



Effect of Economic Announcements on FX Fluctuations: Testing a Unified Approach for Prediction

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ABSTRACT

Market price fluctuations follow a non-stationary process and accurately modelling them is absolutely impossible, however attempts have been made and any results, even the unsuccessful ones, contribute in a better understanding of the fluctuations dynamics. Through the use of a multivariate regression model analysing 237 distinct variables, consist mainly upon macroeconomic announcements, which portray the state of the economy, this study investigates their correlation of actual with predictive patterns. Adding further through the asset market approach, comparing the performance of substitute investment options did not prove any significant results. On the last group of variables, the refinance interest rates as set by central banks, showed an even less impact in a sense proving that monetary policy strategies on a free floating currency has fairly low. Even though multivariate regression model could not accurately predict the price level, there was a positive by-product of trend predictability, among all 42 currency pairs have predictive probability 15 pairs (represent 36% of total sample) lie in the range from 58% to 59%, an indication of relative high predictive probability among all pairs considered for analysis. In addition, 62% of the pairs (26-pairs) documented the predictive probability between 55% and 57%, that is the dominant prediction and only a smaller pair percentage lies below 55. Although the prediction power of the market price movements is not much high, therefore based upon the notion of simplicity and accessibility to data, it has laid down the foundation stone for future research, thus it is expected that it will inspire others to further investigate the phenomena from various angles with relatively more complex methodology.

Keywords: Foreign Exchange Rate, Multivariate Regression, Macroeconomic Announcements

JEL Classifications: C10, F31, G15

1. INTRODUCTION

The research is inspired from the market price manipulation of currencies by speculators, as over the past three decades, an increasing influence of currency prices manipulators, has left countries' economies struggling with attacks orchestrated by major wealth managers, with most notable the incident of "Black Wednesday" in UK in 16th of September 1992, John Soros has earned an estimated \$1.1 billion during that period (Tempest and Matthew, 2005).

The attempt of this research will be to provide the everyday casual investors with the tools to make accurate and precise predictions, up to a degree, concerning their investments in the foreign exchange market. The data which are used are open and freely available for everyone to find and are often used by Forex

brokers to entice excitement and the feeling of urgency on potential clients. From my personal experience working in a Binary Options company in the sales department, I had to inform and discuss with clients the benefits of "economic analysis," how to use the market announcements released to make predictions on the movement of the currency or other financial assets, related to the data announced. However, the most common question asked was "How much will the price drop or rise?," leaving me wondering for myself, the extend of impact that such additional data caused on the market prices. I understand that those alone are not the sole variables painting the picture of market prices and there is a plethora of other factors that play a role, thus the focus will be solely on intra-day price fluctuations, hopefully finding not just correlation but also causation of the daily price fluctuations and understanding the key players' decision making patterns on how they manage the wealth funds under their control.

A strong fact that needs to be considered is that the financial assets under investigation are freely traded and in a floating exchange rate regime, thus the currency price is set by the foreign-exchange market through supply and demand. It is essential to keep in mind that such system is vulnerable to speculators attacks that in the past did not have enough market size to be able to affect the overall price level. However nowadays with wealth funds reaching the size of over a several trillion US dollars, price manipulation is not an impossibility. I find it quite peculiar that through the decisions of a single wealth manager it is possible to manipulate the economy of a whole nation while being legally free to act as he/she pleases to an extent. What makes it even worse, is that the particular incident, mentioned in the first paragraph, was not effective in being an example to avoid and safeguard for similar incidents. Similarly in 1997 with Indonesia, Korea and Brazil, with preceding large private capital inflows that were later on rapidly withdrawn, gave rise to shifts in market sentiment and caused a systemic crisis, which later on lead to a national-level crisis. Pinpointing and taking to justice, the individuals with the blame of that situation, was not just ineffective but also legally impossible.

This gives rise to the concept that size really matters when it comes to foreign currency price speculation and furthermore to investors. Studies on market sentiment, have showed that investors tend to “follow the leader” while tending to their daily transactions. This blind trust and imitation of the major investors have gave rise to a new field in behavioral finance literature with the definition of “herding” as it is defined as “a group of investors trading in the same direction over a period of time.” The imitation of finance “gurus” enforces their effectiveness in manipulating currency prices while central banks are struggling to maintain stability, more often unsuccessfully.

A main hurdle that needs to be considered before continuing further in this research paper which investors face, is information asymmetry. “Low” wealth size investors (under a million dollar worth of capital) have limited impact and understanding of the complex dynamics and schemes of the major key players of the 5.3 trillion daily turnover market, which surpasses the annual global trade within 3 days. In order to overcome this issue, investors rely on the pack-leaders to shine the light towards profitability and from then on it appears to be a rat race to who can complete the trades the fastest while still “being in the green.” However in the meanwhile, the same people that had inflate the prices later on will start “dumping” the now over-priced assets, in a pseudo-legal “pump and dump” scheme¹, with the size of the profits, depending on the influence and wealth of the leaders involved. Usually those “revenues” are limited to minor amounts not affecting the overall performance of the currency involved, however cumulatively the amounts can reach several billions².

As mentioned earlier, this research’s goal is to provide a quantifiable approach on market sentiment and attempt to break down the thinking of foreign exchange investors that effectively

are the ones responsible for the effective market price levels. Using data and information freely and publicly available, this research paper has researched a unified approach on measuring the impact of macroeconomic announcements released throughout a time series of several years, that effectively are the ones that comprise the determinants of exchange rates combining purchasing power parity (PPP) model, gross domestic product (GDP) approach, interest rate approach and market sentiment. Due to time limitation and inaccessibility to a more in-depth data pool, it is limited to daily intervals based on the dates of the macroeconomic announcements releases, hence the results are not meant to be absolute but has provided an approximately accurate estimate of the market price movement in correlation to each data announced.

The currencies under investigation are the components of the “Majors” EUR/USD, USD/JPY, GBP/USD, AUD/USD, USD/CHF, NZD/USD and USD/CAD, with the exception of New Zealand dollar (NZD) as it is the lesser in market liquidity and data would have increased the length of this research considerably. The choice of “Majors” was based due to the fact of being the most frequently traded assets in the foreign exchange market with a share of about 85%³. and there is considerable trust in the truthfulness of data released, contrast to cases such as Greece⁴.

This research investigates the existence of correlation between market price fluctuations of foreign currency pairs and various components of the existing theories on the computation of currency pairs prices. The purpose is to provide a quantifiable formula to be used to measure the announcement’s effect on the closing prices of the exchange rates.

The research paper is structured as follows; review on existing literature concerning the effects of market announcements, followed by a more in-depth focus on the data used and the methodology used to conclude on the results. The results are presented on section 3 which will be split in single currency pairs sub-sections to further investigate and pin-point each pair’s sensitivity to market announcements. Results and the paper’s final statement follows in their respective order.

2. LITERATURE REVIEW

As expressed over, the impacts of macroeconomic news have been the subject of a considerable influx of scholarly research that secured a wide arrangement of money related components. For instance, Schwert (1990), Hakkio and Pearce (1985), Bomfim (1997), Funke and Matsuda (2006), Rangel (2011) or Rühl and Stein (2014) explore different ramifications of macroeconomic declarations on the advancement of value markets.

The reaction of security markets to macroeconomic news has likewise been investigated in an extensive number of studies

1 “Pump and Dump Schemes”. U.S. Securities and Exchange Commission. March 12, 2001.

2 Levine, Matt (12 November, 2014). “Banks Manipulated Foreign Exchange in Ways You Can’t Teach” Bloomberg (USA) Chrispin, Sebastian (20 May 2015). “Forex Scandal: How to rig the market” BBC News.

3 Heath, Alex; Upper, Christian; Gallardo, Paola; Mesny, Philippe; Mallo, Carlos (December 2007), Triennial Central Bank Survey of Foreign Exchange and Derivatives Market Activity in 2007, Bank for International Settlements.

4 Willis, Andrew (13 January 2010). “EU report slams Greece over false statistics,” Euobserver.

among which I specify Urich and Wachtel (1981), Fleming and Remolona (1999) and late commitments by Andritzky et al. (2007). Albu et al. (2014a) and Albu et al. (2014b) use occasion study keeping in mind the end goal to research the impact of quantitative facilitating activities on sovereign credit default swaps. Both the examinations produce comes about that demonstrate that the declarations identified with these strategies have an impact on the flow of CDS returns.

Cash responses to monetary marvels were additionally given imperative scholarly consideration in original papers that for the most part utilized day by day frequencies: Ito and Roley (1987), Hardouvelis (1988), or Hogan and Melvin (1994). From the viewpoint of my study, key commitments were made by Tanner (1997) and Almeida et al. (1998). Despite the fact that reporting clashing results about the impact of macroeconomic variables on monetary standards, these studies fuse high recurrence information, which I can't procure at the present stage. Albu et al. (2014) set forward a methodology that broadens a technique utilized as a part of the examination of merging to a demonstrating setting that permits the examination of the connections between macroeconomic essentials and business sector capitalization. Albu et al. (2014) concentrate on the relationship between macroeconomic development and the elements of value markets for the focal eastern European nations. The examination finds a feeble reliance additionally shows closed linkages for nations, for example, Slovenia and Latvia.

Ahmad et al. (2002) conduct a broad and intense examination of the effect of macroeconomic declarations on trade rates and watch critical news impacts and hilter kilter reaction designs (that is, for the most part the awful news have a higher impact than the uplifting news). Faust and Rogers (2003) utilizes intra-day by day information on an extensive period (1982-2000) with a specific end goal to exhibit that the macroeconomic occasions picked importantly affect the US stock and security markets and on the advancement of a progression of monetary standards (German check, yen and sterling pound). In an exceptionally intriguing methodology, Simpson et al. (2005) watch the impacts of 23 sorts of declaration on trade rates and forward premium. The creators find that the trade rates are affected by occasions connected to purchaser interest, expansion and loan costs however aren't touchy to news on the general condition of the economy.

While considering the conduct of a few trade rates and zero coupon financing costs, Faust et al. (2007) watch that different macroeconomic declarations lower hazard premium for holding remote coin. Evans and Speight (2010) utilize 5 min returns for EUR/USD, EUR/GBP and EUR/JPY trade rates with a specific end goal to concentrate on the response of the unpredictability of euro comes back to an arrangement of macroeconomic declarations. The creators utilize a periodicity balanced model after the rationale of Andersen and Bollerslev (1998) and find that macroeconomic news from the US impels the greater part of responses in unpredictability.

Talking about the response of the JPY-USD conversion scale to Japanese macroeconomic news, Hashimoto and Ito (2010) watch

that the issued GDP figure impacts significantly the swapping scale returns. Different components with critical impacts are: Business overviews directed by the BOJ, value lists like consumer price index (CPI) and PPI while the exchange equalization declarations had an inconsequential effect. In a study that likewise concentrates on the Japanese macroeconomic declarations, Fatum et al. (2012) consider the awry reaction of the JPY-USD swapping scale with 5 min frequencies. The paper concentrates on the 1999-2006 period, portrayed by zero financing costs. Utilizing a model taking into account a straight capacity of the slacked estimations of the profits and slacks for the news variables, the creator demonstrate their asymmetry theory. Călin (2015) focuses on the conceivable association amongst instability and financial development, for an arrangement of ten European states. Utilizing a GARCH approach and the MIDAS-ADL model, the creator reports a noteworthy and pertinent association between the two considered variables on account of Germany.

Concluding that there has been a vast previous literature on correlation models trying to determine the foreign exchange currency prices, it is inspiring to follow their footsteps and proceed in researching following their guidelines but not necessary their methodology. The restrictions placed upon this research will have to be satisfied, even though the quality of results might be impaired. The following subsection will introduce the model that was inspired by the work of others while trying to satisfy simplicity requirements.

3. RESEARCH METHODOLOGY

The methodology to be used in these research paper mainly focused on quantitative analysis of data, using multivariate regression analysis on the proposed model in subsections. The predictions of this analysis is contrasted with actual prices to illustrate the model's accuracy in result section.

3.1. Model Description

The model as mentioned earlier is an attempt to unify PPP model, asset market model, interest rate parity (IRP), balance of payments model and market sentiment, as the macroeconomic announcements comprises of the components of each model. As such the model will be hopefully more accurate in its predictions, with the addition of stock market indices of the respective countries as there is a severe relation between stock indices and currency prices.

$$P_{i,t} = a_i + \sum_{j=1}^{223} (b_{ij} NEWS_{j,t}) + \sum_{k=1}^7 (c_{ik} SI_{k,t}) + \sum_{l=1}^7 (d_{il} MPC_{l,t}) + u_{i,t} \quad (1)$$

Breaking up the components of the model, firstly found is the item under investigation, $\partial P_{i,t}$, illustrating the change of market price of currency pair i at period t . The data used for this element was daily closing prices (using the closing prices of New York stock exchange) as percentage change on the previous time period's closing price. The choice behind this was to reflect only the effects of the model's variables instead of erroneously creating a formula to compute the price level of each foreign exchange currency pair. a_i as a regressor is used as a bench point on which

the value would variate accordingly to the other components. It can be described in a sense as a mean figure which the values of $\partial P_{i,t}$ will variate around. $NEWS_{i,t}$ and its regressor $b_{i,t}$ represents the announcements released relating the foreign exchange rates used in the model. They comprise of 227 distinct announcements, mostly released by governmental agencies, portraying not only macroeconomic results but also sentiment of investors and the general public. For additional information on each individual announcement, have segregated the announcements in 7 categories, based on their origin, however during the regression analysis all our used for all possible combinations of the currency pairs due to asset market model approach justified under the assumption that investors will seek more lucrative investment options if the opportunity arises.

Carrying on, $SI_{k,t}$ and $c_{i,k}$ represent the equity markets indices and their regressors. As mentioned earlier the correlation with equities markets is an important indicator of price movement in exchange rates that should be investigated, as such the following indices have been selected for portraying each currency.

1. Wilshire 5000 total market index
Consists of over 6,700 companies which are headquartered in USA and traded in American stock markets with all pricing information publicly available.
2. Euro stoxx 50 index
Covers 50 stocks from 12 Eurozone countries, usually named the “Blue-chip” index of Europe as it is composed by their respective industry leading companies. The countries in which its stocks are traded are: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Spain.
3. TSX composite index
Comprised by the largest companies traded in the Toronto stock exchange, covering more than 70% of the total market capitalization. Only lists companies incorporated under Canadian law.
4. TOPIX (Tokyo stock price index)
Comprised by 1,669 companies traded in Tokyo Stock Exchange, with market value estimated to be near to 200¥ trillion.
5. FTSE 100 index
Consists of the top 100 companies traded in London stock exchange, representing about 81% of entire market’s capitalization.
6. Swiss market index
Switzerland’s top 20 companies traded exclusively on the Swiss Exchange. Cumulatively holding more than 90% of the entire market capitalization. The choice for this index was a no-brainer as being one of the smallest countries in size, the equity price fluctuations should provide a reasonable return for the purposr of analysis.
7. ASX 200 index
Comprised by companies incorporated in Australia and traded in the Australian stock exchange. The number 200 is not genuinely indicative of the quantity of its components. One of the main factors for the selection of this index was that it represents only free-floating shares, not owned by long term investors, enabling its movements to be a signal for the market sentiment of the Australian equity market.

The terms $MPC_{i,t}$ and $d_{i,t}$ reflect the effects of changes in refinance interest rates, as set by the central banks. The use of this rate was more compelling over other alternatives as it is figuratively the mother of most other rates. Central banks set their monetary policies through this rate, with objective of influencing major factors in the economy. Through the rates being different in various countries though, they impact greatly the money supply and money demand for specific currencies, it has been seen that such changes do not have immediate impact in the economy as a whole but foreign exchange rates are seen to be greatly volatile to such changes.

Concluding on the model’s components we find $u_{i,t}$ representing all other factors, resulting in quote value fluctuations and it has been my goal to minimize it as such to better represent the fitting of the model under investigation.

3.2. Descriptoin of Variables

The selection of variables is segregated in the following established theories.

3.2.1. PPP

By definition it is “an economic theory that measures the amount of adjustment needed on the exchange rate between two countries in order for the exchange rate to be equivalent to each currency’s purchasing power.” It means that based on the goods’ prices then nominal exchange rates should be adjusted to represent each countries’ purchasing power. There is a vast literature available on the PPP hypothesis (Dornbusch and Krugman [1976], Obstfeld and Rogoff [1996] and Dornbusch [1985]). The new evidence showed proof that there is some mean-reversion toward a stable real exchange among the most advanced economies, although the convergence is very slow. It was estimated that it takes 3-5 years to close half of the gap between the real exchange rate and its long-term value, absent of new shocks (Obstfeld and Rogoff, 1996). Rogoff’s work suggested that exchange rates should be linked to relative changes in price levels with deviations that might be only minimal or momentary, on the other hand there is also empirical work, which does not provide any evidence supporting PPP (Abuaf and Jorion 1990).

On behalf of PPP approach, macroeconomics news affecting purchasing power have been selected with the most relevant being CPI reflecting directly the cost to consumer of products and services and further also inflation. Wages being also a key component of purchasing power can be reflected by GDP related macroeconomic announcements as GDP per capita is considered to be a popular measure of economy-wide income levels covering not just consumers but also businesses. Employment level is in itself a macroeconomic variable and a valuable forecast tool for the growth of economies thus exchange rates.

3.2.2. IRP

IRP is a no-arbitrage condition representing an equilibrium state under which investors will be indifferent to interest rates available on bank deposits in two countries. However this condition does not always hold, enabling for potential opportunities to earn risk-free profits from covered interest arbitrage. Two prerequisites in

regard to IRP are capital mobility and perfect substitutability of domestic and foreign assets. When the foreign exchange market is at equilibrium, the IRP condition implies that expected profits from either domestic or foreign financial assets should be equal as the exchange rate will adjust to nullify any arbitrage profits. In simpler words investors cannot earn arbitrage profits by borrowing in a country with a lower interest rate, later on exchanging those funds for foreign currency, and investing in a foreign country with a higher interest rate, as any returns will be lost when exchanged back to domestic currency and the fluctuation of exchange rate will cancel them.

IRP takes on two distinctive forms: Uncovered IRP refers to the parity condition in which exposure to foreign exchange risk (unanticipated changes in exchange rates) is uninhibited, whereas covered IRP refers to the condition in which a forward contract has been used to cover (eliminate exposure to) exchange rate risk. In the data collected, any monetary policy change will be collected and be applied on the model for the investigation of possible correlation, enabling to quantify its impact.

3.2.3. Balance of payments model

The balance of payment model holds that foreign exchange rates are at an equilibrium level if they produce a stable current account balance. A nation with a trade deficit will experience a reduction in its foreign exchange reserves, which ultimately lowers (depreciates) the value of its currency. A cheaper (undervalued) currency renders the nation's goods (exports) more affordable in the global market while making imports more expensive. After an intermediate period, imports will be forced down and exports to rise, thus stabilizing the trade balance and bring the currency towards equilibrium.

Like PPP, the balance of payments model focuses largely on trade-able goods and services, ignoring the increasing role of global capital flows. In other words, money is not only chasing goods and services, but to a larger extent, financial assets such as stocks and bonds. Their flows go into the capital account item of the balance of payments, thus balancing the deficit in the current account. The increase in capital flows has given rise to the asset market model effectively.

For this model macroeconomic news related to imports and exports are considered but also current account and trade balance to better understand the effects on market prices.

3.2.4. Market sentiment

A market-based exchange rate will change whenever the values of either of the two component currencies change. A currency will tend to become more valuable whenever demand for it is greater than the available supply. It will become less valuable whenever demand is less than available supply (this does not mean people no longer want money, it just means they prefer holding their wealth in some other form, possibly another currency).

Market forces are quite complex to be breakdown and provide accurate figures to quantify them, however there are announcements released, describing the sentiment of experts on

the market's performance but also how consumers perceive the current state of economy allowing for us to have a quantified figure to work with.

3.2.5. Asset market model

The asset market approach views currencies as asset prices traded in an efficient financial market. Consequently, currencies are increasingly demonstrating a strong correlation with other markets, particularly equities. Like the stock exchange, money can be made (or lost) on trading by investors and speculators in the foreign exchange market. Currencies can be traded at spot and foreign exchange options markets. The spot market represents current exchange rates, whereas options are derivatives of exchange rates.

3.3. Data and Sources

The time series of the data used are daily prices of the currencies starting from 1st of January 2008 and ending 31st December 2014. The choice of this time horizon was to intentionally incorporate the price fluctuations during the recession of 2008 as the markets have been severely influenced by the mortgage crisis in the USA causing a domino effect throughout the derivatives and equity markets. More emphasis is given on the data during the recovery period as then it is more likely to see the true effect of the variables mentioned earlier.

The model used to generate a projected currency price for the time period between 1st of January 2015 until 31st of December 2015. There is a huge information asymmetry between key market "players" and the common people, leaving this huge market an "exotic" and "elite" investment choice. Having though a simple method that simply uses free and publicly available data to predict price fluctuations, can enable for more individuals to join the market and enhance the dynamics of it.

It is one of my greatest aspirations to provide an "easy to use" (most importantly having easy to access data) prediction model that enables everyday people with just a small understanding and experience of the market to profit by making accurate predictions on the prosperity of the most traded currency pairs in the world.

Having a unified approach of linear regression on a subject which so far have been dominated by statistical probability models, is expected to paint a better picture of not just single triggering events but also the trade patterns of the whole market mechanism. As Einstein tried to provide the world, with his unified theory of everything, similarly it is expected this research will provide a stepping stone for a more unified approach on the price fluctuations of currencies.

3.4. Forex Market

The foreign exchange market is a global decentralized market, enabling investors to trade various currencies. The tools available include all potential positions that can be taken by the counterparties, such as selling, buying and exchanging currencies at predetermined or current prices. In terms of volume of trading, it is by far the largest market in the world, with an estimated daily trading volume of over \$5 trillion (USD). The key players in this market are mostly the larger international banks, with quite notable fact that top 5 of them holding more than half of the total global

share of foreign exchange market's trade volume. Corresponding Table 1 portrays the forex market share proposition.

The Forex market does not characterize the relative costs of various coinage, but rather empowers the players to set the present business sector value level of the estimation of one cash taking into account market powers, request and supply of every particular resource in relative terms to others. In view of the activities of every member a transient harmony is set, however utilized just for a brief period as a source of perspective for the following exchange, in the regularly utilized offer ask framework. The foreign exchange market is unique because of the following characteristics:

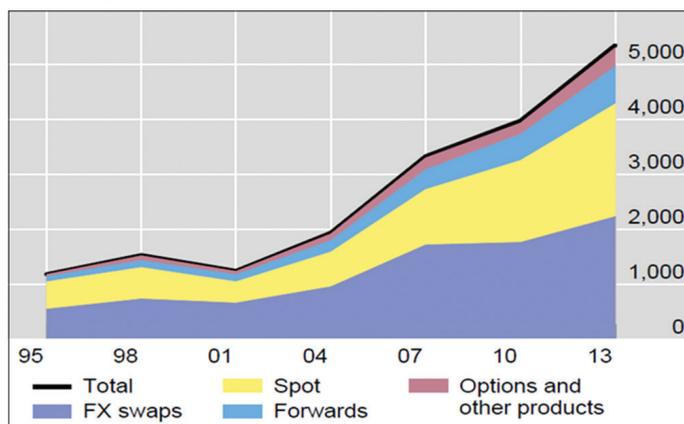
1. High trading volume

Table 2 showing the most recent data on average daily volumes in the global foreign exchange market, through the continuous linked settlement (CLS) system, which is used almost universally by the banking industry to process or settle trades on most major currencies, \$5 trillion a day (as at February 2016). The collapse of Bankhaus Herstatt in June 1974 created a systemic chain of failures throughout the globe. Nowadays, to avoid Herstatt risk, most traders use CLS to settle their payment instructions relating to underlying FX transactions, covering 18 currencies and certain other transactions that result in one-way payments in a subset of those currencies. Various financial instruments - the trade volume of currency based assets are exhibited in Figure 1, among all FX swaps account for the highest share, whileas options contribute the least. Spot contracts serve as second major participant in total share. However, the forwards agreements stand second last among investors prioritise. Collectively FX swaps and spot instruments represents 80% of the total share as most of the lucrative instruments.

2. Geographical dispersion and continuous operation

Foreign exchange trade centres are located throughout the world, but the statistics shows that the top 5 centres hold more than three quarters of each day's trade activity. Ranking first is United Kingdom with an astonishing 41 per cent of the total transactions being processed during its opening hours. Following second is United States of America with 19%, surprisingly followed by Singapore at 5.7%, Japan coming fourth at 5.6% and Hong Kong SAR at 4.1%. The trading hours of the markets are virtually non-stop, however due to low activity during the

Figure 1: Instruments share based on daily FX turnover



Source: Triennial Central Bank Survey, BIS calculations

weekends, most consider trading from 22:00 GMT on Sunday (Sydney) until 22:00 GMT Friday (New York), as the real trading hours of the forex market that ensures Continuous operation and trade availability throughout the weekdays.

3. Low volatility and its solution leverage

With an average daily volatility of <1% it is quite rare for a person to generate high volumes of profits, just by trading plain currencies without having a sizeable capital amount to invest in. It was not uncommon to characterize it as a "rich man's" market. The low budget investors were not only unable to but also unwilling to engage in any activities, as brokers' fees would shrink any profits and increase losses. In recent years though, as seen in the results of Triennial Central Bank Survey in 2013, electronic execution of trades are estimated to be nearly 95% although in reports still being reported as "voice executed" due to its practical benefits (straight through processing) brokerage fees have been at an all time low. Table 3 presents the majors average daily volatility for the period of 2011-2015, ranked based upon standard deviation and volatility. Currency pair of AUD/JPY is the most volatile with highest volatility of 90%, whereas, EUR/CHF pair is least volatile with only 10% value. AUD/USD is second most volatile pair with 51%, GBP/JPY at third one with 43% and rest of all pairs are below 38%. This implies that AUD has the key role in high volatility among all other currencies.

Table 1: Forex market share

Rank	Bank	Market share (%)
1	Citi (USA)	16.11
2	Deutsche Bank (Germany)	14.54
3	Barclays (United Kingdom)	8.11
4	JPMorgan (USA)	7.65
5	UBS AG (Switzerland)	7.30
6	Bank of America Merrill Lynch (USA)	6.22
7	HSBC (United Kingdom)	5.40
8	BNP Paribas (France)	3.65
9	Goldman Sachs (USA)	3.40
10	Royal Bank of Scotland (United Kingdom)	3.38
11	Societe General (France)	2.43
12	Standard Chartered (United Kingdom)	2.40
13	Morgan Stanley (USA)	1.97
14	Credit Suisse (Switzerland)	1.66
15	State Street (USA)	1.55

Source: Euromoney FX Survey 2015

Table 2: CLS February 2016 data

	February 2015	January 2016	February 2016
Average daily input volume of instructions submitted to CLS	1,185,696	1,249,226	1,220,828
CLS Settlement service input	839.062	986.086	946.012
CLS Aggregation service input	346.634	263.140	274.816
Average daily input volume of matched instructions submitted to CLS (USD trillion)	USD4.87	USD4.84	USD5.00

Source: CLS, News Article 15 March 2016

Table 3: Majors average daily volatility 2011-2015

Forex pair	Volatility ranking	SD (%)	Volatility (%)
AUD/JPY	1	0.947	0.896
AUD/USD	2	0.716	0.513
GBP/JPY	3	0.655	0.429
EUR/JPY	4	0.609	0.370
USD/CAD	5	0.598	0.357
EUR/AUD	6	0.556	0.309
USD/CHF	7	0.529	0.280
CHF/JPY	8	0.523	0.273
USD/JPY	9	0.518	0.269
EUR/USD	10	0.497	0.247
GBP/USD	11	0.484	0.237
GBP/CHF	12	0.464	0.215
EUR/GBP	13	0.361	0.130
EUR/CHF	14	0.313	0.098

Source: FX volatility - analysis concepts, trade station labs, SD: Standard deviation

4. Availability of leverage to enhance profit and loss margins
Nevertheless for more complicated derivatives, such as exotic options, the need for voice execution is almost mandatory. In the following table we can see how the execution methods are divided between counterparties, the data reported does not compute to 100% nor 200% as they are based on a net-net basis but in some cases execution is handled internally so it is measured as a single execution.

With electronic trading on the rise, it enabled investors to trade faster and have precise and reliable executions on their trades, giving opportunity for new and more complex instruments with the use of leverage. Leverage in this case has the definition of amplifying the value of the capital under risk. It can increase the profits or losses of an investors depending on the size of his margin account at any given volatility. Small investors if successful in their investment choices can generate vast amounts of funds, as such having the right tools to be able to predict correctly are essential. In the next chapter we will investigate the dynamics of market price fluctuations to justify the concept in mind during the formulation of the model.

3.5. Price Fluctuation

There are many theories concerning the computation of foreign exchange currencies market price, however in its most logical and simplified form it can be described as the weighted average, based on trade value, successful trade prices based on the perceived price level of all wilful and active participants in the specific time period they occurred. Algebraically it can be illustrated:

$$P_t = \frac{\sum_{i=1}^n ETV_{i,t}}{n_t} \quad (2)$$

P_t represents the price as at on period t while $\sum_{i=1}^n ETV_{i,t}$ is the total value of all successfully executed trades during the same time frame, lastly n_t term is the frequency of the successful trades at time t . Investigating further we can consider the executed trades value as a function based on the perceived value the trader has for the asset. Digging deeper, the perceived value is based on the expectations and personal opinion of the performance that the asset will have, which depends on information concerning either that specific asset or other assets which can serve as substitutes for

profitable investment choices. In this thought process, the executed trades made for non-investment purposes are also considered, such as imports and exports based on different currencies due to justifiably, as a percentage of the total trade volume, being conducted by finance experts that will time the execution at a perceived profitable time frame, hence the described justification also applies in the vast majority of cases.

As such the attempt to model the data using a handful of variables is not just simply wrong but also useless as the results will not provide neither strong correlations nor causality. In numerous papers there have been proof that foreign exchange prices of developed economies do not show any stationarity, such as the work of Burke and Hunter (2005), Belaire-Franch and Opong (2005), and Rashid (2006). There is no pattern that could successfully model the daily movements in a simple equation, however non-stationary process model can be transformed into a stationary one by differencing the model with the next movement of the process to fixed time segments. In the example followed, I will explain visually the process.

$$P_t = P_{t-1} + e_t \quad (3)$$

Equation 3 represents a non-stationary process model for price with a random element e_t representing the drift of dependent variable, with mean equal to zero and variance σ^2 , to changes over a single unit of time. Next step taken will be to transform it by subtracting each side with P_{t-1} changes the form to;

$$e_t = P_t - P_{t-1} \quad (4)$$

In this form, difference stationarity is achieved, however e_t due to its characteristics, mean equal to zero and variance which evolves close to infinity as time frame approaches also infinity. In this case, no predictions can be made on the price fluctuations. The main reasons behind it was that, the limited definition used to describe the price fluctuations through the term e_t lets no descriptive terms to be used in any possible descriptive form. Thus, predictive variables should be given to estimate the potential values that it might take.

Following along the next step for this thought experiment to bare any results, the issue arise of what is going on in the brain of the traders during decision making, how do they perceive new information and how do they react to it? The key point on the last question was that something happened in a form of an action or new information is added in their memory "palace" which either is going be reacted upon instantly or later. What is relevant information for each investor differs, hence responses for each new data also alternate amongst each individual. In the quest of satisfying the research question mentioned in the introduction, I settled upon using the data released by the national statistical bureau of Australia, Canada, Euro-zone, Great Britain, Japan, Switzerland and United States as they are highly reliable, publicly available and there are many free sources to retrieve them in digital form enabling easier analysis.

We understand that we are not going to present a model that solves the issue of non-stationarity of market prices and be able to accurately predict e_t term of equations 3 and 4, thus we conclude

this section with a quotation from famous statistician David J. Thompson.

“Experience with real-world data, however, soon convinces one that both stationarity and Gaussianity are fairy tales invented for the amusement of undergraduates.”

4. RESULTS AND DISCUSSION

The data have been analysed in the software NCSS 10, due to the large number of variables used. Attempts have been made in R software but during the printing of results the cap of results was reached, not enabling for the full representation and analysis. Through the NCSS 10 software though, which enables nearly unlimited regressors, which was perfect for the number of 237 independent variables used in our model to estimate the regressors coefficients and through the coefficients of determination determine if the model was suitable to predict accurately the price market fluctuations. This section consists of results concerning the foreign exchange currency pairs with components the 7 currencies AUD, CAD, CHF, EUR, GBP, JPY and USD.

As reported in Table 4, the outcome of the regression analysis shows that there are mixed results pertaining to correlation of the variables in describing the dependent variable. Through the results tables and the charts, the model's predicted prices and actual prices deviate greatly. With coefficients of determination ranging from 25.69% to 55.28%, thus the claim of reliable generalisation may not be possible with these results. The predictions seem to diverge greatly at the head and tail of the time series, indicating even from the very beginning the model has faults. Specially certain currency pairs are seen to be least correlated. The following table lists the pairs with the lowest to highest score of goodness-of-fit test. The pair of CAD-EUR has the lowest R^2 value (25.69%) at other hand EUR-CHF accounts for highest R^2 value (55.28%). Among 42 pairs of global currency, only 7% having R^2 above 50%, however most of the pairs are ranging between 30% and 40%. Further, the currencies seem to be relatively least influences are CAD, EUR, JPY and GBP with lower relative fluctuation, contrastly pairing with CHF the same stronger currencies explained different attribute, most probably due to the fluctuation in CHF.

4.1. Implication

Even though the model seemed less effective being applied as a price model it has been successful in a higher degree of predicting the trend that the prices will follow. After contrasting the predicted price with previous day's price an average predictability of more than 55 per cent have been calculated. Even though it could not accurately predict the price level there was a positive by-product of trend predictability (Table 5). All 42 pairs have predictive probability of $\frac{1}{2}$ ($>50\%$ and $<59\%$). If we form a cluster based upon range of probability, the 15 pairs (represent 36% of total sample) lie in the range from 58% to 59% are JPY-CHF, GBP-USD, CHF-JPY, AUD-JPY, EUR-JPY, CAD-JPY, CAD-USD, USD-GBP, CHF-GBP, JPY-GBP, USD-CAD, GBP-JPY, CHF-CAD, CAD-GBP and JPY-CAD, an indication of relative high predictive probability among all pairs considered for analysis. In addition, 62% of the pairs documented the predictive probability between

Table 4: Ranking of coefficients of determinations (lowest to highest)

Ranking	Currency pair	R ² (%)
1	CAD-EUR	25.69
2	EUR-CAD	26.35
3	JPY-EUR	28.45
4	EUR-JPY	28.72
5	CAD-GBP	30.19
6	GBP-CAD	30.46
7	CAD-JPY	31.72
8	JPY-CAD	31.90
9	AUD-GBP	31.95
10	AUD-USD	32.23
11	USD-AUD	32.42
12	GBP-AUD	32.76
13	JPY-GBP	33.79
14	GBP-JPY	34.22
15	AUD-EUR	35.19
16	AUD-JPY	35.64
17	USD-CAD	36.16
18	EUR-AUD	36.28
19	CHF-USD	36.33
20	CAD-USD	36.59
21	JPY-AUD	36.81
22	CAD-AUD	36.97
23	JPY-USD	37.04
24	GBP-USD	37.49
25	AUD-CHF	38.25
26	AUD-CAD	38.34
27	USD-GBP	38.46
28	CHF-AUD	38.51
29	USD-CHF	38.86
30	USD-JPY	39.04
31	EUR-GBP	40.45
32	GBP-EUR	40.62
33	USD-EUR	43.72
34	EUR-USD	44.07
35	CHF-GBP	44.35
36	GBP-CHF	46.17
37	JPY-CHF	46.54
38	CHF-JPY	48.24
39	CHF-CAD	48.86
40	CAD-CHF	49.86
41	CHF-EUR	54.93
42	EUR-CHF	55.28

55% and 57%, that is the dominant prediction and only a smaller pair percentage lies below 55.

In the online forex trading industry, there is a high risk - high reward trading option that requires the trader to predict if the market price will expire higher or lower than the current price. Those trading options are called binary options and the specific trading instrument is most commonly called HIGH/LOW option. By applying the results of this model, there is likelihood in generating profits. Testing of it have not yet been implemented and positive results are not guaranteed, due to the variety of different trade and investment capital money management strategies.

5. CONCLUSION

Market price fluctuations follow a non-stationary process and accurately modelling them is absolutely impossible, however attempts have been made with varying results, even the unsuccessful

Table 5: Trend prediction probability

Currency pair	P (%)
JPY-CHF	58.65
GBP-USD	58.40
CHF-JPY	58.31
AUD-JPY	58.01
EUR-JPY	57.98
CAD-JPY	57.94
CAD-USD	57.94
USD-GBP	57.84
CHF-GBP	57.71
JPY-GBP	57.71
USD-CAD	57.71
GBP-JPY	57.67
CHF-CAD	57.64
CAD-GBP	57.57
JPY-CAD	57.51
CAD-AUD	57.44
GBP-CAD	57.37
CAD-CHF	57.34
JPY-EUR	57.31
AUD-CAD	57.23
USD-JPY	57.21
GBP-CHF	57.11
JPY-AUD	57.07
CHF-USD	57.04
AUD-USD	56.87
CHF-EUR	56.87
USD-EUR	56.87
EUR-CAD	56.80
USD-CHF	56.74
JPY-USD	56.67
USD-AUD	56.57
CHF-AUD	56.50
EUR-USD	56.50
CAD-EUR	56.40
EUR-GBP	56.33
AUD-CHF	56.30
EUR-CHF	56.22
GBP-EUR	55.80
AUD-GBP	55.26
GBP-AUD	55.13
AUD-EUR	54.52
EUR-AUD	54.09

ones, contribute in a better understanding of the fluctuations dynamics. In our model the used variables, as standalone they portray the state of the economy, macroeconomic releases show real data about how the country, which the currency originate from, efficiently operates. However, they do not reflect the opinion of foreign exchange market investors thus no movements in the market seem to correlate directly to them. Adding further, through the asset market approach, comparing the performance of substitute investment options did not prove any significant results. On the last group of variables, the refinance interest rates as set by central banks, showed an even less impact in a sense proving that monetary policy strategies on a free floating currency has fairly low to no results.

The results can not be discarded though as useless. There has been a small discovery of trend pattern predictability that in a sense shows that the previously mentioned variables, play a role in the decision-making process of investors in a lagged manner. Additional research on the timeliness of effect could

bear some more insight on the subject and show some exceptional discoveries. Unfortunately though it is beyond the scope and focus of this research to do so.

The research goals as set in the introduction section required for a simple model with variables free and open to the public. In respect to simplicity, a simple multivariate regression model was used through a free software which only took two button presses to run the statistical analysis process. The hardest part was to sort and match the independent variable data with the daily prices For that part, after some brief research on algorithms, it was achievable to create the proper datasets needed to run the software. For the pre-mentioned part that will not be an issue for a continuous data collector as each day the new data released will update on the current date row of variables, but only as a starting point. For the data, there is a plethora of available databases that are freely accessible, mainly thanks to the uptrend of electronic forex trading through online platforms. All the variables data was freely collected over the internet, then double checked through the official channels, in majority the governmental statistical bureaus of each respective currency, to ensure the authenticity and reliability of those free databases. None had showed any deviations from the real data except of some minor cases where the releases was re-publish due to some error.

Following the quote by the famous Dale Carnegie, “Develop success from failures. Discouragement and failure are two of the surest stepping stones to success,” conclude with that the model was deemed less effective in accurately predicting the market price movements, however it has showed the weaknesses of the selected variables and has justified the attempts for simplicity and accessibility to data, in a manner as such that some small discoveries can be made. The quest for accurate modelling is always a great deal, thus we hope it will inspire others to further investigate the issue using more complex methodology.

5.1. Limitations and Future Directions

Some of the most noticeable limitations of the study could be:

- The sample size used for each currency pair was between 1st of January 2008 until 31st December 2015, within this 8 years of data, the price fluctuations may not represent the general attitude of investors towards the changes in the independent variables. The issue with sample size was that access to a vaster data pool would be costly thus not applicable for the scope of this study.
- There has been a major mismatch, the independent variables except the stock indices have a non-daily frequency. Some macroeconomic announcements are weekly, others monthly and most notable monetary policy changes in terms of refinancing interest rates have a non-distinct frequency rate that completely scrambles their correlation with the market prices. The reasoning behind my choice of regression analysis though, was to see if even due to their randomness in frequency would be able to model the patterns in the daily market price movements.
- We have used 237 dependent variables that resultantly were inefficient to match the think process of market participants and have led to the low figures that coefficient

of determinations had. The amount was limited as one of the conditions set in this research was simplicity and the lack of cost for accessibility to data, adding additional variables which would require hiring the services of database providers would ultimately break such condition.

- Multivariable regression model as a choice, seems to be less effective in the timing of data as a notion of applying simple model. To predict more accurately some complex models can be applied on discontinuous dependent variables.

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