UNIVERSITY OF MACEDONIA

MBA THESIS

Pairs trading in forex markets: A test of the cointegration approach with the EUR/USD and GBP/USD currency pairs.

Author:Koronidis Georgios (A.M : 25/12)

Supervisor: Dr. Ioannis Papanastasiou

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Abstract

It is well known that pairs trading strategies are used in substantial level in the hedge fund world. At the current paper, we chose to implement one the classic pairs trading strategy, the Engle and Granger cointegration method in the world of forex, the biggest market nowadays, with daily average volume over 4 trillion dollars. Our candidates at this cointegration test were the EUR/USD and the GBP/USD currency pairs, two major pairs that constitutes by the currencies of three of the most important economies all over the world.

Before the core test of cointegration, the reader will be "met" with the fx market history, its current special characteristics, as well as the important factors that, according to the author, make it a non-efficient market (at least most of the times), a fact that created the incentive to test the cointegration strategy as a possible profitable speculation or even hedging method. After this point, the author analyses his two preliminary tests, the fundamental and the scanning methods, the results of whom show important evidence for a possible cointegration occurrence between the two currency pairs. The Engle and Grander test procedure that follows however, shows that the cointegration between the two major pairs does not exist, at least at a 5% level of confidence.

Finally, the author makes a reference to the summaries of the test, while also argues about the great need for further research at forex markets in order to be found possible candidates for a profitable implementation of the cointegration pairs trading strategy.

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How was the current forex market born?

A Synopsis of the international monetary system

The bimetallic standard

In the nineteenth century, the monetary statutes of many countries permitted the simultaneous minting and circulation of both gold and silver coins (see Eichengreen 2008). These countries were on what were known as bimetallic standards. Only Britain was fully on the gold standard from the start of the century, while the German states, the Austro-Hungarian Empire, Scandinavia, Russia, and the Far East operated silver standards. Countries with bimetallic standards provided the link between the gold and silver blocs.

Maintaining the simultaneous circulation of both gold and silver coin was not easy. The incentive for arbitrage when the prices of the two metals fluctuated was substantial. For instance, we could focus on the case of France (see Eichengreen 2008).

Initially, the mint ratio of the two metals was 15.5 to 1—one could obtain from the mint coins of equal value containing a certain amount of gold or 15.5 times as much silver. Both gold and silver coins could be used to discharge tax obligations and other contractual liabilities. In case that, however, the price of gold on the world market rose more than the price of silver, (as it did in the last third of the nineteenth century when gold rose to the point where 16 ounces of silver traded for an ounce of gold) incentives for arbitrage would be created. Thus, in this specific example, the arbitrager could import 15.5 ounces of silver and have it coined at the mint. He could exchange that silver coin for one containing an ounce of gold. He could export that gold and trade it for 16 ounces of silver on foreign markets (since 16 to 1 was the price prevailing there). Through this act of arbitrage he recouped his investment and obtained in addition an extra half ounce of silver.

As long as the market ratio stayed significantly above the mint ratio, the incentive for arbitrage remained. Arbitragers would import silver and export gold until all the gold coin in the country had been exported. Alternatively, if the market ratio fell below the mint ratio (which could happen, as it did in the 1850s, as a result of gold discoveries),

arbitragers would import gold and export silver until the latter had disappeared from circulation. Only if the mint and market ratios remained sufficiently close would both gold and silver circulate. One important tool that governments used in order to discourage the arbitragers was the charging of a nominal fee, known as *brassage* (see Eichengreen 2008), to coin bullion. Although the amount varied over time, in France it was typically about one-fifth of 1 percent of the value of the gold involved, and somewhat higher for silver. The difference between the market and mint ratios had to exceed this cost before arbitrage was profitable.

The question that could be born from the above analysis is why some countries used the bimetallic standard which is accompanied with a so important problem, as the arbitrage motivation. One possible answer that advanced by Angela Redish(1990), is that until the advent of steam power the gold standard was not technically feasible. The smallest gold coin practical for hand-to-hand use was too valuable for everyday transactions. Worth several days' wages, it was hardly serviceable for a laborer. Thus, it had to be supplemented by less valuable silver coins, as under a bimetallic standard.

Another important factor, that strongly supported the parallel use of silver, was the existence of silver mining lobbies (see Eichengreen 2008). Supporting silver's price by creating a monetary use for the metal encouraged its production and led to substantial profits for the silver miners as well as a boost of new job positions. This fact created an extra political pressure to the governments that made them hold the bimetallic standard for a much longer period which led to a delayed gold standard coming (see Eichengreen 2008).

The rise of gold standard

In around 1870s, a major shift to gold standard was taken place in Europe. But what are the reasons for this substantial change? At one level the answer is the industrial revolution. Its symbol, the steam engine, removed the technical obstacle that was referred above. What is more, a greatest factor was the decision of Germany to abandon the use of silver as a parallel currency (see Eichengreen 2008). Thus, with Great Britain, the world's leading economic power and the main source of foreign finance had already been in gold standard and Germany the second-leading industrial power to follow, the rest of countries pushed to the use of gold standard in order to

enhance their trading with the two economically dominant nations. At the end of the nineteenth century, the world was "conquered" by the gold standard. The European countries, USA, as well as the Asian and Latin America nations operated in gold standard.

However, as Eichengreen states only four countries (England, Germany, France, and the United States) maintained pure gold standards in the sense that money circulating internally took the form of gold coin; and to the extent that paper currency and subsidiary coin also circulated, they kept additional gold in the vaults of their central banks or national treasuries into which those media could be converted. At the rest of the countries, money in circulation took the form mainly of paper, silver, and token coin. Those countries were on the gold standard in that their governments stood ready to convert their money into gold at a fixed price on demand. The central or national bank kept a reserve of gold to be paid out in the event that its liabilities were presented for conversion.

But how did the gold standard operate? David Hume had already partly answered this question with his price-specie flow model back in 1752 which explains how gold standard works (see Eichengreen 2008).

So, for a country with a trade deficit, the second set of transactions exceeded the first. It experienced a gold outflow, which set in motion a self-correcting chain of events. With less money (gold coin) circulating internally, prices fell in the deficit country. With more money (gold coin) circulating abroad, prices rose in the surplus country. The specie flow thereby produced a change in relative prices (hence the name “price-specie flow model”). With imported goods having become more expensive, domestic residents would reduce their purchases of them. Foreigners, for whom imported goods had become less expensive, would be inclined to purchase more. Thus, the deficit country’s exports would rise, and its imports fall, until the trade imbalance was eliminated.

However, the above model does not take into account some important issues (see Eichengreen 2008). One was the international capital flows. Net capital movements due to foreign lending were larger, often substantially, than the balance of commodity trade. Hume had said nothing about the determinants of these flows—of factors such

as the level of interest rates and the activities of commercial and central banks. One other feature was the absence of international gold shipments on the scale predicted by the model, leaving thus aside flows of newly mined gold from South Africa and elsewhere to the London gold market, that were an important fraction of countries' trade deficits and surpluses. Finally, what is more, the model could not explain how external adjustment could also take place in the absence of substantial gold movements.

In order to solve the above issues and to achieve a fast intervention in the monetary system when is needed, central banks used the discount rate. As Eichengreen (2008) explains banks and other financial intermediaries (known as *discount houses*) lent money to merchants for sixty or ninety days. The central bank could advance the bank that money immediately, in return for possession of the bill signed by the merchant and the payment of interest. Advancing the money was known as discounting the bill; the interest charged was the discount rate. Thus, if the bank raised the rate and made discounting more expensive, fewer financial intermediaries would be inclined to present bills for discount and to obtain cash from the central bank. By manipulating its discount rate, the central bank could thereby affect the volume of domestic credit. It could increase or reduce the availability of credit to restore balance-of-payments equilibrium without requiring gold flows to take place.

The World War I

The dominant role of gold came into question with the beginning of the World War I (see Eichengreen 2008). At first, in order to mobilize resources for the war, the authorities imposed new taxes and issued government bonds. When the resources so mobilized proved inadequate, they suspended the statutes requiring them to back currency with gold or foreign exchange. They issued *fiat money* (unbacked paper) to pay soldiers and purchase war matriel at home. Different rates of fiat-money creation in different countries caused exchange rates to vary widely.

This event led to a hyperinflation phenomenon in several countries (see Eichengreen 2008). Their inflations had been fueled by the paper money used to finance government budget deficits. Eventually, the problem bred its own solution. This was the return of the gold standard. Germany, Austria, Poland were among the first

countries that returned to the gold standard only to be followed by the rest of the developed countries with the lower inflation pressures such as France in the mid 20s.

However, the return of gold standard did not lead the countries in prosperity. At the late 20s (early 30s) the industrial nations had to major problems. A great banking crisis was the first, with several bank runs taking place. The lender of last resort, the central banks, restricted by the gold standard, did not succeed to boost liquidity in illiquid banking institutions that finally collapsed because of the panic of their depositors. What is more, at those years, the deflation phenomenon dominated the developed economies, as a result of the influence of the gold standard rule in monetary policies. Thus, developed and developing nations in the mid 30s decided to abandon the gold standard rule (see Figure A) that did not seem to be able to solve such substantial issues.

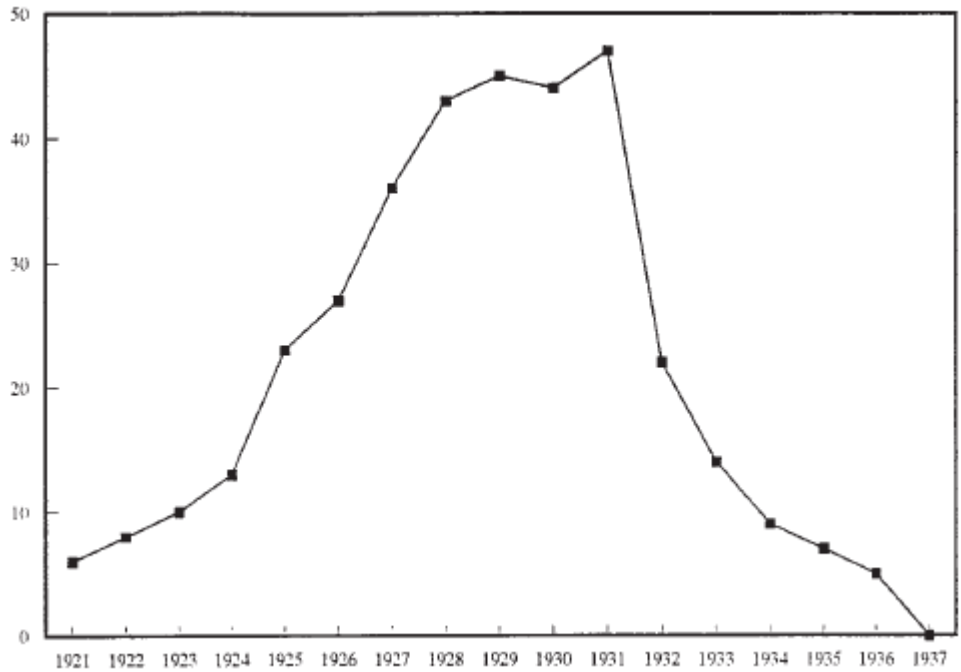


Figure A. **Number of Countries on the Gold Standard, 1921–37.** ***Source:*** **Palyi 1972**

The Bretton Woods system

Bretton Woods system came in a period that the most powerful countries in the world, disappointed by the gold standard and inspired by the capitalism ideology, tried to find a new way to boost the international trading. Thus, in 1944, on July, they

signed the important Agreement after a conference of 20 days at the Mount Washington Hotel in Bretton Woods, New Hampshire, in United States.

As Eichengreen states (2008), the Bretton Woods System departed from the gold-exchange standard in three fundamental ways. Pegged exchange rates became adjustable, subject to specific conditions (namely, the existence of what was known as "fundamental disequilibrium"). Controls were permitted to limit international capital flows. What is more, a new institution, the International Monetary Fund (IMF), was created to monitor national economic policies and extend balance-of-payments financing to countries at risk. These innovations addressed the major worries that policymakers inherited from the 1920s and 1930s. The adjustable peg was an instrument for eliminating balance-of-payments deficits—an alternative to the deflationary increases in central bank discount rates that had proved so painful between the wars. Controls were designed to avert the threat posed by volatile capital flows of the sort that were disruptive in both interwar decades. And the IMF, armed with financial resources, powers of surveillance, and a *scarce-currency-clause*, could sanction governments responsible for policies that destabilized the international system and make them compensate the rest of countries that were adversely affected.

At this point, it is worth to state the Eichengreen's reference to the lessons that Bretton Woods system gave to the governments and the central bankers. At first, it showed an inadequacy of the available adjustment mechanisms as well as a great difficulty of operating a system of pegged exchange rates in the presence of highly mobile capital. For instance, as international capital mobility rose over the 1960s, governments thought to be contemplating devaluation exposed their currencies to attack by speculators. A willingness to devalue once gave rise to expectations that the authorities might devalue again, given their manifest reluctance to pursue deflationary policies. This produced a refusal to devalue at all.

It was also shown that a system of pegged currencies, such as Bretton Woods, demands a strong international cooperation and support among its members especially when it is part of an interlocking web of political and economic groups. However, the cooperation and the support among its members created a great risk of moral hazard occurrence. Before, the strong interdependence between the countries that was created

by the Bretton Woods system, governments and central banks were certain to take all the fiscal and monetary measures in order to defend their gold parities. Under

Bretton Woods, in contrast, there were reasons to doubt that adjustment would take place. As Reichengreen again states, cooperation, while extensive, ran up against binding limits. The inevitability of such limits in a politicized environment is the last but not least lesson of Bretton Woods.

The floating exchange rates

The demise of the Bretton Woods international monetary system in 1973 transformed international monetary affairs when exchange rates were allowed to float (see Eichengreen 2008). The main reason was, as it was referred above, the substantial rise of capital mobility. The fear of massive capital outflows every time that a country considered a parity change was a substantial disadvantage of the previous system. Thus, the floating exchange rates came to the surface and ever since central banks and governments had been aware of the instrument that came to be known as monetary policy, in which a stable and low inflation level as well as the prevention of any possible recession have been the paramount goals.

This international decision for the floating exchange rates was for sure a leap in the dark. No one could really forecast what would really happen. As Eichengreen (2008) states, two groups of thoughts were shown up those days. The one side believed that the demise of par values removed the problem of one-way bets and persistent misalignments. Floating rates would settle down to equilibrium levels from which they would have little tendency to diverge. The contrary and more pessimistic view however, was that the world was about to enter a dangerous era of financial turmoil and instability.

However, the true finally was somewhere in the middle of the two contrarian views. As Eichengreen (2008) again explains nominal and real exchange rates proved to be more volatile not only than they were in the past but also than the academic proponents of floating had predicted. Nominal rates frequently moved by 2 or 3 percent a month; their variability greatly exceeded that of relative money supplies and

other economic fundamentals. Real rates were also volatile (see Figure B). Still, there was not the financial chaos the opponents of floating had anticipated.

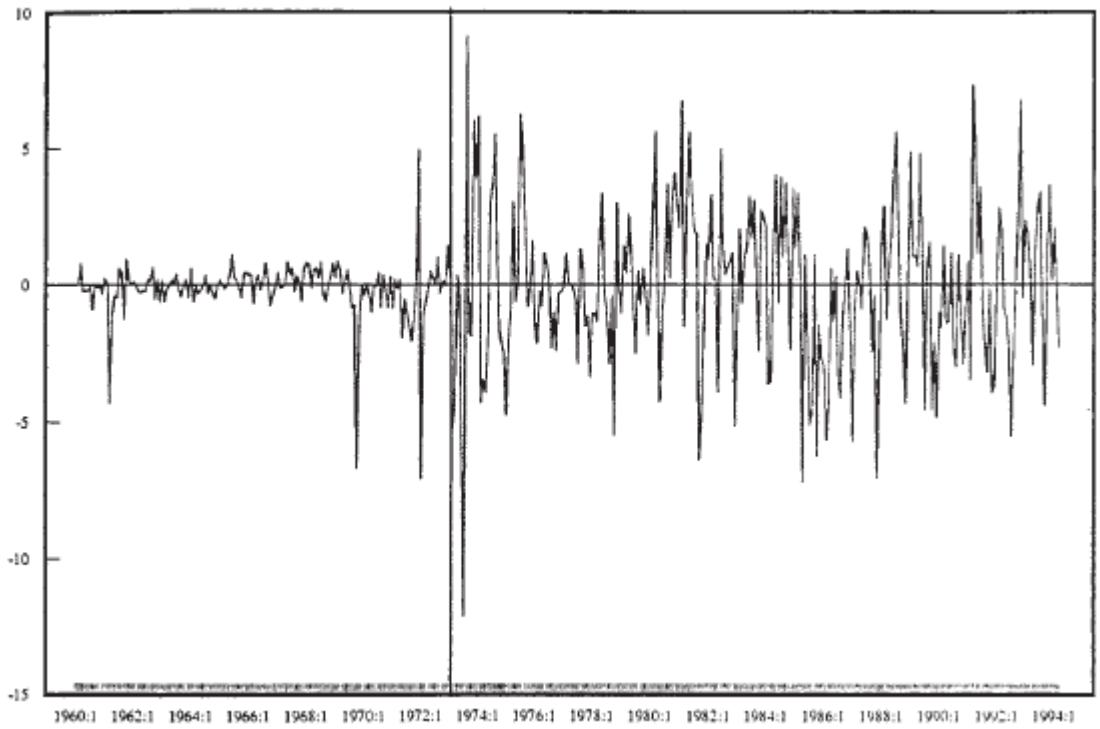


Figure B. **International Monetary Fund, International Financial Statistics various years.**

A new European Bretton Woods system and the born of EURO

The creation of the European Monetary system in 1979 came to disturb the world of floating exchange rates. A group of European countries, led by Germany and France, took the decision to create a European monetary system with relatively pegged exchange rates in order to enhance the trading among them and create stronger bonds that would lead to the federal Europe.

As Eichengreen states, the French were the owners of the idea of the EMS (European monetary system). In fact, they had never wavered in their support for pegged rates. Thus, when the country was forced at Rambouillet to abandon the effort to establish such a system globally, President Valry Giscard d'Estaing redirected his efforts to stabilizing the critical franc/deutsche mark rate. Thus, French officials sought the construction of a sturdier structure within which intra-European exchange rates could be held. Critical to the success of their initiative was the cooperation of the German

government. Giscard's German counterpart, Federal chancellor Helmut Schmidt, saw the creation of the EMS as a logical step toward the political integration of Europe.

The two leaders finally achieved to create the European Exchange Rate Mechanism, in which all the European members agreed to participate except for UK. The currencies of countries agreeing to abide by the Exchange Rate Mechanism (ERM) were to be held within 5 percent bands, as they had been in the final years of the Bretton Woods System. Capital controls were permitted as a way of preserving governments' limited policy autonomy and of giving them the breathing space to negotiate orderly realignments.

In years that followed the majority of new European members also participated in the European monetary system. The Maastricht Treaty, in 1991, was the next substantial step for the European integration.

The aforementioned treaty had three basic stages, in the duration of which, each country member should had accomplished some specific tasks. Eichengreen (2008) describes in detail the three key stages in great detail. At first, Stage I, which commenced in 1990, was to be marked by the removal of capital controls. Member countries were to fortify the independence of their central banks and to otherwise bring their domestic laws into conformance with the treaty. Stage II, which began in 1994, was to be characterized by the further convergence of national policies and by the creation of a temporary entity, the European Monetary Institute (EMI), to encourage the coordination of macroeconomic policies and plan the transition to monetary union. If the Council of Ministers decided during Stage II that a majority of countries met the preconditions, it could recommend the inauguration of Stage III, monetary union. But to prevent Stage II from continuing indefinitely, the treaty required the EU heads of state or government to meet no later than the end of 1996 to determine whether a majority of member states satisfied the conditions for monetary union and whether to specify a date for its commencement. If no date were set by the end of 1997, Stage III would commence on January 1, 1999, if even a minority of member states qualified. When Stage III began, the exchange rates of the participating countries would be irrevocably fixed. The EMI would be succeeded by the ECB, which would execute the common monetary policy.

The first years after the Treaty were really difficult for the majority of the countries-members. In fact, countries such as Italy, France and Finland felt a substantial pressure to weaken their currencies at the exchange rate with mark. This pressure was a start of a great not only financial but also political crisis among the members that at the end had been led in the decision of loosening the bands of their exchange rates.

The major causes of this crisis were two. At the one side, this substantial pressure was born due to the great accumulation of excessive inflation rates compared to Germany. This fact had as a result the lack of competitiveness compared to Germany which led to increasing account deficits a fact that boosted the pressure for devaluation. Matters made worse because of the reluctance of the German government to follow a more inflationary policy in order to help the rest of countries to come in equilibrium. However, the inflation rates were not the only cause. An equally damaging event for the 'weak' countries was the speculative attacks in their currencies. Eichengreen (2008) describes this fact as an example of a self-fulfilling prophecy. He states that even the case that the budget is balanced and that the external accounts are in equilibrium a speculative attack can create major problems. In such a case, the authorities must allow domestic interest rates to rise to ensure its defense, since speculators must be rendered indifferent between holding domestic currency denominated assets, on which the rate of return is the domestic interest rate, and foreign-currency-denominated assets, the return on which is the foreign interest rate plus the expected rate of depreciation. But the requisite rise in interest rates may itself alter the government's assessment of the costs and benefits of defending the rate. The higher interest rates required to defend the currency will depress absorption and aggravate unemployment, also aggravating the pain of the prevailing policies. They will increase the burden of mortgage debt, especially in countries where mortgage rates are effectively indexed to market rates. They will induce loan defaults, undermining the stability of fragile banking systems. They will increase debt-servicing costs and require the imposition of additional distortionary taxes. Enduring austerity now in return for an enhanced reputation for defending the exchange rate later may become less appealing if a speculative attack increases the cost of running the first set of policies. In such circumstances, he concludes, a speculative attack can

succeed even if, in its absence, the currency peg could and would have been maintained indefinitely.

Fortunately as Eichengreen states, in 1993, the situation began to change. With expansion underway in the United States, expansion followed in Europe. If further austerity measures were needed to prepare for monetary union, it would now be easier to implement them against the backdrop of more vigorous growth. European policymakers, for the most part, reaffirmed their commitment to completing the transition to monetary union.

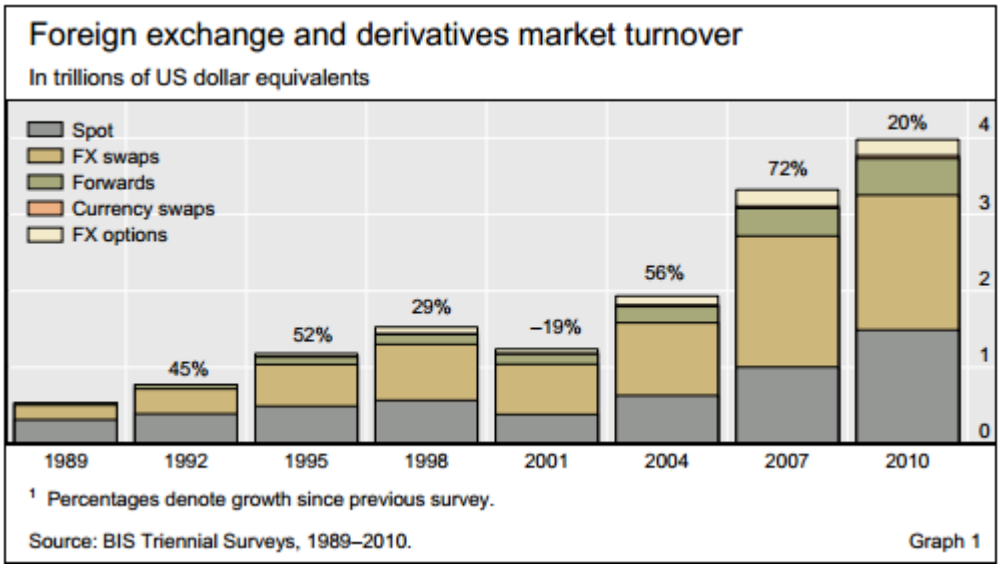
Some years later the European currency, the euro, was introduced at first as an accounting currency in 1999, and later as paper and coin money in circulation on 1st January 2002.Nowadays, seventeen of the twenty seven European countries are members of the European monetary union: Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, the Netherlands, Portugal, Slovakia, Slovenia, and Spain.

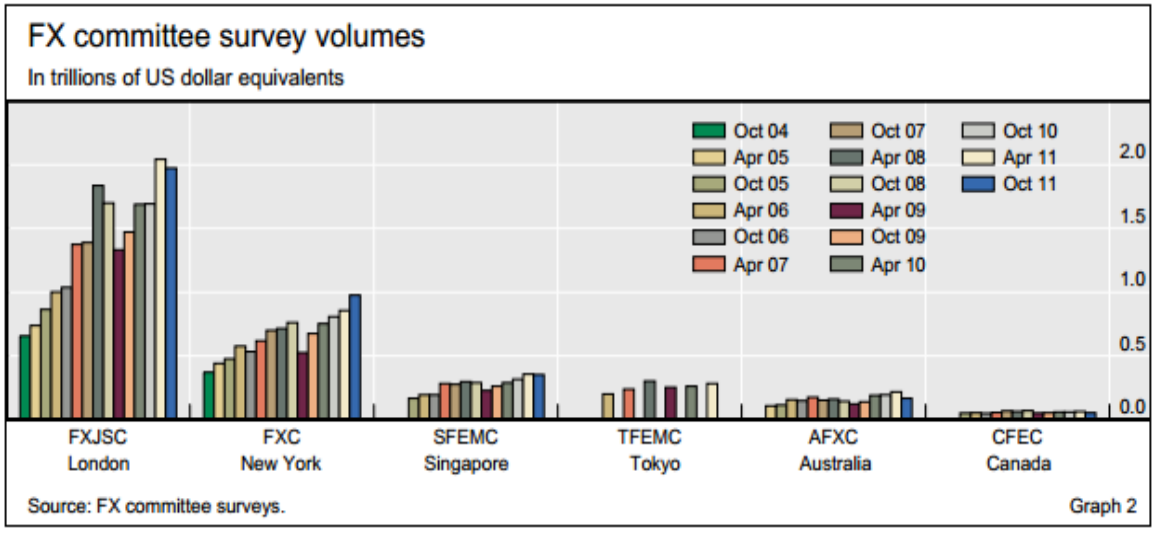
The changes that each country faced with the acceptance of euro as a currency were substantial. They completely understand that the monetary policy was no longer a sovereign but a European policy that European central bank would operate for all Eurozone members. However, besides from the disadvantage of the dependent monetary policy (which for some members is always too tight and for the rest too loose), great advantages took place. For the 'export' countries, such as Germany, it was far easier from that point of time to sell its products to the periphery of Eurozone who took the role of the 'consumers' in the monetary union. The periphery on the other hand, had another great advantage. Entering the monetary union meant that interest rates, which had been high owing to poor prior finances, came down abruptly to French and German levels. Borrowing costs having fallen, households went on a consumption binge and firms rushed to invest. Their additional demands pushed up wages, often dramatically (Eichengreen 2008). Once the party was over, due to the global financial crisis in 2007-2008, the countries then found themselves with excessive wages, lagging competitiveness, and rising unemployment, and large sovereign debts, a situation that even nowadays could not be solved by the Eurozone.

The forex market nowadays

Forex: One of the biggest capital markets

According to the Bank of International Settlements forex trading activity averaged 4 trillion dollars a day in April 2010 and somewhere in 4.7 in October 2011.Thus,it could be easily understood that forex market nowadays is a vast market with substantial daily volumes and an increasing trend (Between 2001 and 2010 turnover in the FX market grew by over 250 percent, see graph 1).What is more, it should be also stated that forex market is divided into some core submarkets that operates all over the world 24 hours 5+ days per week(see graph 2),with London and New York markets being the most 'crowded'.





The players of forex markets

Financial institutions, part 1

Investment banks and hedge funds

Financial institutions are a diverse category that includes hedge funds and other asset managers, regional and local banks, broker-dealers, and central banks (King,Osler, 2011). Relative to corporate customers, financial institutions trade larger amounts and hold forex positions for far longer. Financial institutions tend to be better informed than other end-users as they have strong incentives to invest in information acquisition.

Among financial institutions, leveraged institutional investors – meaning mostly investment banks and some hedge funds appear to be the best informed, by using software that is created by a group of the best programmers in the world. This finding seems logical since leveraged institutional investors face particularly intense incentives to acquire information.

Leveraged currency funds, which grew dramatically during the late 1990s, are known to favor well-defined speculative strategies focused on four factors: fundamentals, interest differentials (i.e. the carry trade), momentum, and volatility (King,Osler, 2011). A worth-mentioned strategy that these funds use is the stop loss hunting. It is a kind of momentum strategy that uses the important information about the spot prices at which is accumulated a substantial amount of stop losses. For example, a

hypothesis can be made that a large investment bank has the information that an important group of traders, who have a short thesis in eur/usd exchange, have their stop losses somewhere in1.30 (on average).If the spot price stands somewhere in 1.2980, the bank could gradually become a buyer and influence the price (only a bank with a great amount of money can influence a price) in order to surpass the 1.3 level. At that time a great group of stop losses* will be activated and will lead the price to the 1.312-1.314 level. Thus, at this moment, the bank could close its buy positions with a profit of 40-60 pips*, which equals to a great amount of money. A historical example could be seen in the following 4 hour-chart (Figure I) when a great amount of stop losses activated when the usd/jpy surpassed the 100 level. It is also worth to be mentioned that this jump of price was made only in a couple of minutes as we see in the second 5 minute chart (Figure II).

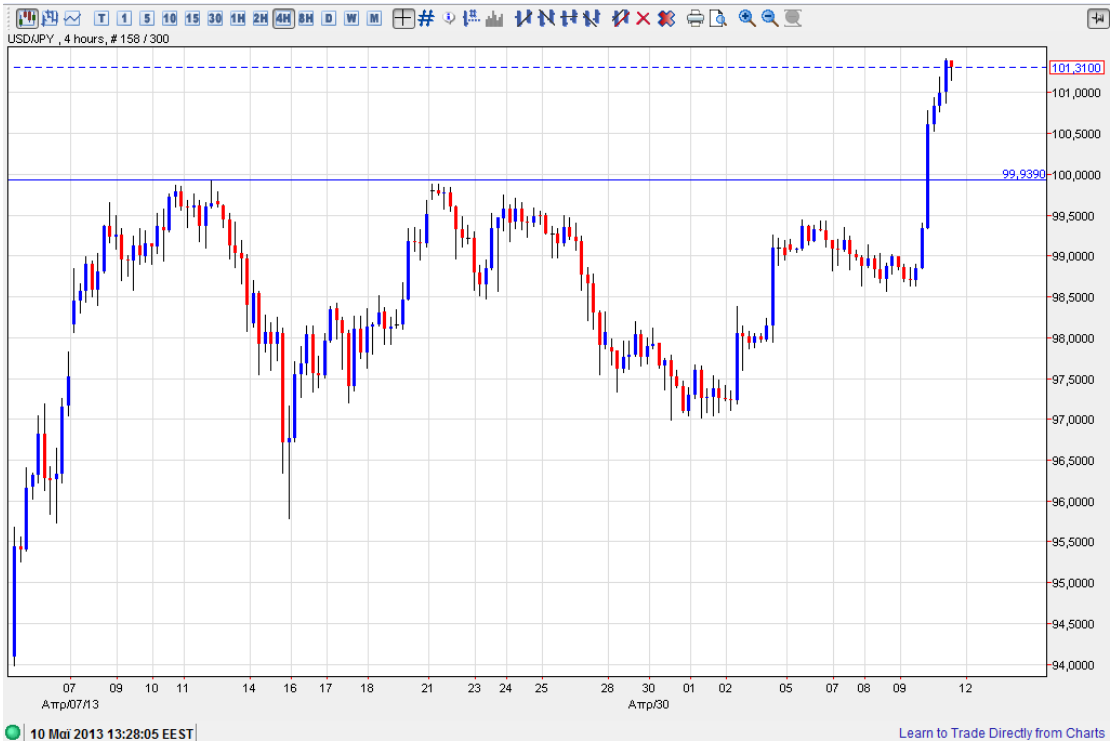


Figure I. The usd/jpy price rocketed after it surpassed the 100 level.sorce dailyfx.com

* Stop-loss: An order placed with a broker to sell a security when it reaches a certain price. A stop-loss order is designed to limit an investor's loss on a security position.

*Pip: The smallest price change that a given exchange rate can make. Since most major currency pairs are priced to four decimal places, the smallest change is that of the last decimal point - for most pairs this is the equivalent of 1/100 of one percent, or one basis point.

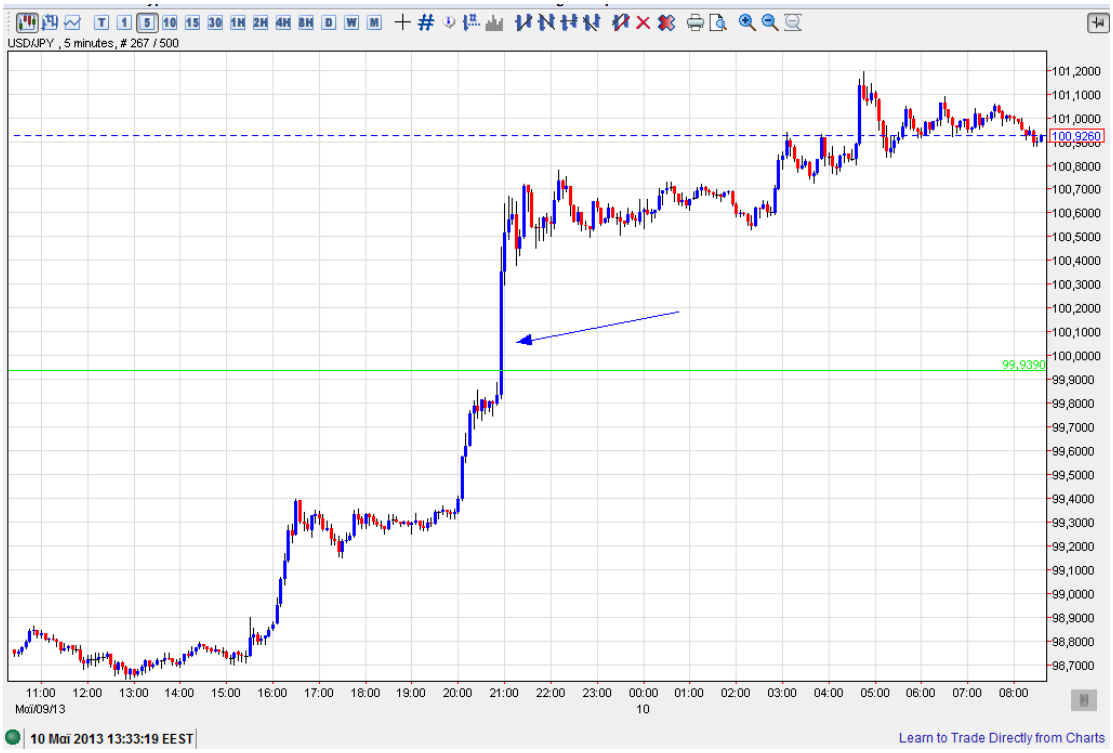


Figure II. The price jumped 40 pips in one five minute candlestick.

Financial institutions, part 2

Mutual and pension funds

Unleveraged asset managers ("real-money investors") include mutual funds, pension funds, endowments, and insurance firms. Perhaps surprisingly, such funds often pay little attention to the exchange rate component of returns when choosing asset allocations (Taylor and Farstrup, 2006). Instead, they concentrate on maximizing expected returns to foreign assets measured in the asset's home currency. Thus, they not operate in forex markets in a speculative manner but in a rather 'hedging' way. By following a hedging strategy the aforementioned institutions try to make the profitability in long-term foreign investments independent to the forex market fluctuations.

Corporate customers

Corporate customers use FX markets to support the treasury operations associated with their core business activities such as mining, shipping, and manufacturing. As

such, corporations primarily use foreign currencies as a medium of exchange, trade relatively small amounts, and hold these positions only briefly(Osler,King,2011). Most corporate customers choose not to engage in speculative forex trading because of the short time nature of their forex market positions (that reduces their risk exposure).What is more, a speculative operation would demand an extra staff such as currency analysts and software that would boost their operation costs in a sector that is not their core activity.

Thus, as King and Osler explain (2011), corporations typically use the forex markets for one side of each exposure. For instance, when a US multinational needs Euro to pay taxes in Germany, for example, sells US dollar to buy the euro in the forex market but then delivers the currency directly to the German government, bypassing the forex market entirely. Similarly, a Japanese exporter of manufactured goods to the United States receives US dollars from the American importer and then sells them in the forex market.

Finally, it should be mentioned that corporations like pension and mutual funds, make use of the options and futures in forex markets in order to stabilize their money flow from a future international transaction.

Retail traders

The retail side of the market, or the retail investors, is the final part of the forex markets. This group consists of individuals that are speculating the currency markets with a relative small amount of money. Some years before the aforementioned group was just a tiny part of the market, but the boost of internet as well as the reduction of spreads* that forex brokers charge, led retail trading to a substantial growth. It is worth to be mentioned that retail traders make their transactions not directly in the market but through the forex broker companies. These "retail aggregators"—accounted for 18% of volume in the 4+ trillion-dollars-a-day currency market, according to the latest annual survey by consultancy Greenwich Associates.

Finally, it should be stated that the retail traders are the less profitable of the market. As it is shown at the tables below, according to fxcm only a percent of 25% are profitable each quarter of the year. This fact is completely natural, if someone states

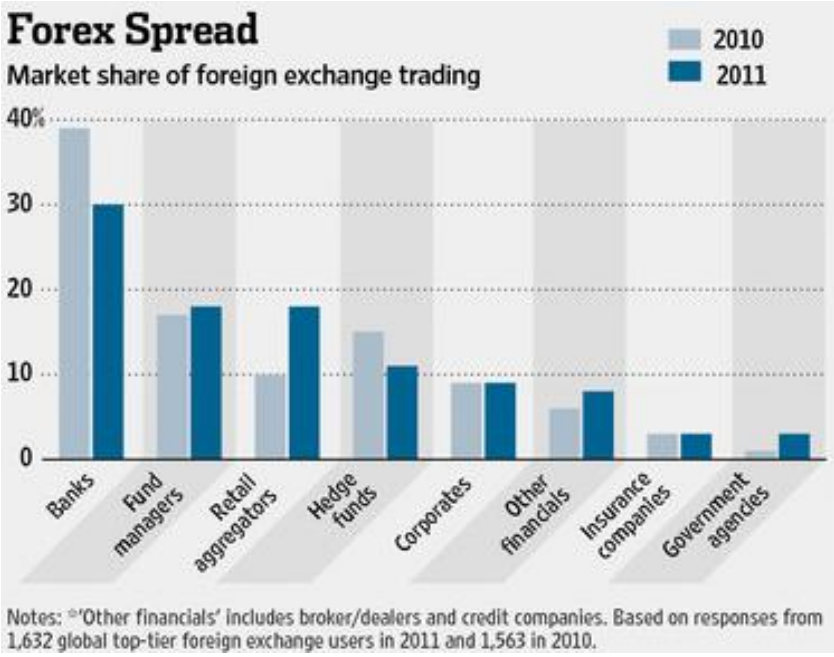
that this part of the market is the least educated, informationed and with the worst trading software.

Quarterly Report	% Profitable	% Unprofitable	Total Non-Discretionary Accounts
Sep - Dec, 2009	26%	74%	22,371
Jan - March, 2010	25%	75%	19,049
April - June, 2010	23%	77%	17,771
July - Sep, 2010	23%	77%	15,023

Source: www.trading-gurus.com

Forex market concentration

The aforementioned groups of investors among with some smaller groups are sharing the total volume of 4+ trillion dollars a day. However, it is worth to be stated that forex market should be considered as substantially concentrated with the group of investment banks being the major player(see graph A).What is more, the share of the aforementioned group is also highly concentrated with a couple of banks having accumulated the greatest part of it (see graph B).



Graph A source: Greenwich associates

Top 10 Currency Traders % of overall volume, May 2007 Rank	Name	% of volume
1	Deutsche Bank	19.30
2	UBS AG	14.85
3	Citi	9.00
4	Royal Bank of Scotland	8.90
5	Barclays Capital	8.80
6	Bank of America	5.29
7	HSBC	4.36
8	Goldman Sachs	4.14
9	JPMorgan	3.33
10	Morgan Stanley	2.86

Graph A. source: euromoney.com

The forex regulatory agencies

Due to its decentralized nature, forex markets do not have a single central regulator agency, and thus its role is being shared by a couple of institutions that each of them is responsible for a geographical region. The most important because of the volume of the transactions that are responsible for, are the **National Future Association** (NFA) and **the Commodity Futures Trading Commission** (CFTC) in US, and the **Financial Conduct Authority** (FCA) in UK. These three institutions (in cooperation with some smaller) have to oversee the daily trading (interbank and non-interbank activity) and prosecute cases of fraud in order to protect the investors-traders.

Because of the importance of the aforementioned institutions it is worth to state some more details about their mission, their organization as well as their size.

Commodity Futures Trading Commission (CFTC) (see www.cftc.gov)

At first, CFTC was created by the in 1974 as an independent agency with the mandate to regulate commodity futures and option markets in the United States. The agency's mandate has been renewed and expanded several times since then, most recently by the Dodd-Frank Wall Street Reform and Consumer Protection Act.

In 1974 the majority of futures trading took place in the agricultural sector. Today, the CFTC assures the economic utility of the futures markets by encouraging their competitiveness and efficiency, protecting market participants against fraud, manipulation, and abusive trading practices, and by ensuring the financial integrity of

the clearing process. Through effective oversight, the CFTC enables the futures markets to serve the important function of providing a means for price discovery and offsetting price risk. It is worth to be mentioned that nowadays CFTC have the oversight of 250 trillion dollars only in swaps markets.

Finally, the core divisions of its operations are the following:

Clearing and Risk (DCR)

The Division of Clearing and Risk oversees derivatives clearing organizations (DCOs) and other market participants in the clearing process, including futures commission merchants, swap dealers, major swap participants and large traders. It monitors the clearing of futures, options on futures, and swaps by DCOs, assesses DCO compliance with Commission regulations, and conducts risk assessment and surveillance. DCR also makes recommendations on DCO applications and eligibility, rule submissions, and which types of swaps should be cleared.

Enforcement (DOE)

The Division of Enforcement investigates and prosecutes alleged violations of the Commodity Exchange Act and Commission regulations. Potential violations include fraud, manipulation and other abuses concerning commodity derivatives and swaps that threaten market integrity, market participants and the general public.

Market Oversight (DMO)

The Division of Market Oversight fosters derivatives markets that accurately reflect the forces of supply and demand and are free of disruptive activity. It oversees trade execution facilities and data repositories, conducts surveillance, reviews new exchange applications and examines existing exchanges to ensure compliance with applicable core principles. DMO also evaluates new products to ensure they are not susceptible to manipulation as well as rule filings by exchanges to ensure compliance with core principles.

Swap Dealer and Intermediary Oversight (DSIO)

The Division of Swap Dealer and Intermediary Oversight oversees the registration and compliance of intermediaries and futures industry self-regulatory organizations

(SROs), including U.S. derivatives exchanges and the National Futures Association (NFA). Under Dodd-Frank, DSIO also will be responsible for developing and monitoring compliance with regulations addressing registration, business conduct standards, capital adequacy, and margin requirements for swap dealers and major swap participants.

National Future Association (NFA) (see www.nfa.futures.org)

In 1974 Congress established the Commodity Futures Trading Commission (CFTC), a federal regulatory agency with jurisdiction over futures trading. The same legislation authorized the creation of "registered futures associations," giving the futures industry the opportunity to create a nationwide self-regulatory organization, that together they form a regulatory partnership that oversees all industry participants.

One of the most important associations of the above system is the National Futures Association (NFA), which was created in 1982. Nowadays, NFA has more than 4200 firms and 55000 associates who must adhere to the same high standards of professional conduct.

The core regulatory activities of NFA are:

- Auditing and surveillance of Members to enforce compliance with NFA financial requirements;
- Establishing and enforcing rules and standards for customer protection;
- Providing an arbitration forum for futures and forex-related disputes;
- Screening to determine fitness to become or remain an NFA Member.

Finally, it is worth to be mentioned that NFA has no funding from the federal government (and so from the taxpayers), and thus it is solely funded by its members and its operational revenues.

Financial Conduct Authority (FCA) (see www.fca.org.uk)

FCA supervises the conduct of 26000 financial firms in UK and regulates the prudential standards of 23000 of those. They intervene when firms:

- treat consumers unfairly
- behave in ways that risk the integrity of the market

Depending on the size and the nature of the business of the firms FCA makes the following activities:

- Continuous conduct assessment for large firms and regular assessment for smaller firms.
- Monitoring products and other issues to ensure firms play fair and don't compromise consumer interests.
- Responding quickly and decisively to events or problems that threaten the integrity of the industry.
- Ensuring firms compensate consumers when necessary.

Finally, it should be stated that FCA is accountable to the Treasury, which is responsible for the UK's financial system, and Parliament. However, it is worth to be mentioned that it is an independent body and does not receive any Government funding. The FCA is funded entirely by the financial services firms that regulates.

Is it for sure, that the forex market is a freely fluctuated market?

As it was stated before, in 1973 there was an international decision to let the exchange rates move in freedom, with the supply and demand of each currency to be the only factors that cause a move in a currency exchange. However, even nowadays, and contrary to the several announcements of G7 or G 20 countries that are strongly opposed to any intervention in forex market prices, we can easily find several examples that a central bank indeed intervened in order to weaken its strong currency (see the charts below). Thus, it should be clearly understood that there are many evidences of a world-spread currency war, in which all the major economies trying to weaken their currencies, in a try to boost their competitiveness and enhance their GDP growth.

Chart 1.In this example(daily chart) we can easily see the two major and direct interventions of the Japanese central bank (marked by the two ellipses) in order to weaken the yen relative to the us dollar.(dates:4th of August 2011,30TH Of October 2011),source:www.ducascopy.com

Chart 2.At this hourly chart we are zooming in the first of the aforementioned interventions,

where we can see the 'violence' of the move with the us dollar advancing relative to yen close to 200 pips in 2 hours (blue ellipse),source:www.dukascopy.com

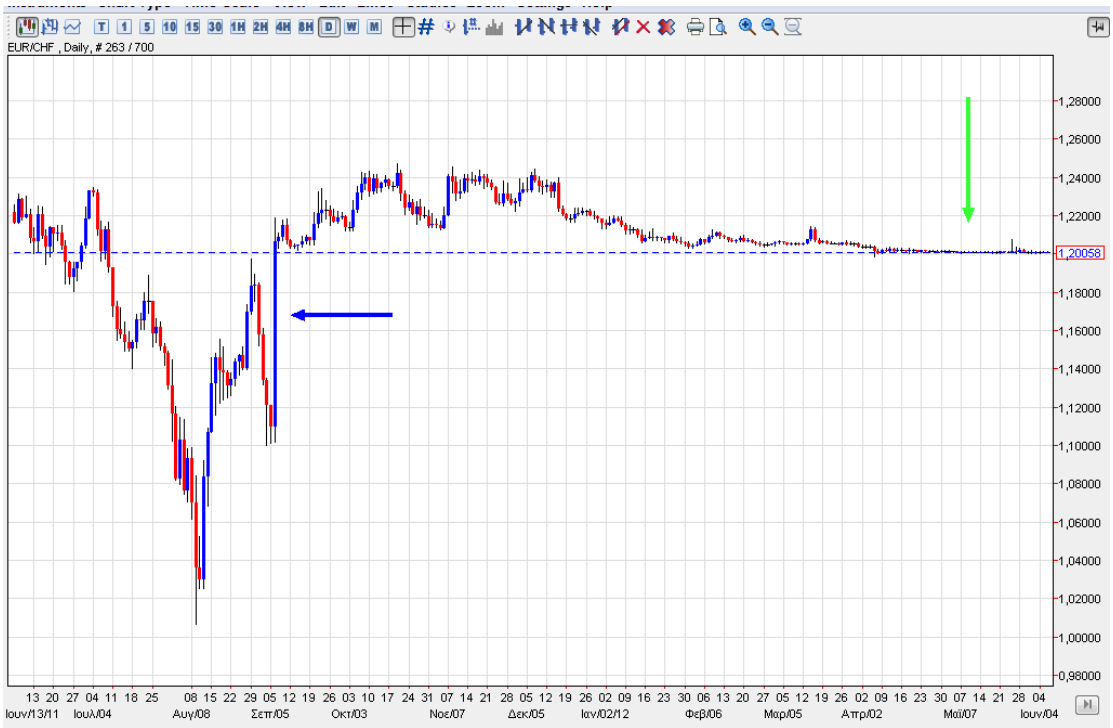


Chart 3.At this daily chart we can see an even more aggressive intervention from the Swiss central bank. We can see that in this case the central bank not only weaken its currency relative to euro in an amount of over 1000 pips,(blue arrow,date:6th of September 2011), but also create a support floor in 1,2 eur/chf under of which it has not allowed any move of the price(see the area of consolidation above the 1,2 ,marked with the green arrow). , source: www.dailyfx.com

After all, is forex an efficient market?

As Fama stated in his PhD thesis, the efficient-market hypothesis (EMH) asserts that financial markets are "informationally efficient". Thus, one cannot consistently achieve returns in excess of average market returns on a risk-adjusted basis, given the information available at the time the investment is made.

So, what does Fama mean by the "informational efficiency" term? The strong-form EMH additionally claims that prices instantly reflect even hidden or "insider" information. Although the efficient-market hypothesis has become controversial, because substantial and lasting inefficiencies are observed (see Nicholson 1968 and Basu 1977), it remains, especially for the stock markets, the dominant theory.

However, in the foreign exchange markets the efficient-market hypothesis is far less strong because of the asymmetric information. As Frankel and Galli stated (1996) banks and other financial institutions have access to information that the rest traders do not have. This information includes accumulated orders to sell or buy or stop loss orders, all of them positioned in specific prices that some institutions legally know. Even this phenomenon takes place also in other markets, the forex market is, because of its highly concentration, as we mentioned above, a place that can effectively used in order to gain some profits.

What is more, forex market, as the majority of markets, because of the substantional transaction volume (see Tobin 1978), especially in some times of month, tends to overreact. This phenomenon of the excessive volatility or market overshooting (see Garner 2012) could be easily found in several examples (see figure 1.1, 1.2, 1.3).

All in all, the aforementioned issues show us the substantial weakness of the EMH application in foreign exchange markets. Thus, the fact that forex is not at least a strong efficient market makes technical or/and fundamental analysis a really powerful tool for the investors in order to "beat the market".

Figure 1(source:www.ducascopy.com)

We **can see the price of EUR/USD jumping up to 40 pips in less than 15 minutes, only to be completely retraced in less than 2 hours(13:30-15:15 GMT+2 time).**

Figure 2(source:www.ducascopy.com)

We **can see the price of EUR/USD jumping up to 40 pips in less than 15 minutes(blue box), only to be completely retraced in less than 2 hours(08:45-10:15 GMT+2 time) by another big candle that this time falls substantially by 50 pips(red box),only to be also retraced in the end of the London session(around 17:30 GMT+2 time).**

The two schools of thought: technical and fundamental analysis

As it was above referred, technical and fundamental analysis are the two ways that investors (or traders) use in order to "beat the market". These two aspects of trading have different points of view for the forecasting of the markets.

The technical analysis fans, believe that the charts can give a clear picture of the aggregate behavior of bulls and bears (buyers and sellers) and thus, help the investor forecast the next move of the market. Technical analysts do not accept the theory of random walk, on the contrary, they believe that specific patterns are repeatedly shown in all the markets and give signals for the future direction of the markets. They state that these patterns are the result of human behavior that does not change throughout the years. Human feelings that dominate the investors such as greed and fear had the same results in the past, and probably will have the same in the future. Apart from the

patterns technicians usually use indicators such as MACD and RSI in order to have better forecasts.

On the other hand, "fundamentalists" focus on financial statements in order to decide their investments. By looking at the balance sheet, cash flow statement and income statement, a fundamental analyst tries to determine a company's value. In financial terms, an analyst attempts to measure a company's intrinsic value. In the case of currencies (forex), "fundamentalists" focus on indicators such as GDP, inflation, balance of payments, as well as central bank's policy and government stability in order to evaluate a pair of currencies and forecast its future price. It should be also referred, that this way of trading has a longer term time horizon than technical analysis at least of some weeks or months in order to have profitable results.

Even though the above points of view seem completely opposite, it should be stated that there are many investors-traders that make use of both tools. For instance, a trader could focus the fundamental aspect of two currencies in order to evaluate their strengths and weaknesses and decide which of them will devalue relative to the other. Consequently, with the bullish or bearish bias that he obtained through the above process, the investor could search for technical signals in order to accordingly buy or sell the pair. A clear example of a very profitable "cooperation" between technical and fundamental analysis is shown at the figure 1.3.

Figure 3(source: www.dailyfx.com)

We **can see the daily price of EUR/USD breaking the resistance of the one year descending channel (strong technical signal), an event that followed the announcement of European central banker mr.Draghi (one day**

before) that the ECB is going to purchase an unlimited amount of short term bonds issued by struggling European nations in order to save the euro(important fundamental event). A buy of eur/usd after the confirmation of the technical signal would made a profit of 1000 pips in less than 6 months.(EUR/USD in September 6th: 1.27-EUR/USD in February 1st :1.37)

Pairs trading

Could it be a profitable strategy in forex markets?

The above conclusion that forex markets do not "obey" in the efficient market hypothesis, created the incentive to make a try and apply a pairs trading strategy, the method of cointegration of two highly correlated pairs. However, before we proceed to our strategy it seems good to make a reference to some information about the pairs trading in general.

Pairs trading history

Pairs trading or statistical arbitrage was first developed and put into practice by Nunzio Tartaglia, while working for Morgan Stanley in the 1980s. Tartaglia formed a group of mathematicians, physicists and computer scientists to develop automated trading systems to detect and make use of mispricings in financial markets. One of the computer scientists on Tartaglia's team was the famous David Shaw. Pairs trading was one of the most profitable strategies that was developed by this team. With members of the team gradually spreading to other firms, so did the knowledge of pairs trading.

Pairs trading, the "neutral" strategy

In order to make the reader clearly understand what the pairs trading is, we should state how the pairs trading is defined and what are the conditions that will make the use of this strategy profitable. Pairs trading is a neutral long/short investment strategy. This means that the trader do not have to forecast the future direction of a market in general or an asset in specific. Thus, without having to forecast a future direction, the only thing that the trader should focus is in finding assets that historically have almost the same price patterns. In other words, the investor should find a pair of assets of

which their prices have a relevant stable spread* historically, no matter what the conditions of the market are in any point of time.

The scanning for possibly suitable pairs

It is clearly understood that the finding the two assets that the spread or the ratio of their prices seems to be mean reverting* is the first key step in any pairs trading strategy. But, how can we easily find assets that are looking as possible strong candidates for a pairs trading strategy? The answer here has both technical and fundamental approach. At first, an investor could use its fundamental knowledge in order to spot assets that has key characteristic. Both of them are influenced by the same economic factors, in the same way (positive or negative), with the same sensitivity (their prices tend to react with the same intensity). In the case of the stocks this research it is far easier with the great help of the beta* of each stock.

As far as the technical approach, a simple yet powerful method in order to find some possible pairs is the "screening". A trader can easily take to assets that passed his "fundamental test" as mentioned above, and make a comparison of their graphs for a duration of some years (five years seems to be an adequate period). Thus, if the historical price actions of the two assets seems to have a great resemblance (see charts below), it could be concluded that this pair has a strong possibility to be suitable for pairs trading and thus it should be further tested.

Finally, at this point, it is important to be stated that, the above simple process is only responsible for scanning possible suitable pairs and do not indicates that a pair that "passed" successfully these tests could be indeed the objects of a pairs trading strategy.

ALPHA BANK **NATIONAL BANK OF GREECE**

At the above charts we can easily understood the process of "screening". In this case we chose two stocks that are in the same sector (banking sector), in the same country-market (Greece).As we can see the screening test in this example is successful, because of the resemblance of the price action of the two stocks (the data of the prices in both cases are from 14/05/2008 up to 14/05/2013),source: www.capital.gr

The most widely accepted "pairs trading" approaches

The distance approach

After the completion of the aforementioned test, the investor can follow several approaches. The first one is the use of the distant approach or the sum of squared differences between the two normalized price series.

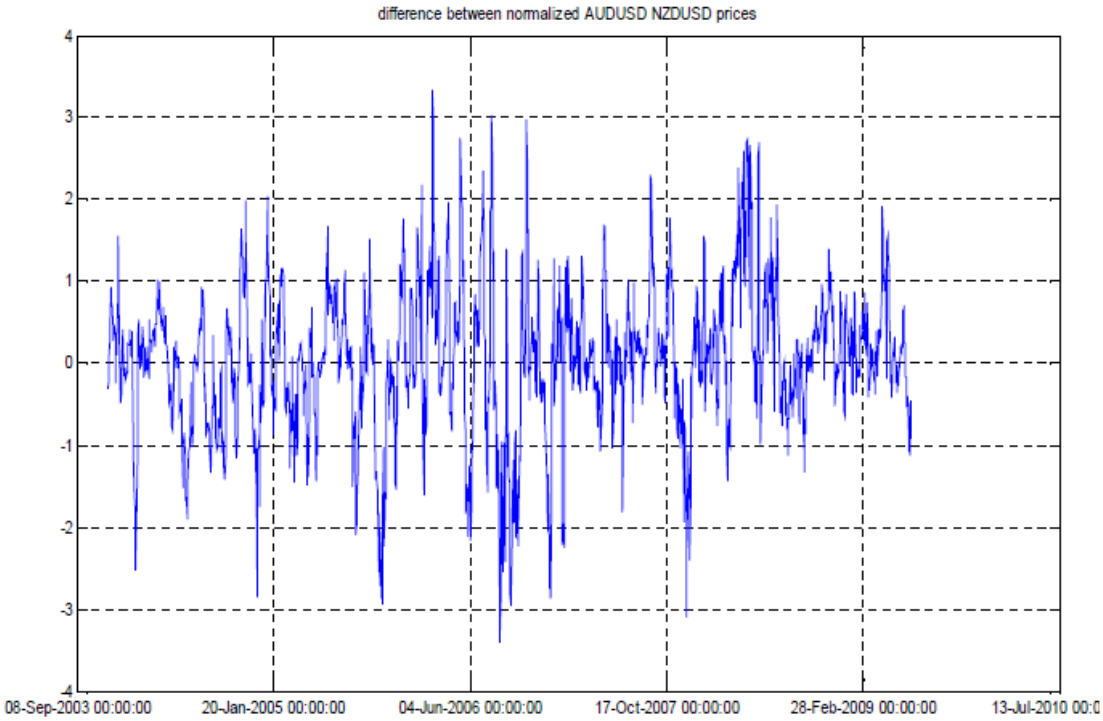
Thus we can divide this method into three steps. At first, the price series of the two assets should be normalized. In order to do this, one should make the following estimations:

$$P_{it} = (p_{it} - E(p_{it}))/\sigma$$

Where p_{it} is the price of asset i at time t, P_{it} is the normalized price of asset i at time t, $E(P_{it})$ is the expectation of P_{it}, (in this case the average, and σ is the standard deviation.

The next step is to find the squared differences between the prices of the two assets and finally aggregate them. The pairs that have the smallest “distance” numbers are the most suitable for pairs trading (Gatev, 1999) and the final phase of the current approach.

At this last step, the investor makes a graph with the differences of the normalized prices of the assets of the pair. If the graph shows a mean reversion (see the chart below) we can apply the pair trading method with the use of upper and lower bounds that the trader use in order to “call” the one asset overbought and other oversold. Thus, at the points of time that the bounds are being hit (usually at the second time in order to have a reversion of the move of the difference) ,the trader buys the oversold asset and sells the other in an analogue amount.



Source: www.forexfactory.com

The cointegration approach

Cointegration refers to a relationship between non-stationary*, unit root processes (Engle, Granger, 1987).

The existence of a cointegration relationship between two variables has the following economic intuition. When two series are cointegrated it suggests that even though both processes are nonstationary, there is some long-run equilibrium relationship linking both series so that relationship is stationary. This long run relationship is represented by the linear combination implicit in the cointegration relationship.

The cointegration tool is a great tool for the pairs trading because it can solve with efficiency the problem of spurious regression. Granger and Newbold (1974) showed that the regression between two series is very likely to be spurious in the sense that it will present a high R2 and significant t-statistics even when the series are completely unrelated. Thus, with the cointegration method an investor can understand if there is a real connection between the assets in order to apply a pairs trading strategy.

In order to find if a pair of assets has indeed a long term relationship, we should make the following process (Engle, Granger, 1987):

- At first we should test that both variables have the same order of integration, for instance, that they are both I(1). This can be performed with the unit-root test*.

- As a second step, we should find the long term relationship of the two assets by using the OLS regression:

  $Y_t = a + bX_t + e_t$

*non stationary: a process that is not stationary. A process Y_t is stationary if the following conditions hold:

1. E(Yt) = μ< ∞ (constant mean)

2. Cov(Yt;Yt¡s) = °s < ∞ (depends on s but not on t)

3. Var(Yt) = σ^2.

It is worth to be mentioned that if the series are indeed cointegrated and that if a, and b are `good' estimates of the cointegrating coefficients, then Yt = a + bXt should be I(0).

- Thus,if the above conditions are satisfied we can extract the residuals of this regression (et) and test for a unit-root in this series: If we find that this series has a unit root then we should reject the case of cointegration. In order to be protected from a possible confusion, we should note that according to the way this test is specified, this is a test of no-cointegration. So, an acceptance of a unit root in the residuals suggests that the residual term is non-stationary, which implies rejection of cointegration.

If also in this case we accept the cointegration, we can work in a similar way with the distance approach. With the help at this time of a “residual” chart, we can apply the pair trading method with the use of upper and lower bounds that are used in order to “call” the one asset overbought and other oversold. Thus, at the points of time that the bounds are being hit (usually at the second time in order to have a reversion of the move of the difference), we can buy the oversold asset and sell the other in an analogue amount.

*One of the most spread and reliable econometric processes for the unit root test is the augmented Dickey-Fuller test (ADF).

Our pair trading candidates: EUR/USD & GBP/ USD

In the current paper, the currency exchanges of eur/usd* and gbp/usd* have been selected as a possible pair of assets for a pairs trading strategy with a cointegration approach. The choice has been made after the successful pass of the aforementioned assets at the “preliminary” tests of fundamentals and screening as they were mentioned above. Thus, at first, it is important to show the process that finally led to

the conclusion that the aforementioned assets can create a pair that could be possibly applied in a pairs trading strategy with profitable results.

The fundamental point of view

From the fundamental side we could state several reasons that could lead someone to think that the two assets could be as a unit, a strong candidate for a pairs trading strategy. The reasons that are of major importance are:

- **The common US dollar parameter**

  At first, we should take into account that US dollar constitutes the second part in both currency pairs. Thus, we could easily understand, that the aforementioned pairs (eur/usd and gbp/usd) have the same sensitivity at the announcement of news and economic results that are relative to the US economy and thus influence the US dollar. For instance, it is for sure that an announcement for a better than expected GDP growth of US economy, it would lead to a stronger dollar and thus to a downtrend move in both eur/usd and gbp/usd. On the opposite side, a lower than expected US CPI* would have a negative influence for the US currency and thus a positive result for the aforementioned currency pairs.

- **The risk on group**

  At forex markets the currencies are usually divided in two groups because of their reaction in the global market's mood. More specifically when there is a a global feeling of optimism and the markets are on their upsides, the investors are buying the riskier but also more profitable (in terms of interest) currencies. This group is called the risk on group and has as major participants at first currencies such as Australian and New Zealand dollar, and as a followers currencies such as the British pound, the euro, the Canadian dollar and else.

*CPI (Customer price Index): The CPI in the United States is defined by the Bureau of Labor Statistics as "a measure of the average change over time in the prices paid by urban consumers for a market basket of consumer goods and services.

*eur/usd => euro/ us dollar, *gbp/usd => great Britain pound/ us dollar

On the other hand, there are currencies that are used to dominate in the markets at more pessimistic and fearful times, known as the safe heaven currencies. In this group we have three major participants, the US dollar, the Japanese yen and the Swish franc. Thus, the fact that the British pound and euro belong to the same risk on group while dollar comes from the opposite side make us conclude that both currency pairs (eur/usd and gbp/usd) are following the same direction and more specifically, in “sunny” days tend to make upward moves while in more turbulent times tend to follow downward trends.

- **The European Union.**

Most of the times economy and politics are two strongly connected and interdependent issues. Thus, the fact that the UK belongs to the same union (EU) with the eurozone countries, should make us understand that there is a great interconnection between the aforementioned countries both in political and economic level. For instance, it could be easily understood that a new European law about international or inter European trade will have the same economical impact in both UK and the eurozone members. From another perspective, a dispute between two major European members would negatively influence not only the eurozone countries but also the UK. To make this argument even clearer, we could refer to a real event that took place recently, when the British Prime Minister David Cameron announced a future referendum in 2015 for the participation of UK in Europe. At the chart that follows, we can see how much short term negative influence had for the UK and the British currency the announcement of a possible exit from EU.

All in all, we conclude that political events that took place in European Union could make substantial influence to the economies of its members and thus led to fluctuations of their currencies (in this case in British pound and euro).

Chart A. We can see that the price of the GBP/USD followed a strong downtrend from the announcement of the referendum (blue arrow,23/01/2013).In fact, it fell more than 1000 pips in less than two months (end of downtrend->red arrow,11/03/2013).source www.dailyfx.com

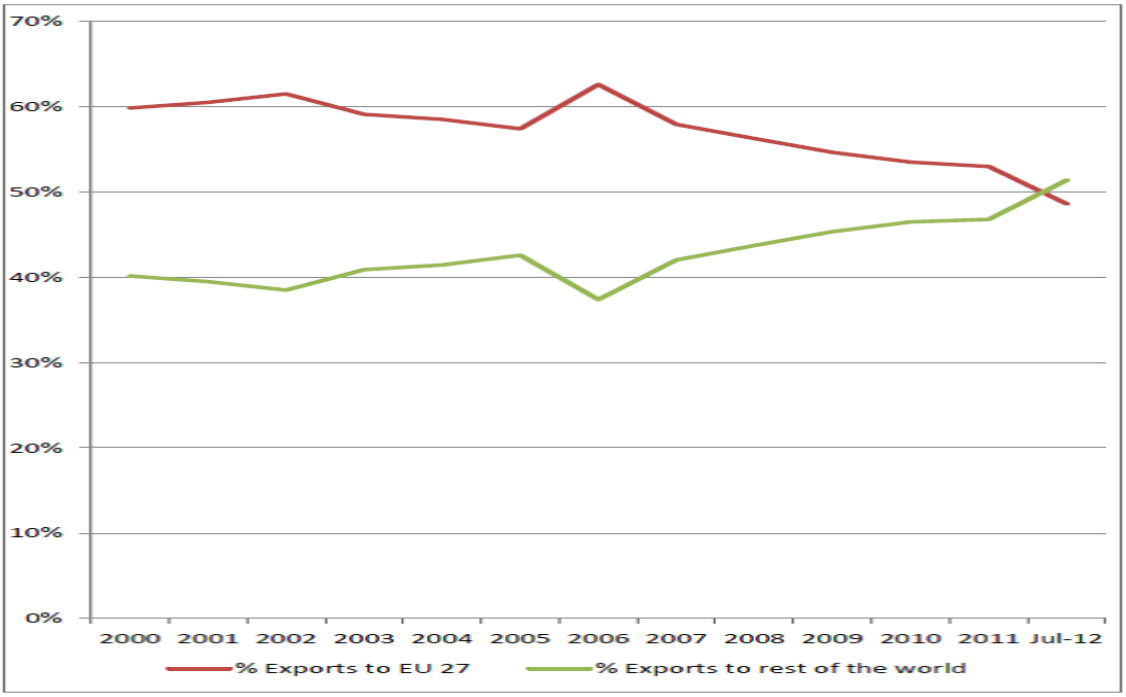
- **The strong bilateral trade relations**

The trade policy of the European Union has been designed to ensure economic cooperation and integrity among the European nations. The free movement of goods and services among the European countries enhanced the economic relations among the European nations and boosted the multilateral and bilateral trade. In our case, it should be stated that a substantial percentage of UK exports comes from the European countries, the vast majority of whom are also members of the Eurozone. What is more, it is also true that a similar inverse phenomenon takes also place with an also important percentage (even though not equal) of Eurozone exports going to UK.

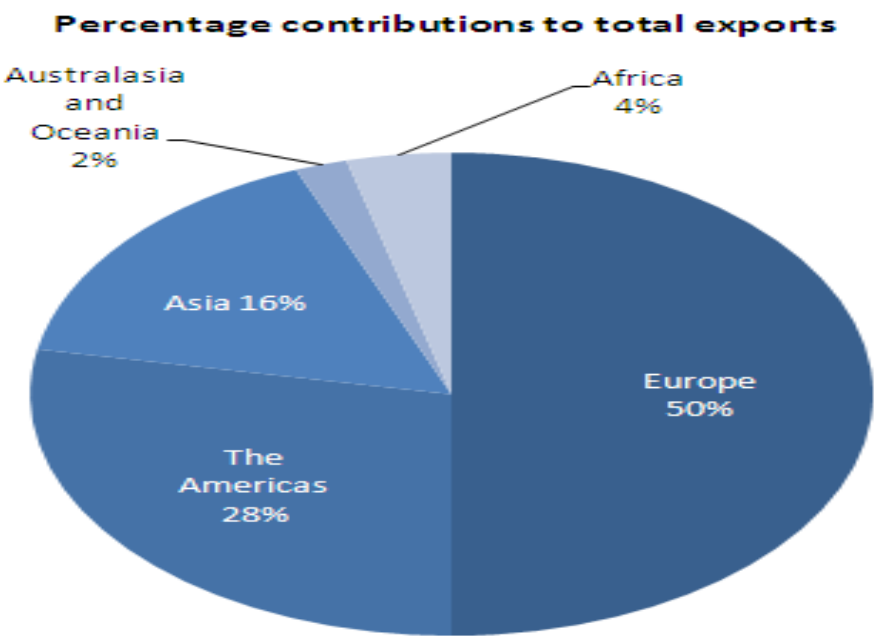
In order to understand the importance of the above facts, it is better to refer some useful hypothetical examples. For instance, if the Eurozone as a whole fall to a recession (as it happens today) it is for sure that the purchasing power of the people of the euro-countries will be reduced. So, with a lower consumption in Eurozone, countries that used to export their goods to the

region, such as UK, would also be negatively influenced. Thus, generally when the Eurozone economy gets worse (and thus its currency weakens), the UK economy will also be dragged down (and thus the pound will be weakened).

All in all, it is for sure that the welfare of the Eurozone economies influences the British economy (and the inverse), and thus a weakened euro would probably lead to a weaken pound (and the inverse).



Graph 4. We can see that despite the strategy of export diversification that the UK tries to aplly in the recent years, its exports (of goods) percentage in Europe remains close to 50%.Source:openeuropeblog.blogspot.com



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Graph 5. The same conclusion comes also from the percentage of service exports. In this chart we can see that the 50% of UK service exports come from EU. source: http://www.ons.gov.uk/

The "screening" test

Apart from the aforementioned fundamental facts that support our view for a profitable pairs trading with EUR/USD and GBP/USD, the "screening" is the second important factor that also seems to agree with our thought (see the charts below). As we mentioned above, screening is the process in which a trader compares the historical price action of two assets in order to identify if there is a possibility of "co-movement" that happens when the two PAs* seem to have great resemblance.

All in all, it seems that we have several factors which show that a gbp/usd and eur/usd pair could be a valid candidate for pairs trading and should be further tested, this time with a statistical and more accurate method that is the cointegration approach.

*PA: price action

EUR/USD **GBP/USD**

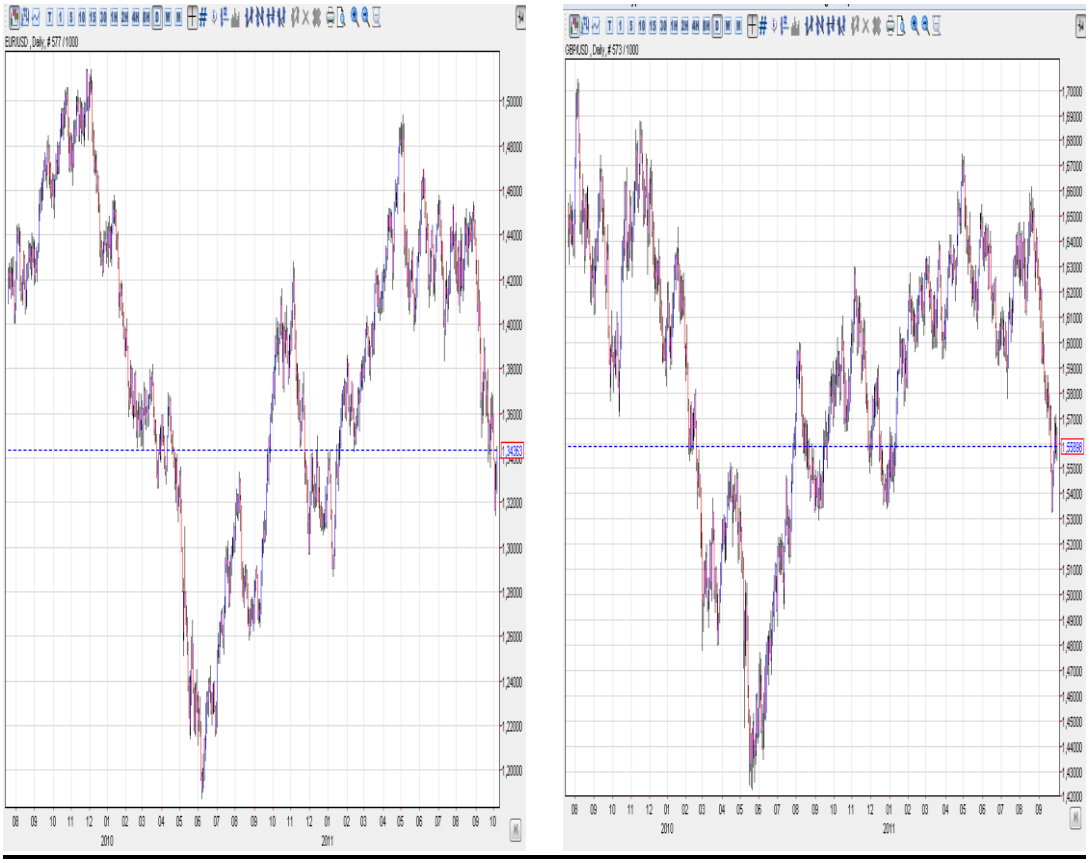


Chart B, C. We can see above that the price action of the two currency pairs have indeed a great resemblance. (date: 20/07/2009-20/08/2011). Source:www.dailyfx.com

The Engle and Granger cointegration test

It is cleared by the above tests that the currency pairs of EUR/USD and GBP/USD have a strong possibility of being the assets of a profitable pairs trading strategy. Thus, it is time to apply the Engle and Granger test in order to test the pair from a statistical point of view.

At first we should test that both variables have the same order of integration, and more specifically, that they are both I(1). This can be performed with the Augmented Dickey Fuller unit-root test. Thus, we applied the aforementioned test in Eviews 7 program with the following process:

EUR/USD unit root test

- At first, we test the stationarity of EUR/USD at its level (including also trend and intercept at the pair).

EViews - [Series: CLOSE Workfile: EYRO2::Eyro2\]

File Edit Object View Proc Quick Options Add-ins Window Help

View | Proc | Object | Properties | Print | Name | Freeze | Sample | Genr | Sheet | Graph | Stats | Ident

Null Hypothesis: CLOSE has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=20)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.722396	0.7406
Test critical values:	1% level	-3.969860	
	5% level	-3.415588	
	10% level	-3.130033	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(CLOSE)
Method: Least Squares
Date: 06/06/13 Time: 10:11
Sample (adjusted): 2 781
Included observations: 780 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CLOSE(-1)	-0.008079	0.004691	-1.722396	0.0854
C	0.010662	0.006434	1.657166	0.0979
@TREND(1)	1.18E-06	1.49E-06	0.791591	0.4288

R-squared	0.004467	Mean dependent var	6.08E-05
Adjusted R-squared	0.001905	S.D. dependent var	0.009383
S.E. of regression	0.009375	Akaike info criterion	-6.497804
Sum squared resid	0.068284	Schwarz criterion	-6.479884
Log likelihood	2537.144	Hannan-Quinn criter.	-6.490912
F-statistic	1.743368	Durbin-Watson stat	1.957363
Prob(F-statistic)	0.175614		

EVIEWS 7, TABLE 1

As we can see at table 1 both the intercept and trend parameter are not statistical significant (see the "blue" numbers, both probabilities> 0.05). Thus, we should remake the test without either trend or intercept parameter.

EViews - [Series: CLOSE Workfile: EYRO2::Eyro2\]

File Edit Object View Proc Quick Options Add-ins Window Help

View Proc Object Properties Print Name Freeze Sample Genr Sheet Graph Stats

Null Hypothesis: CLOSE has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=20)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.092326	0.7117
Test critical values:	1% level	-2.567930	
	5% level	-1.941230	
	10% level	-1.616426	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(CLOSE)
Method: Least Squares
Date: 06/06/13 Time: 10:13
Sample (adjusted): 2 781
Included observations: 780 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CLOSE(-1)	2.26E-05	0.000245	0.092326	0.9265

R-squared	-0.000031	Mean dependent var	6.08E-05
Adjusted R-squared	-0.000031	S.D. dependent var	0.009383
S.E. of regression	0.009384	Akaike info criterion	-6.498424
Sum squared resid	0.068593	Schwarz criterion	-6.492451
Log likelihood	2535.385	Hannan-Quinn criter.	-6.496127
Durbin-Watson stat	1.964416		

EVIEWS 7 TABLE 2

As we can see at the table 2 the ADF test shows that EUR/USD pair is not integrated at its level (see the “blue” probability number> 0.05).After the test at level, we should continue and test the integration of asset in its first difference(without trend and intercept because of their aforementioned rejection).

EViews - [Series: CLOSE Workfile: EYRO2::Eyro2\]

File Edit Object View Proc Quick Options Add-ins Window Help

View | Proc | Object | Properties | Print | Name | Freeze | Sample | Genr | Sheet | Graph | Stats

Null Hypothesis: D(CLOSE) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=20)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-27.42703	0.0000
Test critical values:	1% level	-2.567934	
	5% level	-1.941230	
	10% level	-1.616426	

*MacKinnon (1996) one-sided p-values.

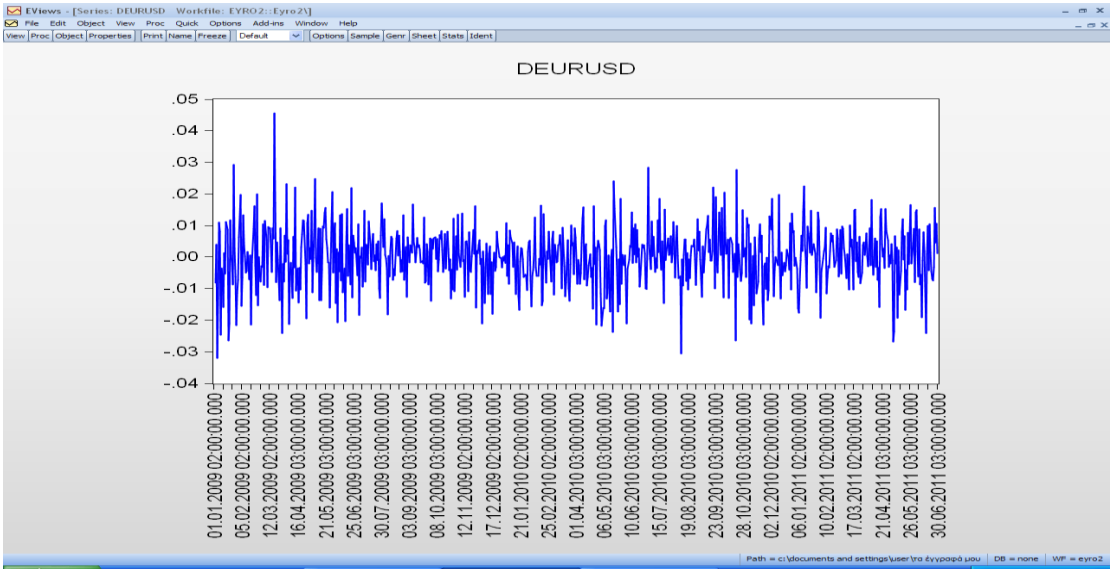
Augmented Dickey-Fuller Test Equation
Dependent Variable: D(CLOSE,2)
Method: Least Squares
Date: 06/06/13 Time: 10:07
Sample (adjusted): 3 781
Included observations: 779 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(CLOSE(-1))	-0.982680	0.035829	-27.42703	0.0000

R-squared	0.491583	Mean dependent var	1.20E-05
Adjusted R-squared	0.491583	S.D. dependent var	0.013160
S.E. of regression	0.009384	Akaike info criterion	-6.498420
Sum squared resid	0.068505	Schwarz criterion	-6.492441
Log likelihood	2532.135	Hannan-Quinn criter.	-6.496120
Durbin-Watson stat	1.997999		

EVIEWS 7 TABLE 3

At this table we can see that the EUR/USD pair is indeed integrated at its first difference-I(1) (probability of ADF test close to zero and smaller than 0.05). The same conclusion could easily be drawn by a much simpler but also less accurate way by looking at the graph of the first difference of EUR/USD (as we could see below at graph I, there is a mean reversion of this variable to the zero number.)



EVIEWS 7, GRAPH I

GBP /USD unit root test

- At first, we test the stationarity of GBP/USD at its level (including also trend and intercept at the pair).

EViews - [Series: CLOSE Workfile: GBP2::Gbp2\]

File Edit Object View Proc Quick Options Add-ins Window Help

View | Proc | Object | Properties | Print | Name | Freeze | Sample | Genr | Sheet | Graph | Stats

Null Hypothesis: CLOSE has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=20)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.242016	0.4649
Test critical values:	1% level	-3.969860	
	5% level	-3.415588	
	10% level	-3.130033	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(CLOSE)
Method: Least Squares
Date: 06/06/13 Time: 10:14
Sample (adjusted): 2 781
Included observations: 780 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CLOSE(-1)	-0.012483	0.005568	-2.242016	0.0252
C	0.019426	0.008518	2.280472	0.0228
@TREND(1)	7.98E-07	1.77E-06	0.449666	0.6531

R-squared	0.006596	Mean dependent var	0.000165
Adjusted R-squared	0.004039	S.D. dependent var	0.010467
S.E. of regression	0.010446	Akaike info criterion	-6.281451
Sum squared resid	0.084777	Schwarz criterion	-6.263530
Log likelihood	2452.766	Hannan-Quinn criter.	-6.274558
F-statistic	2.579591	Durbin-Watson stat	1.914408
Prob(F-statistic)	0.076454		

EVIEWS 7, TABLE 1b

As we can see at table 1b both the trend parameter is not statistical significant while the intercept is indeed significant (see the “blue” numbers, probabilities compared with 0.05). Thus, we should remake the test without the trend parameter.

EViews - [Series: CLOSE Workfile: GBP2::Gbp2\]

File Edit Object View Proc Quick Options Add-ins Window Help

View | Proc | Object | Properties | Print | Name | Freeze | Sample | Genr | Sheet | Graph | Stats

Null Hypothesis: CLOSE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=20)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.227571	0.1967
Test critical values:	1% level	-3.438508	
	5% level	-2.865030	
	10% level	-2.568684	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(CLOSE)
Method: Least Squares
Date: 06/06/13 Time: 10:16
Sample (adjusted): 2 781
Included observations: 780 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CLOSE(-1)	-0.011600	0.005207	-2.227571	0.0262
C	0.018354	0.008174	2.245470	0.0250

R-squared	0.006338	Mean dependent var	0.000165
Adjusted R-squared	0.005060	S.D. dependent var	0.010467
S.E. of regression	0.010440	Akaike info criterion	-6.283755
Sum squared resid	0.084799	Schwarz criterion	-6.271808
Log likelihood	2452.664	Hannan-Quinn criter.	-6.279160
F-statistic	4.962072	Durbin-Watson stat	1.915603
Prob(F-statistic)	0.026194		

EVIEWS 7, TABLE 2b

As we can see at the table 2b the ADF test shows that GBP/USD pair is not integrated at its level (see the “blue” probability number> 0.05).After the test at level, we should continue and test the integration of asset in its first difference(without trend because of its aforementioned rejection).

EViews - [Series: CLOSE Workfile: GBP2::Gbp2\]

File Edit Object View Proc Quick Options Add-ins Window Help

View | Proc | Object | Properties | Print | Name | Freeze | Sample | Genr | Sheet | Graph | Stats

Null Hypothesis: D(CLOSE) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=20)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-26.96310	0.0000
Test critical values:	1% level	-3.438518	
	5% level	-2.865035	
	10% level	-2.568686	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(CLOSE,2)
Method: Least Squares
Date: 06/06/13 Time: 10:16
Sample (adjusted): 3 781
Included observations: 779 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(CLOSE(-1))	-0.964935	0.035787	-26.96310	0.0000
C	0.000183	0.000375	0.488001	0.6257

R-squared	0.483381	Mean dependent var	1.73E-05
Adjusted R-squared	0.482716	S.D. dependent var	0.014534
S.E. of regression	0.010453	Akaike info criterion	-6.281264
Sum squared resid	0.084901	Schwarz criterion	-6.269305
Log likelihood	2448.552	Hannan-Quinn criter.	-6.276664
F-statistic	727.0090	Durbin-Watson stat	1.998801
Prob(F-statistic)	0.000000		

EVIEWS 7, TABLE 3b

At the above table we can see that the intercept parameter of the first difference ("blue" number) is not statistical significant. Thus, we should remake the test without the intercept.

EViews - [Series: CLOSE Workfile: GBP2::Gbp2\]

File Edit Object View Proc Quick Options Add-ins Window Help

View | Proc | Object | Properties | Print | Name | Freeze | Sample | Genr | Sheet | Graph | Stats

Null Hypothesis: D(CLOSE) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=20)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-26.97194	0.0000
Test critical values:	1% level	-2.567934	
	5% level	-1.941230	
	10% level	-1.616426	

*MacKinnon (1996) one-sided p-values.

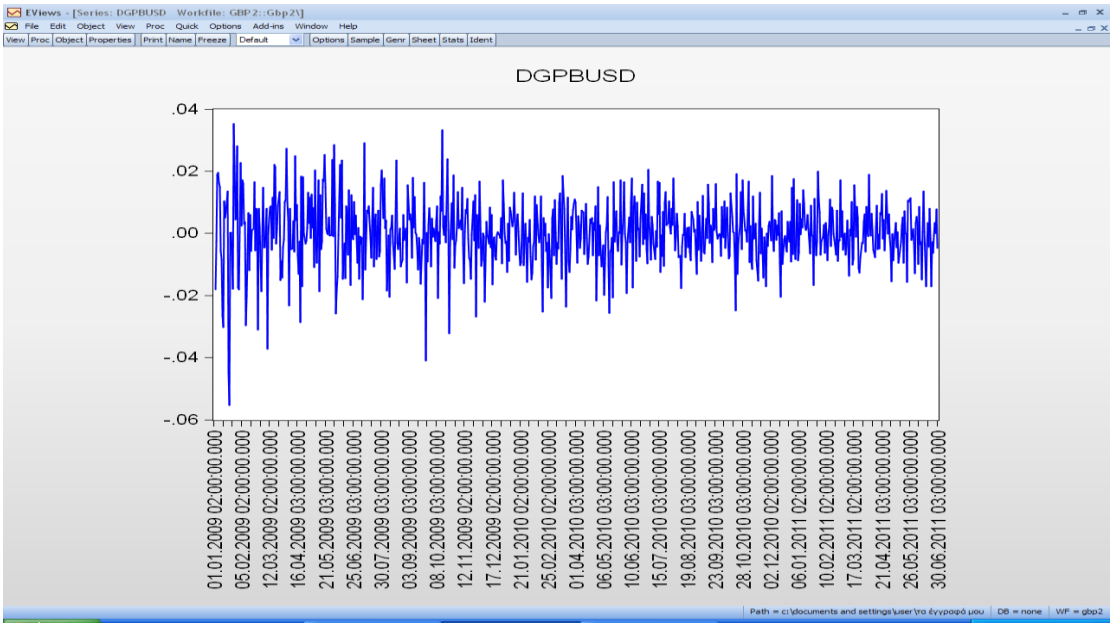
Augmented Dickey-Fuller Test Equation
Dependent Variable: D(CLOSE,2)
Method: Least Squares
Date: 06/06/13 Time: 10:17
Sample (adjusted): 3 781
Included observations: 779 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(CLOSE(-1))	-0.964649	0.035765	-26.97194	0.0000

R-squared	0.483222	Mean dependent var	1.73E-05
Adjusted R-squared	0.483222	S.D. dependent var	0.014534
S.E. of regression	0.010448	Akaike info criterion	-6.283525
Sum squared resid	0.084927	Schwarz criterion	-6.277546
Log likelihood	2448.433	Hannan-Quinn criter.	-6.281225
Durbin-Watson stat	1.998746		

EVIEWS 7, TABLE 4b

At this table we can see that the GBP/USD pair is indeed integrated at its first difference-I(1) (probability of ADF test close to zero and smaller than 0.05). The same conclusion could easily be drawn by a much simpler but also less accurate way by looking at the graph of the first difference of GBP/USD (as we could see below at graph II, there is a mean reversion of this variable to the zero number.)



EVIEWS 7, GRAPH II

The long term relationship

- After we showed that the two currency pairs are indeed I(0), we should proceed to the estimation of its long term relationship. This will be achieved by using the OLS regression in EVIEWS 7 program and will give us an equation of the following form:

$Y_t = a + bX_t + e_t$

EViews - [Equation: UNTITLED Workfile: GBP2::Gbp2\]

File Edit Object View Proc Quick Options Add-ins Window Help

View Proc Object Print Name Freeze Estimate Forecast Stats Resids

Dependent Variable: EURUSD
Method: Least Squares
Date: 06/06/13 Time: 11:23
Sample: 1 781
Included observations: 781

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GBPUSD	0.804572	0.021177	37.99360	0.0000
C	0.107731	0.033240	3.241040	0.0012

R-squared	0.649496	Mean dependent var	1.369309
Adjusted R-squared	0.649046	S.D. dependent var	0.071675
S.E. of regression	0.042461	Akaike info criterion	-3.477886
Sum squared resid	1.404513	Schwarz criterion	-3.465951
Log likelihood	1360.114	Hannan-Quinn criter.	-3.473296
F-statistic	1443.514	Durbin-Watson stat	0.035245
Prob(F-statistic)	0.000000		

EVIEWS 7, TABLE 1c$_1$

As we can see the equation that represents the long term relationship between the two variables is:

$EUR/USD_t = 0.804572 * GBP/USD_t + 0.107731 + e_t$, (et=residual at time t)

At this point another question seems to be risen. What is the reason of our choosing an equation of the form "$Y_t = a + bX_t + e_t$" (with an intercept) and not the simplest form of " $Y_t = bX_t + e_t$" ? This decision is again based on statistics. First of all, as we can see at the table above (table $1c_1$), the probability of the intercept that Eviews give us, is far smaller than 5% (0.012), a fact that shows us that the intercept in this case is statistical significant and should be included to the equation. Another also supporting factor is the comparison between the Rsquare numbers of the two possible equations. More specific, we could easily see that the Rsquare in the case of the equation with the intercept (0.649496, table $1c_1$) is greater than the one of the "simplest" equation (0.644770,table $1c_2$').Thus, for the above reasons we chose the form of "$Y_t = a + bX_t + e_t$", as it was previously analyzed.

Equation: UNTITLED Workfile: EYRO2::Eyro2\

View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: EURUSD
Method: Least Squares
Date: 07/15/13 Time: 19:25
Sample: 1 781
Included observations: 781

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GBPUSD	0.873134	0.000974	896.5729	0.0000

R-squared	0.644770	Mean dependent var	1.369309
Adjusted R-squared	0.644770	S.D. dependent var	0.071675
S.E. of regression	0.042719	Akaike info criterion	-3.467052
Sum squared resid	1.423452	Schwarz criterion	-3.461085
Log likelihood	1354.884	Hannan-Quinn criter.	-3.464757
Durbin-Watson stat	0.037223		

EVIEWS 7, TABLE $1c_2$

The residual process

After the estimation of the equation between the two variables, we should further proceed for the validity of the aforementioned relationship, by testing the integration of its residuals. Thus, we can extract the residuals of this regression (e_t) and test for a unit-root in this series: If we find that this series has a unit root then we should reject the case of cointegration. In order to be protected from a possible confusion, we should note that according to the way this test is specified, this is a test of no-cointegration. Thus, an acceptance of a unit root in the residuals suggests that the residual term is non-stationary, which implies rejection of cointegration.

EViews - [Series: RESID01 Workfile: GBP2::Gbp2\]

File Edit Object View Proc Quick Options Add-ins Window Help

View | Proc | Object | Properties | Print | Name | Freeze | Sample | Genr | Sheet | Graph | Stats

Null Hypothesis: RESID01 has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=20)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.853760	0.1785
Test critical values:	1% level	-3.969860	
	5% level	-3.415588	
	10% level	-3.130033	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RESID01)
Method: Least Squares
Date: 06/06/13 Time: 11:30
Sample (adjusted): 2 781
Included observations: 780 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESID01(-1)	-0.020967	0.007347	-2.853760	0.0044
C	-5.05E-05	0.000610	-0.082787	0.9340
@TREND(1)	-5.93E-08	1.38E-06	-0.042841	0.9658

R-squared	0.012301	Mean dependent var	-7.23E-05
Adjusted R-squared	0.009758	S.D. dependent var	0.007971
S.E. of regression	0.007932	Akaike info criterion	-6.831919
Sum squared resid	0.048889	Schwarz criterion	-6.813998
Log likelihood	2667.448	Hannan-Quinn criter.	-6.825026
F-statistic	4.838330	Durbin-Watson stat	1.790870
Prob(F-statistic)	0.008160		

EVIEWS 7, TABLE 2c

EViews - [Series: ERC Workfile: EYRO2::Eyro2\]

File Edit Object View Proc Quick Options Window Help

View | Proc | Object | Properties | Print | Name | Freeze | Sample | Genr | Sheet | Graph

Augmente

Null Hypothesis: ERC has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=20)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.112435	0.0261
Test critical values:	1% level	-3.438508	
	5% level	-2.865030	
	10% level	-2.568684	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ERC)
Method: Least Squares
Date: 07/15/13 Time: 19:47
Sample (adjusted): 2 781
Included observations: 780 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ERC(-1)	-0.020838	0.006695	-3.112435	0.0019
C	-7.36E-05	0.000284	-0.259465	0.7953

R-squared	0.012298	Mean dependent var	-7.23E-05
Adjusted R-squared	0.011029	S.D. dependent var	0.007971
S.E. of regression	0.007927	Akaike info criterion	-6.834480
Sum squared resid	0.048890	Schwarz criterion	-6.822533
Log likelihood	2667.447	Hannan-Quinn criter.	-6.829885
F-statistic	9.687254	Durbin-Watson stat	1.791096
Prob(F-statistic)	0.001923		

EVIEWS 7, TABLE 3c

EViews - [Series: RESID01 Workfile: GBP2::Gbp2\]

File Edit Object View Proc Quick Options Add-ins Window Help

View | Proc | Object | Properties | Print | Name | Freeze | Sample | Genr | Sheet | Graph | Stats

Null Hypothesis: RESID01 has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=20)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.113904	0.0018
Test critical values:	1% level	-2.567930	
	5% level	-1.941230	
	10% level	-1.616426	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RESID01)
Method: Least Squares
Date: 06/06/13 Time: 11:32
Sample (adjusted): 2 781
Included observations: 780 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESID01(-1)	-0.020835	0.006691	-3.113904	0.0019

R-squared	0.012213	Mean dependent var	-7.23E-05
Adjusted R-squared	0.012213	S.D. dependent var	0.007971
S.E. of regression	0.007922	Akaike info criterion	-6.836958
Sum squared resid	0.048894	Schwarz criterion	-6.830984
Log likelihood	2667.414	Hannan-Quinn criter.	-6.834660
Durbin-Watson stat	1.790946		

EVIEWS 7, TABLE 4c

As we can see at this non cointegration test, our variable (residual) is tested without a trend or an intercept factor (table 4c).This is due to the fact that both factors are not statistically significant (see table 2c,3c, both probabilities are more than 0.05). However, even if we choose to "run" the test with an intercept included (as it usually made in this kind of tests, in order to avoid a possible change of the distribution of the variable), the $t_{statistic}$ of our ADF test will remain almost the same(as in the case of no intercept). Thus, at the final stage of test, with the variable at its level and without trend and intercept (or with the intercept), we can proceed to the comparison of our $t_{statistic}$ with the critical $t_{statistic}$ values of McKinnon (2010).As we can see from the McKinnon table below, the critical $t_{statistic}$ value in our case is -3.3377 (this critical number corresponds to our case where we examine an equation of two variables, with no trend, in a 5% level of confidence). As we could easily see our $t_{statistic}$ is greater than the McKinnon $t_{statistic}$ (-3.113904 > -3.3377), a fact that leads us to accept the zero hypothesis of one unit root occurrence and thus reject the case of the cointegration. However, we should further state that even in looser level of confidence, for instance 10% (we made the whole test with a five percent level), the unit root hypothesis is being rejected and we could accept the case of cointegration. Never the less, we should respect the "rule of majority" that tend to use the 5 % level(as we have done during the whole testing process), and thus state that our two major currency pairs (EUR/USD, GBP/USD) are not cointegrated and we could not apply them in a pairs trading strategy, at least with the cointegration approach.

Mckinnon critical tstatistic values

N	Variant	Level	Obs.	β_∞	(s.e.)	β_1	β_2
1	no constant	1%	600	−2.5658	(0.0023)	−1.960	−10.04
		5%	600	−1.9393	(0.0008)	−0.398	
		10%	560	−1.6156	(0.0007)	−0.181	
1	no trend	1%	600	−3.4336	(0.0024)	−5.999	−29.25
		5%	600	−2.8621	(0.0011)	−2.738	−8.36
		10%	600	−2.5671	(0.0009)	−1.438	−4.48
1	with trend	1%	600	−3.9638	(0.0019)	−8.353	−47.44
		5%	600	−3.4126	(0.0012)	−4.039	−17.83
		10%	600	−3.1279	(0.0009)	−2.418	−7.58
2	no trend	1%	600	−3.9001	(0.0022)	−10.534	−30.03
		5%	600	−3.3377	(0.0012)	−5.967	−8.98
		10%	600	−3.0462	(0.0009)	−4.069	−5.73
2	with trend	1%	600	−4.3266	(0.0022)	−15.531	−34.03
		5%	560	−3.7809	(0.0013)	−9.421	−15.06
		10%	600	−3.4959	(0.0009)	−7.203	−4.01
3	no trend	1%	560	−4.2981	(0.0023)	−13.790	−46.37
		5%	560	−3.7429	(0.0012)	−8.352	−13.41
		10%	600	−3.4518	(0.0010)	−6.241	−2.79
3	with trend	1%	600	−4.6676	(0.0022)	−18.492	−49.35
		5%	600	−4.1193	(0.0011)	−12.024	−13.13
		10%	600	−3.8344	(0.0009)	−9.188	−4.85

Conclusions –Proposals

As our above analysis showed, our two currency pairs (EUR/USD, GBP/USD) are not valid for a pairs trading strategy with a Granger-Engle cointegration approach. Apart from the residual test that reject the cointegration of the two currency pairs, we can see that the R^2 statistic value is only 0.65 approximately (see chart).This statistical measure shows that the regression model that we estimate does not really approximate the real data. Thus, from the above reasons, we could conclude that we can not apply

a pairs trading strategy with the cointegration approach with the two aforementioned assets.

What is more, another more general but really noteworthy conclusion is the great importance of the statistics in the evaluation of any trading strategy. It is for sure, that if a trader just stayed to the fundamental and screening tests in order to check the validity of the two aforementioned currency pairs in order to apply a pairs trading strategy, he would have decided to accept them as suitable and apply the strategy. This "naïve" approach could really cost him both in financial loss and in psychological discomfort. Thus, statistics should be applied any time it is possible in trading in order to be more accurate in checking the accuracy of a trading strategy.

However, the fact that we reject the two currency pairs for a cointegration trading strategy does not mean that we can not apply a cointegration method in forex market. It is for sure that the inefficiencies of forex market that we mentioned in this paper, boost our confidence to search for any edge that could possibly help us in order to "beat" the market, and the cointegration pairs trading could be a key tool in this attempt. There are several other pairs that should be examined for a possible pairs trading strategy. For instance, a good pair for examination could be the AUD/USD and NZD/USD currency pairs. These two "assets" have the tendency to edge higher in risk on environments and lower when the markets "feel" stressed. This comes as a result of the carry trade that many hedge funds and other financial institutions choose to follow. More specifically, both the Australian and the New Zealand dollar are sources of greater investment returns than US dollar or Japanese yen. Thus, when markets seem safe and optimism dominates, some of the biggest financial "players" choose to borrow some US or Japanese money with low cost in order to invest them as New Zealand or Australian money in order to obtain higher returns. This carry trading strategy creates a co-movement of the two aforementioned pairs (AUD/USD, NZD/USD) that needs to be checked statistically for its validity.

Another great "field" for research is the lower time frames. More specifically, for instance, the fact that GBP/USD and EUR/USD are not cointegrated at a daily data level, does not reject the possibility of cointegration existence in lower time frames at some periods of time. In other words, a short term period of cointegration might be

showed if we examined the regression of the two assets in lower time frames such as the “hourly level”. If the cointegration in this level really occurs, not only we could easily implement a pairs trading strategy with far stricter stop loss limits (accompanied with smaller profit potentials), but also we could be protected in a far more efficient way by the fundamental events that many times occur in a long term pairs trading strategy, and cause the “break” of the long term relationship between the two variables. However, like every strategy the aforementioned has also its disadvantage. The weak point here lays to the fact that even if the cointegration occurs its duration is very short term. Thus, even if the Engle-Granger test shows a cointegration between the hourly data of the two currency pairs, the trader should remake the test periodically (every day or weekly) and check not only the existence of the previous cointegration but also the changes in the factors of the equation that might call for a refine of the strategy and additional transactional costs.

Finally, additional research could be made for a possible pairs trading cointegration strategy that includes one forex market “participant” (EUR/USD, GBP/USD, USD/CAD etc) in conjunction with a market index or another asset. For instance, an investor could test the CAD/USD currency pair and a future of oil. These two assets have, “in fundamental level”, really strong bonds because of the fact that Canada is one of most important exporters of oil in the world, and its export revenues are greatly influenced by the oil prices. Thus, when oil futures (and spot prices) edges higher investors tend to buy the Canadian dollar believing that its economy will be positively influenced. Other assets that have “fundamentally created” bonds between them, could be the EUR/USD and Dax30 future index or the GBP/USD and FTSE100 future index. All these aforementioned pairs could possibly be suitable for a cointegration pairs trading strategy and could be further tested.

All in all, at first it should be stated that our two currency pairs (EUR/USD, GBP/USD) have finally been proven not valid for a pairs trading strategy with a Granger-Engle cointegration approach. On the other hand, this fact should not discourage any trader who wants to apply a cointegration strategy at forex markets. Several methods or ways for apply cointegration in forex could be tested for its validity. Firstly, an investor could test other major currency pairs that seem to have strong bonds from a fundamental perspective such as the pair of AUD/USD and

NZD/USD. What is more, a more interesting approach is the test of cointegration between two currency pairs in a shorter time level (hourly, 4hourly close data) and the creation of a more dynamic pairs trading strategy with a continuously refining process as it was stated above. Last but not least, a trader could try to combine a currency pair with another financial asset (index futures,commodity futures erc) and test them for a cointegration occurrence in order to apply a pairs trading strategy. Finally, even if the ideal, for cointegration pairs trading, “forex” assets be found, a trader should further search additional tools to make an optimal pairs trading strategy. The tools should help the trader either reduce its risk (use of options-buy calls or puts) or find the correct timing to get into a trading position (use of candlestick price action patterns-bullish or bearish engulfing patterns, dojis, evening and morning stars). Thus, it is completely understood that there is a great “field” of study the cointegration pairs trading strategy in forex markets, not only as far as the finding of the suitable pair of assets but also in enhancing the trading strategy with other tools such as options and price action signals.

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