

OVERVIEW OF ONLINE FINANCIAL MARKETS

Seminar Paper

SEMINAR ON HIGH FREQUENCY FINANCE

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1. Introduction

This seminar paper shows different aspects of foreign exchange (FX) markets. As will be cited and used a couple of times, FX markets probably tend to be the most efficient and liquid ones. Special emphasis is put on *online* markets where currencies can be traded, such as OANDA, which is located in Zurich, Switzerland, as far as one can speak of the “location” of an online exchange. To show similarities and differences to traditional FX markets, these are presented in advance in chapter 2. As a key example, an introduction to the FX Trade platform offered by OANDA is given at the beginning of chapter 3. Since an online exchange has to choose which kind of products it offers to its clients, and following this argument: which kind of clients it has respectively wants to have, some other online markets are presented as examples in chapter 3.

Chapter 4 tries to provide an overview of some of the latest fascinating research activities related to this topic. Unless an electronic exchange can at least potentially offer individual high frequency data for researchers (and OANDA actually does), these fields of activity crucially hinge on the availability of such “high quality” data. It is now possible to get some insights into market microstructure and individual trading behaviour, for example. The look on such small objects yields some special properties, some referring to econometrics or time series analysis, some being related to questions of definition, like the difficulty to determine what the market price really is.

Finally it shows up that the research done in this area is in a quite early stage of development. There are still a lot of questions left open, some of them crucially depending on the existence of special data sets, which have not been available until the recent past.

2. Foreign Exchange Markets

2.1 FX Markets in general

On FX markets the participants trade different currencies against each other. Particular since the 1970s after the break down of the Bretton Woods System, the major currencies (today: the US Dollar, the EURO, and the Japanese Yen) float freely. The price of one currency in units of another one (the “exchange rate”) follows the patterns of supply and demand. The major participants on the market for foreign

exchange are commercial banks¹. Other participants such as corporations, institutional investors, and seldom also individual private persons usually have to contact their bank or broker in order to obtain foreign currencies. Though throughout the paper the connotation “FX market” is frequently used, one should not be led to the conclusion that there is really *one* exchange where the participants meet (either personally or virtually) to trade with each other. If you compare the institutional settings on the FX market with the common stock market, there is literally no equivalent to the NYSE² or the Frankfurt Stock Exchange, for example.

Nevertheless, the turnover on the worldwide FX market reached a daily volume of 1,200 bn USD in April 2001, while the peak has been reached in April 1998 with 1,490 bn USD³. The largest part is generated through trade in USD, EUR, and JPY, while GBP and CHF still play a significant role⁴. The currency pair, which was traded most, is USD – EUR, it accounts for almost a third of the total turnover⁵. The major locations of currency traders are Europe, the United States, and South-East Asia. Taken these regions together, they provide trading for 24 hours. All these figures include spot market, forward market, and swap market activity. Other derivatives are not as standardized as these, add to another accounting, and are not considered throughout the following examination.

These high volumes represent a very liquid market. This liquidity is also expressed in the tight bid-ask-spreads that are offered by major market participants or market makers.

2.2 Traditional FX Markets

As stated above, the FX market misses a central institution like an exchange. The major market participants trade directly with each other instead: via so-called “over the counter” (OTC) transactions on the telephone. Also today the phone is often substituted by electronic communication, the principles stay the same: A trader receives information from a potential counterparty that is willing to trade currencies at the quoted prices. If our trader is willing to deal, they agree on volume and price. Delivery of the traded currencies is usually two working days later.

¹ Fabozzi, Frank J. et. al. (1994) p. 628

² New York Stock Exchange

³ BIS (2002) p. 5 and *The Economist* (Apr. 12th 2001). Reasons for the decline are manifold; one might be the increased awareness of risk after the Asian currency crisis, another surely is the absence of intra EMS (European Monetary System) trade.

⁴ US Dollar, EURO, Japanese Yen, British Pound, Swiss Franc

⁵ Figures from BIS (2002)

The direct contact is needed because of the credit relationship between the two partners, arising from the difference between long and short positions.

But what is still necessary is a system, which provides the quotes from the different clients; therefore the most prominent are presented below. Though on both systems (Reuters and EBS) together the largest amount within the foreign exchange market is traded, their market shares have been falling.

What stays unclear is the following: While smaller platforms with market makers usually have not only a minimum, but also a maximum volume for a single trade, Reuters and EBS do not have such a restriction. While on EBS and Reuters the best quote is matched with a volume behind it, it seems to be that on both platforms it is *convention* among the participants not to exploit any other quote by dealing huge amounts that the provider of the quote did not intend.

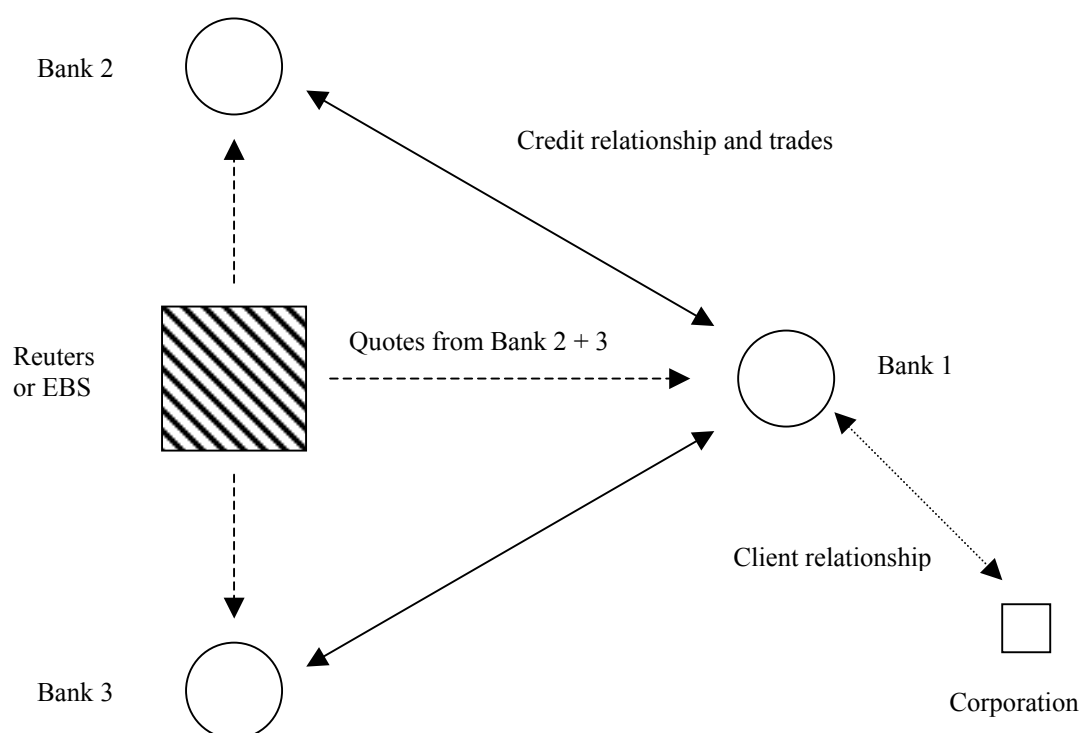


Figure 1: Traditional FX Market. Source: Own.

2.2.1 Reuters

Reuters launched its first information and dealing system for currency traders in 1981, the Reuters Monitor Dealing System. It was upgraded in 1989 to Reuters 2000-1 and 1997 to Reuters 2000-2, which is still active. In the year 2000, Reuters launched its newest system 3000, which runs parallel to the old 2000-2. The core system, namely “Reuters Dealing 3000 Direct” provides information and contact to and from traders in 110 countries. Conversation and dealing is done electronically, not by phone anymore. An additional system “Reuters Dealing 3000 Spot Matching” shows information such as quotes *anonymously*, and these quotes are not indicative anymore: any participant can trade on them, while in the core system the indicative nature of prices implies that both parties (the quoting and the reacting one) can trade on a totally different price. Naturally, the actual traded price does not differ largely from the quoted one, and in most cases it is a *better* price (in terms of the counterparty). But this is only convention. The anonymous quoting needs some restrictive and standardised features, so this system is only available in 38 countries and for 34 currency pairs. Every Reuters dealing system is closed for private or amateur dealing.

In addition to the spot market systems, Reuters provides a platform for forward markets as well (“Reuters Dealing 3000 Forwards Matching”), which is similar to the Spot Matching system.

2.2.2 EBS

Until EBS (Electronic Broking System) launched in 1990, Reuters had virtually no competitor. Today EBS has a substantial market share, one reason for it is the so-called FXNET system, which executes and settles trades in combination with the participant’s back office. Beside this, the offered possibilities are similar to those of the Reuters dealing systems. It is interesting to remark, that EBS market data is also available via Reuters – but not within the Reuters Dealing system, of course.

3. Online FX Markets

3.1 Online FX Markets in general

As can be understood from above, it is very difficult to become a participant on the FX market and it is literally impossible for private persons. But even large corporations usually do not deal directly with more than one bank and via Reuters or EBS, because they often do not have credit relationships to all the banks. These are some of the reasons for the launch of online currency exchanges. Though not all presented exchanges provide the same features, there are some similarities among them.

Either, the exchange minimises the necessary volume for each trade and opens therefore a way for private participants. Or the exchange tries to implement a multi-bank relationship, where each client of the exchange does not need to build up a relation to every bank, but only to one. Some exchanges depict the traditional FX market on their platform, but most platforms have to provide liquidity from the rest of the world market, since volumes on the online platforms are too low to allow full equalisation *within* their platform. Some try to attract several traditional market makers, especially brokers and banks; some play the role of the market maker by themselves, in order to maintain liquidity. Other differences are due to the engine itself, whether it runs within a web browser, a separate client, via the internet, or within a private network.

Most online exchanges provide so-called straight-through processing (STP), which means that the platform settles every trade and cares for delivery.

3.2 FX Trade on OANDA

Some key figures ahead: OANDA has 2,800 clients. They generate between 2,500 and 5,000 trades each day and reach a daily traded volume of 50 – 100 million USD. Some of OANDA'S clients are individual private investors, because there is no binding minimum trading volume⁶. Quotes for several specific currencies are presented by OANDA itself, which acts as a market maker. The quotes are firm, and each client can trade on them. Every client faces a spread between bid and ask rate, but this spread does not hinge on the traded volume. It is as low as the most inter-bank spreads (and sometimes even lower): For the most liquid currencies it reaches

⁶ Actually, it is 1 USD per trade.

down to two or three “pips”, which means: OANDA sells 1 EUR for 0.9874 USD and buys 1 EUR for 0.9871 USD, for example. The quotes presented on OANDA stem from a quantitative algorithm, which takes into account the supply and demand on OANDA itself, together with rates offered on the world market for FX. Especially the latter is due to the prevention of arbitrage possibilities, which might arise if the prices between OANDA and the rest of the world would differ significantly. The volume on OANDA does not provide full equalisation of all trades, up to 40% has to be flow in from the outside as additional liquidity.

Straight-through processing comes very easily for the clients: They automatically open an account, which can be used for other banking transactions as well. The currency trading itself takes place on a web-based engine; no additional program has to be installed. The trading engine is easy to use, and provides exchange rates, graphs (of the price, volatility, etc.), and positions or exposure to the traded currencies. The screenshot (Fig. 2) below shows the trading screen with a EUR/USD chart and the current exposure of the investor. Additionally, there is a continuous computation of realised and unrealised profits & losses. As another major difference to traditional markets and other online markets, OANDA pays continuous interest on balances. Until today, interest is usually only paid on a daily basis, and this *might* lead to a bias in the investor behaviour, since they do not adjust their decisions in intra day trading. Unfortunately, there is not much research being done on the effect of continuous interest.

OANDA was founded in 1996, while the exchange itself (namely FX Trade) was launched in 2000. Besides the fact that until then there has not been any FX market for individual or small corporate investors, also the generation of high frequency data belonged to the intentions of the founders.

For the private individual the existence of an exchange like OANDA is an alternative for the traditional bank-client-relationship. There are advances for any individual concerning the possibility of transactions to different countries. Small corporations now have the chance to hedge their currency risk with short positions even with small amounts.

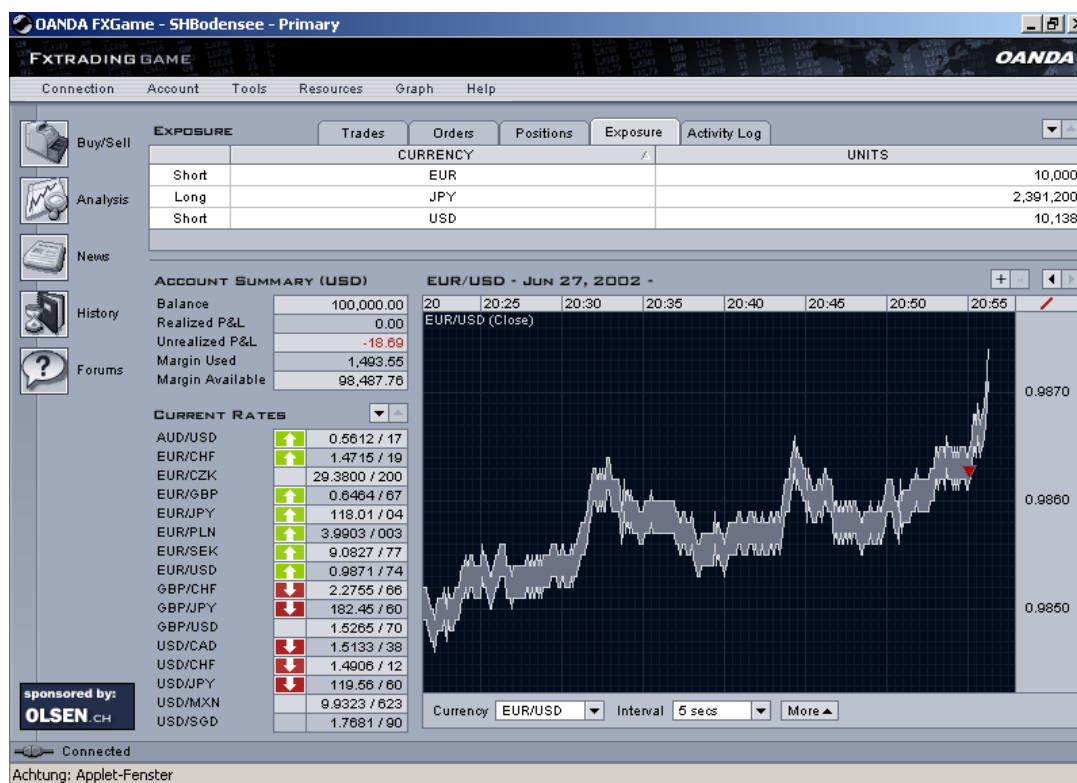


Figure 2. Trading Screen of FXGame. Source: www.oanda.com

3.3 Presentation of other Online Foreign Exchanges

3.3.1 CurrenEx

Founded 1999, CurrenEx today has a few hundred members, how CurrenEx calls its clients. CurrenEx has reached a daily volume of \$ 1.35bn by August 2001⁷. The members form the buy-side of the exchange and exclusively consist of corporations and institutional investors such as hedge funds or asset managers. To meet the special and different demands, CurrenEx has to offer two different trading engines called "FXtrades FUNDS" and "FXtrades CORPORATE". On the sell-side multiple banks act as the providers of prices for spots, swaps, and forwards. A client has the possibility to ask the banks for prices simultaneously, so he can chose between different offers. If wanted or needed for some reasons, the client can also contract with any specific bank he choses in advance. The banks themselves do not only provide prices on request, but can also publish live and streaming quotes for their products.

So while on CurrenEx the clients do not trade with each other, it depicts traditional foreign exchange markets where the sell-side is strictly limited to banks

⁷ Leighton-Jones, Ph. « FX online markets pick up pace » *Financial News* 11, March 17th 2002

acting as market makers. Nevertheless, the simultaneous comparison of quotes yields higher transparency and the clients are not limited to one or only a few banks as participants. Going further, a so-called “*Enhanced Market Access*” system is a real novelty compared to the traditional market structure. Using the infrastructure of CurrenEx as a gatekeeper, a client establishes only one credit line to only one bank, while he gains access to all other participating banks and their quotes via this single credit line.

Because there is no central or dominating market maker, trades on CurrenEx are not restricted to a specific number of currency pairs: A client can request quotes for *any* currency pair, which can be traded afterwards. It almost comes naturally that every own trade and every activity can be put into an electronic report for the client.

Together with the trading engine, CurrenEx provides some additional tools for its clients. It offers real-time quotes, either intra-day or historical, for technical analysis. But especially the historical data is not a result from activities on CurrenEx: „Tradermade International Limited“ provides it. And even the intra-day data and graphs do not use the own upcoming information. Clients can read real-time Reuters news regarding capital markets and foreign exchange. Global acting clients can use FXinternal, which acts as an engine for foreign exchange transactions *within* a corporation.

3.3.2 Choice FX

Again, also Choice FX itself does not act as a trader or market maker. But instead of resembling the current foreign exchange markets with their linkage to banks offering quotes, Choice FX does not separate between actors on the buy-side and actors on the sell-side. Every participant can offer quotes to the other participants while he stays anonymous. Still, if an exchange allows for stop or limit orders, a market maker will have to provide the execution of such orders. At Choice FX, for special currencies market makers provide additional liquidity, especially in the case of the above mentioned order types. Those market makers are bound to a maximum spread of 5 points; every other participant may offer different spreads or no spread at all, presenting only a buy or only a sell offer instead. The minimum trade volume reaches \$ 100,000 (while also a maximum is defined: \$ 10,000,000). Though not explicitly stated, this restriction will lead to a majority of corporations or institutional investors among the clients.

3.3.3 FXall

FXall was launched in May 2001. Large investors such as Citibank, Deutsche Bank AG, and J.P. Morgan Chase back it. It should be remembered that in 2001 only about 5% of the world market for foreign exchange was traded electronically⁸. Anecdotal evidence says that today the trade volume on FXall has reached \$ 1.6bn⁹. Actually, this increasing amount shows that (while overall FX volume has been shrinking) market shares of online exchanges have been rising.

On FXall providers of liquidity set prices for the clients. The fact that there is not only one liquidity provider should lead to competitive prices, says the FXall website. A client takes advantage of the fact that while he requests quotes, all market makers answer simultaneously. The engine of FXall offers straight through processing (STP), which alone is not an outstanding facet, because it usually belongs to the offerings of an online foreign exchange market. The difference with FXall's STP lies in the emphasis put on the adequacy for different groups of clients. There are a couple of different STP suites, matching different needs. Still, the major group of customers addressed by FXall are institutional investors.

3.3.4 STN Treasury

The Sungard Transaction Network Treasury (STN Treasury) is not fully comparable to the above-mentioned foreign exchanges. The difference lies in the traded objects: While all mentioned exchanges allow trade in currencies, only some allow trade in forwards or derivatives. On STN Treasury the variety is much wider, because it also allows for financial instruments which are not as standardized as currencies or forwards, namely loans, deposits, or call accounts. Just as most of the other exchanges, STN offers the possibility to request quotes from different banks and therefore also the possibility to compare them. The banks themselves can choose how to offer quotes, either as a continuous stream, or as a static quote for a selected time. As STN Treasury says, they process 3,000,000 transactions each day, for 10,000 customers. The participating customers and banks remain in their existing relationships, which means that a buy-side client can only deal with a sell-side client if a credit link already exists.

⁸ Cameron, D. and Swann, C. « FXall set to intensify battle in online currency trading » *Financial Times*, May 10th 2001, Front Page

⁹ Leighton-Jones, Ph. « FX online markets pick up pace » *Financial News* 11, March 17th 2002

One major advantage of STN Treasury lies in the fact that Sungard not only offers this electronic exchange, but also a large variety of other tools for corporations, especially for their treasurers.

4. Related Research

4.1 High Frequency Data

As finance is a very empirically oriented science, it might not be too astonishing that the development of new econometric recipes and analysis techniques is crucially driven by it. Therefore it comes almost naturally, that new findings in the area of high frequency finance are either developed or find their application in combination with financial issues. Since technology has not provided high frequency data until the very recent years, this field of study is a rather new one. Especially the foreign exchange market offers data streams which can be used as examples, because of their market properties concerning efficiency etc.

Andersen¹⁰ offers five points of interest which arise while he deals with high frequency data: (a) intraday periodicity, (b) repercussions from news releases, (c) “market opening” effects, (d) a persistent volatility factor, and (e), noise in the series due to recording errors and breakdowns in data transmission. Empirical findings show that intraday volatility exceeds the interday volatility by a factor of 2.5, while this intraday volatility at least partly arises from the intraday seasonal. So taken (a) and (d) together, a high frequency time series usually needs a *filter*, and Anderson proposes one¹¹ to transform the time series. After doing this, an analysis may concentrate for example on features which the time series has in common with low frequency data – only on a more sophisticated level which hopefully yields results that traditional time series did not provide.

Analysis with high frequency data can be done in at least two different ways. First, the existing data can be aggregated to, say, five-minute intervals. By doing this, the common econometric techniques can be applied. But if one chooses the second alternative, namely the time series in its raw tick-by-tick form (so called *ultra high frequency data*¹²), some more elaborate techniques have to be developed, unless the usual assumption of equal length between two points in time has to be relaxed.

¹⁰ Andersen, Torben G. (2000) p. 146

¹¹ Andersen, Torben G. (2000) p. 147. He proposes a FFF – Filter, which is “Fourier Flexible Form“

¹² Ghysels, Eric (2000) p. 154

The uncertainty resulting from the timing of events leads to difficulties. For example: It is doubtful or even impossible to apply the usual VAR techniques or causality tests. But especially for research done on market microstructure, it is important to use the raw material, and again especially there it is interesting to find such causalities, for example between duration and price.

It should not be neglected that a “price” in a theoretical sense might be well defined; nevertheless it is not straightforward to extract the price-variable from a time series. At least two variables compete: Quotes and trades. It should be clear that the exchange rate, at which a trade really has occurred, could be called a price. Unfortunately, these trades can often not be matched with quotes – for example on the Reuters Dealing system, where the market participants can agree on *any* price in bilateral negotiation. Sometimes prices resulting from trades are not available at all. Quotes instead are usually available for research, but it is hard to assign the attribute “price” to a quote when it is only indicative. What if a quote is not indicative, but binding (like on Reuters Dealing 3000 Spot Matching)? And what if the quote is binding, but there is no trade to this “price”? These questions are not as trivial as they might seem, because the price finding process is what research on market microstructure is all about.

4.2 Efficiency and Rationality

On foreign exchange markets the objects which are traded, are currencies - either currencies themselves (spot or forward markets) or derivatives (swaps, etc.). Currencies differ in their risk of appreciation or depreciation against other currencies, and in the interest paid on balances. Actually, there is not much more in what currencies as an asset differ. Taken this homogeneity and adding the huge volume of daily trades, the market for currencies should probably be the most efficient one.

One obvious element of efficient markets is the *absence of risk-less arbitrage possibilities*. It is straight forward that there should not be any of such possibilities between two currencies on the spot and on the forward market, since forward rates are computed in a way to fulfil that efficiency, and since such a possibility would be a very obvious and really risk-less one. Nevertheless, even this efficiency does not follow straightforward, as various approaches showed in the past. Especially a single

regression analysis¹³ of the following form repeatedly rejected the null hypothesis of rational expectations¹⁴.

$$s_{t+\tau} - s_t = \lambda_0 + \lambda_1(f_t - s_t) + \mu_{t+\tau} \quad (1)$$

$$H_0: \begin{array}{l} \lambda_0 = 0 \\ \lambda_1 = 1 \end{array} \quad (2)$$

Equation (1) together with the null hypothesis (2) is simply a representation of the expectations hypothesis, with s_t denoting the spot price and f_t denoting the forward price of a currency at time t , both in logarithms. In this case rationality is expressed by $E_t [s_{t+\tau}] = f_t$, which is implicitly stated by the null hypothesis in (2). Though the null hypothesis has been severely rejected in this fairly simple model, the introduction of a “news” parameter, or the transformation into a VAR¹⁵ model together with an explicit risk premium does not lead to better results. But (at least to the knowledge of the author) especially the “news” model¹⁶ has not been tested again with data without aggregation to daily data points.

It should be noted that it is at least ambiguous among economists whether the hypothesis of rationality itself can be tested at all and therefore if the above-mentioned analysis really rejects rationality. Yet, this analysis does not employ high frequency data, which might lead to the following step.

What is also obvious is the so-called *triangular arbitrage*¹⁷, where three currencies and their prices in terms of the remaining two are compared. The existence of high frequency data yields the possibility to find out whether there are moments when arbitrage possibilities arise, and if or how agents react. Given that on an electronic market a trader can react real-time and within seconds to such a possibility, the usage of high frequency data is the only way to approach to that question. Data which measures prices for currencies only on a daily basis cannot be connected with the action and reaction of traders, because one does not know which prices the traders really faced during their transactions. *Kollias and Metaxas (2001)* find that if a mispricing (hence, an arbitrage opportunity) occurs, its exploitation would yield a return of 0.052% on average. Yet, the average persistence of such an

¹³ Wang, P. and Jones, T. (2002) p. 221

¹⁴ Wang, P. and Jones, T. (2002). The whole model and its empirical results shown here follow their paper.

¹⁵ Vector Auto Regression

¹⁶ Wang and Jones follow the approach mainly introduced by MacDonald, R. et. al. (1983, 1988).

¹⁷ Kollias, C. and Metaxas, K. (2001) pp. 435-436

opportunity is 19 seconds, which is just enough time for an electronic transaction. As average time of persistence they apply the *median*. Other findings imply that the more liquid a market is, the less arbitrage possibilities appear, and additionally, the smaller is the time of their persistence. For example, a round trip British Pounds – German DEM – US Dollar (which depicts within the foreign exchange markets the one of the most liquid round trips before the introduction of the EURO) offers only an average profit of 0.028% and disappears after 7 seconds. This is hardly enough time for a reaction, even on an electronic market, and hence such a mispricing can hardly be called arbitrage possibility. There also seems to be a negative relation between size of the expected profit and its persistence, which should be not too astonishing.

It should be noted that facing such small time periods for reaction also denies arbitrage possibilities (and therefore market inefficiencies), because a reaction to it is not risk-less anymore: While the trader tries to fill in his orders, the price might have changed, leaving the trader even with a loss and not with a secure profit.

4.3 Trading Patterns

The existence of high frequency data allows for the first time a glance into intra day trading patterns, and hopefully even into individual behaviour. Unfortunately, even the pure existence of such data does not per se provide such a view, while the possible insights crucially depend on the quality of the data stream. A research paper by Danielsson et. al. (2002) for example is built upon Reuters data. Though it presents tick-by-tick data of bid and ask prices, it is virtually not possible to extract individual behaviour, due to the following facts. First, not every posted quote on the Reuters system leads necessarily to a transaction; and if so, it stays unclear, when and with what amount such a transaction took place. That is why Danielsson et. al. call these quotes rather *indicative* than firm, because a currency pair can be traded at literally any other spread and price.

In the cited paper there are actually two systems that provide quotes, namely Reuters EFX and Reuters D2000-2, but they don't differ in the first findings. What is obvious at first glance, is one can find a strong seasonal pattern for every single day, leading to a very high volume during office time and low volume during non-office time. Highly correlated with the volume is the order frequency, and on the D2000-2 platform also the bid-ask-spread, which shrinks with higher volume and frequency¹⁸.

¹⁸ Danielsson, J. et. al. (2002) p. 209

The bid-ask-spread therefore provides at least for D2000-2 a measure for market liquidity, in the following sense: the more liquid a market is, the tighter the spread should be. Especially on the EFX system the frequency of quotes instead of the spread turns out to be a proxy for overall market activity¹⁹.

Found such a dissimilarity, Daniellson et. al. try to find a relationship or even causality between the time series of the two data providing systems. They use a VAR model that tries to regress the returns of each series on the lagged returns of the series itself and the other series.

$$r_t = \mu + \alpha z_{t-1} + \beta(L)r_{t-1} + \varepsilon_t \quad \text{with} \quad E(\varepsilon_t \varepsilon_{t-1}') = \Omega \quad (3)$$

Every element of (3) denotes a vector, for example $r_t = (r_t^{D2}, r_t^{EFX})'$, consisting of the two mentioned time series. The pricing error $z_t = q_t^{D2} - q_t^{EFX}$ should be zero in equilibrium. Daniellson et. al. provide the following results. The higher the trading activity is, the closer are the two time series together. But there are still inefficiencies in the following sense: The two α are not zero (but close to); they differ significantly, while α_1 is negative and α_2 is positive. This just represents that EFX is in a limited way predictable via D2000-2. News is incorporated earlier into D2002-2 quotes, leading to the same limited predictability of the EFX quotes following D2000-2. Please note that also the volatility of D2000-2 leads.

Many problems that arise hinge on the only indicative nature of the presented quotes. At least some dealers compute one half of the quotes not in order to transaction intentions, but with a standard spread, because they only want to trade on *one* side of the market. Some of these problems might be solved with high frequency data resulting from trading activity on OANDA. The quotes presented here are binding, eliminating the problem of indicative quotes. And it is possible to match the quotes with a transaction time series, so that one can regard the actually executed trades, and not only the quotes.

Another related field of interest refers to individual behaviour that actually hinges on the fact that transactions can be submitted online, and not via phone or in direct contact with a broker. The underlying research²⁰ examined the behaviour of private investors who managed their stock portfolio themselves. There has not much

¹⁹ *ibid.* p. 213

²⁰ Barber, B. M. and Odean, T. (2002)

research been done on the trading properties of private investors on the FX market, as long as it was virtually impossible for private investors to trade currencies with the same conditions as large corporations or even banks, due to very high minimum volumes per trade for example²¹. Some findings of Barber and Odean are rather unspectacular, but their central corroborated thesis is quite astonishing: On average the investors changing to an online portfolio management beat the market by more than 4% *prior* to their change. After going online the investors showed the following behaviour: Their turnover rate rose from annualised 74% to 96%, with a peak of even 120% (annualised) in the first months of their online trading. The increase of their *speculative* turnover is even more dramatic, since it doubles on average. And their returns do not beat the market anymore: the very same investors who had beaten the market with more than 4% before, now under performed by approx. 3.5%. This change is significant. Barber and Odean try to provide an explanation for this phenomenon. First, the exposure to riskier small growth stocks rises with the switch to online trading. As long as this is by itself not a satisfying cause, the authors state *overconfidence* as the main reason, namely the following different types: the self attribution bias due to their excellent performance before; the illusion of knowledge and control because of the unlimited access to information and the possibility to transmit an order within seconds on the internet; and finally they also showed even before a strong tendency towards riskier assets²². A far more simple explanation for the increased turnover is given by the properties of the usually downward sloping demand curve – online transactions are cheaper than phone transactions and therefore executed more often.

The real exciting insight is this: Although the trading costs are lower, information flows are faster and wider, trades are executed faster, and this finally leading to higher transparency and “better” markets, the performance of the individual still decreases.

4.4 Financial Crisis and Contagion

Although the former chapters imply that FX markets at least tend to be efficient, it happens that single countries or whole regions fall into a financial crisis. A

²¹ The absence of a minimum on OANDA changes this.

²² This argument comes in combination with the selection bias, as long as Barber and Odean needed a long time series and therefore chose one starting in 1992. The investors that switched to online trading at that early stage, definitely had a stronger addiction to risk.

major example is the Asian currency crisis, and the latest example might be Argentina. For the understanding of the following arguments please note that the peso was fixed to the USD via a currency board. One major cause for Argentina's crisis might be the sharp rise of the USD against other currencies²³ that the peso had to follow. This finally led to a gigantic overvaluation of the peso accompanied by declining exports and rising imports. Though the currency board achieved its goal of low inflation, many inhabitants did not believe the fixed peg would last and therefore tried to change their pesos into dollars, yielding another set of problems. One might argue that more trust in markets would have been able to prevent such a crisis.

But even markets did not manage to forecast or prevent the Asian currency crisis of 1997. Cartapanis et al. (2002) develop a model that could help to forecast a future crisis, since it turned out to work ex post for Asia. As they argue that financial vulnerability originally stems from unsustainability, they use fundamental macroeconomic variables to build an indicator for such unsustainable governmental behaviour. Another major variable is used as a proxy for currency overvaluation, while the third part depicts contagion effects²⁴. Their findings show that all three components add significantly to their crisis index, while contagion effects play the smallest role, and macroeconomic unsustainability beside vulnerability due to overvaluation share the major role²⁵. Because of their usage of macroeconomic indices, Cartapanis et al. applied their model on a time series with quarterly data. Unfortunately, the model has not been tested with data of higher frequency or on other countries, Argentina for example. But still it provides a step towards an early warning system.

Though empirical evidence (Cartapanis et al. 2002) shows that contagion effects play a significant, but only minor role, some of the recent research results should be presented. Nevertheless, it provides a view on crisis phenomena apart from traditional fundamental explanations, including the terms of trade or the real interest rate differential²⁶. This view yields a possibility for a definition of "contagion": "it should only be associated 'where a crisis in one country may conceivably trigger a crisis elsewhere for reasons unexplained by macroeconomic fundamentals'"²⁷. In this

²³ Feldstein, M. (2002) p. 11

²⁴ Please see the following page for a closer look on "contagion".

²⁵ Cartapanis, A. et al. (2002)

²⁶ Sell, Friedrich L. (2001) p. 8

²⁷ *ibid.* p. 91. Sell himself cites Masson (1998) "Contagion: Monsoonal Effects, Exchange Rates and Monetary Unification".

definition, contagion is very close related to the so-called herding effect, when investors don't use their private information and follow the behaviour of other (nearly arbitrary) investors. This might have two reasons: First, they don't trust their own information, for good reasons or not; and second, they sometimes misinterpret the behaviour of an investor with trustable information. Still, a portfolio-theory based idea implies a rational explanation, since one investor may have positions in several "dangerous" countries. If one of these positions defaults, it may lead to a portfolio restructuring, including a retreat from other risky positions²⁸.

A similar idea depicts the decision of an institutional investor with a given strategy: If a fund manager faces a sharp loss in one risky position, he may be forced to reduce other positions as well in order to maintain specific proportions within his portfolio. If there is a really sharp decline of not only one position, a fund manager may be forced to sell positions to remain liquidity, therefore even supporting the declining process and spreading it to countries which have not been affected yet.

Finally, one may divide between several types of contagion²⁹: The first element of discretion hinges on the question whether the two countries (the first country and the one which adopts the crisis) are linked via fundamental transmissions channels (like trade in goods) or not. The second element directly refers to the cause of the crisis, namely if there was an event, new information or new interpretation of old information. Sell (2001) introduces a game theoretic approach with two players, the "government" of a country that might potentially be infected, and the "public" as investor. Though this model tries to depict especially the Russian crisis, which infected Brasilia afterwards, Sell himself denies the model's capability as an early indicator. Still, he provides an outlook on what a model which works as an early warning system should take into account: The already cited linkage between countries, the installed exchange rate regime, the capital standards, or the balance sheet of the central bank (from which conclusions like "how long can the central bank defend the peg" can be drawn). Very important for such a model would be, that information and data flows instantaneously and can be put into an immediate analysis. Hence, faster data is better data: But it is still questionable, if the usage of high frequency data could be of help in this case.

²⁸ *ibid.* p. 95

²⁹ *ibid.* p. 115

5. Summary and Outlook

The intention of this paper was to provide insight into the world markets for foreign exchange. The FX market shows an extremely high daily turnover, and together with other properties such as homogeneity of currencies, it is probably the most efficient market one can find. But until the recent past there have been heavy restrictions because of minimum trading volumes for the participants, leading to a situation where virtually only banks or similar institutions took part. The introduction of less restrictive online markets like OANDA changes this, and there has been a substantial shift in market shares towards them.

Such online markets could be excellent providers of high quality and high frequency data. One reason for this lies in the fact that quotes on these markets can be closely related to trades, and this ends the problem of the indicative (and therefore almost useless) nature of quotes, as presented for example by Reuters.

Research done with such data finds itself in an early stage. Though some theoretical work on the properties of high frequency data has been done, and there already are some recipes for time series analysis and econometric testing procedures, there is a lack of research on fundamental economical questions. There are some existing models, which have been confronted with “old fashioned” data, and it would be worthwhile to test them again with tick-by-tick data. Examples for that are tests on efficiency and rationality, or the development of a financial early indicator for an upcoming currency crisis. But other economic phenomena, especially related to studies on market microstructure (hence, the price finding process), crucially hinge on the existence of high frequency data. So does modelling of individual trading patterns and behaviour.

So there is finally only the call for more research in this area, as long as this field at least potentially (if not intrinsically) provides fascinating new insights on markets and market participants.

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Links to Online Markets (examples from 2002-06-07)

OANDA.com, The Currency Site: <http://www.oanda.com>

FXall: <http://www.fxall.com>

CurrenEx: Global Financial Exchange: <http://www.CurrenEx.com>

Choice FX: <http://www.choicefx.com> (also via <http://matchbookfx.com>)

Sungard STN Treasury: <http://www.stntreasury.com/>

Reuters (2000 and 3000): <http://www.reuters.com>

EBS foreign exchange: <http://www.ebsp.com>

Link-List to Online-FX related Sites

FX-Week Links - FX links to the FX world:

<http://www.watersinfo.com/news/fxwk/links.htm>