn, the ECB used extraordinary measures never applied before.

The ECB's monetary policy actions follow the rules of modern central banking and respect the values of central banking stated on the previous section. The ECB has only a monetary policy responsibility being economic policy being the responsibility of the member states. Consequently, the ECB has a sole paramount objective: maintaining price stability through measures that would likely keep a constant inflation rate below but close to 2%, which is believed to be the optimal inflation level to a constant economic growth and wellbeing for the Eurozone as a whole. A stable inflation promotes stability because it

guarantees stable assets and products prices. Therefore, consumers will be able to distinguish normal changes in prices, situation impossible in an over inflationary environment, and companies will have a robust balance sheet since its assets will not lose value caused by inflation. Besides, investment will be promoted in a stable environment because individuals and firms will not need to hedge against inflation diverting resources from productive purposes and because banks will not need to charge a premium for inflation as it would be the case in an unstable environment. Furthermore, control of inflation is important by mainly two more reasons, because inflation creates instability and reduce the value of cash leading consumers not to use cash so often and because an environment of high inflation or deflation creates hard social inequalities (E.C.B., The Monetary Policy of the ECB, 2011, pp. 56-57).

The purpose of having an economic growth *sensu stricto* is not the objective of the ECB. Nevertheless, the ECB tries to influence a constant economic growth, which is believed to derive from a steady inflation rate. Although central banks have found and used different ways to influence the market particularly in times of crisis as explored further, the key way through which they can influence the market is through influencing interest rates. Central banks can better influence short term interest rates, that according to the Expectations Theory, will influence the long term interest rates because the latter are just future expectations of the former (Stigum, 2007, p. 390). Henceforth, one obtains the same interest by investing in a bond or rolling over the investment in short term instruments such as bills. Empirically this is not always true mainly in times of crisis where interest rates are instable (Mehrling, 2011).

Central banks have the monopoly of the money supply and they can influence the liquidity in a given market. Therefore, central banks may try to influence conditions of credit which would then influence economic growth and ultimately lead to a price level development, through charging an interest rate on financial institutions when they try to obtain liquidity at the central bank. As the short term financing, the most common type of financing provided by the central banks, influences short term interest rates in the private banking sector and having in mind that it would at that point have not always a straightforward but at least some influence on the long term interest rates charged on the private sector, central banks can influence interest rates due to the transmission mechanism.

The transmission mechanism is "...the process through which monetary policy decisions affect the economy in general, and the price level in particular..." (E.C.B., The Monetary Policy of the ECB, 2011, p. 58) and it relies on the action of several agents throughout the process in order to succeed. The transmission mechanism begins with the actions of the central bank, which through its operations, influences money market interest rates and

hopefully would end with an impact on inflation. Besides the crucial action of interest rates and the important actions of several agents throughout the process, expectations toward the central bank and its future actions, for instance the expectation of a low interest rate, have also a relevant role. The relevance of expectation is that if the market agents believe events will happen on a different way than the one the central bank anticipates, this will have a negative effect on price developments. Furthermore, the central bank must have credibility and all the market agents must believe in its coherent and effective actions, otherwise, central bank's actions will not have the desired effect. One may take as an example a hypothetical situation where the ECB states as its objective maintaining inflation close to 2% but it is perceived by the market agents as a not effective institution which would not take real actions to influence price stability. This expectation towards the ECB's actions will undermine price stability and may even work against it. On the contrary, the ECB has been able to control inflation rates as desired and even in a crisis situation it maintains its reputation and credibility, that contributed significantly to the success of its policies (E.C.B., *The Monetary Policy of the ECB*, 2011, pp. 61-62).

This quantitative definition of price stability of around 2% of annual inflation is a way of accountability and it also stands for a long term objective of monetary policy. The ECB does not, in normal times, target short term objectives and its policies aim at long term stability. As the central topic of this study is the euro's exchange rate, it is important to reinforce that the ECB has not an exchange rate policy, meaning that the ECB does not have a target for the value of the euro against other currencies. Nevertheless, exchange rates may have extreme importance for monetary policy and economic welfare as stated in the next section.

3.5 The European Central Bank's Monetary Policy Instruments

The ECB has several instruments it uses to influence short term interest rates that are all based on the premise of its monopoly of the money supply to financial institutions. These instruments are always available and the ECB may use them when needed. The different instruments vary according to periodicity, amount and maturity. These instruments are used in normal times and might be distinguished from extraordinary measures undertaken by the central bank in times of special need.

The instruments the ECB uses to fulfill its mission are of two types: *minimum reserves system* and *monetary policy operations* (which include *open market operations* and *standing facilities*). The minimum reserves system consists of the obligation of financial institutions holding deposits at the correspondent NCBs amounting of at least 2% of their partial balance

sheet. Not all assets are under the obligation of the minimum reserves, besides, these holdings at the NCBs are remunerated. More than a stability mechanism the minimum reserve system allows also stabilization of overnight money market interest rates because the interest paid by the ECB on the deposits works as a floor for the overnight interest rate (E.C.B., The Implementation of Monetary Policy in the Euro Area, 2011, p. 11). Moreover, as the 2% of reserves are calculated on an average basis over a period of a month called the maintenance period, some arbitrage may happen because institutions may lend on the money market when they have a surplus and the rates are more favorable. On the contrary, if the money market rates are not favorable, institutions may just keep the reserves at the NCBs and earn interest on them.

	Type of Transaction		Maturity	Frequency
	Liquidity Absorbing	Liquidity Providing		
Open Market Operations				
Main Refinancing Operations		✓	One week	Weekly
Long-term Refinancing Operations		✓	Three months	Monthly
Fine Tuning Operations	✓	✓	Non- Standardized	Non-regular
Structural Operations	✓	✓	Standardized and non- standardized	Non-regular and regular
Standing Facilities				
Marginal Lending Facility		✓	Overnight	Always
Deposit Facility	✓		Overnight	Always

Table 1 – Summary of monetary policy instruments. Based on the approach in: (E.C.B., The Implementation of Monetary Policy in the Euro Area, 2011, p. 13)

Nevertheless, it is mainly through monetary policy operations that the ECB really influences interest rates and consequently price stability. The different instruments available may be distinguished according to their *objective* (liquidity providing or absorbing), *maturity* and *frequency* (frequency in which the mechanism is available). If an instrument is always available, than it becomes a standing facility as are the instruments Marginal Lending Facility

and Deposit Facility. Usually institutions do not use much these instruments because conditions are better on the market. Though, these instruments may be very important on crisis situations. Within the open market operations and according to the instruments' characteristics stated above, the ECB has available: Main Refinancing Operations (MROs) which are the most regular and more important instrument of monetary policy; Long-term Refinancing Operations (LROs); Fine Tuning Operations (FTOs); Structural Operations.

Recalling what was stated before, the ECB influences short term interest rates which have an impact on long term interest rates and through the transition mechanism and as a result of the actions of several agents influences economic growth and price stability, allowing the central bank to adapt policies according to economic cycles and accommodate economic growth as suitable. Therefore, the great impact of the regular instruments the ECB uses, resides on the interest rate it charges to the eligible counterparties of these operations in order for them to obtain financing. For instance, if the ECB needs to boost economic growth and push the inflation up due to a downturn economic cycle or crisis, the regular and primary measure would be to lower interest rates charged to counterparties on the mentioned operations. If the financing on the ECB is eased with a lower interest rate or with the widening of accepted collateral, financial institutions particularly private banks, will recur to this type of credit and consequently lower short and long term interest rates charged on loans and be more favorable to investment as they have a secure source of financing. Obviously, the contrary will happen with a high interest rate charged at the central bank level. This type of financing will only be used by privates if they cannot obtain cheaper financing otherwise and thus, the central bank is the lender of last resort because in normal times the private banks would be better financing themselves in the market than recurring to the central banks. However, in times of crisis central banks recur to extraordinary measures which may sometimes be essential in the short term and have also great importance in the long term perspective. The first measure a central bank might take in times of crisis is to lower the interest rates charged in its operations and this is by itself an extraordinary measure but when this is not enough to control inflation or to stabilize the market that is lacking liquidity, the central banks may adopt more extraordinary measures as the assets purchasing programs pursued by the ECB and described further.

3.6 Extraordinary measures and the Quantitative Easing (QE) program

In normal times the ECB is a lender of last resort influencing the economy having as final objective price stability. Lender of last resort function is possible because the ECB promotes

disadvantageous interest rates in its standing facilities which make financial institutions recur to it only when really needed. Hereafter, financial institutions will only recur to the ECB's liquidity providing operations only when the ECB provides a favorable interest rate. Therefore, the liquidity absorbing operations intend to cool down the economy and will only be successful if the ECB is willing to pay a fair amount for institutions' assets. In normal times or when facing a smaller crisis, these pure monetary operations will be enough to achieve the proposed monetary objectives. Nonetheless, when facing a serious, deep and different crisis as the last financial crisis of 2007/2008 several central banks as the Fed, the Bank of England (BOE), the Bank of Japan (BOJ) and the ECB, were obliged to recur to very extraordinary measures since lowering interest rates was proved not to be enough to achieve monetary policy objectives and to boost economic growth. The straightforward consequence of these new measures is the expansion of central bank's balance sheet caused by several asset purchases, as verified by the comparison between the evolution of ECB's assets and monetary base, the central bank's main liability (chart 4).

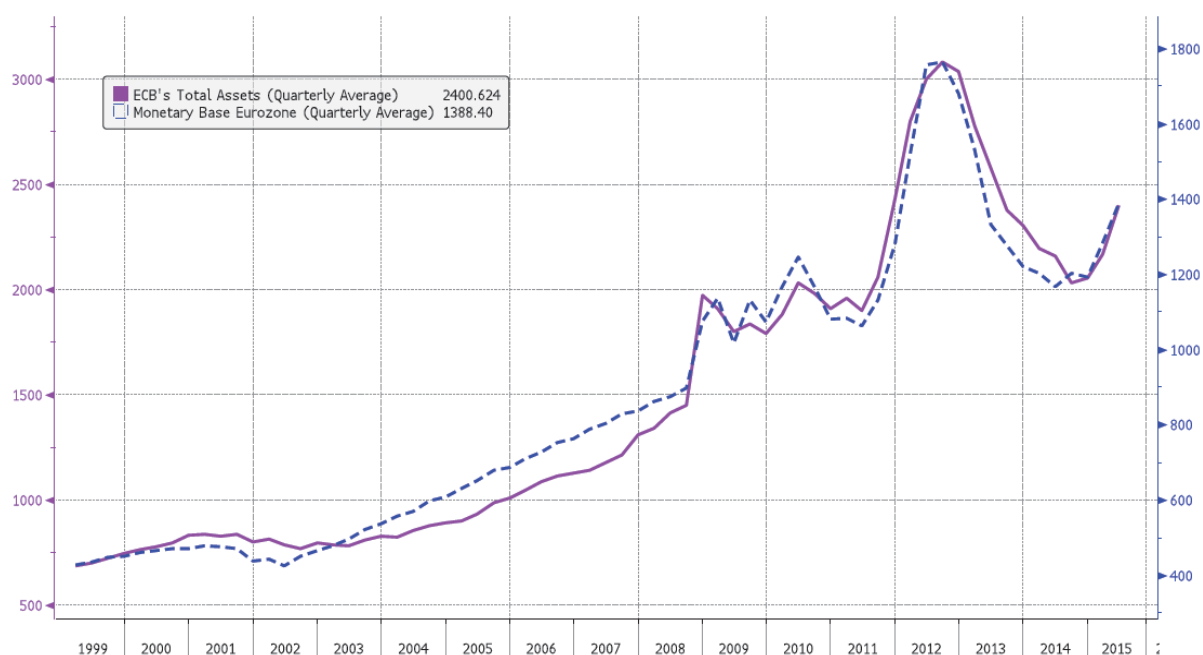


Chart 4 - Evolution of total assets (left axis) on the ECB's balance sheet compared with the evolution of monetary base (right axis). Values in millions of euros. Source: Bloomberg ®

These extraordinary measures range from the extension of maturities and amounts in normal operations as well as its frequency to Quantitative Easing (QE) program. The QE measures can be defined as policies "...that unusually increase the monetary base, including asset purchases and lending programs..." (Fawley & Neely, 2013, p. 52). In these particular

situations central banks are not only a lender of last resort but also a dealer of last resort (Mehrling, 2011) because they not only provide liquidity through reserves but also deal and create ceilings and floors to asset prices like a normal dealer does. Therefore, the central bank tries to create liquidity in certain asset markets acting as a value based investor who created an outside bid and ask spread (Treynor, 1987). Even though the ECB is a latecomer to the QE program this is not a completely new concept for the European bankers' bank. After the 2007/2008 financial crisis the ECB focused mainly on providing liquidity to financial institutions through historical low interest rates on monetary policy operations and only adopted a QE strategy after its counterparties the Fed, the BOE and the BOJ did.

Through its first Covered Bond Purchase Programs (CBPPs) the ECB bought assets since 2009 and since middle 2010 it was also able to buy sovereign government debt in secondary market through its newly launched Securities Markets Program (SMP) during a time of escalation of the debt yields of peripheral European countries. In 2012 the ECB substituted SMP for Outright Monetary Transactions (OMT) program allowing the ECB to buy unlimited amounts of sovereign debt of countries under economic assistance by the European Stabilization Mechanism, though, this mechanism was never used. When comparing the assets purchase size of the Fed, the BOE, the BOJ and the ECB, the latter is the one which accounts fewer assets purchased amounting to 3.5% share of the economy (Fawley & Neely, 2013, p. 77). Furthermore, most of the purchases were sterilized meaning that the ECB pursued reverse measures to nullify the purchases' expansionary effects on monetary base (Fawley & Neely, 2013, p. 81) and consequently the operations only affected interest rates and not monetary basis or monetary aggregates. As a result, these operations are not considered a pure Quantitative Easing program.

The QE program announced in 2015 by the ECB mainly differs from the previous operations because its purchases will not be sterilized. The European QE program is named Expanded Asset Purchase Program (EAPP) and the ECB pursued this measure in a time of very low inflation or even deflation. The ECB will invest through this program €60 billion in "...investment grade securities issued by euro area governments and European institutions..." (Delivorias, 2015) starting in March, 2015 until September, 2016 or until the objective of 2% inflation is met. The QE program has as main objective achieving price stability by providing liquidity and through the transmission mechanism boost economic growth. This is only possible because by buying securities such as government bonds or corporate equities the ECB is playing as a market maker and as a dealer of last resort pushing the bonds' yields down and making other securities more liquid and valuable. Due to this, it is likely that with

more liquidity available the economy will grow faster and it is also likely that with a higher amount of euros circulating in the economy the euro's exchange rate will suffer a down pressure as discussed further. Furthermore, it is important to underline the importance of the behavioral effects of the QE program. The sole ECB's compromise of pursuing a QE program is reinforced by its reputation and this may have *per se* positive impacts such as downward pressure on debt yields or more trust on the economy influencing banks to lend more freely.

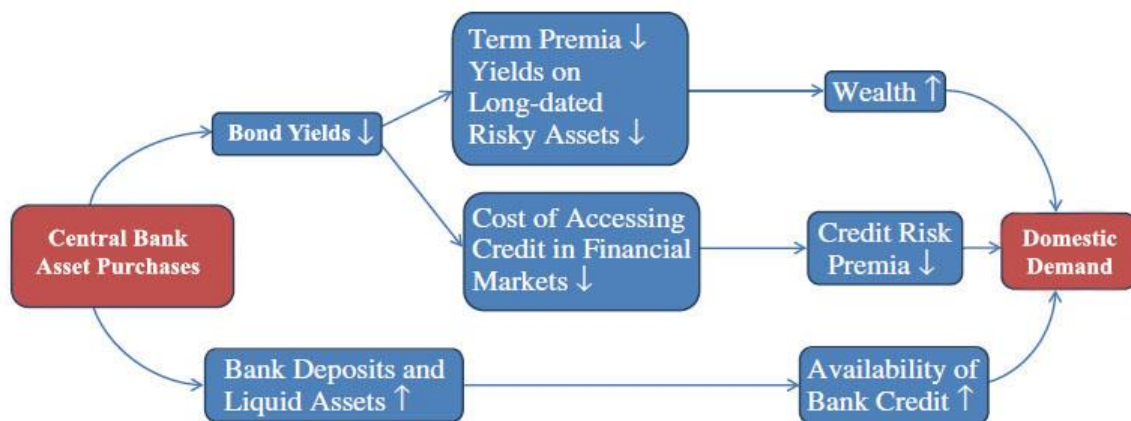


Diagram 1 – Channels for QE's transmission mechanism

According to (Joyce, Miles, Scott, & Vayanos, 2012) the QE has a specific transmission mechanism through which it ultimately influences domestic demand. The channels the QE uses to influence domestic demand are adapted and depicted on diagram 1 above. The model was developed based on the Bank of England's purchases of gilts (British government bonds) and the authors develop the model on the assumption that the assets central banks buy are not perfect substitutes of bank deposits since in a primary phase gilts were bought to non-banks. If both assets were perfect substitutes (in a situation with interest rates close to zero) the gilts' owners would just exchange them for deposits and would compromise the QE effectiveness. The authors go further by saying that the QE affects both banks' liquidity and asset prices (in this case bond yields). Both this axis will influence wealth/risk premium and bank credit respectively. Besides monetary base, the QE will influence domestic demand and consequently inflation, GDP and exchange rates.

Despite its virtues, the QE program has three main weak points. First, the program's late application may influence its success and pertinence because it will be applied after the general down pressure on government bonds and not before (Worstell, 2015). The yields of government debt were very high during the sovereign debt crisis but on the QE's date of application the yields have suffered a downward pressure (chart 5). Second, because as the

main source of financing in Europe is provided by banks the QE's success is mainly dependent on the "...willingness of banks to lend..." (Delivorias, 2015). As happened in the USA and particularly with the first QE its success depends always on the availability of banks to lend since if they are provided with liquidity but they decide to keep it and not reinvest it in the market by lending no economic growth will be verified. Third, the program has a presumed duration of 18 months but it is an open ended program (Delivorias, 2015). Therefore, the €60 billion amount may not be enough to cover the expenses with the program and in fact, this value still leaves the ECB amount of QE financing much below the financing provided by its counterparties, specifically, the Fed, the BOE or BOJ.



Chart 5 - Daily 10 years sovereign bond yields on secondary market comparison between seven Eurozone countries. (Greece on left-vertical axis). Source: Bloomberg ®

4. The Euro's Exchange Rate

An exchange rate is the position of a currency against the other and one of them will worth less than its counterparty. Exchange rates are determinant in several situations as explored further and because of their tremendous importance they can also be a source of conflict. In an event of a trade between two parties the seller would wish to have a weak currency and the buyer would wish to have a stronger currency. Notwithstanding, if the products of the seller become too much attractive for a long time it may cause internal disequilibrium to the buyer who would now wish to have a weaker currency and compete internationally with its counterparty. The so called “currency wars” or competitive devaluation can cause more harm than progress but they are one of the proofs of the importance of exchange rates and the evidence of the states’ effort to get the lowest exchange rate in order to become more competitive internationally and boost internal economy. This became a tough situation to deal with thanks to the exchange rates’ free floating system that is the base of the current international monetary system.

In fact, this competition for the less valuable currency is a major example of exchange rates international importance. We may recall the international tension between the US and China since the second influences exchange rate markets and imposes capital controls which impacts in a downward manner the quotation of Yuan against dollar and limits the effects of a counter intervention. As explored along this work, there are strong reasons to believe that the Quantitative Easing programs influence the depreciation of national currencies. Therefore, the US condemns China’s actions on exchange rate markets but China may reasonably state that the US dollar is also being consciously depreciated attributable to the American Quantitative Easing programs (Portes, 2012). Surely QE’s changes are gradual and influence in a more moderate way currencies’ quotations besides respecting international rules for exchange rate markets. Nevertheless, China has a point on this and after all proves the importance of exchange rates internationally.

4.1 International Monetary System

In the hierarchy of money not all types of payment have the same importance and currency is only one type of money in the hierarchy which may be used to clear a trade. The types of money are aligned in the hierarchy according to their abundance and liquidity being the most abundant types of money in the economy the less liquid and that bear with them higher risk. The most liquid money in the hierarchy and that can be used mostly likely in international trades at the highest level are reserves such as gold or Special Drawing Rights

(SDR) issued by the International Monetary Fund (IMF). These are followed by currency which is a very liquid type of money and probably the most liquid money in the current system but more volatile than the previous and rarest ones. Following reserves and currency in the hierarchy of money is some kind of debt such as bank deposits which are liquid since it is very likely that banks have sufficient liquidity to respond to deposits' withdrawals. Positioned in the last place of the hierarchy are the less liquid instruments: securities and other types of debt. These instruments are promises to pay in the future and hence are less liquid being it harder to exchange them for another type of money or to clear a transaction. It is also the task of central banks to pay close attention to hierarchy above and influence the quantity of each type of money in the market: *reserves* (make banks hold higher quantities of reserves that could also be deposits hold at the central bank); *currency* (central banks issue currency and can influence the quantity circulating in the market); *bank deposits* (monetary policy has a direct influence in bank deposits since if this policy makes it harder for banks to obtain financing their intra-trade interest will raise and will favor savings through a higher paid interest rate on deposits); *debt* (central banks can reduce the quantity of debt and securities circulating in the market absorbing them into their own balance sheet and accept them as collateral for lending). The hierarchy and the mechanisms central banks use to influence it are so important that international monetary systems are shaped by them. Therefore, exchange rates are tremendously influenced by international monetary systems.

Exchange rates can be set as either fixed or floating meaning that the currencies under the first system are usually backed up by other asset, mainly gold, which is higher in the hierarchy of money. Under this system currencies are pegged to other asset and among themselves. Consequently, exchange rates are mostly immutable and the relation among them is very stable. Nevertheless, this is a very rigid system that allows low flexibility and low expansion of currency in circulation used to boost economic growth. This system is known as gold standard and was used during the 19th century until the I World War with controversial appliance in the interwar period.

In the 1940s the postwar conference of Bretton Woods created a new and more elastic system that stands in between the gold standard and the flexible system of exchange rates currently operational. Bretton Woods was a much less ambitious proposal than the John M. Keynes' proposal of Bancor which would be some kind of world currency managed by a world central bank, that, would by its turn hold deposits from surplus countries and lend money to the deficit countries. Nevertheless, the Bretton Woods system was a more elastic system where the US dollar was pegged to gold and all other currencies were pegged to the

US dollar. The system would work perfectly if dollar was accepted as reserve and used as international currency but the promise of dollar convertibility into gold would put the system in danger, as happened during the 1960s, leading to the system breakdown in 1971.

Since then, the convertibility of the dollar into gold and the peg of national currencies to dollar have been lost and exchange rates are free to float creating this huge volatility among different currency pairs and made currency the ultimate money. Henceforth, exchange rates are set at international financial markets in which the prices of different currencies are settled according to the demand and supply for a given currency against another. So, it is clear that currency brokers and dealers have a paramount role in the current system. It is through them that buyers and sellers can meet and reach a deal being also through them that exchange rates are set. The tremendous growth of online currency brokers eased foreign exchange and in exchange for a spread these brokers offer a wide range of currencies to negotiate. Obviously, this can be used for different purposes ranging them from hedging to pure speculation. As explored further exchange rates can influence monetary policy and be a tool to boost or cool economic growth and that are the main reasons leading central banks to try to influence the free floating exchange rates by trading in the foreign exchange markets targeting the valuation or devaluation of the home currency against others.

Recalling the international finance theory of the impossible trinity (exchange rate stability, capital mobility and monetary independence), one may conclude from the above that *fixed exchange rates* regime allows both exchange rate stability and capital mobility but, on the other hand, *flexible exchange rate* regime favors capital mobility and monetary independence. Indeed, the only way of pursuing monetary independence and exchange rate stability is through capital controls which are not common nowadays (Reinert, 2012, p. 274). As stated before and explored further, the QE's programs may have an appreciation effect on national currencies. Thus, as these programs are characteristic of western developed countries one may conclude that the emergent economies face a strong valorization of their currencies. When emerging markets face the impossible trinity they also face a hard decision since they have to choose between: first, resist appreciation by losing monetary control, face inflation and possible asset price bubbles or through reversing free capital circulation which fed economic development; second, let the currency appreciate and lose competitiveness internationally (Portes, 2012). In the end, these economies might opt for letting currency appreciate since according to (Portes, 2012) it might be the less harmful option because it will favor higher real incomes and put a growing pressure on the economy that will by its turn be

more oriented to the domestic market and less to international markets in which it lost competitiveness.

4.2 Importance of exchange rates

In fact, exchange rates can be determinant in different situations. To make the study of exchange rates clearer one might distinguish three levels affected by currency's exchange rate: *state level* (sovereign debt, foreign exchange operations, inflation, economic growth and imports/exports), *corporate level* (mainly multinational companies affected by exchange rate exposure (Moffett, Stonehill, & Eiteman, 2009, pp. 252-330) and price competitiveness); *citizen level* (affected by exchange rate impact on imported goods and consumer prices). For the purpose of the current work we will drive our attention to the broadest level, namely, the state level. At this level exchange rates may strongly impact inflation. Exchange rates influence the prices of imported goods for when the national currency is overvalued the imported goods are cheaper and accordingly, it reduces inflation because the national economy will slow down since it is cheaper to buy abroad and because national products will be much less competitive either nationally or internationally which makes the demand for them shrink. As a consequence, we conclude that a high interest rate tends to lower inflation and vice versa since a low interest rate will make national products cheaper in international markets and as imports become more expensive they will shrink leading to national economic growth. When exploring the influence of exchange rate on goods and thus on prices, we also observe that an overvalued currency is good when imported goods serve as inputs for the economy. This will make the imported goods cheaper and will boost economic growth (E.C.B., 2011, pp. 61-62). A clear example are the countries which do not produce oil and have to import it to serve as a final good or to serve as input to the creation of other goods. As great part of oil transactions are carried out in US dollars this is particularly important for all the countries that do not share this currency. So, they would be better with an overvalued home currency making the price of oil cheaper and just then, through the transmission mechanism, give a boost to the economy through a cheaper input product. Here is also important to remember that for the Eurosystem members which have mostly other Eurosystem members as their trade counterparties, exchange rates have a reduced impact on goods' prices and a low exchange rate may strongly boost European economy if Eurosystem members sell also outside of it.

We explored above how the ECB may take advantage of a low exchange rate to boost European economy and also its impact on inflation, prices of imported goods and on

economic growth. Now we turn to the negative effect of a low exchange rate on foreign currency operations and on sovereign debt. If a central bank wishes to intervene in foreign exchange markets either to influence exchange rates or to acquire foreign currency reserves it would benefit from a stronger national currency. The same happens to sovereign debt to be paid in foreign currency because if the euro's exchange rate is weak against the foreign currency in which debt will be paid, the European state will need more euros to pay its debt.

As discussed above, exchange rates are too much important and have too much impact on the three levels mentioned to be left indifferent in the study of monetary policy. The importance of foreign exchange can also be verified in the huge amount of foreign exchange trading conducted every day and on the impressive growth of Over the Counter (OTC) foreign exchange derivatives (E.C.B., 2010, pp. 93-100). Therefore, during the following pages we will study the euro's exchange rate and specifically the impact that the ECB's monetary policy and actions have on it. We will understand which impacts specific monetary policy measures have on the euro's exchange rate and if other actions or events may also influence it. In this last case, for instance, we will understand if the reputation and credibility of the ECB alone can influence exchange rates. Specifically, we will understand if actions such as the "whatever it takes" policy have as a huge behavioral impact as they had, at least temporarily, on sovereign debt yields on the secondary market.

4.3 Current events and their impacts on the euro's exchange rate

The ECB and the euro are a very contemporary topic, since the current events put even a stronger pressure on the European bankers' bank to act. Europe is going through a period of low economic growth accompanied by very low inflation and even periods of deflation. The ECB tried to control this through its traditional methods but the fact is that the price stability and the market operations to provide liquidity seem to be insufficient. Bearing this scenario in mind, the announcement of the European QE program was somehow expected but it had either way a great impact and was commented around the world. It led some to question the long time it took to the ECB to take an action and also argue that this type of operation is outside the scope of the ECB leading some countries to be against it (Gilbert, *Draghi's Gonna Have a Bad Day at the Office*, 2015) and (Gilbert, *Two Cheers for Mario Draghi*, 2015). Besides, the fear of a default on the sovereign debt of several countries that will be bought by the ECB raised a deeper concern in other Eurosystem countries about the QE. Apart from the critiques, it is very likely that this program puts a lower pressure on the euro's exchange rate because it will increase the quantity of euros in circulation (De Grauwe, 2015). Furthermore,

the expectations of the market players towards the QE program are very important and as this program is also partly dependent on the willingness of banks to lend, the market players' faith on the QE program depends not on the ECB alone. During the same period Greece elected a government standing against the financial aid program applied to this country and also supported by the ECB. The concern about this situation is obvious and some argue that the Greek issue could have serious consequences (Whitehouse, 2015).



Chart 6 – Monthly average EUR/RUB rate from January, 2014 to June, 2015.

Source: Bloomberg ®

Given the system of free floating exchange rates and the clear influence some events have on the random walk of currencies, it is very likely that the expectations pressure these events create may influence either Europe as a whole or the euro's exchange rate in particular. Recalling events of this kind and the consequences they may have on exchange rates, one may think about the recent ruble's free fall (chart 6) as a consequence of different situations ranging from Europe's economic sanctions to Russia to the Russian intervention in Ukraine (Bershidsky, 2014). Recalling what was said above about the fixed and flexible exchange rates, it is interesting to dig on the Swiss franc peg to the euro which was broken on the last 15th of January, 2015 (chart 7). In 2011 the Swiss National Bank (SNB) announced that the franc would be pegged to the euro and that the central bank would do whatever was needed to maintain the minimum value of $\text{EUR/CHF} = 1, 20$ (BBC, 2011).

In fact, this peg was successful, and forced the EUR/CHF rate to work as a fixed exchange rate being the franc perceived as a safe and trustworthy currency with a stable

quotation. As a result, investors wanted to hold francs but this demand for currency made its value appreciate. In order to maintain the desired value for the franc, the SNB needed to print francs and act directly in the market buying euros in order to low the franc's value which made the SNB to increase significantly its reserves. At the same time, the Swiss economy grew also in result of a depreciated currency. However, in January, 2015 as a result of the huge effort made to maintain the peg, due to some opposition to this policy and thanks to the solid fear of an European QE program that would make the euro depreciate, the SNB decided to cancel the peg to the euro allowing the franc to float freely (W., 2015). The effects on the EUR/CHF rate are visible: from 2011 the exchange rate was stable and around EUR/CHF = 1, 20 and in January, 2015 it depreciated significantly, this meaning a very strong appreciation of the franc against the euro (Wong, 2015).

4.4 EUR/USD exchange rate



Chart 7 – Monthly average exchange rates of EUR against USD, CHF, JPY and GBP (from upper-left to bottom-right). Source: Bloomberg ®

We decided to analyze specifically the relation of the euro against the US dollar and understand how the ECB's policy influenced this free floating exchange rate. In fact, the

EUR/USD exchange rate is the most traded in the world and it makes sense since these two currencies represent the two most developed, most industrialized and interconnected economic areas in the world. Therefore, most of the commercial transactions are carried out in one of these currencies and when carrying out international transactions most of the companies need to convert their national currency into euros or dollars. Furthermore, if Europe and the United States have a close relationship it is likely that companies of one country need to convert their national currency into the other country's currency. Henceforth, an unstable EUR/USD exchange rate may cause strong difficulties and the lack of liquidity in one of these currencies affects the developments in the world economy as was the case after the subprime crisis when the European companies were not able to finance themselves in US dollar which obliged the ECB and the Fed to create a currency SWAP line. Nowadays, both the euro and the US dollar are reserve currencies internationally and companies, particularly financial institutions, depend on them to pursue their activities.

The EUR/USD exchange rate is also representative of other exchange rates because the movements made in the EUR/USD are mirrored in major currencies (chart 7). One may take as an example the peak the euro suffered in the beginning of 2008 and that happened not only against the US dollar but also against several other currencies (e.g. NZD, CAD, AUD, JPY, CHF and GBP). Furthermore, when the euro was officially adopted in 1999 it had a declining trajectory against the US dollar and also against several other currencies. Therefore, we believe that the EUR/USD exchange rate is able to mirror major movements of the euro against several currencies.

Therefore, we believe that limiting the analysis to the EUR/USD exchange rate will allow us to spot the effects of monetary policy in the exchange rate in a more clear and transparent way. If a basket of currencies against the euro, for instance, was to be adopted in this analysis, the final result would be less transparent since several currencies were being used and the behavior of each one against the euro would not be as well known. Furthermore, the EUR/USD exchange rate never had a peg, that meaning it has been floating freely. If an exchange rate has a peg it is maintained artificially at a given value as happened with the EUR/CHF exchange rate and this exchange rate does not explicitly show natural oscillations caused by the most diverse set of events.

4.5 EUR/USD Historical Perspective

The technical analysis concepts are very important and allow us to identify paths in the currencies' exchange rates such as low averages (values that usually a currency does not fall

beyond against another) or the contrary values; they allow us to spot correlations among exchange rate pairs or a rising or decreasing trajectory; they also warn us that there are periods which might be repeated in the future, for instance, repeating the same patterns of exchange rate. Still, the path of currencies' exchange rates is mainly a random walk and against several technical analysis predictions the value of a currency against another is mostly unpredictable. Recurring to fundamental analysis and behavioral finance concepts and apart from normal oscillations on exchange rates we notice that the path of currencies' exchange rate is affected by events which have an impact on the perception of investors about a given currency, for instance, the value or safeness of it. Accordingly, it is interesting and important to start this study with a historical perspective of the euro's path against the US dollar.



Chart 8 – Monthly average EUR/USD exchange rate from January, 1999 to September, 2015.

Source: Bloomberg ®

The euro was introduced officially in 1999 and in a historical perspective we conclude that it has been a strong currency being it well above the parity value for most part of its life (chart 8). After the euro's introduction in 1999, it suffered a sharp decrease in its value since 1 EUR worth 1,362 USD in January, 1999 and in the end of 2000 1 EUR only worth 0,9427 USD. Notwithstanding, after this period of three years and in the beginning of 2002 the euro increased its value significantly having a strong rising path. In the beginning of 2004 the EUR/USD was 1,2478 that is a much stronger value than the euro had two years before. After 2004 and until 2015 the EUR/USD exchange rate was never weaker than 1,20 except for a short period in 2005. The euro's exchange rate has had regular peaks, the strongest in 2008, not only against the dollar but also against several other currencies, probably because of

the huge financial crisis hitting the USA enhanced by the failure of the bank Lehman Brothers. This increased value of the euro might be the perception of investors that it could be a safer currency than the US dollar to hold investments. The perception that the US dollar may depreciate caused by an instable situation might lead investors to convert their assets into euros favoring a higher value for this currency. Yet, 2008 was not the only period characterized by a strong rise in the EUR/USD exchange rate followed by a sharp depreciation almost until the lowest value of the EUR/USD = 1.20. These peaks occurred almost in a perfect timespan of two years observable in the periods of 2004-2006; 2007-2009; 2009-2011; 2011-2013.

It is also interesting to notice that, despite the hard crisis in Europe, the euro has been a strong currency against the dollar and although it had periods of depreciation the recovery was fast. A strong euro may be good behaviorally because it shows the strength and robustness of the Euro area and the European Union. From the economic perspective, a strong euro favors imports and buying goods, which may be economic inputs such as oil. On the other hand, the strong European currency has injured exports outside the Eurozone because European products are more expensive in international markets favoring other markets' exports such as the USA.

After this long period (2003-2014) of a strong euro against the dollar, the European currency seems to start devaluating since 2014. Since 2006 the EUR/USD have not been lower than 1, 20 and this value was well surpassed in 2015. The sharp depreciation of the euro against the dollar has been clear since 2014 and this seems to be a consistent path. This depreciation starts when a low inflation rate is registered and when the ECB is urged to act in order to solve the inflation problem, tackle sovereign bond yields and promote economic growth in the Eurozone.

4.6 EUR/USD Exchange Rate in Specific Periods

As stated before there are events which influence and may even cause a change in the exchange rate. Monetary policy or specific announcements may have this effect on the euro's exchange rate. We are going to further analyze the impacts such events have on the EUR/USD exchange rate in specific periods. We will narrow the movements in the currency to shorter periods of time and understand the effect an event had on these movements. In order to do this it is pertinent to distinguish between *long term* effects (e.g. the announcement of a peg that will stabilize the exchange rate for an undetermined period as the EUR/CHF case shows) and *short term* effects (e.g. such as announcements which may influence investors'

perception of a currency but that would later prove not totally true or not as strong as previously perceived). The former are the ones lasting longer and result in a real change in the exchange rate, for instance, an announcement of a policy influences investors to act in a given way which will persist for a long period of time. The latter would be events called “dummies” that will influence exchange rates for a small period of time. Previous values will return not long after the event took place.

4.6.1 Foreign exchange operations in 2000 (2000-2001)

The first interesting period to analyze the impact of monetary policy measures is the period of the year 2000 and right after. In September and November of 2000 the ECB intervened directly on foreign exchange markets in order to influence the value of the euro, since the currency was depreciated against reference currencies, namely, the US dollar, the British pound, the Japanese yen, and the Canadian dollar (chart 9). In order to do that and cooperating with other central banks the ECB bought euros to artificially increase the value of the currency. The ECB did not create a peg and the intervention was mainly outside the objectives of the ECB's monetary policy since it does not have a target for exchange rates.

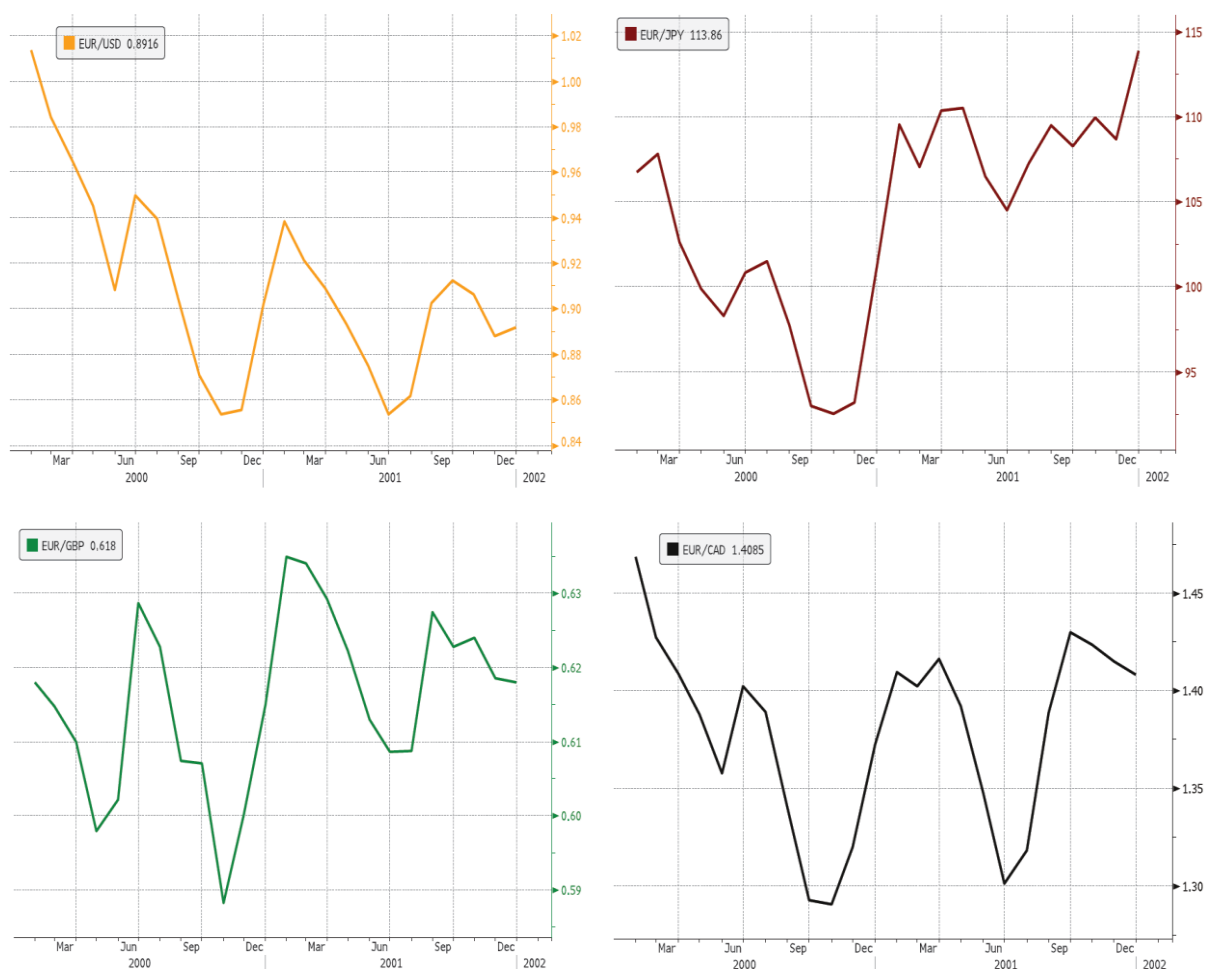


Chart 9 – Monthly average exchange rates of EUR against USD, JPY, GBP and CAD (from upper-left to bottom-right), in the period 2000 to 2002 Source: Bloomberg ®

ECB's operations had identical effects on all the currencies targeted and in fact these operations had some results affecting the euro's exchange rate. Since 1999 that the euro has been depreciating against the dollar and in October, 2000 it declined to a very low value: EUR/USD = 0, 8489. The ECB's operation in September resulted in a sharp rise in the exchange rate on the next month. The second operation in November, 2000 was even more successful and the euro's exchange rate against the dollar increased even more as the euro appreciated. In a very short period of time (from October, 2000 to December, 2000) the EUR/USD increased from around 0, 85 to slightly above 0, 94. This might be considered a good result. Nonetheless, in the beginning of 2001 the euro suffered a free fall keeping the previous trajectory. This lower trend was only reversed in the year 2002 when the euro adopted a rising trajectory until very recently. Therefore, we consider that this operation was not successful because it only caused a short term effect on the euro's exchange rate.

This analysis proves that either the central bank has a strong strategy to peg the currency to another and is able to pay for these operations or the strategy is likely to fail. In this specific case, the ECB influenced the market by increasing the value of the euro. Though, after its intervention all the work was reversed to previous values stated by the market alone. Only after a considerable period did the values really increase and not in result of the ECB's intervention in the foreign exchange market.

4.6.2 Euro's appreciation period (2002-2007)

The EUR/USD trajectory is one of consistent appreciation from 2002 until 2008 (chart 9). The euro appreciated from 0, 8594 in the beginning of 2002 to 1, 4861 in the beginning of 2008. This period was also a very consistent period in the Eurozone as it registered some economic growth verified through a consistent growth of real GDP and also through a very stable inflation.

Since 2000 that the ECB has been able to maintain the inflation rate close to 2% but its purpose was not completely achieved once inflation was for many times above the 2%. Nevertheless, its value, although slightly above, was close to the proposed value and supported by a rising trajectory of real GDP growth since 2003. The Eurozone was almost stagnated in the end of 2003 and then the GDP started growing adopting the already mentioned consistent trajectory of growth until 2008 (chart 10).

Having done this analysis it is not surprising that the EUR/USD exchange rate had accompanied the growth of real GDP that was supported by a stable inflation even if above the value it should be. An appreciated EUR/USD exchange rate would mean a deceleration in

real GDP growth and would put a lower pressure on inflation as it is verified in the period of 2007. In this period inflation in the Eurozone was close but below 2% and the real GDP growth reduced simultaneously with a strong appreciation of the EUR/USD exchange rate. As the ECB does not have a policy for exchange rates, it could not guarantee a lower EUR/USD exchange rate in order to promote exports and improve demand for European products in international markets. On the other hand, this “economic cool down” could be needed as the Eurozone was growing in the beginning of 2007 around 4% in terms of real GDP growth.

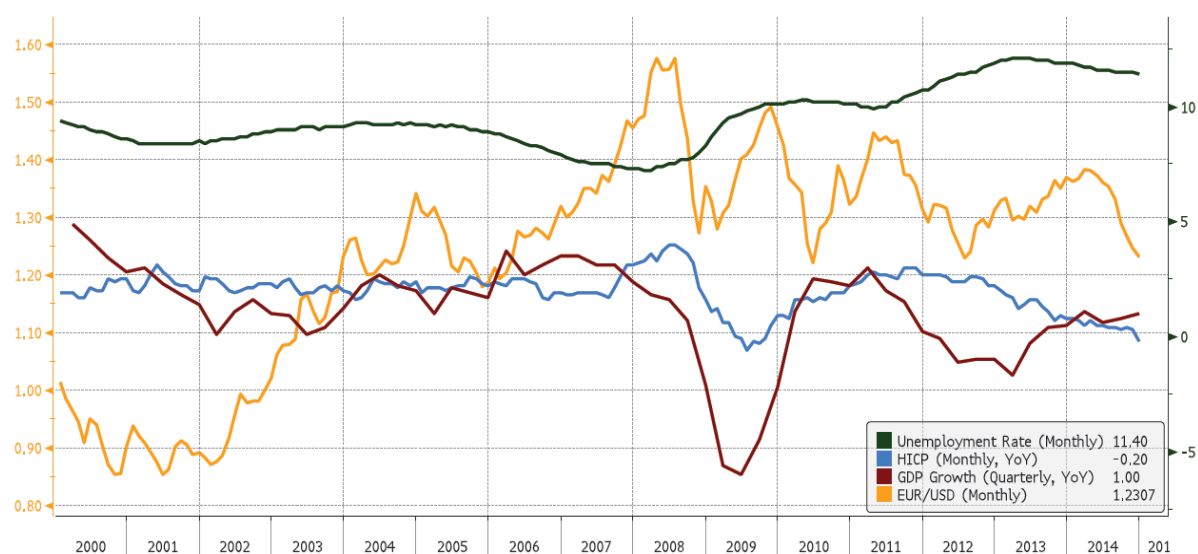


Chart 10 – Comparison of EUR/USD exchange rate (monthly, left-vertical axis), real GDP growth in the Eurozone (quarterly) and Eurozone inflation (monthly) in the period 1999 to 2015. Source: Bloomberg ®

Despite this normal and prosperous period, some awareness started to appear in August 2007 concerning financial markets instability and quickly the ECB governing council approved extraordinary LTROs (August and September) in order to mild this situation. However, this approach was unsuccessful and the financial crisis would hit Europe as it did in the United States.

4.6.3 Financial crisis period (2008-2013)

In fact, the most interesting periods to focus on when studying the ECB's monetary policy and its impact on the euro's exchange rate are the periods named “financial crisis period (2008-2013)” and the “current period and European QE (2014-2015)”. These periods are characterized by very new measures that the ECB was obliged to take in order to control inflation/deflation and try to support economic growth (GDP growth) through adequate monetary policies. Here is possible to clearly identify impacts on the exchange rate, which

was quite volatile and without a clear tendency during these periods. Furthermore, it is also possible to understand that not only the monetary policy *per se* but also behavioral impacts influenced the euro's exchange rate, in other words, the behavioral impact of the ECB taking several measures to address financial markets' instability may be behaviorally as powerful as the monetary policy measures themselves.

In reality, the first signs of awareness concerning the upcoming financial crisis appeared earlier in 2008, when in February, the ECB announced supplementary LTROs and, in March, the signs of difficulties in the Eurodollar market appeared, leading the ECB to announce liquidity providing operations in US dollars for European institutions (annex 1). From the end of 2007 until middle of 2008 the Eurozone suffered a period of stagflation in which the inflation continued rising and the GDP started decreasing. In fact, in the beginning of 2008 the GDP decreased severely and in the beginning of 2009 the Eurozone's GDP was decreasing almost 6% and it kept in a negative zone until the beginning of 2010 (chart 10).

Due to this instable, and crisis environment the ECB was urged to act in order to target inflation, since in the end of 2007 it was uncontrolled, and also to minimize the crisis effects. In 2008 the ECB adopted a strategy of supplementary monetary policy operations such as LTROs. The basis of these operations is to provide liquidity to financial institutions through loans and against good collateral. Thereafter, the interest charged was progressively less, the counterparty numbers were widened and the collateral accepted was eased (annex 1). This was the main strategy of the ECB during the crisis period and until the present day.

In 2008 it was already clear that the financial crisis had reached Europe since there was market instability and the ECB was constantly applying new measures trying to fight it (annex 1). Until the end of 2008 the Eurozone had a steady and controlled increase of monetary base but this situation was altered with the application of measures with an expansionary character such as extraordinary refinancing operations or the CBPPs applied along the crisis period. Nevertheless, these operations were sterilized but their effects have been felt for some time. What is verifiable is that the expansion of monetary base has a clear and controlled path and when some operations affect the quantity of money in the Eurozone their effects are later offset and the monetary base shrinks and goes back to the previous path. This expansion has also its effects on the euro's exchange rate against the US dollar (chart 11; annex 9, 10 11).

There is a connection between the temporary expansion of the monetary base in the Eurozone and the depreciation of the euro against the dollar and also the inverse relation. In other words, when the monetary base is expanded in the Eurozone even temporarily, the euro's exchange rate depreciates and when the monetary base goes back to its regular path the

euro's exchange rate appreciates (chart 11). Specifying: in the end of 2008, the beginning of 2009, the beginning and mid-2010, from mid-2011 until mid-2012 and the end of 2014, in which there was an expansion of monetary base, the exchange rate of the euro depreciated and when the expansionary effect of the monetary base was reverted the euro appreciated again.

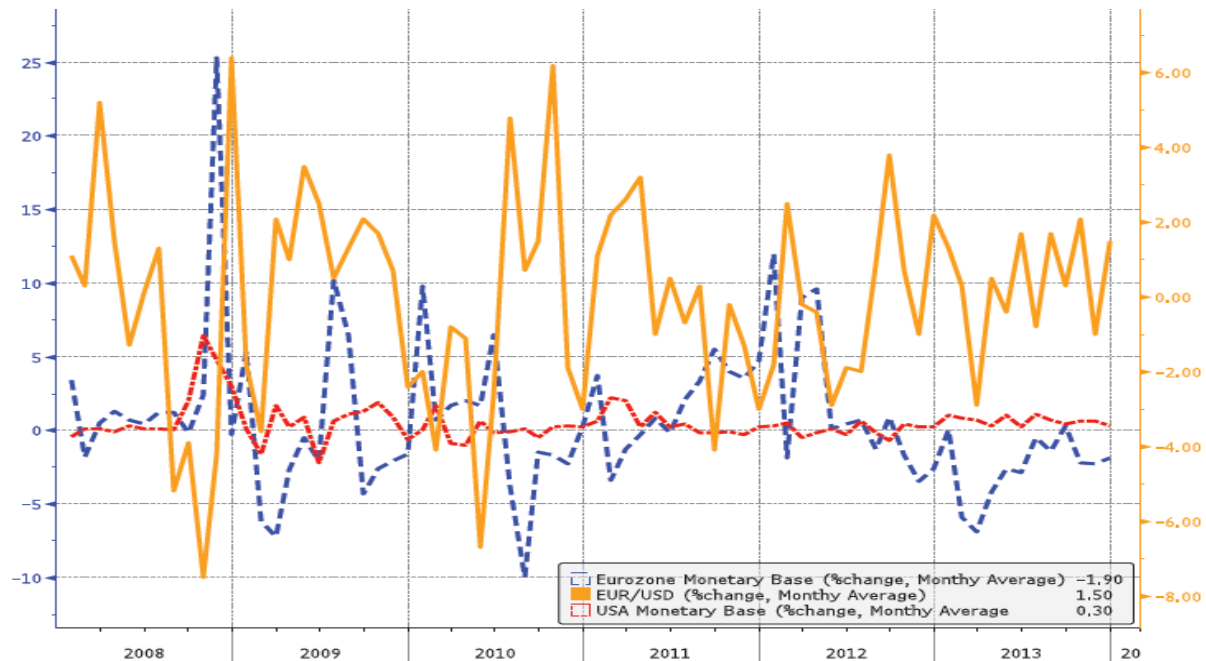


Chart 11 – Percentage changes from previous year of Eurozone and USA monetary bases (same left-vertical) and EUR/USD exchange rate (right-vertical axis) from January, 2008 until end-2013. Source: Bloomberg ®

As already mentioned, during the crisis period the expansion of the monetary base in the Eurozone was the result of several extraordinary operations taken by the ECB albeit it had adopted a more conservative monetary policy when compared with the QE programs adopted in the USA. The ECB started new programs aimed at the securities markets, which temporarily influenced the monetary base. As the market for securities lacked liquidity and was unstable during the crisis period, the ECB decided to tackle this issue by buying securities and creating ceilings and floors for their prices, in other words, being a dealer of last resort. These operations started in May, 2009 when the first Covered Bonds Purchase Program (CBPP) was announced. This program intended to intervene in the covered bonds' market and provide refinancing to financial institutions. The first CBPP was followed by two similar programs: the CBPP2 launched in October, 2011 and the CBPP3 announced in September, 2014. The last CBPP was complemented by an Asset-backed Securities Purchase Program (ABSPP) under which securities would be bought on primary and secondary markets (annex 1).

Exactly one year after the announcement of the first CBPP, the ECB launched the Securities Markets Program (SMP) that was a complement to the already existing CBPP because it allowed the intervention in the private securities market but also in the public debt market (annex 1). The purchases amounted to around €210 billion and were only done in the secondary market and the assets were to be held until maturity. The SMP was launched in May, 2010 and it is interesting to notice that this period coincided with the huge turmoil in the sovereign debt markets. The last purchase under the SMP was done in February, 2012 and this program was replaced by the Outright Monetary Transactions (OMT) program announced in September, 2012 (annex 1). The OMT allowed the ECB to buy unlimited amounts of sovereign debt of countries under an adjustment program (previously European Financial Stability Facility [EFSF] and current European Stability Mechanism [ESM] programs in close cooperation with the International Monetary Fund [IMF]).

Nevertheless, these operations were to be sterilized meaning that their expansionary effects on monetary aggregates would be cancelled by contrary operations. In other words, the money placed in the money market when the ECB buys bonds or securities is to be removed. Bearing this in mind, we conclude that the expansionary effects are lighter than the ones subsequent to a QE program and that the main objective of these programs was the securities prices and yields without a huge impact on the monetary base. Nevertheless, we conclude that there was an impact on the monetary base albeit temporarily.

Along the crisis period the ECB also extended and increased the frequency and the allotment of refinancing operations mainly LTROs. Another measure that the ECB started adopting in January, 2009 was the decrease of the key interest rates charged or offered. In January, 2009 the ECB decreased the interest charged for refinancing operations to 2%, the marginal lending facility interest to 3% and also decreased the interest offered on deposit facility to 1% (annex 1). Reducing the interest rates charged allows the counterparties to have cheaper financing and makes them recur more frequently to the ECB as a lender of last resort, which will become not a bad counterparty anymore. A very low interest offered on deposits conveys the idea that the ECB does not want to hold deposits of private institutions but would rather prefer that these institutions to invest their money and circulate it among them. A very low interest makes less attractive to hold a huge deposit in a safe at the ECB and leads private institutions to invest in the private market. Although it started in 2009, it was under the Draghi's administration that the sharp decreases in the key interest rates charged/offered by the ECB occurred. Draghi assumed that the ECB would do "whatever it takes" to save the euro and get the inflation back to normal because for him "the euro is irreversible". In

September, 2014 the ECB announced that it would decrease even more the key interest rates. In June, 2014 the interest rate offered on deposits became negative for the first time and in September, 2014 the key interest rates were again decreased to historical values: 0.05% on MROs, 0.30% on marginal lending facility, -0.20% on deposits (annex 1). Summing up, this strategy has two main objectives: first, to provide liquidity to financial institutions through cheap refinancing, that is granted against a wide range of collateral; second, to impel financial institutions not to hold big deposits at the ECB but rather invest and lend among them.

On the other side of the Atlantic several QE programs were to be adopted by the Fed during the crisis. Particularly, along this period there are three points in which it is possible to clearly verify that the increase of the monetary base affects the exchange rate in a downward manner: the three QE programs in the USA that were never sterilized contrarily to the operations in the Eurozone. The QE1 (November, 2008) followed the failure of Lehman Brothers and was announced in the peak of the financial crisis. It also influenced the exchange rate of the EUR/USD: with the announcement of the program a severe increase in the value of the euro was also verified exactly during the months of November, 2008 and December, 2008. This was a very light effect, which was consolidated in February, 2009 when the euro began an upward trajectory (chart 11). The Fed's president speech in August, 2010 suggesting a QE2 also caused a sudden appreciation of the euro against the USD. At that time, the announcement of the QE2 (November, 2010) caused a steady euro's appreciation effect. The announcement of "Operation Twist" also created a very brief appreciation of the EUR/USD in September, 2011, only justified by a behavioral effect since this operation targeted securities and did not affected the monetary base (chart 11; annex 9). Henceforward, a third sudden peak happened with the Federal Open Market Committee's (FOMC) speech (August, 2012) in which a QE3 is suggested. In September, 2012 with the actual announcement of QE3 the euro started again a rising trajectory against the US dollar. The inverse (the depreciation of the euro) also coincides with the conclusion of the American QE programs: QE1 is downsized in November, 2009 and actually ends in August, 2010. In the same month the new QE is suggested; QE2 finishes in June, 2011 followed by a depreciation of the euro; QE3 ends in October, 2014 and leads to a sharp depreciation of the euro (chart 11 and 12; annex 9 and 10).

Summing up, the volatile period (2007-2013) of the EUR/USD exchange rate is characterized by three sudden peaks (2008, 2010, and 2012). These specific upward turning points coincide with the suggestion or actual announcement of QE1, QE2 or QE3 by the Fed. The inverse scenario happens with the conclusion of the mentioned programs. What this fact suggests is that the huge increase of the monetary base in the USA attributable to the QE

programs and an easier access to the US dollar influenced the appreciation. A clear appreciation or depreciation of the euro against the dollar is verified when the monetary base trajectory is the inverse between the USA and the Eurozone, that is to say, when it is expanded in one bloc and diminished in the other.

It would be interesting to notice that the described impact of the American QEs in the EUR/USD exchange rate is in line with findings of (Neely, 2010) and (Glick & Leduc, 2013). In fact, (Neely, 2010) studied the impacts of the Fed's announcements of the LSAPs during the year of 2009 and the author concluded that the announcements and the QE program had a depreciation impact on the EUR/USD exchange rate. On the same line as the previous author are (Glick & Leduc, 2013), who used intraday data of the EUR/USD exchange rate and created a variable which measured the surprise effect of the Fed's announcements (variable calculated based on the futures' market movements). The authors also found that the Fed's LSAPs announcements resulted in a depreciation of the dollar when the surprise about the Fed's announcements was high. In short, both authors believe that the announcements of such QE programs are enough to cause currency depreciation. Furthermore, we believe that this surprise effect (short term effect) might be consolidated (long term effect) by the expansion of the monetary base. The authors (Glick & Leduc, 2013) believe that the correlation between the surprise effect and currency depreciation is very high and this is in line with the described above. Thus, as markets are made by people and tend to react in the same way to the same stimulus, it is very likely that the theory also applies to the Eurozone reality.

Hence, it is interesting to analyze the fact that not only pure economic or monetary policy events influenced the quotation of the EUR/USD. Similarly to the euro's depreciation starting in July, 2008 when the ECB increased the monetary base and started the supplementary liquidity providing operations, acknowledging the turmoil in financial markets and the economic crisis, also in November, 2009 the depreciation of the euro coincided with two important events: the downsize of Large-scale Asset Purchases (LSAPs) within the Fed's QE1 and also with the start of the turmoil in the Eurozone sovereign debt markets, fact verified by the analysis of the 10 years sovereign bond yields (chart 12). On the one hand, the connection between the EUR/USD rate and the downsizing of LSAPs is straightforward and has been already explored. Nevertheless, sovereign bond yields do not have a direct financial or economic connection with exchange rates, their connection being more behavioral, since higher yields mean a premium caused by less confidence in the ability of a country to repay its debt, which then has a direct connection to the faith in a stable and healthy economic and financial environment. As a consequence, it is expected that markets' faith in low economic

prospects also mean a depreciation of the currency of that country, in this case, the euro. This event is verified again in June, 2010 when a strong agitation in the sovereign debt markets is clear. The sovereign bond yields sharpen their disequilibrium and what was before correlated becomes now what it seems to be the beginning of the sovereign debt crisis. The important fact to retain is that when the uncertainty is strong about the economic and financial prospects of the Eurozone, the EUR/USD exchange rate tends to depreciate, since the investors perceive holding euros as a riskier investment. This fact is proved by the current events in Greece and the consequent depreciation of the euro, as explored further.

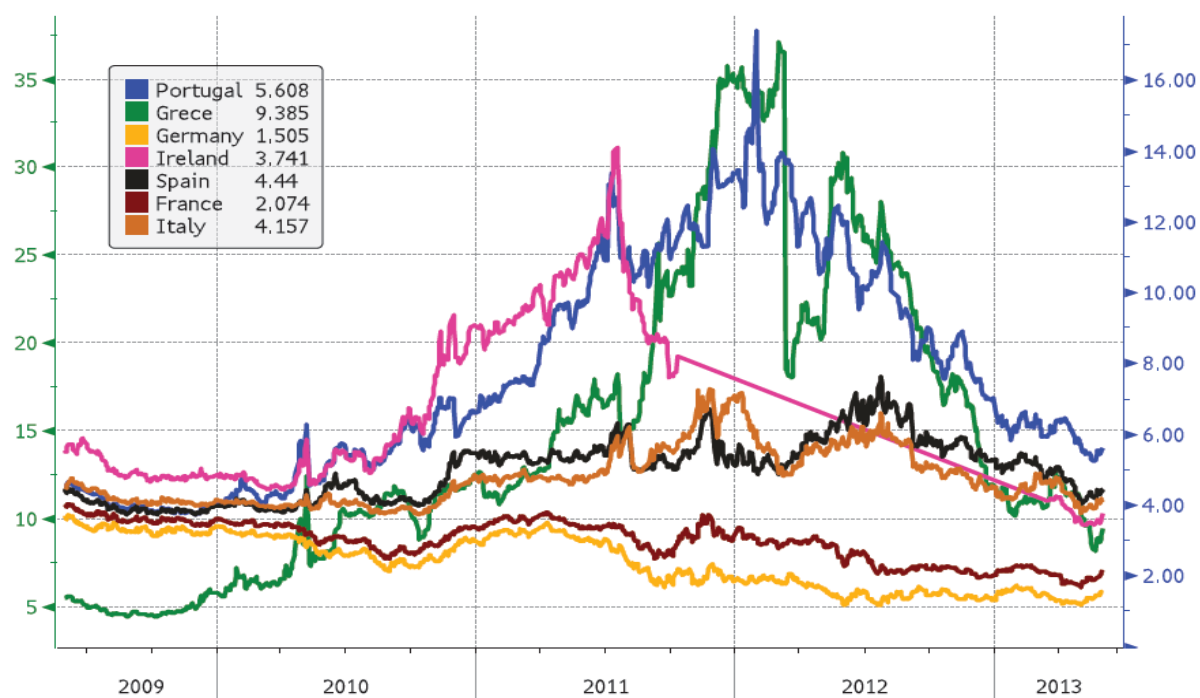


Chart 12 – Daily 10 years sovereign bond yields on secondary market comparison between seven Eurozone countries. (Greece on left-vertical axis). Source: Bloomberg ®

If the foreign exchange markets reacted to the first strong signs of financial and economic instability in the Eurozone, they did not react as clearly when the adjustment programs (Greece, Ireland and Portugal) were announced. In fact, all the announcements were followed by an increase in the EUR/USD exchange rate as if the investors perceived them as a sign of stability and action. When Greece's program was announced in May, 2010 a small depreciation of the euro was verified according to the already existing tendency but soon the euro appreciated against the US dollar (chart 8). In November, 2010 when Ireland announced the conclusion of the negotiation for the adjustment program, the euro suffered a sharp appreciation against the dollar (chart 8). In the Portuguese case when the program was

announced in May, 2011 the euro appreciated smoothly and thereafter suffered the sharp depreciation of August, 2011. The Portuguese adjustment program announcement coincided with the peak of the sovereign debt crisis which broke the steady increase of the GDP and inflation that was verified in the Eurozone during 2010. In the first quarter of 2011 the GDP started a sharp decrease and inflation kept on rising for a small period and after adopted a decreasing trajectory that has remained until today (chart 10). A similar event takes place with the second Greece's adjustment program announced in March, 2012 during a time of low and decreasing inflation and negative GDP growth (chart 10). The EUR/USD exchange rate was in an increasing trajectory but with the uncertainty of a new program and as a result of the hard financial and economic situation it adopted a downwards trajectory. Therefore, it seems that foreign exchange markets tend to react negatively to financial and economic uncertainty but somehow positively to clear measures such as the adjustment programs since they seem to be perceived as a solution to the problem.

Concluding this section about the crisis period in the Eurozone, it is important to highlight that this was a period of turmoil in several aspects with several events happening at the same time. As described, the sovereign debt crisis, the QE programs in the USA and the several extraordinary measures and programs in the Eurozone happened simultaneously. As a result, it is very hard to conclude whichever event had the predominant impact on the random walk of the euro. As the international monetary system is a free floating system it is not straightforward anymore that a given event has a given consequence on the exchange rates. From our analysis what is clear is that each described event had its impact on the EUR/USD exchange rate ranging from behavioral impacts to financial and economic impacts seeming the latter to be predominant.

4.6.4 Current period and the European QE (2014-2015)

The period ranging from 2014 to 2015 is clearly characterized by a continuous and sharp depreciation of the euro against the US dollar. In only one year (31st of December, 2013 until 7th of July, 2015) the euro depreciated by 19.65% against the dollar, a tendency that is maintained at the present. 2014 was a year characterized by low economic results with the GDP growing at about 1% and with very low inflation becoming it negative in the end of the year (chart 10). Besides, there was also uncertainty related with the end of the Irish (December, 2013) and Portuguese (May, 2014) adjustment programs but with decreasing sovereign bond yields and, simultaneously, Greek sovereign bond yields rose significantly during 2014 predicting the negative and uncertain events of 2015 (chart 5).

During the year of 2014 the ECB did not present different measures to fight these not new but for sure persistent and serious issues. The ECB insisted on the already known sterilized operations. The proof is the announcement of the CBPP3 and the new ABSPP in September, 2014 which both forced an increase in the total assets on the ECB's balance sheet. Besides, the policy focused strongly on lowering the interest rates charged/offered by the ECB and in September, 2014 the following values were applied: 0.05% on MROs, 0.30% on marginal lending facility, -0.20% on deposits (annex 1). Almost 7 years passed since the beginning of the crisis, the financial pressures in the markets still exist and financial institutions still face issues with finding liquidity in the market. Consequently, the ECB decided to, in fact, offer money in a form of a loan to financial institutions which now are more, due to the ease of criteria for eligibility as counterparty and accepting lower quality collateral. Moreover, the deposits' rate is already very negative, that influences financial institutions to not to hold deposits at the ECB above the mandatory minimum reserve. Furthermore, after the decision to stop these operations in January, 2014, the ECB in coordination with the Fed decided to maintain the liquidity providing operations in the US dollar for Eurozone institutions in June, 2014 (annex 1).

Nevertheless, the GDP was growing very slowly and the alarming situation of inflation kept its downward path while the unemployment rate was decreasing slowly by about 11,5% in the middle of 2014 (chart 10). Therefore, the ECB was urged again to act quickly, since the measures applied were not having the desired outcome. Hence, the big news appeared early in January, 2015 when the ECB announced the European QE program for long expected and desired (annex 1). This program aims at spending at least €60 billion in assets purchases including sovereign debt in the secondary market. The QE program started in March, 2015 and quickly impacted several factors. First, it had the behavioral importance of letting investors and Eurozone citizens know that the ECB is able to use a very new and quite uncertain measure in order to keep up with its objectives, provide a stable economic and financial environment through a sustainable growth with inflation at about 2%. For investors this is important because their confidence in the euro may increase as well as their perception of the ECB's capacity to intervene, and about better prospects for economic growth as well as financial stability. For citizens this attitude may influence them because they may feel more stability and this could lead them to purchase and consume more during times of slow but steady unemployment rate decrease. Second, the QE influenced directly the total assets under the ECB's balance sheet (chart4). The ECB's total assets suffered a very sharp increase since March, 2015 by reason of the purchases under the QE. Therefore, recurring to a simple

accounting rule which is valid and likely permanent because the QE is not sterilized, (if the assets increase the same has to happen to liabilities), we know that the liabilities of the ECB had also to increase and as the main central banks' liability is currency it is straightforward that the monetary base had necessarily an increase. Third, the QE program clearly influenced the euro's exchange rate. With a strong increase in the ECB's assets and also with an increase in monetary base the euro depreciated strongly against the dollar following the trajectory it has been following since 2014 (chart 13; annex 10).

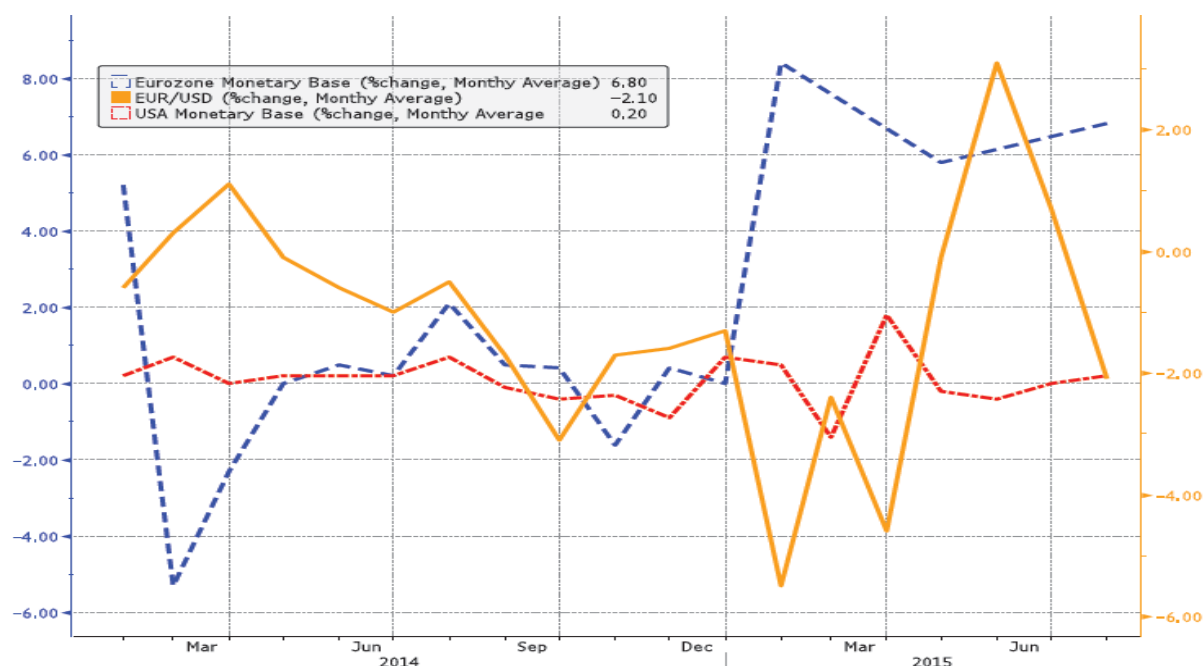


Chart 13 – Percentage changes from previous year of Eurozone and USA monetary bases (same left-vertical) and EUR/USD (right-vertical axis) exchange rate from January, 2014 until August, 2015. Source: Bloomberg ®

Though we cannot make infallible predictions in a free floating system, it is very likely that a big increase in the monetary base will influence the exchange rates in a downward way. Here as before we suggest that besides the instability environment verified in 2014 and the ECB's persistence in recurring to already attempted measures also the conclusion of the QE3 in the USA influenced the depreciation of the euro. The end of purchases under the QE3 announced in the end of October, 2014 coincides with a sharp depreciation of the euro since November, 2014. This depreciation was further consolidated in February, 2015 after the European QE announcement in the previous month. Similarly to what happened during the financial crisis period also during 2014 and 2015 the euro's exchange rate also depreciated as a result of increases in the monetary base and this relation was even stronger when the monetary base evolves in opposite ways in the Eurozone and the USA. Afterwards, in March,

2015 the ECB's assets suffered a huge increase thanks to the beginning of the QE and a depreciation of the euro against the dollar was subsequently verified but the contrary happened in the next month (end of month February, 2015 EUR/USD = 1, 1196; end of month March, 2015 EUR/USD = 1, 0731; end of month April, 2015 EUR/USD = 1, 1224). However, in May, 2015 the EUR/USD exchange rate depreciated again and since then it has stabilized and kept floating around similar values. The average of the EUR/USD exchange rate since March, 2015 and until June, 2015 has been 1, 126 euros.

During the months of May, June and July of 2015 it is clear that the euro stabilized in values between EUR/USD = 1, 10 and 1, 15. Both the huge monetary base increase in the Eurozone and the contrary scenario in the USA as a consequence of the end of the QE3 both contributed to this severe depreciation of the euro (chart 13; annex 10). Nevertheless, the euro is under pressure as a result of the events occurring in the Eurozone related to the Greek crisis. The Greek election, resulting in the victory of an extremist left wing party in January, 2015 made Greece declare itself against several measures essential to obtain more financing from the European Stability Mechanism. The cause was huge uncertainty about the future of Greece's economy and public finances and also huge turmoil in the financial sector. The confidence and trust on the euro is also evaluated according to the developments in Greece. At a time of severe currency depreciation caused by the expansion of the monetary base and due to economic and financial instability, these developments may be crucial to decide whichever direction the euro will follow.

5. Statistical Analysis

It was previously argued that there are several behavioral and economic aspects influencing exchange rates. Particularly, it was said that the euro's exchange rate was influenced, on the one hand, by official announcements, economic/financial instability and sovereign debt crisis and, on the other hand, by the direct ECB's intervention on the exchange rate markets and the expansionary monetary policy. The more interesting period to study on about the ECB's monetary policy impact on the euro's exchange rate is the period characterized by the non-conventional monetary policy, that is to say, the liquidity providing programs. In fact, we argued that the most lasting and visible effect of monetary policy on the euro's exchange rate is the monetary base expansion. In order to prove that beyond the graphical analysis, we developed several correlations (r) between monetary bases values and the EUR/USD exchange rate. Furthermore, we have run several linear regressions (Y) in order to obtain a regression function that proves the previously developed correlations and also can give an indication for future values of the dependent variable (the EUR/USD exchange rate). In order to develop these calculations we decided to use weekly average values for the three variables: Eurozone values published on Thursdays; US values published on Wednesdays; EUR/USD values as Fridays average. These values were collected from January, 1999 (introduction of the euro currency) until September, 2015 (current period) and from official databases.

Given the several aspects which can influence exchange rates we decided to run the correlations and regressions based on specific periods. One may take as an example a correlation run in a very long period, for instance, 2008-2015. During this period there were three QE programs in the USA and several refinancing operations in the Eurozone with less lasting effects but anyway with expansionary effects. Besides, several behavioral effects may have occurred, for instance, sovereign bond crisis or official announcements. This correlation will not be completely able to capture the real effects of the monetary base expansion on the euro's exchange rate attributable to the high level of noise affecting the calculations and the occurrence of simultaneous and possibly contrary monetary policies.

Next we analyze the different periods and present the correlation and regression values connecting the calculations with real monetary policy events and their impact on the EUR/USD exchange rate. It is always important to notice that apart from the normal period of 2000-2007 all the others are analyzed under the assumption of very low or even negative reference interest rates. Concerning specifically the ECB and the Eurozone, the reference

interest rates have been decreasing since 2009 being all well under 1% in November, 2013, and being for the first time negative in June, 2014 (0.15% on MROs, 0.40% on marginal lending facility, -0.10% on deposits) (annex 1).

5.1 Conventional Monetary Policy Period (2000-2007)

During the period ranging from 2000 until 2007 the monetary policy of the ECB followed the rules of a conventional monetary policy in a normal economic period. The monetary policy was pursued recurring mainly to reference interest rates changes and less to increase in the monetary base which is graphically verified by several but short term increases resulting in normal refinancing operations. During this period the Eurozone monetary base increased regularly as happened with the monetary base in the United States, where too much percentage change is not verified. Nonetheless, from 2000 until 2007 exchange rate seems to be more connected to changes in the US monetary base ($r_{(USA\ MB; EUR/USD)2000-07} = 0,17$) than to similar changes in the Eurozone, where there is no correlation (figure 1).

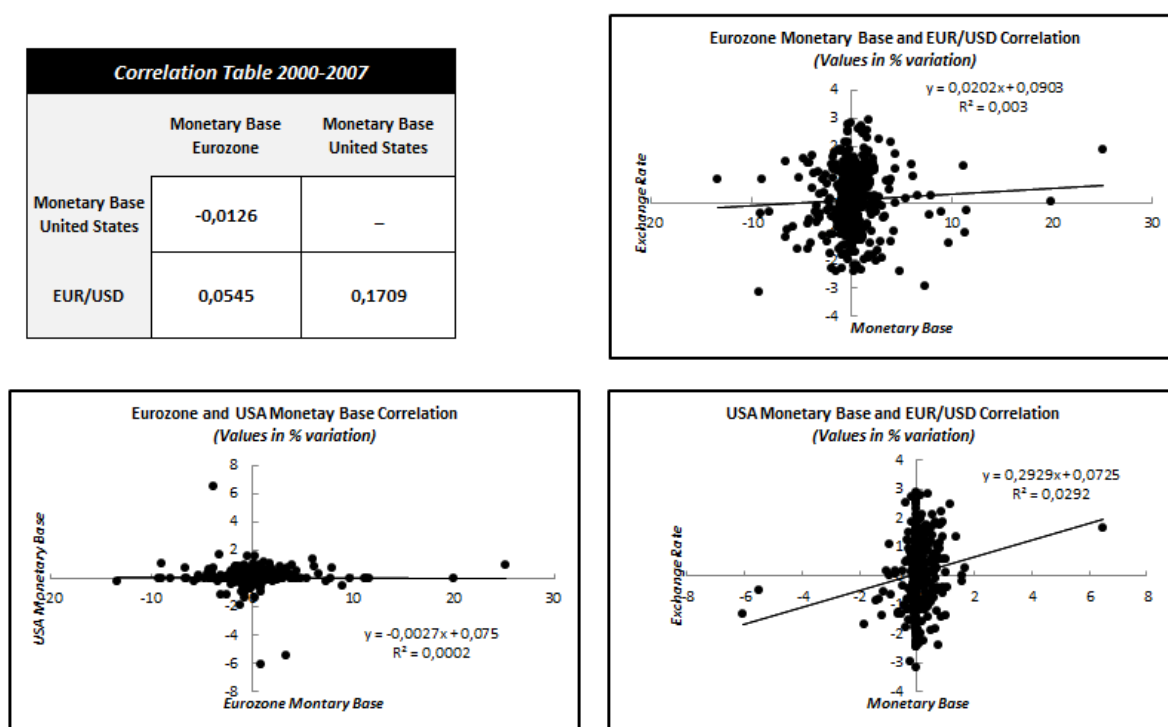


Figure 1 – Correlation table and graphs (2000-2007)

5.2 Financial crisis period (2008-2014)

The so called normal period is interrupted with the awake of the financial crisis in 2008, which started in the USA and soon spread to Europe. 2008 was a turbulent year with the EUR/USD exchange rate depreciating in a free fall and with the first signs of different

monetary policies on both sides of the Atlantic to tackle several financial and economic imbalances. In fact, the different monetary policies taken by the ECB and the Fed start in 2008 and are clear in 2009. In fact, the Fed started increasing the monetary base earlier than the ECB, besides the fact that during the period of 2008-2013 there is almost no negative percentage change in the monetary base in the USA, which means that its value kept increasing. On the other hand, the Eurozone registers higher percentage changes in the monetary base during the same period but as a result of sterilization effects it also registers several negative percentage changes, meaning a decrease in the monetary base. As a result, taking the complete crisis period as a sample does not allow a clear correlation between the monetary bases increase and the exchange rate thanks to annulation effects of both monetary policies and several innumerable events that also affected exchange rates (annex 3).

In 2009 the first American QE was operating and as a consequence the monetary base increased in a non-sterilized way, a tendency maintained during the year and confirmed by the percentage changes. The first QE program contrasts with the conservative stance of the ECB that started sterilized supplementary liquidity measures in 2008 but only took more serious stances in 2009 with the decrease in reference interest rates and new sterilized supplementary liquidity operations. Nevertheless, the European measures also had an impact on the monetary base increase and several variations were verified in 2009. As these operations were sterilized, their effects had a short life and positive changes in the monetary base were shortly corrected by negative changes. As expected, we obtain two clear correlations between the monetary bases and the exchange rate for the year of 2009. The euro appreciated when the Fed increased the monetary base ($r_{(USA\ MB; EUR/USD)2009} = 0.17$) and depreciated when the ECB increased monetary base ($r_{(Eurozone; EUR/USD)2009} = -0.10$) (chart 14; annex 4).

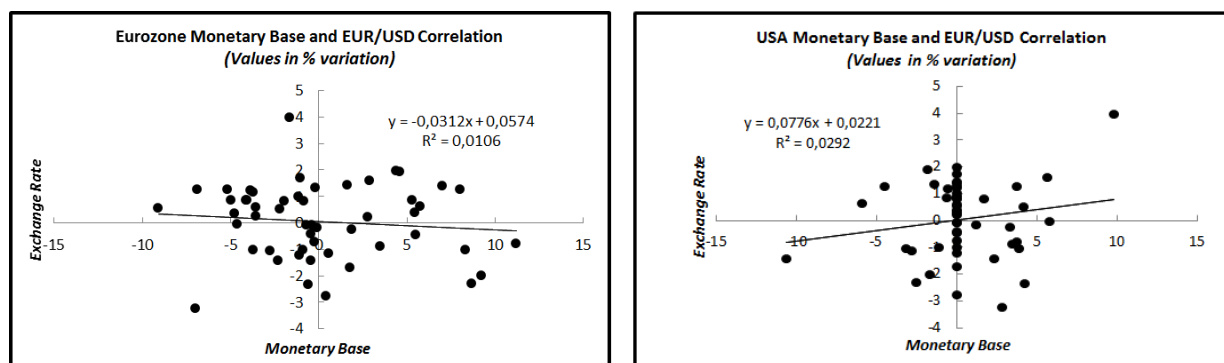


Chart 14 – Correlation graphs for 2009

In the beginning of 2010 the Eurozone monetary base suffered a severe increase as consequence of the first CBPP announced in May, 2009 and its effects remained until the end of this program in June, 2010 with a consequent monetary base reduction until mid-2011. By reason of the conclusion of the American QE1 the monetary base stagnated and then slightly decreased from January, 2010 until November, 2010 when the QE2 was announced leading the monetary base to increase again until June, 2011. Thus, with these two contradictory policies and as a result of several other events such as the sovereign debt crisis which also influenced exchange rates, no correlation was found between the monetary bases and the EUR/USD exchange rate for the years of 2010-2011 (chart 15; annex 6).

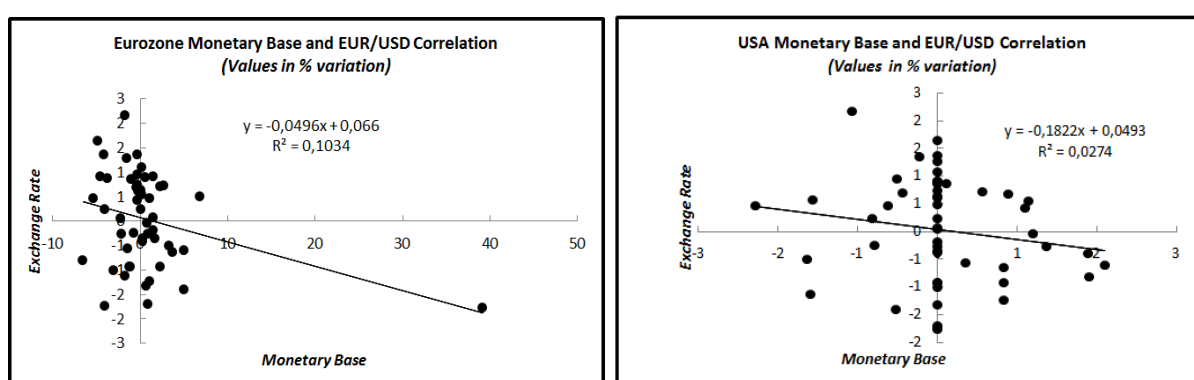


Chart 15 – Correlation graphs for 2012

It is in 2012-2013 that we verify opposite monetary policies implemented by the Fed and the ECB. This is because of different timing for new liquidity providing operations, the QE3 for the USA and the CBPP2 for the Eurozone. The CBPP2 (the most relevant liquidity providing programs operating along with several other measures), which started in October, 2011 and was concluded in October, 2012, had visible expansionary effects on the monetary base since mid-2011 and for great part of 2012 with the Eurozone monetary base reducing drastically with the end of the mentioned program. On the other hand, the Fed concluded QE2 in June, 2011 and QE3 was only announced in September, 2012. As a consequence, the USA monetary base remained stagnated for great part of 2011 until September, 2012 when it increased again as also verified by the monetary base percentage changes. Caused by the increase in the Eurozone monetary base and the stagnation of the USA monetary base, the EUR/USD exchange rate depreciated from 2012 until the middle of that year when it slightly increased and after remained stable until end of 2013. As expected for the year of 2012 we obtained a very expressive negative correlation between the Eurozone monetary base and the EUR/USD exchange rate ($r_{(Eurozone;EUR/USD)2012} = -0.32$) and due to almost a stagnation of the

monetary base and the depreciation of the EUR/USD as explored before we also obtained a negative correlation between the USA monetary base and EUR/USD exchange rate ($r_{(USA\ MB; EUR/USD)2012} = -0.17$).

The CBPP2, which caused the very expressive monetary base increase in the Eurozone, was concluded on the last day of October, 2012 and soon the sterilization effects were known with the monetary base decreasing severely. This fact is proved by clear negative variations in the monetary base starting in October, 2012 and lasting for the complete year of 2013 until April, 2014. On the contrary, the Fed announced its QE3 program in September, 2012 and it was only concluded in the end of the October, 2014. Therefore, the US monetary base has constantly increased since the beginning of the program and the first slightly negative variation in this indicator was only verified in September, 2014.

Hence, as the expected consequence, the euro appreciated since the end of 2012 until mid-2014, which was verified by consecutive positive variations of the exchange rate. In the period of 2013-2014 we obtained no correlation between the Eurozone monetary base variation and the EUR/USD exchange rate but, as expected, we obtained a clear positive correlation between the US monetary base and the EUR/USD exchange rate ($r_{(USA\ MB; EUR/USD)2013-14} = 0.19$) (chart 16; annex 7).

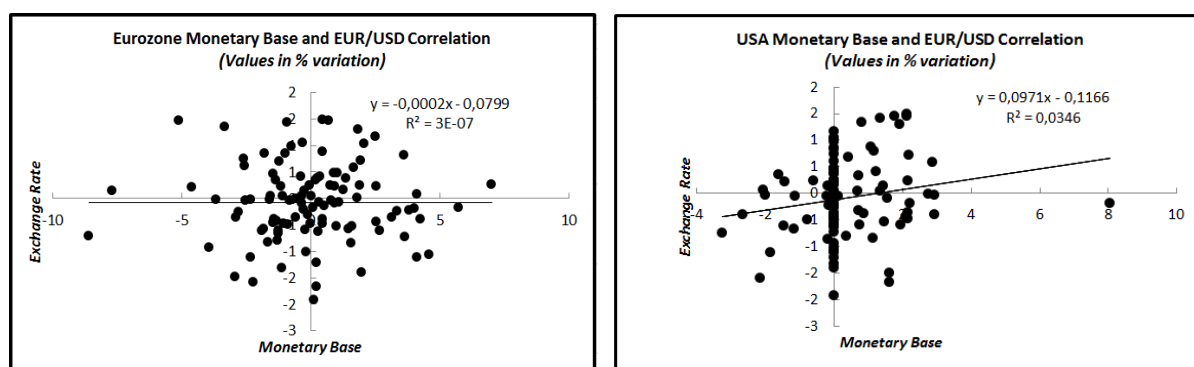


Chart 16 – Correlation graphs for 2013-2014

5.3 Current period and the European QE program (2015)

The years of 2014-2015 are characterized by the end of the QE3 program in the USA and by the beginning of the ECB's Expanded Asset Purchase Program in 2015, in other words, the European QE program. With the conclusion of the QE3 in October, 2014 the tendency of monetary base increase was reverted and registered negative variation values since September, 2014 until January, 2015. Since that moment, the monetary base has remained stable until now, with short shrinking and expansionary periods within stable boundaries,

recalling normal monetary policy periods. The tendency was the contrary in the Eurozone, where an increase in monetary base was already verified in 2014 but a sharp increase in this indicator is verified in January, 2015 attributable to the CBPP3 launched in September, 2014 together with the Asset-backed Securities Purchase Program (ABSPP). Moreover, the European QE was announced in January, 2015 and begun in March, 2015 causing a considerable increase in the Eurozone monetary base since April, 2015, tendency that has remained until now. Concerning the EUR/USD exchange rate, it has been verified that the euro has followed a depreciation path in the year of 2015 and graphically it is verified that it reacts negatively in very specific periods to positive variations in the Eurozone monetary base. We would therefore expect to obtain consistent correlations with the previous findings but this is not verified. The correlation between the US monetary base and the EUR/USD is negative ($r_{(USA\ MB; EUR/USD)2015} = -0.34$) and the contrary happens with the Eurozone monetary base and the EUR/USD ($r_{(Eurozone; EUR/USD)2015} = 0.33$) (chart 17; annex 8). We believe that this is owing to the fact that our analysis only comprehends half of 2015 events in a time when several impacts besides monetary bases affect the exchange rates. Besides, the European QE program is still in an incipient phase and clearer results should be found later. The recent behavior of the euro against the dollar may also justify the findings, since, at the present time, the EUR/USD stabilized after a free fall since April, 2014 until March, 2015. Since the latest date when the euro registered its lowest value in 2015 of about EUR/USD = 1, 05, the European currency fluctuated until its highest value of about EUR/USD = 1, 16 in August, 2015. When the exchange rate gets near the latest value it seems to depreciate again.

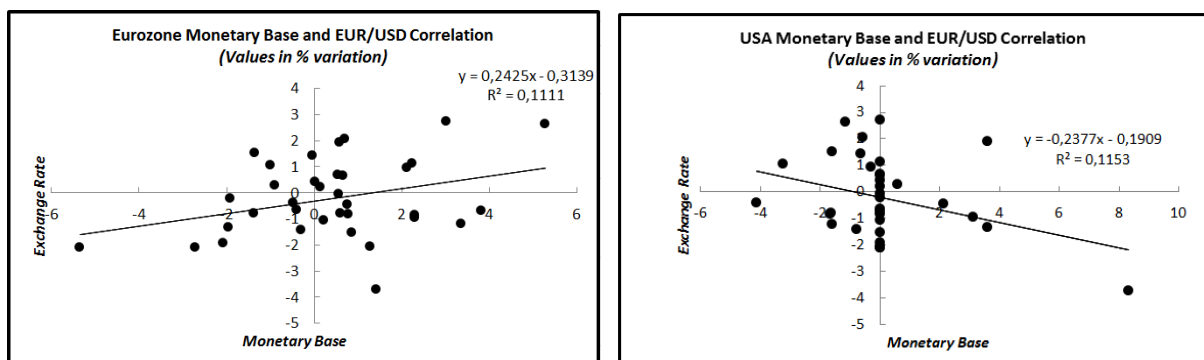


Chart 17 – Correlation graphs for 2015

6. Conclusion

Today the ECB is perceived as the key in the Eurozone and its importance and recognition have been growing due to its sole control of the monetary policy in one of the most crucial economic areas in the world. The NCBs together with the ECB form the Eurosystem which is connected by the common currency, the euro, and by a progressively more agile and competent institutional network. The European bankers' bank follows the modern principles of central banking and respects the principle of independence to avoid political influence on the monetary policy. Nevertheless, it is not easy to conduct a monetary policy in an area with such disparities among countries in several macroeconomic indicators such as GDP, unemployment or inflation. Besides, the ECB has to respect the mandate with which was granted by the European leaders and may face difficulties when trying to expand its scope of action as happened with some countries' opposition to the European QE program.

In fact, the ECB has only one specific objective: to maintain the inflation in the Eurozone close to but below 2% since this rate will guarantee a stable and healthy economic environment. To pursue this objective it has available several liquidity providing or absorbing instruments that through the transmission mechanism should affect several economic agents and ultimately influence inflation. During the so called "normal period" (2000-2007) this objective was most of the times met but this changed with the awake of the financial crisis and its strong effects. After the year of 2007 the inflation target was seldom met and negative real inflation values were registered as in the year of 2015. A very low inflation rate also represents a low economic growth as confirmed by the GDP indicator.

The ECB as other central banks was urged to tackle this situation with extraordinary measures. The ECB adopted a conservative stance when compared to other central banks, in this case, the Fed. The Fed soon started the series of the American QE programs without sterilization but its European counterparty only initiated the European QE several years later and adopted instead several extraordinary liquidity providing measures together with SWAP lines and reduction of reference interest rates, similarly to the Fed. The main reason to the decision of sterilizing the monetary base expansionary effects of the extraordinary measures was the fear of uncontrolled inflation that after all was not verified. In fact, when the ECB expanded its balance sheet through assets purchases, it did not do it by increasing the quantity of money in circulation but instead by increasing the reserves accounts of commercial banks at the ECB, specifically, the current accounts. Consequently, the quantity of real money was not increased but the monetary base was because this indicator is composed by current

accounts and currency in circulation as per formula (*Monetary base=Current accounts + Currency in circulation*). Indeed, if we compare the percentage change from the previous year of current accounts and currency in circulation we verify that the first registers several changes and the second does not since it has a regular and controlled growth (annex 11). In 2015 the ECB decided to start its quantitative easing program that can be larger than what first was expected in a time of a depreciating euro against the dollar.

The direct consequence of the several ECB's extraordinary operations and the Fed's QEs is the expansion of the monetary base. This effect on the balance sheet of the central banks has a depreciation effect on the home currency of the central bank pursuing this policy. What is verifiable in Europe and in the USA taking the EUR/USD exchange rate as the study object is that when the monetary base is expanded on the USA the exchange rate appreciates and the contrary happens when the ECB expands the monetary base. There are several other events that affect the exchange rates (behavioral events and pure economic events) being that the reason why some periods do not verify a strong connection between monetary base expansion and exchange rates. It would be interesting, for example, to study the effects of surprise on the EUR/USD exchange rate and verify if as happened in the USA the surprise announcements of the ECB also affects the euro's quotation. Besides, it becomes very difficult to spot monetary base expansion effects on a given exchange rate when two expansionary monetary bases act simultaneously. It is likely that the effects here spotted are also verifiable on other exchange rates being then interesting to understand which behavior the euro or the dollar adopted against other currencies (not under the effect of an expansionary monetary base) during times of simultaneous active monetary policies.

During times of very low and sometimes negative reference interest rates these non-conventional monetary policy measures with their expected effects seem to be the best alternative for central banks to take. Through them, central banks may be able to stabilize asset prices and stimulate the economy through providing the market with liquidity. The effects of these policies on exchange rates are clear and may be positive to countries undertaking them because generally a low exchange rate makes national products more attractive abroad and limits imports. Nevertheless, it is crucial to mention that in a globalized world with a free floating system of currencies national measures are actually global and will affect other economies. Thus, positive national effects can also become negative elsewhere in the world.

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8. Annexes

Annex I – Main Events with Possible Effects on the EUR/USD Exchange Rate

	<i>Selected relevant events</i>
2007	
2 nd of January	Slovenia joins euro area and Bulgaria and Romania join EU
25 th of May	Specification of assets eligible as collateral for eurosystem credit operations. Limited to issuers in the European Economic Area and located in one of the G10 countries.
14 th of August	Jean-Claude Trichet statement. Reference to financial and money markets instability.
22 nd of August	Supplementary LTROs due to euro money market instability amounting to 40 billion euros.
6 th of September	Supplementary LTROs due to euro money market instability without any specific amount.
2008	
1 st of January	Cyprus and Malta join euro area
7 th of February	Renewal of the two supplementary LTROs initiated in 2007. Renewals amount to 60 billion euros each.
6 th of March	ECB's annual accounts for the ending year of 2007. The ECB has a surplus of 286 million euros compared to the 1,379 million euros of surplus in 2006.
11 th of March	ECB in cooperation with the Fed provides USD liquidity to European institutions
28 th of March	Supplementary LTROs. One operation of six months (25 billion euros), two operations of three months (50 billion euros each).
2 nd of May	Increase of USD financing to European institutions
30 th of July	Measures to enhance the USD financing for European institutions
31 st of July	Renewal of the supplementary LTROs announced in February, 2008 amounting to 50 billion euros each
4 th of September	Renewal of LTROs announced in March, 2008 with same amounts
15 th of September	The bank Lehman Brothers declares bankruptcy
18 th of September	Pressure on Eurodollar markets. Financing of USD for European Institutions focusing on overnight financing
22 nd of September	Statement of G7 finance ministers supporting extraordinary measures
26 of September	Continuous pressure in Eurodollar markets. New measures to USD financing in Europe
29 of September	Supplementary STRO maturing in November. Expansion of SWAP line between the Fed and the ECB from 120 to 240 billion USD
3 rd of October	Enlargement of counterparties to fine-tuning operations
7 th of October	New facilities to provide USD financing and allotment increase of six months LTROs
8 th of October	Reduction of interest charged in standing facilities
13 th of October	New facilities to provide USD financing
15 th of October	Enlargement of collateral accepted

25 th of November	First QE program (QE1) was announced in the USA
26 th of November	Syndicated loans under England and Wales laws are not accepted as collateral
2009	
1 st of January	Slovakia joins euro area
15 th of January	Monetary policy decisions: decreasing in interest charged for refinancing operations to 2%; marginal lending facility 3%; decrease in interest offered on deposit facility to 1%
3 rd of February	Against the announcement at the end of 2008, SWAP lines with the Fed will continue until 30 th of October
5 th of March	ECB's annual accounts for the ending year of 2008. The ECB has a surplus of 2,661 million euros compared to the 286 million euros of surplus in 2007. ECB announces that it will continue the current frequency of all supplementary LTROs and special-term refinancing operations as long as needed and beyond 2009. These operations will have a fixed rate.
19 th of March	Liquidity providing operations in USD announced
2 nd of April	Monetary policy decisions: further decrease in all reference rates. 1.25% interest on MROs; 2.25% interest on marginal lending facilities; 0.25% offered interest on deposits
6 th of April	ECB assumes a possible slowdown in European financial integration due to the market turmoil and financial crisis
7 th of May	Monetary policy decisions: further decrease in reference rates. 1% on MROs; 1.75% on marginal lending facility; 0.25% offered on deposits. LTROs with 1 year maturity were announced besides the regular and supplementary measures already in place. Covered Bond Purchase Program (CBPP) is announced
15 th of June	Report acknowledging the severity of the crisis and possible future downturn developments
25 th of June	Expansion of USD SWAP lines with the Fed until February, 2010
24 th of September	Refinancing operations in USD will continue until January, 2010
November	Start of turmoil in sovereign debt yields
4 th of November	Large-scale Asset Purchases (LSAPs) within the QE1 are downsized
2010	
27 th of January	USD SWAP lines will end on 1 st of February
3 rd of March	Greece presents additional measures for financial consolidation
4 th of March	ECB's annual accounts for the ending year of 2009. The ECB has a surplus of 2,218 million euros compared to the 2,661 million euros of surplus in 2008. Announcement of the phasing-out of non-standard measures.
12 th of April	ECB recognizes signs of retrenchment in the EU
2 nd of May	Greece signs the first adjustment program
3 rd of May	ECB announces the suspension of minimum credit requirement threshold for Greek government debt in credit operations
10 th of May	Extraordinary measures announced due to severe tensions in financial markets. Securities Markets Program (SMP) is announced and private and sovereign debt will be purchased in sterilized

	operations. Extra three and six months LTROs. Reactivation of USD SWAP lines and liquidity providing operations with the Fed.
30 th of June	Covered Bond Purchase Program (CBPP) is complete
10 th of August	QE1 finishes in the USA
27 th of August	Fed's president suggest a possible QE2
3 rd of November	Second QE program (QE2) was announced in the USA
28 th of November	Negotiations for Ireland's adjustment program completed
16 th of December	ECB raises capital by 5 billion euros (to 10.76 billion euros) due to volatility in foreign exchange rates, interest rates and gold prices
21 st of December	Prolongation of USD liquidity providing operations until August, 2011
2011	
1 st of January	Estonia joins euro area
3 rd of March	ECB's annual accounts for the ending year of 2010. The ECB has a surplus of 1,334 million euros compared to the 2,218 million euros of surplus in 2009. New three months LTRO.
11 th of March	Presentation of Portuguese measures to address economic challenges
31 st of March	As it did for Greece the ECB announces the suspension of the rating threshold for debt instruments of the Irish government
7 th of April	Increase in the reference rates. 1.25% interest on MROs; 2% interest on marginal lending facility; 0.50% offered on deposits
5 th of May	Portuguese adjustment program is announced
22 nd of June	QE2 finishes in the USA
29 th of June	Prolongation of USD liquidity providing operations
7 th of July	Monetary policy decisions: increase in the reference rates. 1.50% interest on MROs; 2.25% interest on marginal lending facility; 0.75% offered on deposits.
7 th of August	Jean-Claude Trichet welcomes financial measures by Spain and Italy
15 th of September	Additional USD liquidity providing operations
21 st of September	The Fed announced "Operation Twist"
6 th of October	New Covered Bond Purchase Program (CBPP2) is announced with an amount of 40 billion euros and will be undertaken in primary and secondary markets
1 st of November	Mario Draghi is appointed as President of the ECB
3 rd of November	Monetary policy decisions: decrease in the reference rates. 1.25% in MROs; 2% for marginal lending facility; 0.50% offered on deposits
8 th of December	Monetary policy decisions: decrease in the reference rates. 1.00% in MROs; 1.75% for marginal lending facility; 0.25% offered on deposits Announcement of measures to support bank lending and money market activity: 36 months LTROs, reduction of reserve ratio to 1%, increasing collateral availability
16 th of December	Two FTOs of one day are announced
2012	
16 th of January	The number of Monetary Financial Institutions decreased in the euro area
1 st of March	Greece second adjustment program is signed
8 th of March	ECB's annual accounts for the ending year of 2011. The ECB has a

	surplus of 1,894 million euros compared to the 1,334 million euros of surplus in 2010.
14 th of March	Announced the first negative GDP growth in the EU and euro area (-0.3%)
26 th of April	Sovereign debt crisis intensifies and affects the financial system
22 nd of June	ECB widens the collateral accepted for credit operations. Although the haircut is higher, ECB accepts Asset Backed Securities (ABS), namely, Commercial Mortgages (CMBSs), Residential Mortgages Backed Securities (RMBSs) and loans to small and medium-sized enterprises as collateral
5 th of July	Monetary policy decisions: decrease of reference rates. 0.75% interest on MROs; 1.50% interest on marginal lending facilities, 0.00% offered on deposits
2 nd of August	Mario Draghi proclaims that “the euro is irreversible” and assumes the ECB will expand sovereign debt purchases
22 nd of August	Federal Open Market Committee (FOMC) suggests a possible QE3
6 th of September	The Outright Monetary Transactions (OMT) program is officially announced
13 th of September	Third QE program (QE3) was announced in the USA
31 st of October	Covered Bond Purchase Program (CBPP2) is concluded
13 th of December	SWAP lines with the Fed, Bank of Canada, Swiss National Bank, Bank of England and Bank of Japan are extended until February 2014
2013	
21 st of January	Monetary financial institutions in EU and euro area continue to decrease in number
21 st of February	ECB's annual accounts for the ending year of 2012. The ECB has a surplus of 2,164 million euros compared to the 1,894 million euros of surplus in 2011. ECB announces that holds 218 billion euros in securities resulting from SMP.
21 st of March	ECB will cut Emergency Liquidity Assistance (ELA) to Cyprus until 25 th of March unless it accepts an adjustment program
25 th of March	An agreement is reached for Cyprus and ELA continues
2 nd of May	Monetary policy decisions: decrease in reference rates. 0.50% on MROs, 1% on marginal lending facilities, 0.00% on deposits
1 st of July	Croatia joins the European Union
10 th of October	SWAP line with People's Bank of China
31 st of October	SWAP lines with the Fed, Bank of Canada, Swiss National Bank, Bank of England and Bank of Japan are converted in standing arrangements, meaning, will remain in place until further notice
7 th of November	Monetary policy decisions: decrease in reference rates. 0.25% on MROs, 0.75% on marginal lending facilities, 0.00% on deposits
27 th of November	Financial Stability Review suggests alleviation of financial market tensions but challenges remain
15 th of December	Ireland's adjustment program is concluded
2014	
1 st of January	Latvia joins the euro area
21 st of January	Number of monetary financial institutions decreased again in 2013

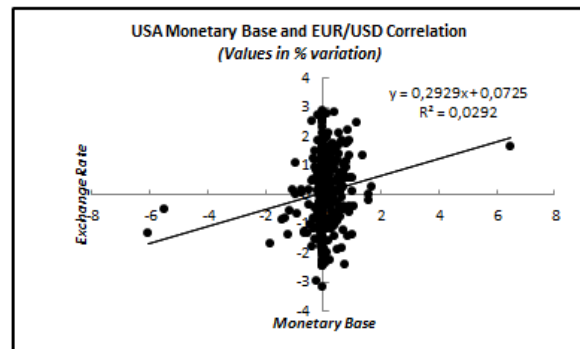
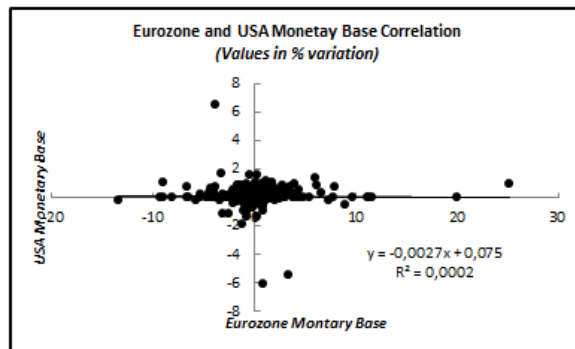
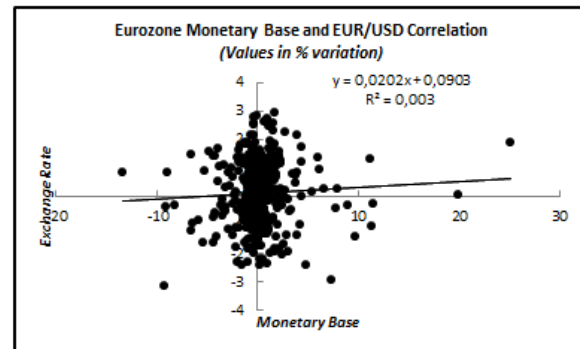
24 th of January	USD funding conditions have improved, part of liquidity providing operations will cease
20 th of February	ECB's annual accounts for the ending year of 2013. The ECB has a net profit of 1,440 million euros compared to the 1,166 million euros of net profit in 2012.
17 th of May	Portugal's adjustment program is concluded
5 th of June	Monetary policy decisions: decrease in reference rates. 0.15% on MROs, 0.40% on marginal lending facility, -0.10% on deposits
17 th of June	USD liquidity providing operations continue beyond 31 st of July until further notice
22 nd of August	Mario Draghi speech on the annual central bank symposium in Jackson Hole: "whatever it takes" speech
4 th of September	Monetary policy decisions: decrease in reference rates. 0.05% on MROs, 0.30% on marginal lending facility, -0.20% on deposits. Third Covered Bonds Purchase Program (CBPP3) is launched together with the Asset-backed Securities Purchase Program (ABSPP).
29 th of October	QE3 finishes in the USA
27 th of November	Weak economic prospects are acknowledged
2015	
1 st of January	Lithuania joins euro area
22 nd of January	The ECB announces the QE program (Expanded Asset Purchase Program) amounting to 60 billion euros which will include the buying of European government bonds. This program will encompass the already existing programs: Asset-backed Securities Purchase Program (ABSPP) and Covered Bonds Purchase Program (CBPP3)
4 th of February	ECB's Governing Council lifts current waiver of minimum credit rating requirements for marketable instruments issued or guaranteed by Greece, meaning, sovereign bonds need to fulfill the minimum credit rating to be eligible as collateral for credit operations
1 st of March	Start of the European QE program
30 th of June	Greece's second adjustment program concludes with high uncertainty

Annex 1 - Selected relevant events. Based on data in:

<https://www.ecb.europa.eu/press/html/index.en.html> and (Fawley & Neely, 2013)

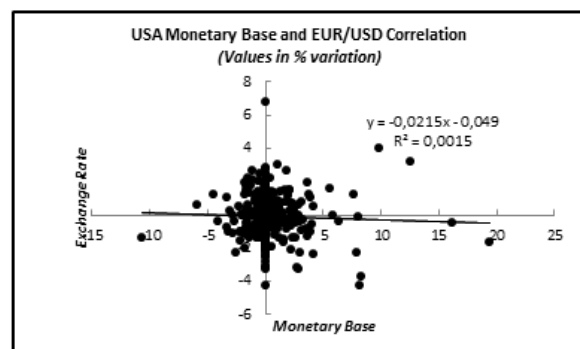
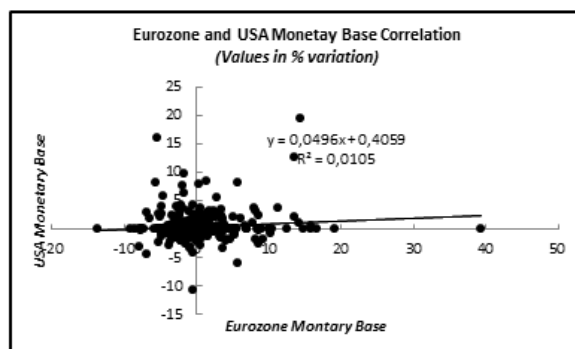
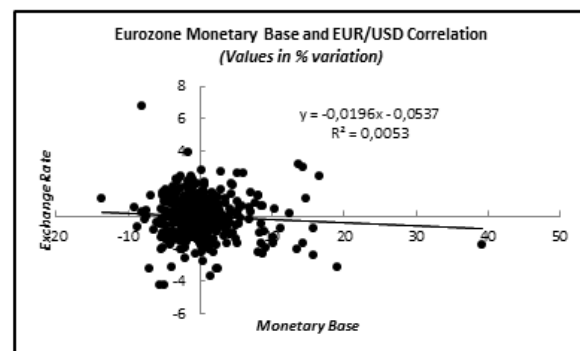
Annex II – Correlation Tables and Graphs

Correlation Table 2000-2007		
	Monetary Base Eurozone	Monetary Base United States
Monetary Base United States	-0,0126	–
EUR/USD	0,0545	0,1709



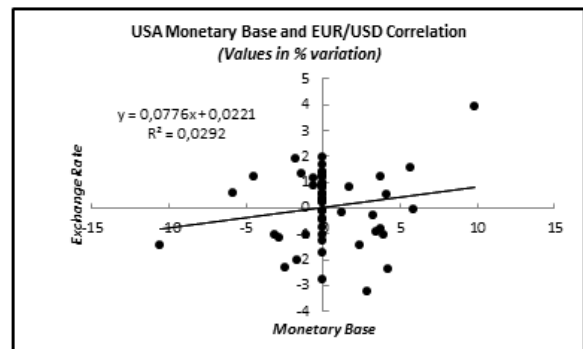
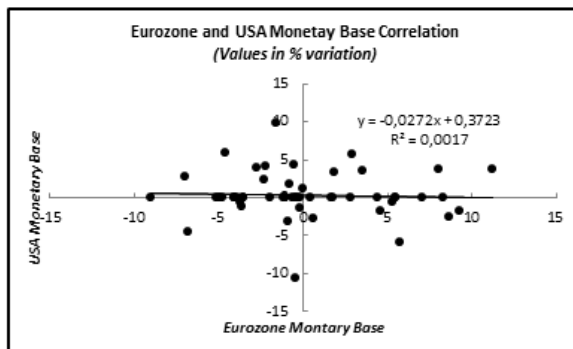
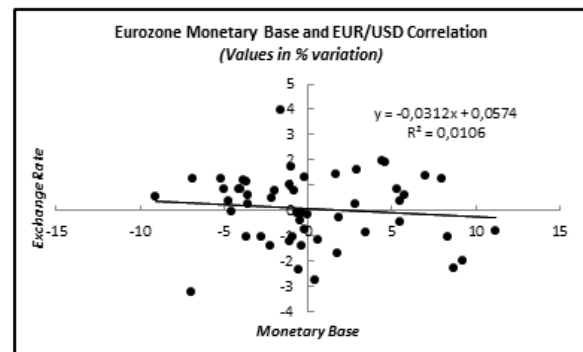
Annex 2 – Correlation table and graphs for 2000-2007

Correlation Table 2008-2015		
	Monetary Base Eurozone	Monetary Base United States
Monetary Base United States	0,1023	–
EUR/USD	-0,0725	-0,0386



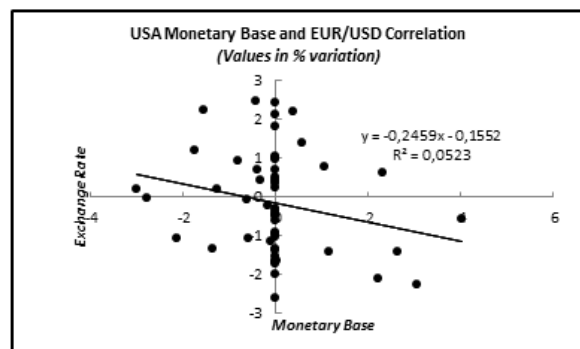
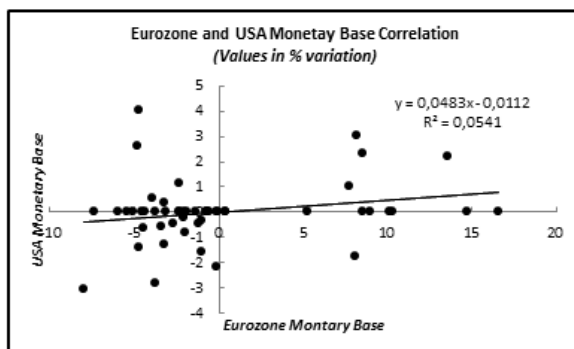
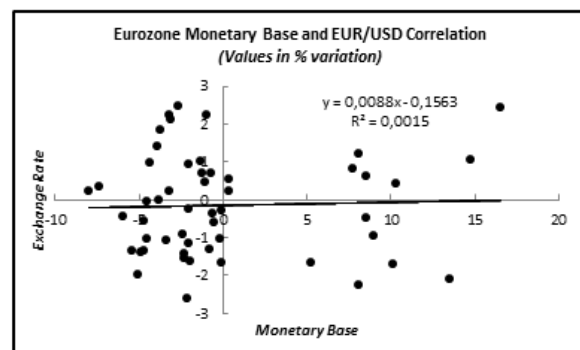
Annex 3 – Correlation table and graphs for 2008-2015

Correlation Table 2009		
	Monetary Base Eurozone	Monetary Base United States
Monetary Base United States	-0,0409	—
EUR/USD	-0,1030	0,1709



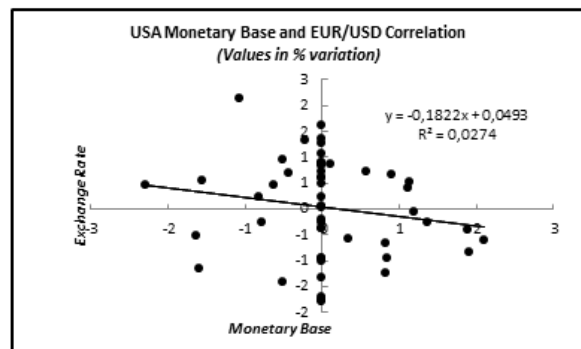
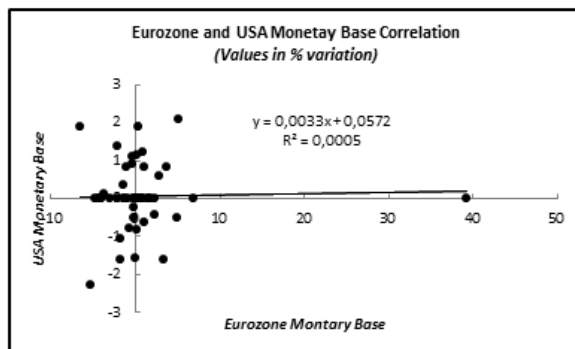
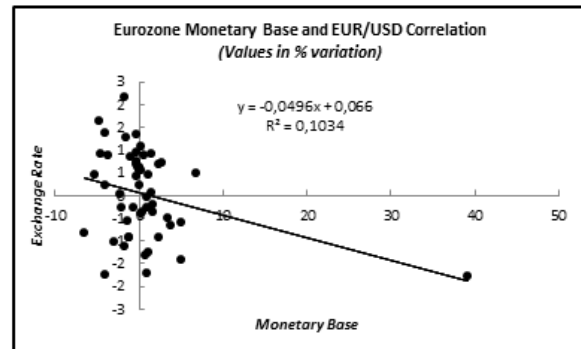
Annex 4 – Correlation table and graphs for 2009

Correlation Table 2010-2011		
	Monetary Base Eurozone	Monetary Base United States
Monetary Base United States	0,1225	—
EUR/USD	0,0080	-0,0882



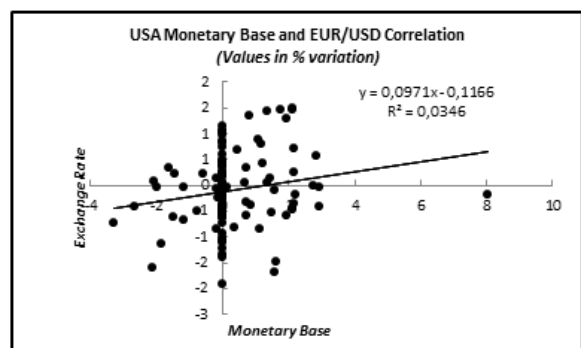
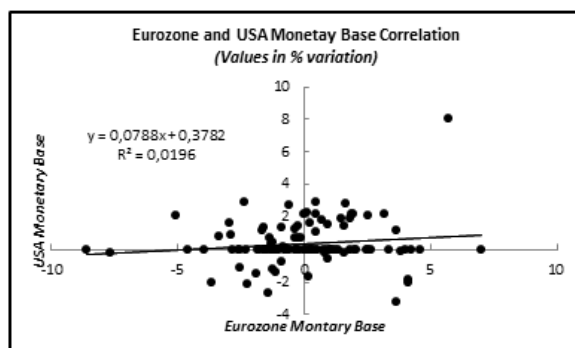
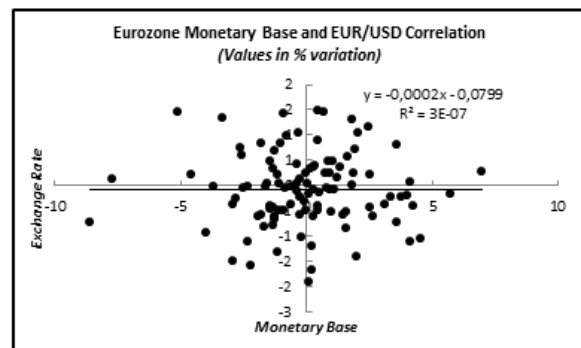
Annex 5 – Correlation table and graphs for 2010-2011

Correlation Table 2012		
	Monetary Base Eurozone	Monetary Base United States
Monetary Base United States	0,0233	–
EUR/USD	-0,3216	-0,1657



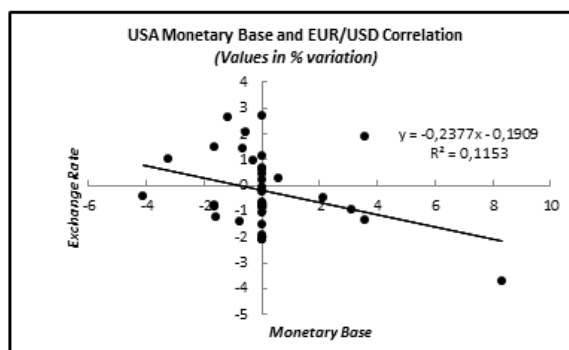
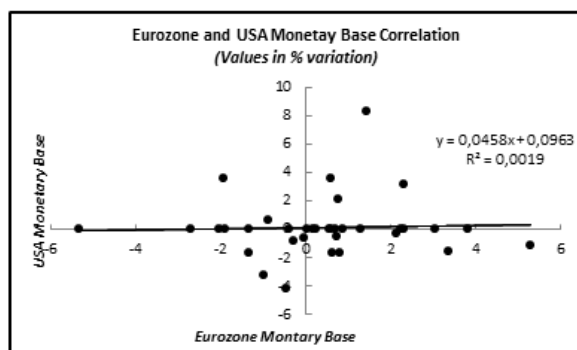
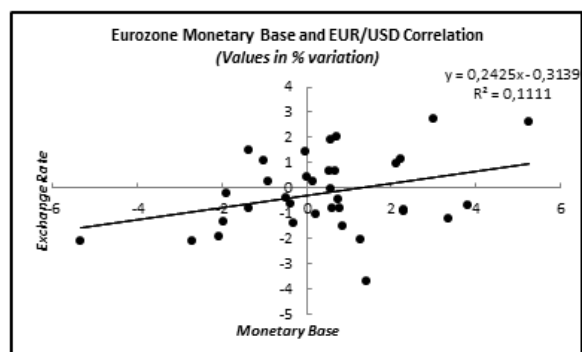
Annex 6 – Correlation table and graphs for 2012

Correlation Table 2013-2014		
	Monetary Base Eurozone	Monetary Base United States
Monetary Base United States	0,1399	–
EUR/USD	-0,0006	0,1859



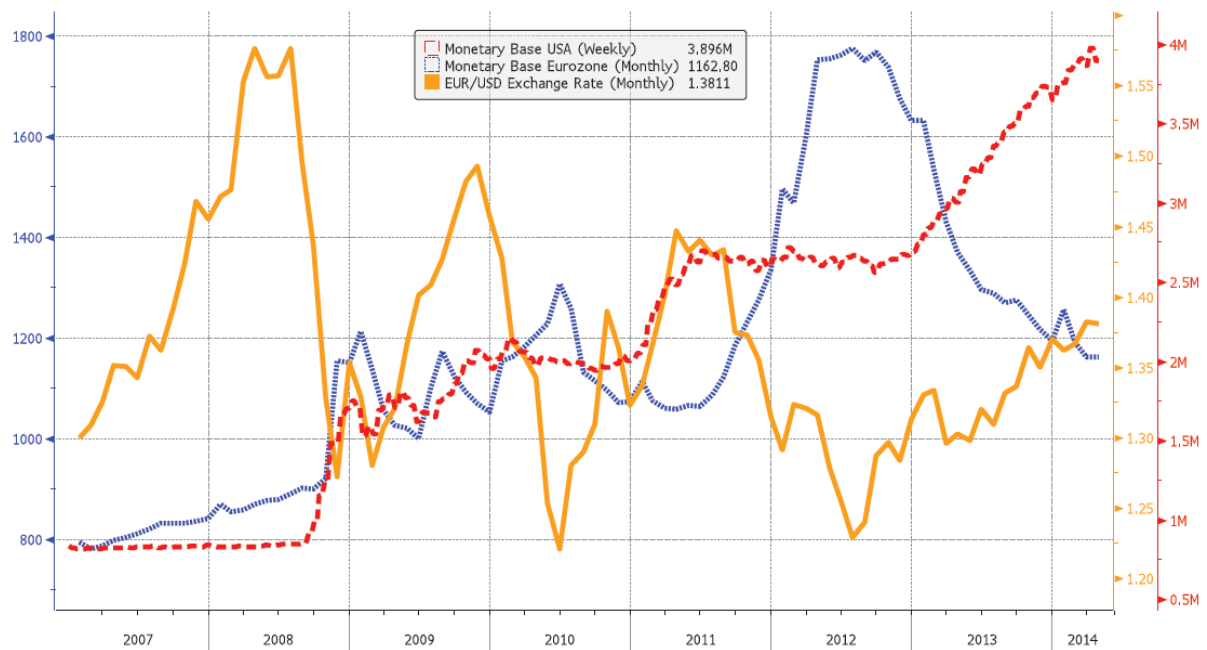
Annex 7 – Correlation table and graphs for 2013-2014

Correlation Table 2015		
	Monetary Base Eurozone	Monetary Base United States
Monetary Base United States	0,0441	–
EUR/USD	0,3333	-0,3396

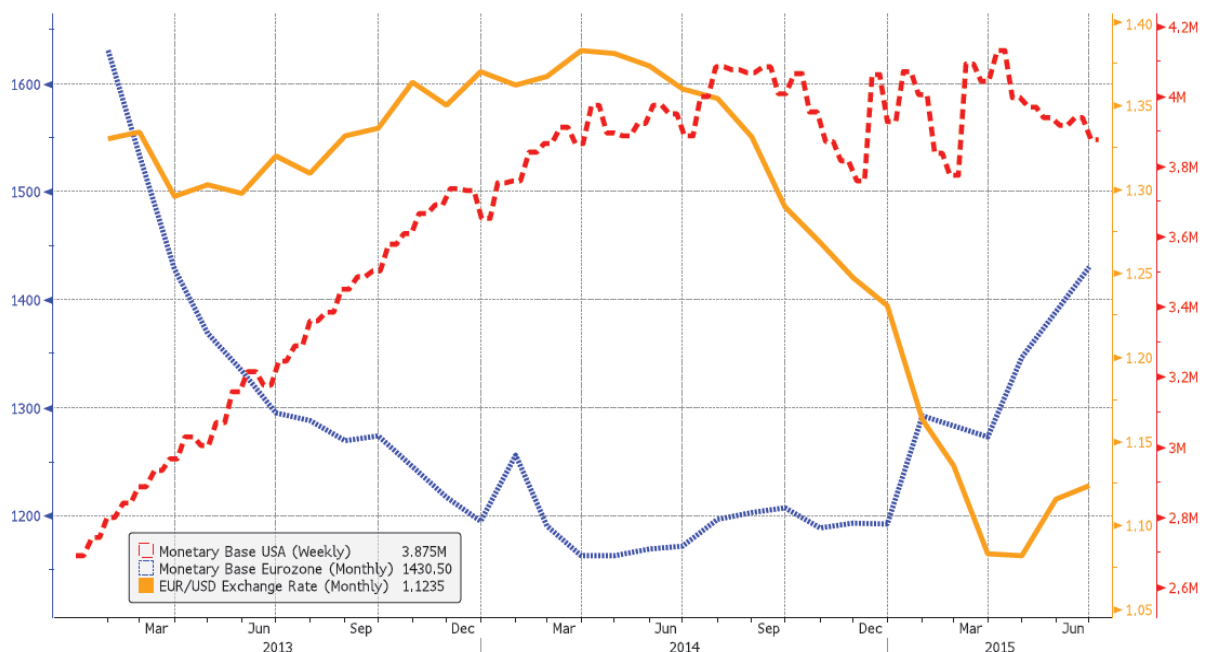


Annex 8 – Correlation table and graphs for 2015

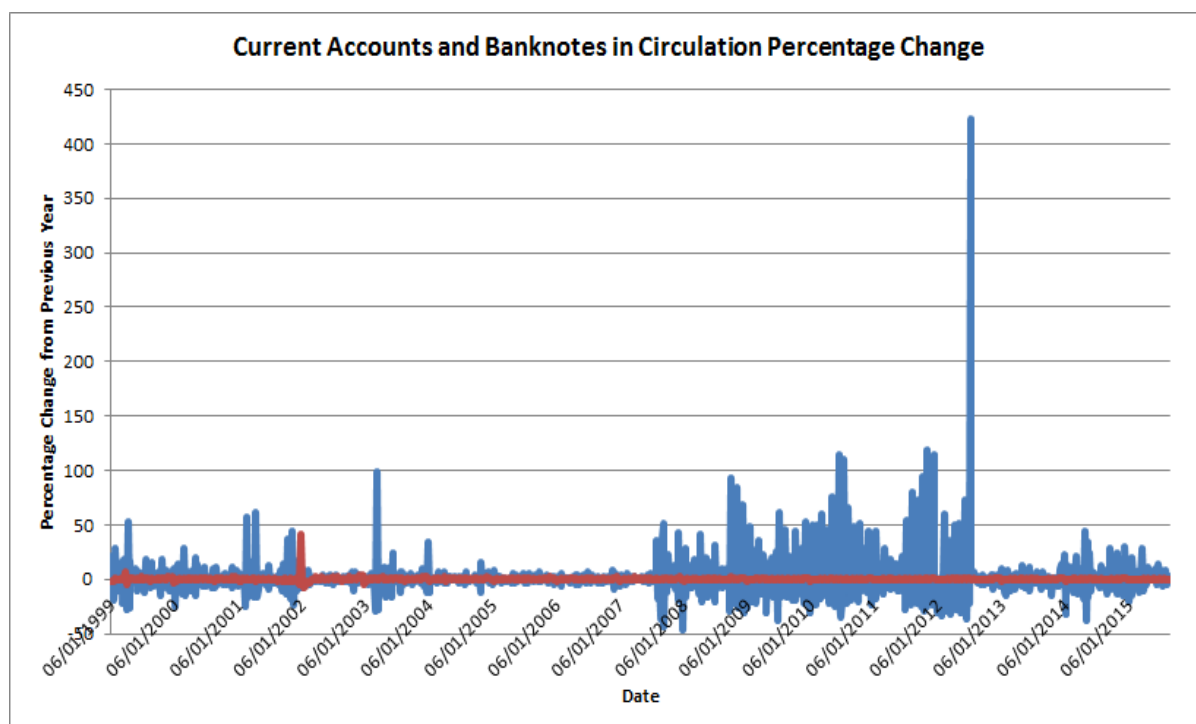
Annex III – Monetary Base Expansion



Annex 9 – Monetary base evolution in the USA (red) and the Eurozone (blue), values in thousands of millions (continental European scale) or billions (USA scale), i.e. 1,000,000,000. Comparison with monthly average EUR/USD exchange rate (yellow). Source: Bloomberg ®



Annex 10 – Monetary base evolution in the USA (red) and the Eurozone (blue), values in thousands of millions (continental European scale) or billions (USA scale), i.e. 1,000,000,000. Comparison with monthly average EUR/USD exchange rate (yellow). Source: Bloomberg ®



Annex 11 – Comparison between Eurozone expansion of current accounts (blue) and banknotes in circulation (red). Values in percentage change from previous year.