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Investors Impact on Currency Returns: Theory versus Practice

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The present research paper entitled:

Investors Impact on Currency Returns: Theory versus Practice

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RÉSUMÉ

Le but du présent rapport de recherche sera dans un premier temps d'effectuer une vaste et exhaustive revue de littérature relative à une toute nouvelle approche économique pour étudier le taux de change : l'analyse de la microstructure des taux de change. Par la suite, nous investiguerons la relation potentielle entre les transactions de change des plus grands investisseurs américains et leur impact sur les variations du taux de change.

Dans la partie empirique, nous explorerons la relation entre lesdites positions de change des grands investisseurs américains (pour différents produits financiers) et la volatilité du taux de change. Nous allons tester si (1) leurs positions financières impliquent une plus grande volatilité du taux de change et (2) si ces grands investisseurs ont l'habilité de prévoir la direction future que prendra le taux de change. À cet effet, nous utiliserons une spécification VAR et un test de Wald de causalité à la Granger dans la première sous-section, puis une régression simple par moindres carrés ordinaires et une régression non paramétrique dans la seconde sous-section.

Le résultat est que pour certaines devises, les positions financières des grands investisseurs américains impliqueront une plus grande volatilité future du taux de change associé. Néanmoins, nous ne trouverons pas de telles relations (à l'exception de l'euro) en ce qui a trait à la relation entre les positions financières des grands investisseurs américains et les variations directionnelles subséquentes des taux de changes associés.

ABSTRACT

The present research paper aim at two main objectives: (1) carry out a comprehensive literature review of exchange rates economics related to the new microstructure approach to exchange rates determination; and (2) investigate the relationship between foreign currency positions taken by very large U.S. players and exchange rate movements.

In the empirical section we will explore the relationship between FX positions in different financial instruments by large US market participants and exchange rate volatility. We want to test if (1) the positions of large markets participants cause exchange rate volatility (second moment) and (2) if these large participants have the ability to forecast the level (first moment) of exchange rates. For that matter, we use VAR specifications and Wald Granger-causality tests in the first subsection and regression analysis and non parametric-approach in the second subsection.

We find that for some currencies, large players' positions Granger-causes exchange rate volatility, although we found no evidence (except for the euro) that position-taking by large players helps to forecast subsequent variation of the exchange rate.

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TRADITIONAL THEORIES OF EXCHANGE RATE DETERMINATION

Introduction

How currencies price is fixed? *What* has an impact in the spread settlement process? We had to wait until the late 1990's before academics started proposing models that considered both question together in order to appreciate currencies fluctuations. The new literature related to this new approach is the so-called *Microstructure of foreign exchange markets.* The goal of the present paper will be two fold. Firstly, we will seek to brush a clearer picture of how these empirical models were developed and how they work. Secondly, we will perform an empirical investigation of one of these models. Before getting into new microstructure models of exchange rates determination, we will consider previous classical models of exchange rates economics in order to appreciate the new exchange rates models in their chronological perspective.

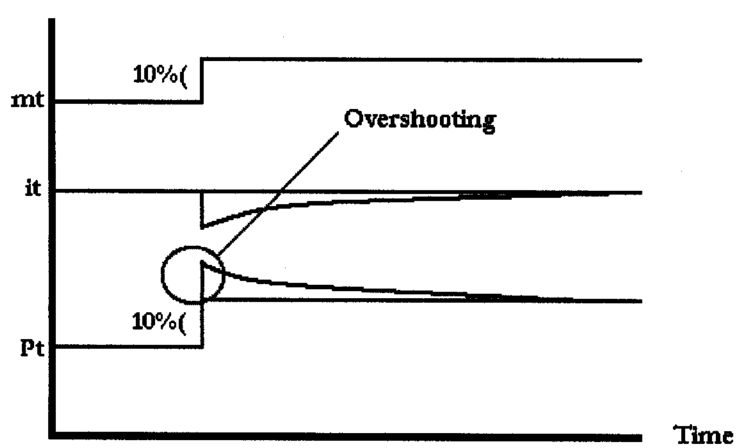
Traditional asset market approach

Prior to the new literature investigation, we must at least be familiar to a certain extent with the principal models of exchange rate determination. Originally, economists tended to tackle down the currency valuation problem by looking at the big picture, or in economists' terms, by looking at the macroeconomic variables. Going back to the Bretton Woods era, scholars were more focused on external adjustment of the current account and the international liquidity problem associated to the constraints on international capital flows and temporary shocks (isolated or spread). From this era emerged a system of floating exchange rates *à la* Mundell, when a substantial number of countries stopped pegging their homeland currency (mainly to the US Dollar). At that time (early seventies), the asset market approach appeared as the ultimate concept. Within that model, the exchange rate adjusts instantly to equilibrate the demand and supply for any shocks to the national economy. Several alternatives to this generic framework exist, generally divided between the monetary approach and the portfolio balance approach. Without going any further in the specific details of these two approaches, we will briefly go over some of these significant exchange rates determination models.

Assessing traditional models

In the early seventies, a new advance in international economics seemed to have finally nailed down the apparently inexplicable problem of exchange rate's fluctuations (volatility). That new paradigm was called the asset market approach to exchange rate, initiated by Dornbusch, Frankel, Mussa and others. The most notable of these asset market models is Rudiger Dornbusch's (1976) sticky-price model (the "overshooting" notion). Dornbusch's rational expectations reformulation of the Mundell-Fleming model was designed to cope with (1) the unexpectedly high volatility of exchange rates compared with their underlying macroeconomic variables and (2) with the violation of the purchasing power parity condition. Hence, at the opposite of the flexible-price model, the sticky-price model does not allow for immediate responses of prices to monetary shocks. Only in the long-run can the prices adjust. Over long horizon, the response of the exchange rate to an expansion (contraction) of the monetary base is a rise (decline) in the long-run equilibrium exchange rate (i.e. appreciation or depreciation). In the short-run, however, the analysis is not that straightforward as prices cannot adjust. The reaction has to take place through the expectations formation and their impact on the interest rates. In this model the exchange rate will often *overshoot* its final long term equilibrium level over short period of time (see figure 1.1 below). The exchange rate depends not only on current demand and supply of international goods and services but also on agents' expectations about future innovations in the GDP, the money supplies, etc.

Figure 1.1 - Rudiger Dornbusch (1976) sticky-price model



The other famous initiative in international macroeconomics was Meese and Rogoff (1983) out of the sample[1] approach. In their well-known article entitled *"Empirical Exchange Rate Models of the 1970's: Do they fit Out of Sample?"*, they compare all the main theoretical models of exchange rates developed until the eighties against a random-walk forecast in order to appreciate their forecasting power. They found the hardly acceptable result (especially at the time) that short run exchange rates are impossible to predict via traditional macroeconomics models. At a minimum, they rejected the idea of historical macroeconomics' parameters predictive power. Furthermore, they provided evidences in opposition to the purchasing power parity theory (in the short-run convincingly, over longer horizon not so persuasively), and moreover contested the common belief of a strong connection between exchange rate and fundamental macroeconomics.

For approximately 20 years following this abovementioned seminal article in the *Journal of International Economics*, traditional models (also known as "structural" or "canonical" in the literature) continued to discouraged macroeconomists of finding a solution to the apparently unpredictable volatility of exchange rates. For that period of time, no other alternative arose to overthrow the random-walk forecast. There are some significant exceptions (models) such as Nelson Mark's (1995) -multiple-period log exchange rates regressions- who illustrated "*evidence that long-horizon change in log nominal exchange rates contain an economically significant predictable component*". Nonetheless, as of today, no so-called traditional models of exchange rate determination emerged as a good empirical fit according to economists' consensus. Therefore, beside some supports in the long-run equilibrium, the traditional approach is empirically a very poor estimator of future exchange rates, notwithstanding the horizon.

This difficult situation has leaded some notorious economists to search for alternatives (to look for unconventional substitute theories) that might better account for exchange rates movements. One possible solution recently came from an unexpected field: the microstructure of finance; more specifically, the microeconomics of asset pricing. The overview of the current literature related to the microstructure of foreign exchange (FX) markets is the subject of section 2. Section 3 review models related to large investors impact

[1] Out-of-sample: measured on data that was not used to form the prediction function. This contrast with in-sample R^2 usually used in predictability tests.

on FX rates. Section 4 describes our data-set. Section 5 presents our models and results, where we investigate the relationship between FX positions taken by very large U.S. players and exchange rate movements. Section 6 concludes and supplies some perspectives on our results as well as insights on the future of the microstructure approach to FX markets.

THE MICROSTRUCTURE OF FOREIGN EXCHANGE MARKETS

New microstructure approach to exchange rate determination

In 1990, Richard Meese, reflecting on possible explanations for the poor empirical performance of traditional macroeconomics' approach to exchange rate determination, suggested that perhaps some essential variables were missing to these models' equations. Going even further, Frankel and Rose (1995) paper's impact on past macroeconomics models was like the straw that broke the camel's back. They boldly proclaimed that macroeconomics fundamentals were not to be key explanatory building blocks this time. Then where to explore for new creative approaches? Which ingredients had not yet been tasted? The answer came from the microeconomics empirical literature. These articles were addressing securities price mechanisms problems[2]. Through high frequency *transaction-level* data[3], they explored what was driving stock prices' movements. Their goal was to understand the relationship between available public information and trading orders (and the underlying predictive potential). To our knowledge, Lyons (1995) was the first to apply these techniques to currencies' valuations (net FX order flow). However, before digging any deeper in his model and related approaches, one needs to get a basic understanding of FX market's structure. Moreover, a brief depiction of FX markets' participants (beliefs, convictions and trading motives) is essential for the paradoxical *helicopter's view* necessitated to realize why a *microstructure* approach might well be the most advantageous one to get a handle on currencies' fluctuations.

FX market microstructure analysis

International macroeconomists have recently made an effort to gain a fairly good knowledge of the FX market organization. Their central attempt has been the study of FX traders' behavior (see Table 2.1 below for more details). To that extent, they needed to learn how market microstructure actually worked. According to Maureen O'Hara (1995), *"market microstructure (theory) is the study of the process and outcomes of exchanging assets under explicit trading rules"*. We shall stick to this definition when referring to market microstructure. The major

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[2] Important early papers in this line include the 1988 article by Larry Glosten and Larry Harris, the 1991 article by Joel Hasbrouck (see Payne (2003) in the present paper), and the 1991 article by Ananth Madhavan and Seymour Smidt. Reference: Economic Policy Web Essay: Lyons on the failure of exchange rate models.

[3] High-frequency data (tick-by-tick transactions) are key when studying microstructure models (they have different features relative to distributions, correlations and scaling properties that cannot be observed at lower frequencies).

distinctions between FX markets and other liquid assets markets (stocks, bonds, etc.) is that (1) FX market is a far more *active*, (2) highly *decentralized* market that (3) operates almost *24 hours per day* around the world. Let's dissect each of these features in turn. With a $1,210 billion worldwide turnover per day, the FX market is by far the most active market in the world. For illustration, in the United States, the daily FX turnover is $254 billion per day, 10 times the turnover of U.S. government bonds and 50 times the turnover of the NYSE stocks[4]. As for the FX market operating over the clock and from several far-away cities on earth, it is no surprise that the market has practically no rules imposed on its functioning. FX markets colossal turnover involve spot and forward contracts as well as more sophisticated options and swaps to perform a wide range of functions, mostly currency conversions and provision of credit (international payments process), and management of exchange rate risk (hedging and speculation). Of these transactions, approximately 40 percent are completed via direct dealing (quote-driven) and the remaining 60 percent via brokered trades (order-driven).

Table 2.1 - Summary table of major distinctions between Micro and Macro approaches

Microstructure Approach	Macroeconomics Approach (Empirical failures)
Focus on agents behavior and market characteristics	Focus on Macro fundamentals and representative agents
→ heterogeneity: information, horizons → institutional constraints: market makers, liquidity traders *(speculation)*, risk sharing *("hot potato" passing generates pyramiding of volume)*, price discovery *(trades are informative since private information is conveyed)*	→ goods trade represent a small fraction of FX market → asset markets move quickly in response to expected changes *("news" quickly incorporated in price)* → only public information moves market → all share same information

[4] Source: Bank for International Settlements, *"Central Bank Survey of Foreign Exchange and Derivatives Market Activity in April 2001,"* October 2001, www.bis.org.

FX market participants

As the mouse or the chimpanzee is key to biology or neurology researches, FX traders are key to research in the field of microstructure exchange rate determination. The analogy somehow lacks concreteness, considering that the formers are those being manipulated, whereas the latter are the manipulators. Nonetheless, the study of FX traders (e.g. their viewpoint, strategies and trading patterns) helps us understand how they influence currencies fluctuations.

Undoubtedly the most useful paper in that regard is Cheung & Chinn 2001 traders' behavior survey. In their mail survey to FX traders located in the United States, they documented trading practices and views for a representative sample (142) of the traders' population. From their extensive investigation, the most significant findings are:

1- rise of electronically-brokered transactions at the expense of traditional brokers;
2- importance of market norm (implicit convention between brokers) has bid-ask core determinant;
3- half of the participants believe major players dominate in some specific currency markets (such as USD/GBP and CHF/USD);
4- technical trading is a rising trend;
5- macroeconomics news are rapidly accounted for into exchange rates;
6- besides for interest rates, the declining importance of macroeconomics variables;
7- difference between long-run (economics fundamentals) and short-run (excess speculation and institutional customer/hedge fund manipulation) fluctuations;
8- positive perception of speculation (enhancement of market efficiency and liquidity, even if it seems to increases volatility);
9- central bank intervention is not significantly effective and generates volatility;
10- purchasing power parity (PPP) is a useless concept.

We can subsequently assess the impact of these traders' straightforward responses. The intuitive reaction is to compare traders' views with academics' views. One should then be able to find some substantial differences from theory and practice respective standpoint. In order to build suitable and efficient empirical models, the academician will have to consider these discrepancies. This is precisely what the following authors did when conceptualizing their empirical frameworks.

Main microstructure literature

To get a fair overview of the most important current literature related to the microstructure of FX markets, one shall reflect on three seminal papers: Evans & Lyons (2002), Payne (1999) and Froot and Ramodarai (2001). We will briefly make an overview of each of them in turn.

Explanatory power of order flow

Agreeing that the traditional approach did not yield satisfying conclusions, various economists consider a second approach where the centerpiece is the role of trades in price determination. The *order flow* is at the heart of the model. Order flow is a convenient measure of net buying pressure. It is defined as the net of buyer-initiated orders and seller-initiated orders. That is for the technical definition. In this paper, however, we are more interested about the intuitive (perceivable) meaning of order flows: "what information does this net buying pressure carry on to the market participants?"; or put differently: "what is the impact of a given level of net buying pressure on the exchange rate?". The implication is that order flows bear a considerable amount of information about the participants (dealers and traders) views and expectations on fundamental determinants of exchange rates. A good analogy for order flow would be one of the six senses (i.e. a transmission link between information and subsequent action).

The initial effort to undertake this new approach was done by Richard K. Lyons, who eventually continue is work with co-authors, most notably Martin D.D. Evans. Lyons, back in the early 90's, joined a friend who was a spot FX trader for a large bank in New York City to observe the market first-hand. The off the record goal behind his visit was clearly to figure out some new insights about aggregate exchange rate fluctuations. Indeed, his time spent in the trench yield to completely unforeseen ideas. Lyons observed that major economic variables were not that much of a deal down there (as reported by Cheung & Chinn (2001)). Following his new understanding of the FX trading game, he tries to understand what might be the connection between FX traders' actions and exchange rates movements. Without actually finding the *cause* (the underlying initial event (motivation)) he was able to tackle down the *symptom* (the order flow) and the *sequel* (the exchange rate variation).

Therefore, Lyons (1995) and most significantly Evans and Lyons (2001, 2002) were the first to propose net FX order flow as a good predictor of exchange rates' fluctuations. In their most significant model, Evans and Lyons (2002) consider a simple linear model using transaction-level data of the two largest floating exchange rate markets[5]. According to their model, daily exchange rate variations are determined by changes in the interest rate differential, as suggested by traditional models, but also and most importantly by changes in signed order flow. The equation is of the following form[6]:

$$\Delta S_{t+1} = \beta_i \Delta(i_t - i^*_t) + \beta_z Z_t$$

Where ΔS_{t+1} is the first difference in the log of the FX price within day t (i.e. S_{t+1}-S_t), $\Delta(i_t$-$i^*_t)$ is the first difference in the interest rate differential (i.e. $(i_t$-$i^*_t)$-$(i_{t-1}$-$i^*_{t-1})$), and Z_t is the difference between the number of buyer-initiated trades and seller initiated trades in day t. Their simultaneous-move game model differs from previous game-theory models for two reasons: (1) it accounts for inventory shocks from incoming orders; and (2) it takes account of the "hot potato" phenomenon (i.e. the fact that trades are not necessarily conditioned on a market-clearing price approach, such as an auction model). All agents are now risk-averse, yet acting strategically to make a profit base on private information contained in order flow.

From Figure 2.1 at the following page, it is noteworthy how the correlation between exchange rate and order flows movements is clear. As a matter of fact, their model of daily inter-dealer

[5] Evans and Lyons employ daily data for all bilateral transactions completed among FX dealers via Reuters Dealing 2000-1 electronic trading system in the spot DEM/USD and YEN/USD markets between May 1st and August 31st 1996.

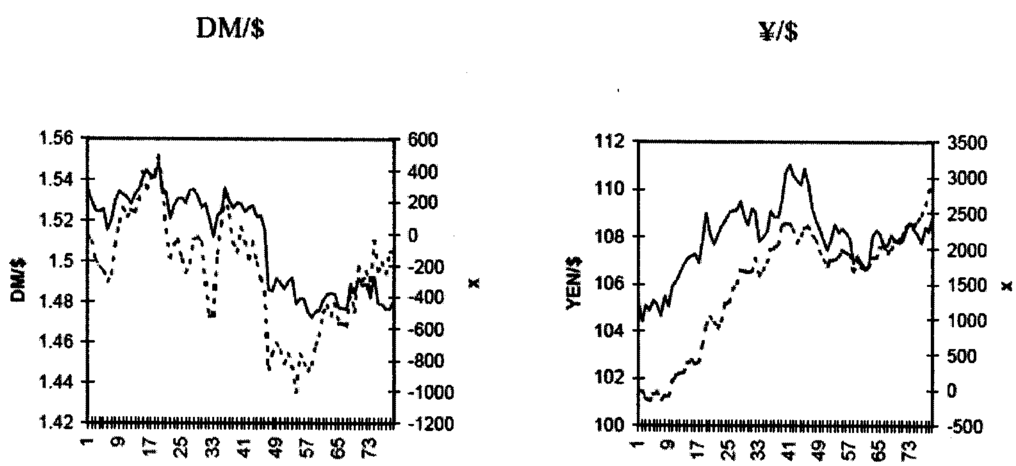
[6] Reported coefficients for the various specifications are estimated using OLS.

order flow explains about 60 percent of daily exchange rate changes, compared with less than 10 percent for traditional models.

Figure 2.1 – Explanatory power of order flows

Four Months of Exchange Rates (solid) and Order Flow (dashed)

May 1-August 31, 1996



Clearly the empirical fit of Evans and Lyons' model is impressive, yet has difficulty to remain as impressive pass the first sight impression. As a matter of fact, the explanatory power of their model dies away rapidly, adding to the fact that proper forecasts are not obtained since actual values of the explanatory variables are used. Moreover, one can criticize the linear regression they proposed with legitimacy, arguing a potential simultaneity bias (if the true relation is rather the exchange rate movements causing the order flow). This last point leads us to our second main author.

<u>Order flow and exchange rate return analysis</u>

For Evans and Lyons, the relation between order flows and exchange rate variations seems incontestable. Nevertheless, some academicians were questioning this apparently obvious relation; amongst them a professor at London School of Economics. Payne's, simply looking at the same question the other way-around, doubts the possible feed-back effect of exchange rates on order flow. To test his intuition, Payne (1999) employed an alternative methodology. He based his study of the DEM/USD spot market over the week of October 6th to October 10th 1997 using a simple linear vector autoregression (VAR) model. Joel Hasbrouck (1991) was the first to use that kind of model in a microstructure framework in his analysis of trades and quotes of the NYSE.

Also in contrast with Evans and Lyons, Payne applies Hasbrouck's methodology to a transaction data-set[7] (i.e. the brokered section of the FX spot market, whereas Evans and Lyons analyze the direct market). A week might appear as a very short period of time to analyze anything in such a big market. His data-set actually contains information over roughly 30,000 transactions, with a total volume of more than $60 billion. Within all account a substantial number. The equations he used are the following ones:

$$r_t = \sum \alpha_i r_{t-i} + \sum \beta_{zi} z_{t-i} + \varepsilon_{1,t}$$

and

$$z_t = \sum \gamma_i r_{t-i} + \sum \delta_{zi} z_{t-i} + \varepsilon_{2,t}$$

Another difference between Evans and Lyons and Payne is the notion of time. In Payne, the interval (t, t-i) does not refer to a given (fixed) period of time. Instead of using calendar time, Payne use an event time defined as either the moment when the exchange rate best quotes are revised (i.e. the best bid and ask prices) or when a transaction is completed via the Reuters Dealing 2000-2 trading system.

In a nutshell, Payne's conclusion is that time-of-the-day and liquidity effect complicate the relation between order flow and exchange rate returns (he deducted this finding from the fact that the asymmetric information coefficients (β_{zi}) are not stable across different level of market liquidity). Therefore, even when feed-back trading rules are accounted for, order flow imbalance is still a key determinant of exchange rate variations.

[7] Payne considers all inter-dealer trades (brokered and direct) completed via Reuters Dealing 2000-2, whereas Evans and Lyons considered only indicative quotes, i.e. brokered transactions.

Fundamentals and heterogeneous information

The most sizeable and comprehensive work regarding microstructure approach to exchange rate determination is certainly *Currency Returns, Intitutional Investor Flows, and Exchange Rate Fundamentals*, soon to be published by Froot and Ramadorai. Capitalizing on their exclusive access to order flow information[8], they try to assess the relation existing between order flow, exchange rate returns and fundamentals. If we compare Froot and Ramodarai's study with the studies depicted above (i.e. Evans and Lyons (2002) and Payne (1999)), there are some major differences, the most important ones being:

- Froot and Ramodarai employ an exhaustive (including all sorts and types of transactions) data-set of over 6 million FX transactions. Earlier studies have only access to partial data-sets.
- Their models go further than earlier models combining three VAR models (excess return, fundamentals and order flow) with a decomposition à la Campbell. Indeed, their VAR model is a sophisticated extension of Payne's formulation.
- Their excess return decomposition allows a distinction between movements in exchange rates caused by shifts in expected interest rate differentials (i.e. fundamentals) as well as innovations due to variation in expected future returns.

As pointed out above, they use Campbell decomposition of permanent and transitory components of asset returns with the intention of investigating the long-run effects of international flows on exchange rates and the connection with the fundamentals. Studying the covariance-matrix between flows and returns, they find that some traders employ positive feed-back rules over short-term horizons and then unwind their speculative position, as if they were following negative feed-back trading rules over the long-run. In the light of their findings, there is no clear link between order flow and exchange rate variations in the long-run. Permanent components of exchange rates are not to be affected by order flow over a certain period of time, which may vary across currencies, however never exceeding horizons longer

[8] Their cross-border FX transactions data-set come from State Street Corporation, which is the largest US master trust bank and one of the world's largest global custodians (approximately $7 trillion of assets under custody). The FX data-set records transactions conducted in 111 currencies by 13,230 funds. After filtering for different basis, their final sample included 19 currency areas for a total of 6,402,392 transactions recorded between January 1, 1994 and February 9, 2001.

than about 40 trading days (this is when the effects begin to reverse, i.e. negative feed-back). For Froot and Ramodarai, the positive impact of order flow on exchange rate stressed in Evans & Lyons and Payne is rather a transitory phenomenon not necessarily related to fundamental information. Even though they find the relationship between order flows and fundamentals to be noticeably weaker, they find evidences that over short periods of time, order flows anticipate future improvements in fundamentals. As goes the saying amongst traders: "buy on rumors, sell the facts!". Finally, order flows wouldn't have much to say about future exchange rate innovations whereas fundamentals may have plenty to say, especially over long horizons.

To make the link between the main points of these microstructure papers' short review, one has to consider one theoretical paper. Bacchetta and van Wincoop (2003) have offered a possible rationale for the empirical evidences outlined by Evans and Lyons, Payne, and Froot and Ramadorai. They suggest that a transitory liquidity shocks will have a persistent impact on exchange rates only if two conditions (hypotheses) are respected in the FX market. The first condition is that risk-averse traders should possess heterogeneous beliefs over the exchange rate fundamentals (i.e. their interpretations of fundamentals, expectations formation and subsequent actions will differ for the same signal). For the second condition the traders should be able to observe imperfectly correlated signals on fundamentals. Without going into to the nuts and bolts of their arguments, the reasons for a transitory liquidity shock to have a persistent impact on exchange rates are (1) a *risk-sharing* mechanism, as investors need to be compensated for any extra risk they take through their FX positions; and (2) an *information-based* mechanism, as in the face of the unclear nature of FX markets, investors confound a variation of the exchange rate due to a liquidity shock with one induced by fundamental information. The empirical implications of their formal models are interestingly aligned with those of previous mentioned microstructure researches, especially Froot and Ramodarai, in that liquidity shocks are more likely to have only transitory effect on exchange rates, although fundamental shocks would have long lasting effect (persistent) on exchange rates.

LARGE INVESTORS IMPACT ON CURRENCY RETURN

Order flow impact

What we would be interested to test in this paper's empirical part is the impact of traders' actions on currency return. Concretely, we seek to observe if aforementioned authors' general conclusions are valid. The more complete set of tests that we could have possibly replicated to that extent would have been those of Froot and Ramodarai (2001). However, this type of experimentations is beyond our reach for several reasons. First and foremost, we clearly do not benefit from the standing that Messrs Froot and Ramadorai boast in the academic and business circles. For that reason, it is far more complicated for us to get access to complete and exhaustive data-sets from major financial institutions. Second, even to get access to limited elderly data-sets, we face tricky privacy issues. Finally, high frequency complete data-sets are practicably impossible to get due to the multiple natures of the trading devices (the vast majority of financial institutions used several different trading platforms to perform the entire volume of daily trades).

Frequency attainable

Higher the frequency attainable, the more useful a set of data could be. Stated otherwise, the information has to come from as close as possible to the trader. The ultimate data-set would be represented by the entire daily book of trades performed by the main market maker in a global top five FX banks for a period of ten years of more; tick-by-tick data (i.e. transaction by transaction, on a real-time basis). One can easily imagine how difficult it would be to get such a data-set.

We will come back to our data-set in part four. The whole point here is to make it clear we had to bring into line our objectives with the reality of the difficulty of getting good FX data-sets (for a master degree research paper) and somehow bring down our ambition (at least in term of frequency accessible). As a direct consequence of these hard to get reliable FX data-sets, we had to consider models at lower frequency. To our knowledge, the best models are those presented in Wei & Kim (1999).

The big player in the FX market

In their 1999 NBER working paper, Wei & Kim study the potential existence of private information in the FX market and how that would exacerbate volatility in the market place. In order to test their hypothesis, they used the broad concept of order flow as used in the Microstructure papers mentioned earlier. The difference with those previous papers lies in that Wei & Kim make use of average indicative quotes (as of ends-of-day) instead of tick-by-tick transactions data. Nevertheless, their intuition is analogous: big players (major market makers) ought to have an impact on currency return (via their transactions - the sum of their order flows -). Did they find any evidence of their initial assumption? Answering this question (by means of recently release data-sets) will be the objective of this paper's empirical section 5. In this upcoming section, we will test if major Highly Leveraged Institutions (HLI), such as hedge funds and proprietary desks of commercial and investment banks, possess a central role in determining currency return and (or) in exacerbating market volatility. The results for developing markets follow.

Big player in developing markets

Corsetti, Pesenti and Roubini (2001) investigate the role of large traders in determining and propagating market volatility during crisis episodes in developing markets. Their investigation is dual: the first part is devoted to various market-power and position-taking models' analytical results; while the second part of their study presents some evidences (on a comparative basis) of the existence of a correlation between large traders' fund net currency positions (such as the Quantum Fund, the Quasar Fund, the Emerging Growth Fund, etc.) and the exchange rates catastrophe in several developing countries. The intuition behind their study is that very large investors (shall we say *speculators*?) have tremendous market-power stemming from their size, reputation and easy access to funds all leading to a huge leverage potential. This sheer power may perhaps create potentially trouble financial phenomenon such as herding, noise trading, bandwagon effect, etc. and ultimately lead to currencies' collapse.

While a guilt-ruling might not be as straightforward as it might seem initially, much circumstantial evidences of aggressive trading before and during currency crisis advocate that traders do have some impact. On the other hand, currency crisis are inextricably due to fundamental problems in a given country macroeconomics and traders' actions are more likely to precipitate things out than anything else. Therefore, worst traders can do is contribute to existent currency pressures in the presence of weak or uncertain fundamentals by building considerable short positions (i.e. orders to sell a currency without holding it) via leverage.

Big player in Canada

In the academic literature, no author has tackle down the potential relationship between major Canadian players order flows and exchange rate return. Nonetheless, a significant piece of microstructure analysis has been done by Chris D'Souza of the Bank of Canada (BOC). In his BOC 2002-16 Working Paper, an exhaustive analysis of the microstructure of FX intervention in Canada is undertaken using both a simultaneous inter-dealer trading model and a vector autoregression model. His main result highlights the need for a central bank to consider FX dealers' reaction when devising intervention strategies. Otherwise, the central authorities won't be able to attain desired results. To an important extent, FX dealers build their positions based on information (signals) conveyed by customer trade-flow. D'Souza findings thus stress the need for central banks to be able to forecast overall net customer trade in the market to deliver effective policies.

D'Souza (2002) focused on (1) the relationship between FX intervention (by the BOC) and nominal exchange rates; and (2) the order's impact power between the central bank and the major market makers (traders). By contrast, in our empirical section, our effort will be to find if the absolute value of the total financial positions of large market participants implied subsequent exchange rate volatility, and if so, to which degree. We will not pay attention to central bank interventions as it does not fit our definition of major HLI players. The three main rationales behind the exclusion of a central bank from our major players list are the following:

1- a central bank is a non-for-profit organization;

2- a central bank is not supposed to take any speculative positions;

3- a central bank has a certain role in maintaining its country currency's exchange rate relative to other currencies (mainly the USD), and therefore act upon relatively predictable manners;

In the next sections, we will present in turn our data-set and the models that we use for our microstructure analysis.

INFORMATION DATA STRUCTURE

Data: major US's FX players positions

Our data-set is made publicly available on the U.S. Treasury Board Website[9] and consist of the aggregate weekly foreign currency positions of the major U.S. FX market participants. The downside of using such a data-set is the low frequency. However, there is a major advantage to use this data-set as aggregate positions include all types of transactions performed in the FX market for every major participant. Besides Froot and Ramodarai (2001), all the previous studies were lacking this level of precision. The three different types of trades (representing roughly the third of all transactions each) are the following ones (see figure 4.1 and Table 4.1):

- Direct inter-dealer: banks face another bank's bid-ask spread, at which they can transact immediately;

- Brokered inter-dealer: get best price of all posted buys (bid) and sells (ask). If a bank posts an order it may not be executed;

- Customer-dealer: banks execute client's trades.

Figure 4.1 – Three types of FX trades

[9] Treasury Bulletin report at http://www.fms.treas.gov/bulletin/

Table 4.1 – Trading channels in the inter-bank market[10]

	Incoming trades (Non aggressor)	Outgoing trades (Aggressor)
Direct inter-dealer	Trade at own quotes	Trade at other dealers' quotes
Brokered inter-dealer	Dealer give quote(s) to a broker	Dealer trade at quotes given by a broker

The FX major participants are defined as banks and other financial institutions with more than USD 50 billion equivalent in FX contracts on the last business day of any calendar quarter during the previous year of a given report. The FX market is a very large market yet dominated by a very small number of FX banks, doing the bulk of their business in a very small number of cities in the world, which are (enumerated by USD daily volume): London (32%), New York (18%), Tokyo (8%), Singapore (7%), Frankfurt (5%) and Zurich, Paris and Hong Kong with all 4% of the market. There is of course FX trading going on outside these major cities, but almost the entire market liquidity comes from these eight financial centers. Another interesting fact about FX market is how American banks dominate and direct the market. As a matter of fact, Citibank, JP Morgan Chase, State Street and Bank of America boost a market price-setting power which extends far beyond their home country borders. This is the reason why it is so relevant to study the major American participants.

We extracted our large players FX positions data from the Treasury Bulletin reports, which contain information on positions in all type of FX financial instruments. The report enclose holdings of six major currencies: the Canadian dollar (CAD), the Japanese yen (YEN), the Swiss franc (CHF), the pound sterling (GBP), the euro (EUR) and the U.S. dollar (USD). Positions are all reported in USD and cover all type of transactions performed in the FX market, that is to say the amounts of FX spot contracts bought and sold, FX forward contracts

[10] Trading options (inspired by Bjonnes and Rime (2001)).

bought and sold, FX futures bought and sold, and one half the notional amount of FX options bought and sold[11]. Follow a succinct definition of all these types of transaction:

- FX spot contract: the most basic foreign currency financial instrument, a FX spot contract consist of a bilateral agreement at an agreed exchange rate whereby a party delivers a specified amount of a given currency against receipt of a specified amount of another currency from a counterparty within two business day from the settlement date. According to Bridge Information Systems, Inc., spot contracts account for 37% of the total FX activity.

- FX future: it is the agreement for the delivery of a standardized amount of a currency at a pre-specified exchange rate for a future date. FX futures are the only FX products traded on regulated exchanges similar to the stock markets. FX futures account for only 1% of the total FX activity.

- FX forward contract: similar to the spot contract, only having maturity of more than two days. At the opposite of FX futures, FX forward contracts are open to any currencies in any amount. FX forward contracts include different type of transactions such as forward outright deal or swap deal. The definition of all the different types of FX forward contracts is beyond the scope of the present paper. As a whole, all the various FX forward contracts account for 57% of the total FX activity.

- FX options: contrasting with previous contracts, FX options allow the party to choose whether or not it will enter into an agreement. Consequently, the buyer of a FX option has the right but not the obligation to trade a specific amount of currency at a predetermined exchange rate and within a predetermined period of time, giving reciprocally the seller of that FX option (the counterparty) the obligation to deliver the currency under the predetermined terms if and when the buyer wants to exercise his

[11] The net options position, or the net delta-equivalent value of an option position, is an estimate of the relationship between an option's value and an equivalent currency hedge. The delta equivalent value is defined as the product of the first partial derivative of an option valuation formula (with respect to the price of the underlying currency) multiplied by the notional principal of the contract. We will come back to this definition in section 5.

option. FX options represent actually only 5 % of all the FX activity, although this ratio is growing at high-speed year after year.

Data: exchange rates and volatility

Daily exchange rate data used to calculate the volatility (Vol_t) was obtained from the New York Federal Reserve Website[12]. The volatility measures were calculated as follow:

$$\sigma^2 = \sqrt{\left[\frac{1}{5}\sum_{i=1}^{5}\left(r_{t+\frac{i}{5}} - \bar{r}\right)^2\right]}$$

where the standard deviation of daily return is calculated from the first log-difference between spot rate at time t+i/5 and spot rate at time t+(t-1)/5. The data-set for the Canadian dollar, the Japanese yen, the Swiss franc, the pound sterling, and the U.S. dollar is from July 3rd, 1996 to December 31st, 2003, for a total of 1956 days. As for the euro, the data-set starts on January 4th 1999 and ends on December 31st, 2003, for a total of 1303 days.

[12] New York Federal Reserve: http://www.federalreserve.gov/releases/h10/Hist/

MODELS AND RESULTS

Models and methodologies

In this section, which is largely inspired by Wei & Kim's paper, we explore the relationship between FX positions in different financial instruments by large US market participants and exchange rate volatility. We want to test if (1) the positions of large markets participants cause exchange rate volatility (second moment); and (2) if these large participants have the ability to forecast the level (first moment) of exchange rates. For that matter, we will use VAR specifications and Wald Granger-causality tests in the first subsection and a regression analysis and a non-parametric approach in the second subsection.

Subsection 1: big players ↔ exchange rates movements

In this first subsection, we will display the linear vector autoregressions (VARs) and subsequent results obtained for each type of financial positions (i.e. options, spot and total) relative to exchange rates volatility to answer our first question, which is: "Do the FX positions of large markets participants cause exchange rate volatility?". As in Payne (1999) and Froot and Ramodarai (2001), Wei & Kim (1999) used a simple linear vector autoregression model in order to account for possible two-way relationship (feed-back effect) of exchange rate volatility and large players' positions. All the following empirical test are conducted on five highly traded currencies (GBP, CHF, YEN, Euro and CAD), and over four different horizons, that is one week, two weeks, four weeks (approximately one month) and 12 weeks (approximately a quarter). Then, to test for the potential relationship, we use a standard Wald Granger causality test, which is not dependant on the normality assumption. Indeed, the Wald statistic should be robust to variations in the underlying distributions[13]. Our goal is to determine whether lagged dependable variables (various large players FX positions) have significant explanatory power for current dependable variable (exchange rates' volatility in subsection one and exchange rates' variation in subsection two). One has to remember that a variable X Granger-causes Y if Y can be better forecasted using the historical values of both X and Y then it can using only those of Y alone. For the causal relationship to be valid, we also need to use appropriate lags length, since insufficient lags length yield to autocorrelated errors (and most importantly incorrect test statistics) and too many lags reduce the power of the test. We then had to

[13] Greene page 590 : See Lutkepohl (1993, pp.93-95).

determine the optimal lags length for every distinct VAR model. For that matter, we considered various information criterions (Akaike, Bayesian, Schwarz and adjusted R^2) before selecting to minimize the Schwarz Bayesian Information Criterion (SBIC). Each of these criterions has its flaws and virtues, and none is perfect. SBIC criteria often lead to simpler model for its higher penalty on the number of degrees of freedom lost.

Options positions ↔ exchange rates volatility

FX market's liquidity is impressive, yet some studies have shown that big players' actions can have a substantial impact on exchange rates explosive nature. Numerous studies have tried to analyze the effect of options trading (over various underlying assets, predominantly stock prices) on the volatility of related spot market with very mixed and confusing results. Some studies on stock options yielded to the conclusion of a *reduction* in volatility for listed stocks. Other studies on stock index options yielded to the exact opposite conclusion, where underlying stock price volatility was *accentuated.* And as the studies investigate other assets (commodities, GNMA, etc) the results are never predictable, as net option trading could either increase or decrease underlying asset price volatility. Wei & Kim suggested that these apparently conflicting findings might have a possible unifying interpretation. They supposed that in markets where asymmetric information is widespread (such as individual stocks), the introduction of options might convey more information (and more efficiently) inducing a reduction in volatility of the underlying asset prices. On the other hand, in those markets where asymmetric information is limited (such as stock index), options trading might lead to augment the speculative positions of day traders and other noise agents, as a result further exacerbating FX volatility. The problem is there is no agreement has to know whether asymmetric information is negligible (conventional view) among FX traders of whether we may expect a negative association between FX options and currencies' volatility (as advocated by Lyons, Ito and Melvin (1997)).

To explore this disagreement, the specification we exploit is the subsequent VAR:

$$Vol_t = A_L Opt_t + B_L Vol_t + \varepsilon_{Vol,t}$$

$$Opt_t = C_L Opt_t + D_L Vol_t + \varepsilon_{Opt,t}$$

where Vol_t is the exchange rate volatility, Opt_t is the absolute value of the delta equivalent of the net outstanding foreign currency options contracts at the time of the survey (weighted average), and A_L, B_L, C_L and D_L are one-sided lag polynomials (i.e. $A_L = A_1L + A_2L^2 + A_3L^3 +$ etc.).

Null hypothesis:

1- Opt does not Granger-cause Vol (i.e. the coefficients on A_L are jointly insignificantly different from zero).

2- Vol does not Granger-cause Opt (i.e. the coefficients on D_L are jointly insignificantly different from zero).

Table 1 reports the results of our Granger tests. Selected lags length as well as Wald Granger causality tests outcomes are reported. The results are mixed. In 60 percent (12 out of 20) of the Granger tests from options positions to subsequent exchange rate volatility, we can reject the null of non-causality (at the ten percent level two times and below the five percent level ten times). On the other hand, we can reject the null of non-causality in the reverse direction only 30 percent (6 out of 20) of the time (one occasion at the ten percent level and five times below the five percent level). Even more interesting is the distribution of these rejections. For the Japanese yen and the euro, we can always and over all horizons reject the null of non-causality from options positions to subsequent exchange rate volatility, whereas we are able to do so only twice for the Canadian dollar and barely once for the UK Sterling pound and the Swiss franc. Same pattern for the rejection of the null of non-causality in the reverse direction: we can reject the null over all horizons for the euro, merely on one occasion for the UK Sterling pound and the Swiss franc and not a single time for the Japanese yen and the Canadian dollar.

How to interpret this complex blend of signals? One thing for sure, except for the euro, one cannot forecast accurately the variations in a currencies options positions of large US players by studying the associated past exchange rate volatility. However, if someone is to closely keep an eye on large US players currency options positions (especially the yen, the euro and the Canadian dollar), he might get a fairly good flavor of the upcoming associated currency's exchange rate volatility.

At this point, it is important to clarify the factual implications of our tests. We are not establishing that options trading by large US players *causes* (in 12 out of 20 cases) more volatility in the related FX rate. What we are establishing is that option trading *tends to lead* (in a time sequence manner) to a subsequent increase in FX rate's volatility. Therefore why this relationship? Could traders have a better understanding about future exchange rate volatility and try to benefit from it via derivatives products? This might be true or not, but in either case, traders can benefit from their allegedly better knowledge without any change in the net delta value of the options. As a matter of fact, if they have expectations about future movements in exchange rates, they can buy both a call and a put, in a neutral option strategy called a straddle[14]. So why traders would expose them to odd risk when they can simply use a synthetic FX strategy yielding to the exact same return? Hence rationally better informed traders' moves may not automatically lead to a correlation between their options' positions and subsequent volatility. Moreover, if option trading is made in order to take advantage of better information about future volatility, we do not see why other financial positions (i.e. spot, forward and futures) should be correlated with future exchange rate volatility.

Nevertheless, Cheung & Chinn (2001) survey's answers (as well as some good common-sense) tell us that there is no reason in the world why traders would only use options to take advantage of the supposedly better information they possess. They would certainly use the full panoply of financial products available to them, which range from a basic spot deal to the most exotic derivatives' product in the market. Then, if both derivatives and spot products are use to speculate on currencies' movements, we might find a positive relation between spot,

[14] When traders are not sure about the direction of future exchange rates' variations that would be induce by a release of certain economic data, a popular choice among FX option traders would be to buy a straddle. For example, in a quiet market preceding a "big OPEC storm", a long straddle strategy would consist of a long call and a long put on the same currency, at the same strike price and with the same expiration dates.

forward and futures contracts and subsequent exchange rates volatility. This is the relationship we consider next.

Spot, forward and futures positions ↔ exchange rates volatility

$$Vol_t = A_L Spt_t + B_L Vol_t + \varepsilon_{Vol,t}$$
$$Spt_t = C_L Spt_t + D_L Vol_t + \varepsilon_{Spt,t}$$

where Spt_t is a short form for the cumulative net positions in spot, forward and futures contracts.

Null hypothesis:

3- Spt does not Granger-cause Vol (i.e. the coefficients on A_L are jointly insignificantly different from zero).

4- Vol does not Granger-cause Spt (i.e. the coefficients on D_L are jointly insignificantly different from zero).

Table 2 presents the results of these two Granger causality tests. Again, in a similar fashion, the results we get are mixed. In 55 percent (11 out of 20) of the Granger tests from spot, forward and futures positions to subsequent exchange rate volatility, we can reject the null of non-causality (at the five percent level two times and at one percent level nine times). In contrast, we can only reject the null of non-causality in the reverse direction 25 percent (5 out of 20) of the time (one occasion at the ten percent level and five times below the five percent level).

What is really interesting here is again the striking distribution of these rejections. For the Japanese yen, the euro and the Canadian dollar (except for the 1-Week horizon), we can always and over all horizons reject the null of non-causality from spot contracts' positions to subsequent exchange rate volatility. For the UK Sterling pound and the Swiss franc, there is not a single time when we can reject the null hypothesis. Even more remarkable is the distribution of the rejections in the reverse direction. Beside the Japanese Yen over the 4-

Weeks horizon, all the other rejections of the null of non-causality in the reverse direction concern the Canadian Dollar.

That is to say we can learn a great deal about the subsequent variations in Canadian dollar spot contracts by studying the past volatility of the Canadian dollar exchange rate with the U.S. dollar. However, we cannot do so for any other currency, other than the Japanese yen over a month horizon. Moreover and more importantly, for three out of five currencies, the spot contracts' positions can help predict a large amount of the associate exchange rate volatility in the future.

<u>Net foreign currency positions ↔ exchange rates volatility</u>

$$Vol_t = A_L Net_t + B_L Vol_t + \varepsilon_{Vol,t}$$

$$Net_t = C_L Net_t + D_L Vol_t + \varepsilon_{Net,t}$$

where Net is a short form for the net absolute value of positions in all products (i.e. spot, forward, futures and options).

Null hypothesis:

5- Net does not Granger-cause Vol (i.e. the coefficients on A_L are jointly insignificantly different from zero).

6- Vol does not Granger-cause Net (i.e. the coefficients on D_L are jointly insignificantly different from zero).

The results of the Granger causality tests are reported in Table 3. Not surprisingly, we get comparable results. In 55 percent (11 out of 20) of the Granger tests from absolute value of total positions to subsequent exchange rate volatility, we can reject the null of non-causality (at the ten percent level two times and below the five percent level nine times). In the reverse direction, we can reject the null of non-causality 40 percent (8 out of 20) of the time (three times at the ten percent level and five times below the five percent level).

Needless to say, the results we get here are quite similar to those of previous tables, the interpretation being the same. Once more we realize that derivatives as well as spot positions are not constantly taken because of better information about future volatility (remember the risk hedging provided by a straddle), but sometime taken with the intention of speculating on the level of exchange rate movements. Obviously, occasionally (most of the time?) the difference between a speculative position and a hedging one is almost impossible to make. The fundamental idea to remember here is that sometime traders are aware and willing to take (calculated) risk even if they would have been able to avoid it, in order for them to make speculative (and *potentially* highly profitable) bet on a given currency's future level.

Subsection 2: big players' ability to forecast the level of exchange rates

In this second empirical subsection, we want to address the question that naturally emerges from our first subsection discussion: "Do large players have a better ability to forecast the level (i.e. the first moment) of exchange rates?". That is to say, even if they might have an impact on exchange rates' volatility, can they predict in which direction (increase or decrease) is the exchange rate going to move in the following period? We examine this question using two methods: a regression analysis (subsequently called parametric approach to contrast with the second method); and a non-parametric analysis.

It is essential to clarify what we want to test. In fact, it is a union of two empirically equivalent premises, which are:

1- because large players have better information about exchange rate variation, they can on average profit from this knowledge by buying (selling) when they expect a subsequent rise (fall) in a foreign currency value;
2- because large players have a significant market power, their action of buying (selling) typically leads to a rise (fall) in a foreign currency value.

What we are affirming here is that if we end up finding that future rise in a foreign currency value is predicted by large players' current net purchases of this particular currency, either *or* both premises *can* be true. Alternatively, if we are not able to demonstrate a positive correlation, *neither* premise can be true.

Parametric approach: regression analysis

In this section, we want to define by simple regression analysis if the net absolute value of positions in all products in the previous period has any predictive power over next period associated foreign currency's variation. The simple regression specification used is the usual one:

$$S(t) - S(t-1) = \alpha + \beta \, NET(t-1) + \varepsilon(t).$$

where S(t) is the exchange rate (value of the five foreign currencies in units of U.S. dollars) at the end of week t, and NET(t) is the net foreign currency position of the large players at the end of week t. Bear in mind that either the better information hypothesis or the market power hypothesis would imply $\beta > 0$.

Table 4 presents the results of our regression analysis. The regressions show that, over almost all horizons for all currencies, we cannot reject the null hypothesis that the coefficient on the foreign currency variable is zero even at the ten percent level. However, they are some noticeable exceptions, such as the euro for which at all horizons we can reject the null, implying that our premise (either the better information one or the market power) is valid for this currency. There are also some other minor exceptions, but the overall result exhibit that for at least four out of five currencies, the major players as a group do not have better information on a systematic basis regarding the variation in the level of exchange rates (first premise); nor do they seem to own a particular market power that commands over the movement of the exchange rates to match their expectations (second premise).

Non-parametric approach: the Henriksson-Merton test

The previous regression analysis studying the correlation between the magnitude of exchange rate variation with the size of foreign currency positions has shown that we cannot make the point for a causal relationship. Now we investigate the same question turning to a non-parametric approach. One of the major theoretical contributions to evaluate the market timing ability of fund managers was proposed by Merton (1981) and subsequently empirically developed by Henriksson and Merton (1981). We choose to perform this second test for two reasons:

1- evidences ((McFarland, Pettit, and Sung, 1982; So, 1987) have pointed out that exchange rate change do not necessarily follow a normal distribution and the non-parametric approach relieves us of the need to make this assumption to make valid finite-sample inference;
2- however, if we maintain the normality assumption, the non-parametric approach might assess a weaker yet appealing hypothesis, that is the potential correlation between the direction (not the magnitude) of currency variation with a investment (speculation?) decision (regardless of the size).

Closely following Henriksson and Merton's (1981) logic, we state these two conditional probabilities:

$$p1(t) = \text{probability} [Net(t) \leq 0 \mid R(t) \leq 0]$$

$$p2(t) = \text{probability} [Net(t) > 0 \mid R(t) > 0]$$

where R(t) is the return on an investment from week t to week t+1 (i.e. R(t) = S(t+1) - S(t)). Therefore, p1(t) and p2(t) describe the conditional probabilities of a correct position given that the currency in question decreases or increases afterwards in value, relative to the U.S. dollar. In this case, a necessary and sufficient condition for a forecast (i.e. large players' position) to have a predictive value, is that the summation of p1(t) and p2(t) must be considerably greater than one. Otherwise, if $p1(t) + p2(t) \leq 1$, large players' position have no predictive power. To implement the test we have to classify our sample of N observed positions and outcomes in the following way:

	Actual Returns	
Predicted Returns	$R(t) \leq 0$	$R(t) > 0$
$LPPi(t) \leq 0$	n1	N2 - n2
$LPPi(t) > 0$	N1 - n1	n2
	N1	N2

where:

LPPi(t) is large players' positions at the end of week t;

N1 = total number of outcomes with $R(t) \leq 0$ (i.e. successes in the population);

N2 = total number of outcomes with $R(t) > 0$ (i.e. failures in the population);

n1 = number of correct forecasts given $R(t) \leq 0$ (i.e. successes in the sample);

n2 = number of correct forecasts given $R(t) > 0$ (i.e. failures in the sample);

N = N1 + N2 = total number of observations.

and defining:

n = number of times forecasters predict that $R(t) \leq 0$, or n = n1 + N2 – n2.

Null hypothesis:

- Large players do not have superior forecasting abilities (i.e. $p1(t) + p2(t) \leq 1$).

Under this null hypothesis, the probability distribution of n1 (the number of correct forecasts given that $R(t) \leq 0$) is characterized by the following hypergeometric distribution and is independent of both p1(t) and p2(t):

$$P(\hat{n}1 = n1 \mid N1, N2, n) = \frac{\binom{N1}{n1}\binom{N2}{n-n1}}{\binom{N}{n}}$$

or in a widened set-up:

$$P(\hat{n}1 = n1 \mid N1, N2, n) = \frac{\dfrac{N1!}{n1!(N1-n1)!}\dfrac{N2!}{(n-n1)!\left[N2-(n-n1)\right]!}}{\dfrac{N!}{n!(N-n)!}}$$

with the feasible range for n1 given by:

$$\underline{n1} \equiv \max\{0, n-N2\} \leq n1 \leq \min\{N1, n\} \equiv \overline{n1}$$

Since N1, N2 and n are observable we can straightforwardly make use of the above equations to test our null hypothesis without having to estimate the conditional probabilities. We can use the above equations to establish confidence intervals (with confidence level C) to perform one-tail tests[15] of our null hypothesis in the following manner:

$$\frac{\sum_{x=x^*}^{\overline{n1}} \binom{N1}{x}\binom{N2}{n-x}}{\binom{N}{n}} = 1 - C$$

where x*(C) is the solution to the above equation . Our null hypothesis keep the same interpretation, however one could now reject the null hypothesis of no forecasting ability only if n1 $\geq$ x*(C). Computation of the confidence intervals is unproblematic when the sample is small. However, the larger the sample, the more complicated the computation becomes. Fortunately, for those large samples' cases (especially when N1≈N2) where the computation becomes complex, the hypergeometric distribution can be accurately approximated by the normal distribution. In these specific cases, the parameters used for the normal approximation are the following mean and variance:

$$E(n1) = n * \left(\frac{N1}{N}\right)$$

and

$$\sigma^2(n1) = \frac{N-n}{N-1} * n * \frac{N1}{N}\left\{1 - \frac{N1}{N}\right\}$$

We then apply the non-parametric test to our data and reported our results in the tables 5 and 6, using as independent variables the net foreign currency positions in the former table and the change in the net foreign currency positions in the latter one.

[15] Henriksson and Merton (1981): "*(...) we would argue that a one-tail test (or at least one which weights the right-hand tail much more heavily than the left) is more appropriate in this case. If forecasters are rational, then it will never be true that p1(t) + p2(t) < 1, and a very small n1 would simply be the "luck of the draw" no matter how unlikely.*"

Starting with table 5 results, we found that we can reject the hypothesis of no predictive power at the one percent level for the euro for all periods and for all but one period (12-Weeks horizon) for the Canadian dollar. For all the other currencies over all periods, we cannot reject the hypothesis of no predictive power even at the ten percent level.

When we go into change in the net foreign currency positions (table 6), there is no single currency for which we can reject the hypothesis of no predictive power at the ten percent level (for all horizons), apart from the British Pound over the 12-Weeks horizon (at the five percent level).

In consequence we observe from table 5 that large players' positions have some kind of power in predicting the *direction* of Euro/USD and CAD/USD exchange rates' changes, but not even a weak power when it comes to forecast the YEN/USD, USD/GBP and CHF/USD exchange rates' movements. Then, even if large players' positions seem to have some power over the forecasting of the Euro and the CAD (their future innovations' direction), when it comes to large players positions' adjustments (table 6), i.e. changes in their currency positions, the subsequent forecasting ability is virtually none existing.

WRAPPING-UP

The present research paper aim at two main objectives: (1) carry out a comprehensive literature review of exchange rates' economics related to the new microstructure approach to exchange rates' determination; and (2) investigate the relationship between foreign currency positions taken by very large U.S. players and exchange rate movements.

Through the microstructure of FX markets' literature review we established some broad findings on which to benchmark our later empirical results. Lyons (1995) proposed net FX order flow as a good forecaster of exchange rate movements. Even though the robustness of his model was repeatedly debated, the suggested relationship was to create a large new exchange rates economics' field. Then Payne (1999), testing for possible feed-back effect, concluded that even when feed-back trading rules are accounted for, order flow imbalance is still a fundamental determinant of exchange rate variations. Follow the significant study of Froot and Ramodarai (2001). Although they find the relationship between order flows and fundamentals to be noticeably weaker than suggested in previous studies, they find some evidences that over short periods of time, order flows might anticipate future improvements in fundamentals. Finally, they understood through their models that order flows don't have much to say about future exchange rate innovations whereas fundamentals have plenty to say, especially over long horizons.

More specifically, we also considered papers about large market makers' impact on currency returns. Authors of these papers have hypothesized that major FX market players (such as hedge funds and proprietary desks of commercial and investment banks) have an essential role in determining currency return (and-or exacerbating FX market volatility). For Canada, although not explicitly addressing large players' issue, Bank of Canada's D'Souza (2002) emphasized the need for central banks to consider large FX dealers' reactions when developing intervention strategies in order to attain desired results. Large FX players build their positions to some extent by means of the information (signals) conveyed by their customers' trade-flow. Effective policies must thus be conceptualized in such a way as to take account of net customers' trades, according to D'Souza. On the other hand, Corsetti, Pesenti and Roubini (2001) directly investigate the role of large FX players in determining and propagating market volatility during crisis episodes in developing markets. They concluded that several circumstantial evidences of aggressive trading before and while currency crisis might suggest that large FX players do have a considerable impact, attenuating somehow their verdict in saying that the worst traders can really do is simply contribute to currency pressures when and where there are already weak fundamentals in place.

Based on all these studies' evidences, we try to investigate the relationship between foreign currency positions by large U.S. players and exchange rate movements, to a large extent by following Wei & Kim (1999) research paper. Indeed the majority of our findings are in line with those of Wei & Kim. First we found that for the Japanese yen, the euro and the Canadian dollar, both the absolute value of the options positions and the absolute value of the spot, forward and futures positions are positively correlated with a subsequent variation in exchange rate volatility. This suggests that large players' positions in these three currencies are likely to have contributed to an increase in these currencies' exchange rate volatility. The reverse causality relation held for the Canadian dollar (all the time, except over the 1-Week horizon) for the Japanese yen when considering total foreign currency positions, whereas the reverse causality also held for the Euro when taking into account option positions only. Nonetheless, for the UK Sterling pound and the Swiss franc, this positive correlation between FX positions and a subsequent variation in exchange rate volatility (in both directions) was not apparent, suggesting large players' position-taking in these two markets does not seem to affect exchange rate volatility.

Second, in our regression analysis and then in our non-parametric analysis we found sequentially that position-taking by large players does not help to forecast subsequent variation of the exchange rate and that large players are not expected to have a systematic ability to anticipate the magnitude or the direction of the exchange rate movement. Overall, one obvious exception goes exactly in the opposite direction of these findings: the euro. For this currency, large U.S. player's positions seem to have a real impact on subsequent exchange rate's variation (and also its magnitude). Apart from the Euro, our findings are contradictory with both our premises, i.e. (1) that large FX players have superior information about exchange rate movements; and (2) that they have market power so that their FX investment decisions tend to impact related currency's value.

This paper does not completely elucidate all the rationales behind our findings, but subsequent researches in this field might consider studying some of these possibilities as potential answers especially to our mixed findings' results in the first empirical subsection:

1- smaller relative size (i.e. larger number) of market participants in the British Pound and Swiss Franc markets versus other currencies' market;

2- different goal (i.e. less speculative positions versus more hedging positions) in market participants in various markets:

3- the very nature of European's currency trading markets (regulations, taxes, etc.) compared with those of American and Asian markets;

4- relation between home country economy growth rate and size with aggressive FX position-taking and subsequent exchange rate's movements;

5- credit (default) risk management, FX position-taking and exchange rate's movements.

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Table 1 - Currency Options Positions and Exchange Rate Volatility: Granger Causality Tests.
(major market participants, weekly, 07/03/96 - 12/31/03)

			H0: Foreign Currency Options Positions Do Not Cause Exchange Rate Volatility.			H0: Exchange Rate Volatility Does Not Cause Foreign Currency Options Positions.		
	# Obs.	Lag Length	chi2	Prob > chi2		chi2	Prob > chi2	
UK Sterling Pound								
1-Week	391	1	0.0700	0.7913		0.4859	0.4858	
2-Weeks	388	2	0.0920	0.9550		8.5217	0.0141	*5
4-Weeks	388	1	0.1298	0.7186		1.7393	0.1872	
12-Weeks	368	2	5.0995	0.0781	*10	2.9296	0.2311	
Swiss Franc								
1-Week	391	1	1.6169	0.2035		0.1552	0.6936	
2-Weeks	390	1	3.9874	0.0458	*5	1.4689	0.2255	
4-Weeks	388	1	1.6431	0.1999		1.3218	0.2503	
12-Weeks	380	1	2.0019	0.1571		4.0728	0.0436	*5
Japanese Yen								
1-Week	391	1	13.1202	0.0003	*1	0.0058	0.9393	
2-Weeks	388	2	17.0550	0.0002	*1	4.5152	0.1046	
4-Weeks	380	3	49.0815	0.0000	*1	1.7367	0.6288	
12-Weeks	380	1	72.1549	0.0000	*1	1.9973	0.1576	
Euro								
1-Week	260	1	4.5869	0.0322	*5	9.1106	0.0025	*1
2-Weeks	259	1	6.7832	0.0092	*1	12.6211	0.0004	*1
4-Weeks	257	1	2.9527	0.0857	*10	5.2329	0.0222	*5
12-Weeks	249	1	6.9325	0.0085	*1	3.3201	0.0684	*10
Canadian Dollar								
1-Week	389	3	2.0970	0.5525		0.9283	0.8186	
2-Weeks	388	2	2.3410	0.3102		0.7097	0.7013	
4-Weeks	388	1	3.0348	0.0815	*10	0.3363	0.5620	
12-Weeks	380	1	4.6040	0.0319	*5	0.4431	0.5056	

Notes:

1) *1, *5 and *10 denote confidence levels of 1 percent, 5 percent and 10 precent, respectively.

2) Lag lengths are determined by minimizing Schwartz-Bayes Information Criterion (SBIC).

Table 2 - Spot, Forward & Futures Positions and Exchange Rate Volatility: Granger Causality Tests.
(major market participants, weekly, 07/03/96 - 12/31/03)

			H0: Spot, Forward & Futures Options Positions Do Not Cause Exchange Rate Volatility.			H0: Exchange Rate Volatility Does Not Cause Spot, Forward & Futures Positions.		
	# Obs.	Lag Length	chi2	Prob > chi2		chi2	Prob > chi2	
UK Sterling Pound								
1-Week	391	1	0.0195	0.8889		0.0079	0.9291	
2-Weeks	388	2	3.2315	0.1987		2.5909	0.2738	
4-Weeks	388	1	1.2457	0.2644		2.0304	0.1542	
12-Weeks	368	2	0.1695	0.9187		0.4898	0.7828	
Swiss Franc								
1-Week	391	1	0.7692	0.3805		0.1452	0.7031	
2-Weeks	390	1	1.0883	0.2969		0.3152	0.5745	
4-Weeks	388	1	0.7754	0.3786		0.4691	0.4934	
12-Weeks	380	1	2.6299	0.1049		1.2290	0.2676	
Japanese Yen								
1-Week	391	1	8.1790	0.0042	*1	0.1151	0.7345	
2-Weeks	388	2	14.0178	0.0009	*1	4.0811	0.1300	
4-Weeks	388	1	18.3312	0.0000	*1	3.4380	0.0637	*10
12-Weeks	380	1	25.4984	0.0000	*1	1.8291	0.1762	
Euro								
1-Week	260	1	4.8903	0.0270	*5	0.9890	0.3200	
2-Weeks	259	1	5.0249	0.0250	*5	0.0137	0.9070	
4-Weeks	257	1	6.7509	0.0094	*1	1.8149	0.1779	
12-Weeks	249	1	9.2434	0.0024	*1	0.0005	0.9816	
Canadian Dollar								
1-Week	389	3	4.9512	0.1754		6.3413	0.0961	*10
2-Weeks	388	2	10.6580	0.0048	*1	7.8031	0.0202	*5
4-Weeks	388	1	17.1506	0.0000	*1	7.8759	0.0050	*1
12-Weeks	380	1	18.7593	0.0000	*1	33.3703	0.0000	*1

Notes:

1) *1, *5 and *10 denote confidence levels of 1 percent, 5 percent and 10 precent, respectively.

2) Lag lengths are determined by minimizing Schwartz-Bayes Information Criterion (SBIC).

Table 3 - Total Currency Positions and Exchange Rate Volatility: Granger Causality Tests.
(major market participants, weekly, 07/03/96 - 12/31/03)

			H0: Total Currency Positions Do Not Cause Exchange Rate Volatility.			H0: Exchange Rate Volatility Does Not Cause Total Currency Positions.		
	# Obs.	Lag Length	chi2	Prob > chi2		chi2	Prob > chi2	
UK Sterling Pound								
1-Week	391	1	0.0295	0.8636		0.0065	0.9359	
2-Weeks	388	2	3.4908	0.1746		0.8793	0.6443	
4-Weeks	388	1	1.3265	0.2494		1.3198	0.2506	
12-Weeks	368	2	0.2842	0.8675		1.0875	0.5806	
Swiss Franc								
1-Week	391	1	0.0868	0.7683		0.0171	0.8958	
2-Weeks	390	1	0.0001	0.9936		0.0619	0.8036	
4-Weeks	388	1	0.0854	0.7701		0.1810	0.6705	
12-Weeks	380	1	1.5660	0.2108		0.4098	0.5221	
Japanese Yen								
1-Week	391	1	3.8836	0.0488	*5	0.0459	0.8304	
2-Weeks	388	2	8.0467	0.0179	*5	5.7088	0.0576	*10
4-Weeks	388	1	10.2399	0.0014	*1	5.5814	0.0182	*5
12-Weeks	380	1	8.1284	0.0044	*1	4.3076	0.0379	*5
Euro								
1-Week	260	1	3.8322	0.0503	*10	0.2628	0.6082	
2-Weeks	259	1	3.6719	0.0553	*10	0.2574	0.6119	
4-Weeks	257	1	5.9125	0.0150	*5	2.8029	0.0941	*10
12-Weeks	249	1	7.5192	0.0061	*1	0.0086	0.9260	
Canadian Dollar								
1-Week	389	3	4.5366	0.2090		7.6040	0.0549	*10
2-Weeks	388	2	10.4994	0.0052	*1	9.6822	0.0079	*1
4-Weeks	388	1	16.0071	0.0001	*1	9.9019	0.0017	*1
12-Weeks	380	1	16.6894	0.0000	*1	30.7096	0.0000	*1

Notes:

1) *1, *5 and *10 denote confidence levels of 1 percent, 5 percent and 10 precent, respectively.

2) Lag lengths are determined by minimizing Schwartz-Bayes Information Criterion (SBIC).

Table 4 - Parametric Test:
Foreign Exchange Rate Returns and Net Foreign Currency Position
(major market participants, weekly, 07/03/96 - 12/31/03)

Dependent Variable: $\ln(Spot_{t+1}) - \ln(Spot_t)$

	1-Week		2-Weeks		4-Weeks		12-Weeks	
UK Sterling Pound								
Intercept	5,8		12,8		26,5	*5	81,1	*1
	5,8		*8,4*		*12,0*		*18,2*	
Net Foreign	-0,6		-1,4		-3,1	*5	-11,3	*1
Currency Position	*0,6*		*0,9*		*1,2*		*1,9*	
# of Obs.	391		390		388		380	
Root MSE	0,0102		0,0149		0,0211		0,0317	
Adj. R2	-0,0004		0,0040		0,0131		0,0845	
p-value	0,3572		0,1113		0,0136		0,0000	
Swiss Franc								
Intercept	1,0		2,2		6,2		26,6	
	8,1		*11,6*		*16,1*		*29,2*	
Net Foreign	0,5		1,1		1,9		2,7	
Currency Position	*1,3*		*1,8*		*2,6*		*4,7*	
# of Obs.	391		390		388		380	
Root MSE	0,0145		0,0209		0,0290		0,0523	
Adj. R2	-0,0022		-0,0017		-0,0012		-0,0017	
p-value	0,7083		0,5636		0,4631		0,5594	
Japanese Yen								
Intercept	-9,2		-5,8		10,7		155,6	*5
	18,8		*26,7*		*38,4*		*69,8*	
Net Foreign	-2,7		-1,4		4,0		49,9	*5
Currency Position	*5,4*		*7,7*		*11,0*		*20,1*	
# of Obs.	391		390		388		380	
Root MSE	0,0159		0,0226		0,0325		0,0589	
Adj. R2	0,0019		-0,0025		-0,0023		0,0135	
p-value	0,6170		0,8558		0,7196		0,0134	
Euro								
Intercept	37,2	*1	71,6	*1	127,7	*1	345,9	*1
	15,5		*22,0*		*30,1*		*50,2*	
Net Foreign	1,2	*1	2,3	*1	4,2	*1	11,5	*1
Currency Position	*0,4*		*0,5*		*0,7*		*1,3*	
# of Obs.	260		259		257		249	
Root MSE	0,0144		0,0204		0,0279		0,0463	
Adj. R2	0,0338		0,0630		0,1073		0,2536	
p-value	0,0017		0,0000		0,0000		0,0000	
Canadian Dollar								
Intercept	0,4		0,7		3,9		-3,0	
	4,5		*6,4*		*9,1*		*16,5*	
Net Foreign	0,7		1,3		3,8	*5	5,5	
Currency Position	*0,9*		*1,3*		*1,9*		*3,6*	
# of Obs.	391		390		388		380	
Root MSE	0,0080		0,0113		0,0159		0,0288	
Adj. R2	-0,0011		0,0002		0,0081		0,0036	
p-value	0,4432		0,2984		0,0425		0,1255	

Notes:

1) *1 and *5 denote confidence levels of 1 percent and 5 percent, respectively.

2) Coefficients for Intercept and Net Foreign Currency Position are multiplied by 10^4 and 10^7, respectively.

Table 5 - Non-Parametric Tests: Conditional Probability of a Correct Net Foreign Currency Position.

(major market participants, weekly, 07/03/96 - 12/31/03)

Currency/ Time Horizon	N	N1	N2	P1(t)	P2(t)	P(t)	
UK Sterling Pound							
1-Week	391	181	210	0,29	0,69	0,97	
2-Weeks	390	187	203	0,25	0,65	0,90	
4-Weeks	388	184	204	0,21	0,62	0,83	
12-Weeks	380	194	186	0,19	0,59	0,78	
Swiss Franc							
1-Week	391	191	200	0,65	0,30	0,95	
2-Weeks	390	185	205	0,62	0,27	0,89	
4-Weeks	388	176	212	0,63	0,28	0,91	
12-Weeks	380	174	206	0,65	0,32	0,97	
Japanese Yen							
1-Week	391	177	214	0,99	0,01	1,00	
2-Weeks	390	176	214	0,98	0,00	0,98	
4-Weeks	388	179	209	0,97	0,00	0,97	
12-Weeks	380	165	215	0,97	0,00	0,97	
Euro							
1-Week	260	135	125	0,98	0,08	1,06	*1
2-Weeks	259	135	124	0,99	0,10	1,09	*1
4-Weeks	257	120	137	1,00	0,09	1,09	*1
12-Weeks	249	121	128	1,00	0,10	1,10	*1
Canadian Dollar							
1-Week	391	190	201	0,78	0,34	1,12	*1
2-Weeks	390	184	206	0,77	0,34	1,11	*1
4-Weeks	388	188	200	0,77	0,34	1,10	*1
12-Weeks	380	186	194	0,70	0,29	0,99	

Notes:

1) *1 and *5 denote confidence levels of 1 percent and 5 percent, respectively, using a one-tailed test.

2) $P1(t) + P2(t) = P(t)$

3) Null hypothesis is that the combined conditional probabilities equals one, $H0 : P1(t) + P2(t) = 1.00$.

4) N = total number of observations; N1 = number of observations where $S(t+1) - S(t) < 0$; N2 = number of observations where $S(t+1) - S(t) > 0$; P1(t) is the conditional probability of a correct position probability given $S(t+1) - S(t) < 0$; P2(t) is the conditional of a correct position given $S(t+1) - S(t) > 0$.

Table 6 - Non-Parametric Tests: Conditional Probability of a Correct Change in Net Foreign Currency Position
(major market participants, weekly, 07/03/96 - 12/31/03)

Currency/ Time Horizon	N	N1	N2	P1(t)	P2(t)	P(t)
UK Sterling Pound						
1-Week	391	181	210	0,52	0,46	0,99
2-Weeks	390	187	203	0,51	0,52	1,03
4-Weeks	388	184	204	0,52	0,48	1,00
12-Weeks	380	194	186	0,54	0,55	1,09 *5
Swiss Franc						
1-Week	391	191	200	0,44	0,46	0,89
2-Weeks	390	185	205	0,45	0,48	0,94
4-Weeks	388	176	212	0,43	0,50	0,94
12-Weeks	380	174	206	0,42	0,47	0,89
Japanese Yen						
1-Week	391	177	214	0,49	0,48	0,97
2-Weeks	390	176	214	0,51	0,48	0,98
4-Weeks	388	179	209	0,52	0,50	1,02
12-Weeks	380	165	215	0,55	0,40	0,95
Euro						
1-Week	260	135	125	0,47	0,43	0,90
2-Weeks	259	135	124	0,45	0,48	0,93
4-Weeks	257	120	137	0,43	0,36	0,78
12-Weeks	249	121	128	0,55	0,35	0,91
Canadian Dollar						
1-Week	391	190	201	0,51	0,49	1,00
2-Weeks	390	184	206	0,48	0,48	0,95
4-Weeks	388	188	200	0,53	0,45	0,97
12-Weeks	380	186	194	0,55	0,46	1,01

Notes:

1) *1 and *5 denote confidence levels of 1 percent and 5 percent, respectively, using a one-tailed test.

2) $P1(t) + P2(t) = P(t)$

3) Null hypothesis is that the combined conditional probabilities equals one, $H0 : P1\ (t) + P2\ (t) = 1.00$.

4) N = total number of observations; N1 = number of observations where $S(t+1) - S(t) < 0$; N2 = number of observations where $S(t+1) - S(t) > 0$; P1(t) is the conditional probability of a correct position probability given $S(t+1) - S(t) < 0$; P2(t) is the conditional of a correct position given $S(t+1) - S(t) > 0$.