

An Empirical Analysis of Spread for Two Types of FX Brokers

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ABSTRACT

Foreign exchange market is the largest financial market with a daily turnover more than \$4 trillion. The existence of many brokers in this market makes the decision of choosing the right broker difficult. For traders, bid-ask spread is one of the most important factors in order to choose a broker with minimum cost of exchange. There are two different main types of brokers in terms of bid-ask spread. Some offer fixed spread and others offer variable spread for exchange of currency pairs.

There has been uncertainty among traders whether fixed spread or variable spread brokers offer the lower bid-ask spread and as a result the lower cost of transaction. This study makes an empirical analysis of spread for these two types of brokers. Liquidity features of currency pairs have a significant role in exchange of currency; hence this feature is measured and investigated.

The findings based on this research shows that variable spread brokers tend to have a lower spread and as a result the traders profit is higher compared to trading with fixed spread. Furthermore, under this study, the currency pairs with the USD has been identified most liquid.

Keywords: foreign exchange market, bid-ask spread, liquidity

ÖZ

Döviz piyasası, günlük cirosu 4 trilyon dolardan fazla olan en büyük finansal piyasadır . Bu pazarda birçok brokerın varlığı doğru broker'ı seçmeyi zorlaştırır. Döviz alım satımı yapanlar için en uygun maliyetli broker'ı bulabilmek için alış-satış aralığı en önemli faktördür. Alış satış aralığı açısından iki farklı türde broker vardır. Bazıları sabit aralık sunarken bazıları da değişken fiyat aralıkları sunmaktadır.

Döviz ticareti yapanlar arasında sabit veya değişken fiyat aralığı sunanların hangisinin daha düşük maliyetli olduğu belirsizdir. Bu çalışma, bu iki tipteki brokerların ampirik analizini yapmaktadır. Dövizlerin likidite özellikleri, döviz alım satımında önemli rol oynamaktadır. Bu nedenle bu özellik ölçülüp, incelenmiştir.

Bu çalışmanın sonuçlarına göre değişken fiyat aralığı sunan brokerlar sabit fiyat sunanlara göre daha az maliyetlidir. Bunun yanında döviz çeşitleri içinde en likit özellikte olan Amerikan Dolarıdır.

Anahtar kelimeler: Uluslararası döviz piyasası, alış-satış aralığı, likidite

To My Loving Wife

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TABLE OF CONTENTS

ABSTRACT	iii
ÖZ	iv
DEDICATION.....	v
ACKNOWLEDGMENT.....	vi
LIST OF TABLES	x
LIST OF FIGURES	xii
LIST OF ABBREVIATIONS.....	xiii
1 INTRODUCTION	1
1.1 Background	1
1.2 Aim of the study.....	2
1.3 Methodology, Data and Limitations	3
2 FOREIGN EXCHANGE MARKET	5
2.1 What Is Foreign Exchange Market?.....	5
2.2 Why Does Foreign Exchange Market Exist?	6
2.3 Where Is the Location of Foreign Exchange Market?	7
2.4 Who Uses Foreign Exchange Market?.....	7
2.5 Characteristics of FX Market	8
2.6 When Is FOREX Market Open for Trading?	9
2.7 Trading Sessions	11
2.7.1 Asia-Pacific Session.....	11

2.7.2 European Session	12
2.7.3 North American Session	12
2.8 The Mechanics of Currency Trading	13
2.8.1 Base and Counter Currencies	15
2.8.2 Long and Short Positions	16
2.8.3 Currency Quotes.....	17
2.8.4 Spread.....	19
2.8.5 Trading Platforms.....	20
2.8.6 Regulations.....	20
3 FOREIGN EXCHANGE INSTRUMENTS	23
3.1 The Importance of Interest Rate.....	24
3.2 The FX Forward Market	25
3.3 Rollovers	26
3.4 FX Transactions	28
3.4.1 Spot Transactions	28
3.4.2 Forward Outright Transactions	30
3.4.3 FX Swaps	31
3.5 Derivatives	32
3.5.1 Synthetic Agreements for Foreign Exchange	34
3.5.2 Currency Futures	34
3.5.3 Currency Swaps	35
3.5.4 Currency Options	35
3.6 Types of Orders.....	37
3.6.1 Market Order	37

3.6.2 Limit, Take-profit and Stop-Loss Orders.....	38
3.6.3 GTC, GFD and OCO Orders.....	39
4 EMPIRICAL ANALYSIS OF SPREAD FOR TWO TYPES OF FX BROKERS ..	40
4.1 Data and Methodology	41
4.2 Bid-ask Spread	43
4.3 Liquidity	56
5 CONCLUSIONS.....	63
REFERENCES.....	67
APPENDICES	71
Appendix A: Spread for Major Currency Pairs.....	72
Appendix B: Spread for Cross Currency Pairs	81
Appendix C: Liquidity Measure (LQM) for Major Currency Pairs.....	90
Appendix D: Liquidity Measure (LQM) for Cross Currency Pairs	99

LIST OF TABLES

Table 2.1	The major U.S. dollar currency pairs	14
Table 2.2	The most actively traded currency pairs	15
Table 3.1	The New York foreign exchange rate	25
Table 3.2	Bid and ask cross rate calculation	29
Table 3.3	Cross rate involved direct and indirect exchange rate	30
Table 3.4	Calculation of forward rate	31
Table 3.5	Rights of holder and writer of option.....	36
Table 4.1	Fixed spread for major currency pairs (in pips)	45
Table 4.2	Fixed spread for cross currency pairs (in pips)	47
Table 4.3	Descriptive statistics for selected major currency pairs spread.....	49
Table 4.4	Descriptive statistics for selected cross currency pairs spread.....	49
Table 4.5	Difference between the fixed spread and the average variable spread for major pairs currency (in pips)	51
Table 4.6	Difference between the fixed spread and the average variable spread for cross pairs currency (in pips)	53
Table 4.7	Test of equality for the variable spread mean	56
Table 4.8	Liquidity (LQR) for selected major currency pairs	59
Table 4.9	Liquidity (LQR) for selected cross currency pairs	59

Table 4.10	<i>t</i> -test result for the equality of LQR mean	61
Table 4.11	Differences between mean of major currency pairs	62

LIST OF FIGURES

Figure 2.1	Forex open market time	10
Figure 2.2	A quotation for EUR/USD	19
Figure 3.1	Global OTC derivatives	33
Figure 4.1	Graphical representation of average variable and fixed spread for various pairs of currency	54

LIST OF ABBREVIATIONS

BIS	Bank for International Settlement
CDS	Credit Default Swap
CFTC	Commodity Futures Trading Commission
CME	Chicago Mercantile Exchange
ERA	Exchange Rate Agreement
FXA	Foreign Exchange Agreement
FOREX	Foreign Exchange Market
FX	Foreign Exchange
GFD	Good For Today
GMT	Greenwich Mean Time
GTC	Good Till Cancelled
ISO	International Standardization Organization
MATIF	Marché à Terme International de France
NFA	National Futures Association
OCO	One Cancel the Other
OTC	Over The Counter
PIP	Percentage In Point
SAFE	Synthetic Agreements for Foreign Exchange
SIMEX	Singapore International Monetary Exchange

Chapter 1

INTRODUCTION

1.1 Background

Trade has existed through ages from the era of barter system to the gold standard epoch of the 19th century. Currently, globalization and technological innovation have made exchange so easy that with a simple click on the computers, trading can be completed regardless of distance. Warady (2010) states that:

The evolution of currency trading can be traced back to the Middle-Ages. It became more pronounced with the wide acceptability of bills of exchange by international merchant bankers. These bills of exchange represented transferable third-party financial instrument, which facilitated both flexibility and growth in the trades that included foreign exchange. Obviously, this bit of currency exchange history is the precursor to the foreign exchange market we know today. (p.1)

Investors are willing to make profit from the difference between buying and selling price of currencies; companies, governments and tourists all exchange currencies to facilitate international transactions. Nowadays, a variety of trade agreements have accelerated globalization, and lowered trade and transaction barriers.

Financial intermediaries such as banks, including central, commercial and investment banks; multinational corporations, partnership businesses, insurance companies, import-export companies, pension funds as well as individuals, commonly trade hard currencies

like the US dollar, Euro, British pound and Yen in the foreign exchange market. Galant and Dolan (2007) state:

Today, global financial and investment flows dominate trade as the primary non-speculative source of foreign exchange market volume. Whether it is an Australian pension fund investing in U.S. Treasury bonds, or a British insurer allocating assets to the Japanese equity market, or a German conglomerate purchasing a Canadian manufacturing facility, each cross-border transaction passes through the foreign exchange market at some stage. (p.7)

1.2 Aim of the study

The outstretch of foreign exchange brokers on accessible trade-networks, self-service electronic exchange transaction systems and real time market traders could make the decision on choice of exchange tough. An important guide when choosing a broker is to seek for a broker that offers the appropriate exchange rate in today's foreign exchange market. Profit making by buying and selling currencies at a net gain price through brokers is one of the trading activities of foreign exchange market and the main objective of this study is to make a comparison between two different types of brokers, namely fixed-spread and variable spread brokers. The thesis tries to compare the bid-ask spread between the two types of brokers and to find out which one offers the lowest spread, measuring the liquidity and cost of trading.

To achieve this, emphasis is placed on the difference between fixed spread versus variable spread. The scope of the analysis includes the most actively traded currencies.

1.3 Methodology, Data and Limitations

To compare the two types of broker, first, exchange rates including buy and sell price is taken from the foreign exchange market for the selected currency pairs traded on the foreign exchange market. Next, the difference between buy and sell prices is calculated. This difference will be compared between the two types of brokers. Then, the results would indicate which type of broker offers the least cost of transaction since the difference between buy and sell price represents the transaction costs. As liquidity is another indicator for the cost of transactions, therefore it will be measured and compared with other actively traded currencies. At the end, *t*-test statistic will be conducted for the liquidity and the spread of the samples.

Actual exchange rates are needed as a sample data for this study. Data is extracted from the foreign exchange market through an online broker¹. Since the interval of exchange rate quotations is thirty minutes, the analysis has been limited to only one week. Getting data from the foreign exchange market every half-hour is not an easy task. Due to this difficulty, the range of analysis is based on weekly data. Indeed, one-week sample is not an acceptable indicator for an analysis; the trends and price movement may vary during the next weeks.

The thesis is structured as follows: Chapter one is the background of study, with statement of problems and objectives of the study. Chapter two is a conceptual perspective on foreign exchange markets, and provides an overview of the market principles and features such as the location and the working hours of these markets.

¹ OANDA fxtrade, www.oadna.com

Chapter three explains some commonly traded foreign exchange instruments including foreign exchange contracts/options, derivatives and types of orders. Chapter four provides a comparative empirical analysis on two types of brokers' spreads in addition to extending a perspective on liquidity measures. The last chapter summarized the results and includes the concluding remarks.

Chapter 2

FOREIGN EXCHANGE MARKET

Markets exist to allow buyers and sellers of goods to execute transactions and exchange their assets. In the case of foreign exchange market, it allows a wide range of different types of buyers and sellers to exchange their currencies. The importance of foreign exchange market should not be underestimated. The FX market determines the price at which currency is bought and sold for a variety of currencies. In fact, there is a lot of jargon surrounding the foreign exchange markets. This chapter sets out to give a clear understanding of how and why this market function. The existence of foreign exchange market refers to a very long time ago. Einzing (1970) states that:

The first foreign exchange markets consisted of meeting-places of money-changers functioning in commercial centers. They were familiar figures in market places and harbors in the Ancient Middle East and Greece, with their tables, scales and weights, displaying a variety of domestic and foreign coins. (p.18)

2.1 What Is Foreign Exchange Market?

The Foreign Exchange Market, also known as FX, FOREX or currency market is the largest financial market for trading currencies in the world. According to the Bank for International Settlements, global foreign exchange market turnover was 20% higher in April 2010 than in April 2007, with an average daily turnover of \$4.0 trillion compared to \$3.3 trillion.

Market participants use the foreign exchange market, as it is commonly known, when they need to convert one currency to another. This conversion is achieved by selling one currency in exchange for another. The relative amounts of each currency are regulated by the foreign exchange rate between the two currencies.

2.2 Why Does Foreign Exchange Market Exist?

According to Reuters Financial Training (1999), foreign exchange market exists as a result of Trade and investment, speculation and hedging. Companies who import or export goods are buying them in one currency and selling them in another. This means they pay out money in one currency and receive money in another. They therefore need to convert some of the money they receive into the currency in which they pay for goods. Similarly, a company that buys an asset in a foreign currency has to pay for it in the local currency, and so will need to convert its home currency to the local foreign currency.

The FX rate between two currencies varies in line with the relative supply and demand for the two currencies. Traders can make profits buying a currency at one rate and selling it at a more favorable rate. Speculation makes up by far the largest proportion of trading in the FX markets and provides liquidity.

Companies who have assets in foreign countries are exposed to the risk of these assets varying in value in their home currency due to fluctuations in the FX rate between the two relevant currencies. While the foreign assets may retain the same value over time in the foreign currency, they produce profit or loss in the company's domestic currency if

the FX rate changes. Companies can eliminate these potential profits or losses by hedging. This involves executing an FX transaction that will exactly offset the profit or loss of the foreign asset caused by changes in the FX rate.

2.3 Where Is the Location of Foreign Exchange Market?

Unlike the other financial markets, there is no any specific physical location where traders get together to exchange their currencies. Transactions are conducted through internet, telephone lines and the network systems among banks. Since FX transaction is traded over-the-counter, there are many market places for foreign exchange market.

2.4 Who Uses Foreign Exchange Market?

According to Reuters Financial Training (1999), traders, Commercial and Investment Bank, Central Banks, Corporate Customers and Brokers are considered as FX users. Although FX traders buy and sell currencies, most importantly they induce price. The FX trader who is quoting is a market-maker; he is 'making a market'. The FX trader who dealing on a price quoted is a market-taker. Traders can be both market-makers and market-takers if they provide prices to the market as well as deal on prices quoted to them. The majority of FX trading is conducted by these banks whose traders 'make' the market through continuous interbank trading. Most of the trading is for speculation or hedging. However, these banks also provide foreign exchange services for their corporate customers. Banks like the US Federal Reserve and the Bank of England use FX to manage reserves and intervene to keep the market place normal. Many organizations who import or export goods and services require FX for trade and investment. They also need to minimize their exchange risk. Brokers act as intermediaries between counterparties, matching buying and selling orders, the

counterparties remain anonymous to each other until the deal is struck. Brokers know which dealer has the highest bid (buying) price and which has the lowest ask (selling) price. Brokers do not hold a position but earn their income from the commission they charge on deals or the spread between bid and ask price.

2.5 Characteristics of FX Market

A number of advantages have made the foreign exchange market a unique market in compared to the other financial markets. Unlike other financial markets, trading is continuous 24 hours a day with the exception of weekends.

Extremely high market liquidity is another advantage of foreign exchange market. That is because trading volume in the FX market makes this market the largest in the world. The possibility of making profit with price movement either up or down is exclusive. The term 'short sale' is used in the stock market when the traders is willing to take advantage of a decrease in the price of stock, however, traders need to pay a percentage of fee as a premium. However in the foreign exchange market, this trade strategy can be used without any additional fee. The use of leverage adds another advantage to the foreign exchange market. It also increases profit and loss margins according to the trader's account size.

The trading commission is zero for the most of the brokers. Generally, the cost of transactions is insignificant in compared to the other financial markets. Almost all of the FX brokers provide a practice account or demo account for newcomers to the foreign

exchange market. This account is usually opened free of charge. Last but not least, the access to the FX market is fast and easy and users can trade from anywhere in the world.

2.6 When Is FOREX Market Open for Trading?

Foreign exchange market is a 24-hour market, as one financial center closes, another is still open for trading. In fact, working hours overlap around the world. In other words, the FX market acts like the sun over the earth. Figure 2.1 illustrates the open market times for the FX market. Galant and Dolan (2007) state that:

There is no officially designated starting time to the trading day or week, but for all intents the market action kicks off when Wellington, New Zealand, the first financial center west of the international dateline, opens on Monday morning local time. Depending on whether daylight saving time is in effect in trader's own time zone, it roughly corresponds to early Sunday afternoon in North America, Sunday evening in Europe, and very early Monday morning in Asia. (p.9)

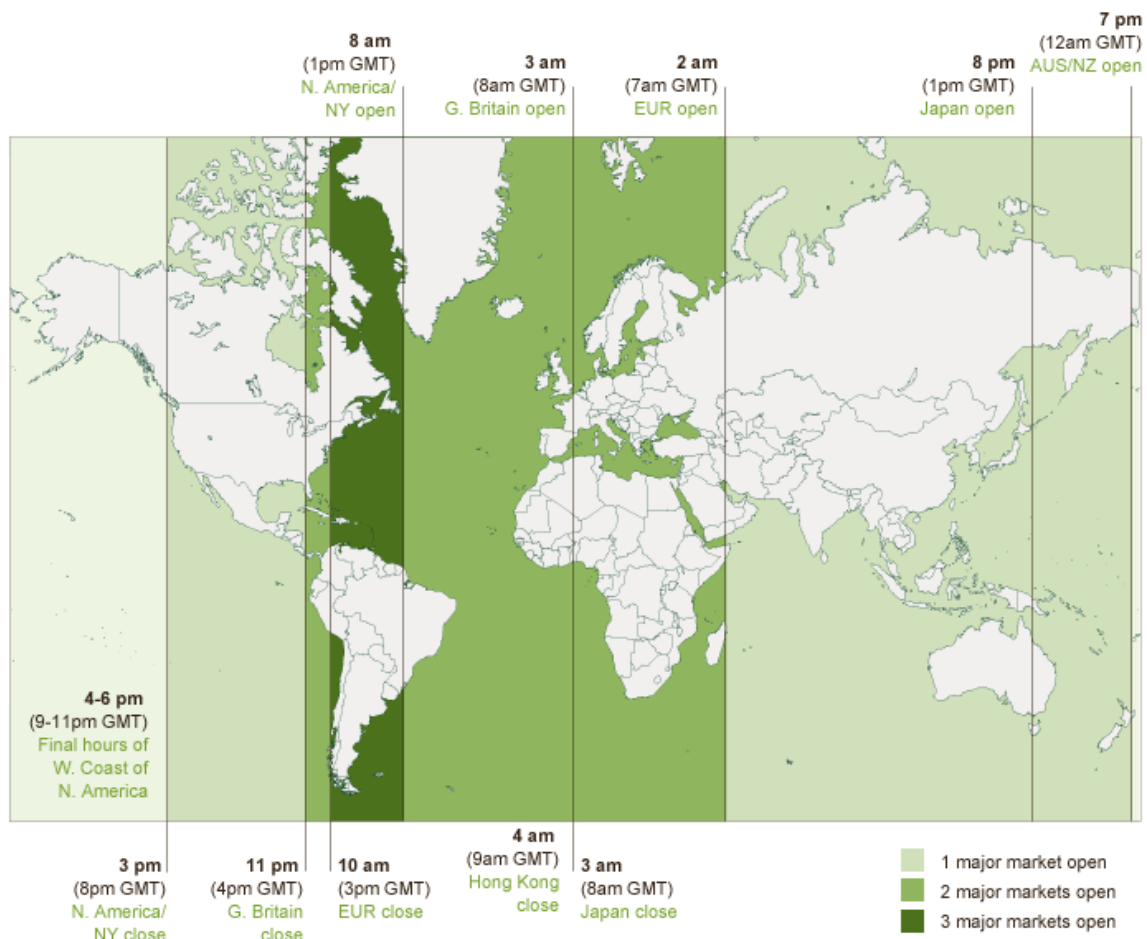


Figure 2.1 Forex open market time

Source: High Yield Kiosk link (hykl.net)

The Sunday open represents the starting point where currency markets resume trading after the Friday close of trading in North America (5 p.m. Eastern time). This is the first chance for the forex market to react to news and events that may have happened over the weekend. Prices may have closed New York trading at one level, but depending on the circumstances, they may start trading at different levels at the Sunday open. (p.10)

2.7 Trading Sessions

Foreign exchange market is open for trading from 20:15 GMT on Sunday in Asia-Pacific and it will be closed 22:00 GMT on Friday. FX trading is divided into the following sessions.

2.7.1 Asia-Pacific Session

According to Galant and Dolan (2007), “currency trading volumes in the Asia-Pacific session account for about 21 percent of total daily global volume” (p.6). New Zealand, Australia, Japan, Hong Kong and Singapore are the major financial trading centers in Pacific Asia. That is to say, data reports and news from New Zealand, Australia and Japan as the most actively traded currency pairs, have an important role in the FX market in this session.

Due to Japanese market size and its significant role in the FX market, a big amount of Asia-Pacific session is focused on the Japanese news and data reports, Japanese currency pairs U.S dollar/Japanese yen, Canada/Japanese yen, Euro/Japanese yen, Australian dollar/Japanese yen and New Zealand dollar/Japanese yen. Additionally, it is important to study Japanese financial institutions since they are active during this session.

Almost half of the trading session in Asia overlaps the opening of the financial centers in Europe. According to Galant and Dolan (2007), “European financial centers and London account for over 50 percent of total daily global trading volume, with London alone accounting for about one-third of total daily global volume” (p.10). Half of the trading session in Asia is intersected with the half of trading in North America. At this time, the market liquidity is absolutely high.

2.7.2 European Session

Data reports and news from Europe including countries such as the United Kingdom, Switzerland, France, Germany and Italy are released in the early morning hours of the European session. Consequently, the most active trading and movements takes place in the European currencies and the euro cross currency pairs such as EUR/GBP and EUR/CHF. Asian trading centers gradually begin to close in the late morning hours of the European session, and North American markets come in hours later.

2.7.3 North American Session

There is an overlap between European and North American session. As a result, trading activity becomes more considerable. Many of the price movements occur during this session. Galant and Dolan (2007) mention “the North American trading session accounts for roughly the same share of global trading volume as the Asia-Pacific market, or about 22 percent of global daily trading volume” (p.11).

Some of the most important decisions for U.S dollar value are made at 8:30 a.m. Eastern time of U.S. when data and news are released in the North America. Some of these data is released one or two hours later. Additionally, Canadian news and data are also released during this time. European financial institutes usually begin to close their operation around noon Eastern time. As London and European market close, the volatility can be generated in British and European currency pairs. Pacifico (2007) states:

On most days, market liquidity and interest fall off significantly in the New York afternoon, which can make for challenging trading conditions. On quiet days, the generally lower market interest typically leads to stagnating price action. On more active days, where prices may have moved more significantly, the lower liquidity can spark additional outsized price movements, as fewer traders

scramble to get similarly fewer prices and liquidity. Just as with the London close, there's never a set way in which a New York afternoon market move plays out, so traders just need to be aware that lower liquidity conditions tend to prevail, and adapt accordingly. (p.18)

2.8 The Mechanics of Currency Trading

The foreign exchange market has a specific trading behavior. The mechanism might take some time to get accustomed especially for new traders. However, most FX trade behavior is straightforward, especially at the end of the day. In fact, some new FX traders especially those who are familiar with other markets such as stock market face some problems. For instance, an investor buys 1000 shares of Apple Inc., he or she owns 1000 shares and predict the increase in price. When he or she wants to close the position, he or she sells the shares bought earlier. However, in the FX market, the purchase of one currency involves the sale of another currency exactly at the same time. That is to say, if a trader predicts an increase in Euro, the question is "Increase against which currency?" Another currency such as U.S. dollar or Japanese yen would be the answer. Therefore, if Euro goes up against Yen, Yen also goes down against Euro. The same thing takes place in the stock market. When a trader buys a stock, he or she sells cash and vice versa.

Consequently, currency trading always deals with currency pairs that combine two currencies. Each currency has been assigned a nickname and abbreviation. International Standardization Organization (ISO) labels codes for each currency. Currency pairs that includes U.S. dollar are referred as major pair currencies. Table 2.1 lists the *major currency pairs* in addition to the countries, name and nickname.

Table 2.1 The major U.S. dollar currency pairs

Currency Pairs	Countries	Name	Nickname
EUR/USD	Euro/U.S.	Euro-dollar	N/A
USD/JPY	U.S./Japan	Dollar-yen	Gopher
GBP/USD	United Kingdom/U.S.	Sterling-dollar	Sterling or Cable
USD/CHF	U.S./Switzerland	Dollar-Swiss	Swissy
USD/CAD	U.S./Canada	Dollar-Canada	Loonie
AUD/USD	Australia/U.S.	Australian-dollar	Aussie or Oz
NZD/USD	New Zealand/U.S.	New Zealand-dollar	Kiwi

Source: International Standardization organization (www.iso.org)

Not only most of the FX trading occur in the U.S. dollar pairs, but also cross currency pairs are considered as an alternative of the U.S. dollar. Cross currency pairs are those that does not include the U.S. dollar. Cross currency pairs help FX users to directly tailor their trade for specific currencies according to the news and data release.

For example, trader research might present the Australian dollar has the worst forecast of all the major currencies in a certain period, based on interest rates or the economic situation. In order to use this information to make profit, the trader wish to sell AUD, as mentioned earlier, it must be in pair. For example, the trader considering U.S. dollar, should buy USD/AUD, which means buy USD and sell AUD at the same time. If USD turns out to be as worst as AUD, what would the trader do?

Additional analysis may suggest that another currency economically and politically

looks better, let us take Japanese yen as an example. In this case, trader would buy the pair JPY/AUD, that means buying Japanese yen and selling Australian dollar. Therefore, the trader would be better off by finding a cross pair that best suit him or her.

The most actively traded cross currency pairs is the currency pairs that involve EUR, JPY and GBP. They are called Euro crosses, yen crosses, and sterling crosses. Table 2.2 lists the most actively traded cross pairs in addition to the countries and the market names.

Table 2.2 The most actively traded cross pairs

Currency Pairs	Countries	Market Name
EUR/CHF	Eurozone/Switzerland	Euro-Swiss
EUR/GBP	Eurozone/United Kingdom	Euro-sterling
CAD/JPY	Canada/Japan	Canada-yen
EUR/JPY	Eurozone/Japan	Euro-yen
GBP/JPY	United Kingdom /Japan	Sterling-yen
AUD/JPY	Australia/Japan	Australian-yen
NZD/JPY	New Zealand/Japan	New Zealand-yen

Source: International Standardization organization (www.iso.org)

2.8.1 Base and Counter Currencies

Currency pairs are combined in an out of the ordinary order. For example, although Euro-dollar (EUR/USD) is a U.S. dollar cross, why not it is quoted as Dollar-euro (USD/EUR)? Galant and Dolan (2007) answer this question: “These quoting

conventions evolved over the years to reflect traditionally strong currencies versus traditionally weak currencies, with the strong currency coming first.” (p.18)

Additionally, this behavior indicates the base currency, which is the first currency in the pair. When a currency pair is bought, actually, the base currency is bought. For example, if 1,000 NZD/USD is bought, 1,000 New Zealand dollar have just been bought and 1,000 lots have been sold in U.S. dollar. If 50,000 CAD/JPY is sold, 50,000 Canadian dollars have been sold and 50,000 Japanese yen have been bought.

The denomination of the currency pair is called counter currency. Counter currency is very important for the foreign exchange traders since their profit and loss is in the counter currency. The example explains this statement further. If a trader buys EUR/CHF, he or she makes profit on condition that it rises, his or her profits are not in Euros, and actually they are in Swiss francs.

2.8.2 Long and Short Positions

Like in other financial markets, positioning is used in the foreign exchange market. In the FX trading, buying and selling take place simultaneously, and it might be confusing. A market position in which a trader buys a security is referred to a long position. In the foreign exchange market, buying a currency pair is considered a long position. Traders with a long position expect the exchange rate to go up; therefore, they sell the currency pair at a higher price than they bought before. For a long position to be closed, trader has to sell the underlying currency pair. If a trader with a long position buys currency pairs at the different price, he adds to longs and gets longer.

Conversely, a market position is referred to a short position in which a trader sells a security that she or he never holds. In the stock market, short sell requires borrowing the stock and paying a fee to the broker in order to sell the stock. Unlike stock market, in the foreign exchange market, short position is as normal as long position. In the FX market, it refers to simply selling a currency pair by selling the base currency and buying the counter currency. Going short or getting short is an exchange in the opposite way. Traders with short position expect the market price to move lower, therefore, they buy currency pairs that sold before with a lower price and make profit. If a trader with a short position sells currency pairs at the different price, he adds to shorts and gets shorter. Galant and Dolan (2007) state that:

Currency pair rates reflect relative values between two currencies and not an absolute price of a single stock or commodity. Because currencies can fall or rise relative to each other, both in medium and long-term trends and minute-to-minute fluctuations, currency pair prices are as likely to be going down at any moment as they are up. To take advantage of such moves, forex traders routinely use short positions to exploit falling currency prices. Traders from other markets may feel uncomfortable with short selling. (p.20)

If a trader has no position in the market, he or she is referred to a term 'square' or 'flat'. Moreover, closing an open position is called 'squaring up'. FX traders with short position are likely to buy in order to square up. However, traders with long positions need to sell to square up. Squared-up traders are not concerned with the financial risk in the market.

2.8.3 Currency Quotes

In this section, it is explained that what does price quotation mean and how FX brokers show the price of currencies. It should be considered that different online brokers have a

different trading platform and as a result the currency prices might be quoted in a different way.

In the foreign exchange market two prices for each currency pair are displayed on the FX trading platform. The left side price is called bid and the right side price is called ask or offer. However, some brokers show the bid price on the top of the ask price. The bid price is the price at which the market maker or the actual entity on the other side of the trade would buy the base currency and therefore the rate at which the client could sell. The ask price is the price at which a market maker would sell the base currency and therefore the rate at which the client could buy. The bid price is always lower than the ask price. According to Melvin (2004) each price quotation has two parts: “the big figure and the dealing price. The big figure refers to the first three digits of the overall currency rate and is usually shown in a smaller font size or even in shadow. The dealing price refers to the last two digits of the overall currency price and is brightly displayed in a larger font size” (p.60). Bickford (2005) states:

A percentage in point or pip is the smallest commonly quoted change of an exchange rate of a currency pair. The major currencies, except the Japanese yen, are priced to four decimal places. For these currencies a pip is one unit of the fourth decimal point, or 1/100th of one percent. For the Japanese yen, a pip refers to one unit in the second decimal point, because the yen is much closer in value to one hundredth of other major currencies. (p.36)

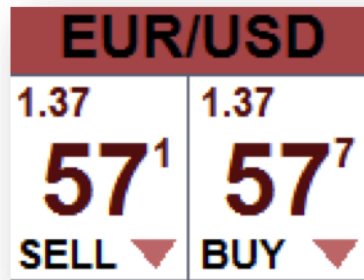


Figure 2.2 A quotation for EUR/USD

Source: OANDA.com

Figure 2.2 shows price quotation for EUR/USD from an online FX broker. The 1.37 is the big figure and is displayed smaller. The 57 is the dealing price and is displayed bigger. Most brokers use five decimal in their platform; however, others may show four decimal price quotations. In Figure 2.1, five digits is quoted, and the dealing price is 571 and 577 for EUR/USD.

2.8.4 Spread

The difference between the rate at which the bid can be sold and the rate at which the ask can be bought or simply the different between the bid and ask price is referred as ‘Spread’. In Figure 2.1, the EUR/USD spread is 0.6 pips. Most FX brokers use spread-base trading system; however, those that use commission-base trading system, add the commission to the spread.

Indeed, different brokers have different spreads. Additionally, spreads vary among currency pairs. As a general rule, liquid currency pairs have a smaller spread; conversely, the less liquid currency pairs have a wider spread. The less active traded currency pairs are less liquid and have a wide spread. According to O'Hara (1995), "liquid currency pairs have a lower transaction costs and they are less volatile" (p.2).

The spread is a measure of the liquidity and the cost of transactions. The zero bid-ask spread does not exist since there is no transaction cost for buying and selling the underlying asset. Chapter four will conduct further research and empirical analysis on the bid-ask spread and the liquidity.

2.8.5 Trading Platforms

Traders connect to brokers through Internet to execute their transactions. For this connection, a platform that provides the information and send the orders to brokers is required. A variety of platforms have been designed since the beginning of the FX trade through Internet. One of the most important platforms that banks, investment institutions, hedging funds and individual traders are using is Currenex. The new version of this platform called Currenex Viking has been recently supplied and it enjoys high popularity in the foreign exchange market. Bloomberg, Reuters, FXCM and virtual trading are the other common platform. One of the most popular platforms among the foreign exchange brokers is Meta trader from Metaquotes, a Russian company. These platforms have been altered through years and the user-friendly factor has also been improved compared to the primary versions.

2.8.6 Regulations

Regulations are one of the important factors that must be considered in order to trade in the foreign exchange market. Egan (2005) states that:

The leverage on a standard trade is a breathtaking 100 to 1. That means a customer who puts up \$1,000 controls 100 times that, or \$100,000. Despite the sky-high leverage that makes forex trading risky, regulation of the industry is limited. Trading desks worldwide deal in an over-the-counter market linked by computers and the Internet. Transactions are completed largely on trust and consummated with an electronic handshake. Daily turnover is estimated at 20 times the value of equities traded on the world's stock exchanges. No international body regulates this global commerce. (pp.1-2)

The regulatory environment in the foreign exchange market is different from that of the stock market. Because the foreign exchange market is relatively new, its regulations are still developing gradually in some countries, while it does not exist in some countries.

Traders can evaluate the regulatory environment of any country by comparing it with the U.S brokerage firm regulations. In the United States of America, the retail forex market currently falls under Commodity Futures Trading Commission or CFTC with the passing of commodity modernization act in 2000. The industry body that currently enforces the law set by the CFTC is the National Futures Association or NFA.

The capital that brokers maintain is important because unlike in the stock and futures market if the FX broker goes bankrupt, trader's account is not protected under the current regulations. Latest financial stability figures of FX brokers in the U.S can be checked on a website. This helps FX traders to check the situation of the FX brokers before they choosing a foreign exchange broker.

Net capital requirement or required liquid assets is set by the CFTC in the U.S and it was recently raised to 20 million USD for the foreign exchange brokers. If the firm's liquid assets drop below this amount the CFTC will step in and shut the firm down in order to

protect FX client funds. Traders can ensure for the non-U.S brokerage firm in the same way in order to protect their funds.

Chapter 3

FOREIGN EXCHANGE INSTRUMENTS

As has been mentioned in Chapter 2, foreign exchange market is operated over-the-counter (OTC) with 24 hour trading worldwide. Reuters Financial Training (1999) define foreign exchange deal as “A contract to exchange one currency for another at an agreed rate on a specific delivery date” (p.49). They also state the principal components of a deal as follows: Trade date, counterparty, currencies, exchange rate, amounts, value date and payment instructions. In order to enter into a contract within foreign exchange market, traders need to use an appropriate financial instrument. According to Cecchetti (2008), “a financial instrument is the written legal obligation of one party to transfer something of value, usually money, to another party at some future date, under certain condition” (p.41).

Among all financial instruments, forwards and futures are the simplest and easiest to use. “A forward, or forward contract, is an agreement between a buyer and a seller to exchange a commodity of financial instrument for a specified amount of cash on a prearranged future date” (p.198). Forward contracts are private agreements and the customized nature of the forward contracts has made it difficult to resell them to someone else. In contrast, “a future, or futures contract, is a forward contract that has been standardized and sold through an organized exchange” (p.198). Future contracts

specify that the seller (who has the short position) will deliver a specified quantity of a commodity or currency to the buyer (who has the long position) on a specific date, called settlement date, for a predetermined price. At the time of the agreement, no payment is made. The seller benefits if the price of underlying asset decreases, while the buyer benefits from the increase of the price of that asset. In foreign exchange market, any transaction type imposes a specified period for delivery of currencies and hence, the traders are supposed to pay attention to the interest rate within such delivery period.

3.1 The Importance of Interest Rate

FX traders always wish to increase the profit. Speculation in the currency trading as an investment opportunity has some determinants. One of the important elements of an investment is the real rate of return. Reuters Financial Training (1999) defined the following equation for the currency trading.

$$\textit{Real rate of return} = \textit{Interest rate} - \textit{Perceived rate of inflation} \quad (3.1)$$

Money circulates usually in the countries that real rate of return is at the high level. A possible way to attract capital to the country is to have relatively high interest rates. Potetial higher rate of return attracts foreign investor and increases the demand for local currency, as a result, the value of the exchange rate of local currency appreciate. Central banks attract foreign capital by raising interest rate, in fact, real rate of return in the local economy increases. In contrary, decrease of interest rate leads an outflow of capital. Inflow and outflow of capital make the local currency stronger or weaker. Change of interest rate by central bank affects the foreign exchange rate in the local economy. The

difference between interest rate of two currencies is called interest rate differential and it is traded on special market called FX forward market.

3.2 The FX Forward Market

According to Melvin (2004), “the forward exchange market refers to buying and selling currencies to be delivered at a future date” (p.70). Table 3.1 indicates forward exchange rate in different maturities for selected currencies.

Table 3.1 The New York foreign exchange rate quoted at 16:00 ET on January 31, 2003

Country (Currency)	U.S. \$ equivalent	Currency per U.S. \$
Australia (Dollar)	0.5875	1.7021
Britain (Pound)	1.6472	0.6071
1 Month Forward	1.6438	0.6083
3 Months Forward	1.6365	0.6111
6 Months Forward	1.6268	0.6147
Canada (Dollar)	0.6572	1.5216
1 Month Forward	0.6564	1.5232
3 Months Forward	0.6545	1.5279
6 Months Forward	0.6514	1.5352
Japan (Yen)	0.008341	119.89
1 Month Forward	0.008349	119.77
3 Months Forward	0.008369	119.49
6 Months Forward	0.008396	119.10
New Zealand (Dollar)	0.5448	1.8355
Switzerland (Franc)	0.7332	1.3639
1 Month Forward	0.7336	1.3631
3 Months Forward	0.7346	1.3613
6 Months Forward	0.7360	1.3587

Source: International Money and Finance

As an example, in order to buy Canadian dollar for delivery in 180 days, it costs 0.6514 per Canadian dollar. Melvin (2004) states:

If the forward exchange price of currency exceeds the current spot price, that currency is said to be selling at a forward premium. A currency is selling at a forward discount when the forward rate is less than the current spot rate. In the

event that the spot and forward rates are equal, the currency is said to be flat.
(p.71)

According to Table 3.1, Japanese yen is selling at premium; however, Pound Sterling is selling at a discount.

3.3 Rollovers

According to Galant and Dolan (2007), “one market convention unique to currencies is rollovers. Rollovers represent the intersection of interest-rate markets and forex markets” (p.20). What is actually traded in forex market is a contract that requires one currency to be exchanged for another and deliver in two business days. For example if a trader buy one contract of EUR/JPY, he or she is buying 100,000 Euros and selling the equivalent amount of Japanese yen. This technically requires trader to deliver the equivalent amount of Japanese yen portion of the trade to the bank account of the party that he or she is trading with. The party that the trader is dealing with is therefore technically required to deliver 100,000 Euro portion of the trade to trader’s bank account within two business days.

As some trader is trading simply for speculation, they do not need physical delivery of the currency. Hence, forex broker automatically rolls the position over to the next delivery day if the position is held after 5 p.m. Eastern time of the U.S. There is U.S. dollar debit or credit made to the trader’s account depending on whether trader has an open long or short position to account for the interest portion of the transaction. As most other transaction which involve holding or borrowing money, trading currencies also involves an interest payment or credit depending on whether trader is a holder of currency or a borrower of a currency. For instance, if a trader buys one contract of

USD/JPY, which means buying U.S. dollar and selling Japanese yen, he or she earns interest on U.S. dollar that has been bought and pays interest on Japanese yen that has been sold in order to buy the U.S. dollars. The reason for this is when trader sells a currency; he or she is borrowing that currency and then exchanges the borrowed currency for the equivalent amount of currency that is buying. The interest that traders pay and receive is two-days' worth of interest derived from the overnight interest rates of the countries whose currencies are traded. Federal Reserve sets overnight interest rate in United States for U.S. dollar and central banks in the other countries throughout the world set the overnight interest rate for their currencies.

Rollover rates are deemed according to interest rate differential of the two currencies involved in the transaction. For instance, if a trader buys a currency with the higher interest rate and sells the currency with the lower interest rate, he or she will earn money for holding this position after 5 p.m. when rollover occurs because the interest rate differential is in trader's favor. Having considered USD/JPY in the example above, assume overnight interest rate in United States is 2.5% and overnight interest rate in Japan is 0.5%, buying USD/JPY means earn 2.5% on U.S. dollar and pay 0.5% on Japanese yen. In this case, the interest rate differential is +1.75%, which is favorable for the trader if he or she hold this position after 5 p.m. Conversely, by selling USD/JPY, trader pay 2.5% on U.S. dollar and earn 0.5% on Japanese yen. In this case, the interest rate differential is -1.75%, which is against the trader. Rollovers are affected by the amount of the difference between interest rates of two currencies, therefore, the higher difference implies the higher rollover effect and vice versa.

3.4 FX Transactions

Foreign exchange market is the largest market in the world with an average daily turnover of \$4.0 trillion. This turnover involves spot transaction, forward outright and FX swaps. Spot transaction is an exchange of currency with delivery of two business days after trade date. Forward outright transaction refers to an exchange rate which is agreed to buy or sell currencies at a date in future. Traders can be protected against loss of adverse movements of exchange rate. FX swaps are the combination of both spot and forward at the same time. As a result, forward outright transactions and FX swaps involve future dates for the currency exchange.

Most foreign exchange deals involved U.S dollar, in case of an exchange rate not involving the U.S. dollar, say EUR/GBP, a cross rate is calculated by buying U.S. dollar with Euro and selling the U.S. dollar for Pound sterling. The three types of FX transaction that shortly mentioned in this section are spot transactions, forward outright transactions and FX swaps. Spot transactions are divided to major pair currencies and cross pair currencies.

3.4.1 Spot Transactions

Foreign exchange market involves spot traders, which concentrate on specific currency pairs such as EUR/USD and USD/JPY. Generally, most FX transactions were done on the spot with delivery of two business days, which is the time that banks can settle the deal giving both side of the deal time to complete settlement details. There are some limitations such as time difference between two parties or a holiday in one of the country that decelerate the settlement arrangement. Despite the fact that technology has

accelerated the transaction speed, most of the spot transactions are delivered in two business days after the date of trade called value date.

In fact, an exchange rate between two currencies excluding the U.S. dollar is a cross rate. The dollar rate does not appear in the final cross rate, however, it is actually used in the calculation and it is useful to know. For example, suppose someone is in Switzerland on the way to Canada and needs to convert Swiss franc to Canadian dollar. He is supposed to use the exchange rate of CAD/CHF. Theoretically, he needs to do two things. First, buy U.S. dollar with his Swiss franc at the ask price, then, buy Canadian dollar with his U.S. dollar at the bid price. CAD/CHF will be the consequence. Table 3.2 presents the calculation of bid and asks cross rates for dollar rates against currency pairs. B1 and B2 are the bid rate for currency 1 and 2, A1 and A2 are the ask rate for currency 1 and 2.

Table 3.2 Bid and ask cross rates calculation

Currency pairs	Bid	Ask
USD/Currency 1	B1	A1
USD/Currency 2	B2	A2
Cross rates	Bid	Ask
Currency 1/Currency 2	$\frac{B2}{A1}$	$\frac{A2}{B1}$
Currency 2/Currency 1	$\frac{B1}{A2}$	$\frac{A1}{B2}$

Source: The Reuters financial training series

Table 3.3 shows the scenario in which an indirect and a direct exchange rate are included in the cross rate. In this case, bid and ask rates are multiplied in order to calculate the rates.

Table 3.3 Cross rate involved direct and indirect exchange rate

Currency pairs	Bid	Ask
Currency 1/USD	B1	A1
USD/Currency 2	B2	A2
Cross rates	Bid	Ask
Currency 1/Currency 2	$B1*B2$	$A1*A2$

Source: The Reuters financial training series

3.4.2 Forward Outright Transactions

A forward outright foreign exchange transaction is a non-negotiable deal, which is traded OTC. Reuters Financial Training (1999) define it as follows: “a forward outright FX transaction is an FX deal between two counterparties in which one currency is bought in exchange for another at a rate which is agreed today, for delivery at an agreed future date” (p.90). Forward outright transactions are agreements between a bank and a client. Funds are not exchanged until the delivery date. The forward rate is different from the spot rate and it is not a prediction of spot rate in the future. Forward price is quoted for 1, 2, 3, 6 and 12 months maturity. However, customers need a specific maturity other than these may get price from a bank for a different maturity. This is called a broken date rate.

To obtain the forward rate from the exchange rate, forward points must be added to or subtracted from the spot rate. Table 3.4 indicates whether to add or subtract the forward points.

Table 3.4 Calculation of forward rate

Forward points	Base currency trading	Forward rate
Greater value first high	at a discount	Spot minus forward point
Smaller value first low	at a premium	Spot plus forward point

Source: The Reuters financial training series (1999, p.90)

3.4.3 FX Swaps

FX swaps are traded OTC and they cover a considerable majority of FX transactions. According to Reuters Financial Training (1999), an FX swap can be defined as “an FX deal, which involves the simultaneous purchase and sale of a specified amount of one currency in exchange for another for two different value dates” (p.91). FX swaps have two value date which is called legs, at the time exchange of fund take places. Swaps are divided into three main types, that is, spot against forward, forward against forward and short dates.

In spot against forward, the first exchange or first leg occurs on the spot date which is two business days after the transaction, and second leg occurs in the forward date, say, 6 months after spot transaction.

In forward against forward, first leg occurs on the forward date and second leg on a later forward date which is called forward forward date. For instance, the first leg of forward against forward is begun 1 month after spot transaction and the second leg is begun three months after spot transaction. This is referred to 1 x 3 forward forward swap.

Short dates are swaps in which first and second leg have maturity less than one month. For instance, the first leg can be spot and the second leg may be occurs 10 days after spot.

3.5 Derivatives

Derivatives can either increase the expected profit and the risk exposure, or hedge traders' position if used accurately. Traders come to agreements that they normally would not accept without derivatives. Additionally, derivatives act as insurance and play an important role in foreign exchange market. Hetamsaria (2005) states:

The history of derivatives is surprisingly longer than what most people think. Some texts even find the existence of the characteristics of derivative contracts in incidents of Mahabharata. Traces of derivative contracts can even be found in incidents that date back to the ages before Jesus Christ. The first 'futures' contracts can be traced to the Yodoya rice market in Osaka, Japan around 1650. These were evidently standardized contracts, which made them much like today's futures. (p.1)

According to Cecchetti (2008), “a derivative is a financial instrument whose value is derived from the value of some other financial instrument, called the underlying asset” (p.196). These underlying assets can be stocks or stock market indices, agricultural products or in our case, foreign exchange rates. An example of derivative in foreign exchange market is an agreement between two parties that obligates one to pay the other

depending on the movement in exchange rate in a currency pairs in the next 6 months. Derivatives can be used as a risk management tool while it can be used to speculate.

According to the Bank for International Settlements “after an increase of only 3% in the second half of 2010, total *notional amounts outstanding* of over-the-counter (OTC) derivatives rose by 18% in the first half of 2011, reaching \$708 trillion by the end of June 2011”.

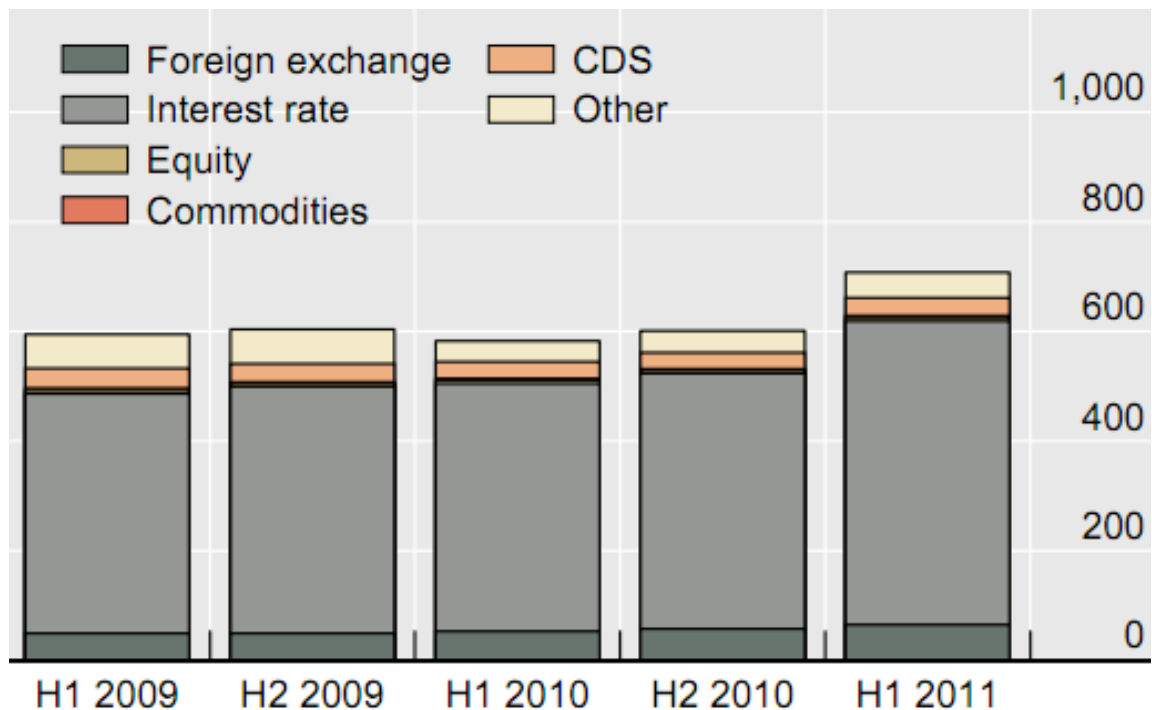


Figure 3.1 Global OTC derivatives

Source: Central banks of the G10 countries and Switzerland; BIS

Figure 3.1 indicates “after an increase of only 3% in the second half (H2) of 2010, total notional amounts outstanding of over-the-counter (OTC) derivatives rose by 18% in the

first half (H1) of 2011, reaching \$708 trillion by the end of June 2011, Notional amounts outstanding of credit default swaps (CDS) grew by 8%, while outstanding equity-linked contracts went up by 21%” (Kleist, 2011, p.1).

Although the principle of FX derivative instruments is covered in the previous section, FX derivative instruments is divided in the following sections:

3.5.1 Synthetic Agreements for Foreign Exchange

Foreign Exchange Agreements (FXAs) and Exchange Rate Agreements (ERAs) are used to lock-in forward FX differentials. FXA is where settlement is based on the forward rate on the start date of the contract and spot rate at settlement differential. However, ERA is based on two forward rates instead of forward and spot rate. Synthetic Agreements for Foreign Exchange or SAFEs, which is the collective name of FXA and ERA are OTC derivatives that perform similar role for forward FX as ERAs do for short-term interest rates, that is guarantee exchange rates for a fixed period commencing in the future. (Reuters Financial Training, 1999, pp.283-284)

3.5.2 Currency Futures

A contract that sets an agreement between two currencies on the specified exchange rate for a predetermined date in the future is called currency future contract. This contract as a risk management tool, allows FX traders to buy or sell a future contract against direction of an existing commitment in the market. That is, profits or losses in the transaction are offset with profits or losses in the future market. Reuters Financial Training (1999) define currency future contracts as follows:

These are forward transactions with standard contract sizes and maturity dates which are traded on a formal exchange. The contract is a binding obligation to buy or sell one currency against another at an agreed rate of exchange for a future delivery date. (p.93)

Chicago Mercantile Exchange (CME), Singapore International Monetary Exchange (SIMEX), and Marché á Terme International de France (MATIF) are example of exchanges that trade currency futures.

3.5.3 Currency Swaps

An agreement between two parties to swap interest rate payments of a foreign currency loan is called currency swap. The nature of currency swap agreements is OTC and it allows both side of the agreement to offset the effects of foreign exchange movements in the determined foreign currency. Reuters Financial Training (1999) define currency future contracts as follows:

An agreement between counterparties in which one party makes interest payments in one currency and the other party makes interest payments in a different currency on agreed future dates until maturity of the agreement. (p.94)

The principle of currency swaps is similar to interest rate swaps except that in currency swap, there are two different currencies.

3.5.4 Currency Options

Currency options have a similar principle as interest rate option. An agreement that gives the holder the right to buy or sell a specified amount of currency at a fixed price at a time in the future is called currency option contract. This contract gives the holder the right to buy or sell, not the obligation. Table 3.5 illustrates the rights and obligation of option.

Table 3.5 Rights of holder and writer of option

Who	Call	Put
Buyer or Holder	Right to buy	Right to sell
Seller or Writer	Obligation to sell if the buyer or holder decides to buy	Obligation to buy if the buyer or holder decides to sell

Source: The Reuters financial training series (1999, p.95)

According to Bodie et al. (2009), “a call option gives its holder the right to purchase an asset for a specified price, called the exercise, or strike, price, on or before some specified expiration date (p.672). The holder of this contract chooses whether to exercise depending on market price movements. Therefore, the option might be remain unexercised. In order to purchase this contract, buyer must make a payment to the writer of the contract. This purchase price is called premium. Bodie et al. (2009) state “A put option gives its holder the right to sell an asset for a specified exercise or strike price on or before some expiration date” (p.673). In order to use this definition in foreign currency options, Bodie et al. (2009) state: “a currency option offers the right to buy or sell a quantity of foreign currency for a specified amount of domestic currency” (p.677). Foreign currency options are quoted in fraction of unit of foreign currency.

Option contracts are normally quoted in two different styles; American and European style. Holders of the American style options may exercise the contract on or before the expiry date, however, the holders of European style options are supposed to exercise the option only on the exact date of expiry.

When an exchange rate movement is against trader's position, currency options as insurance can save the trader from losses. Currency options play an important role in the foreign exchange market.

3.6 Types of Orders

A wide variety of order types are offered by the FX brokers. Orders provide traders a significant flexibility and security in order to manage their positions. Traders can better manage the risk of FX trade and take advantage of the orders by placing an order such as 'take profit' or 'stop loss' and walk away from their computers. By utilizing the different order types, positions are protected from adverse market price movements and traders can limit the potential losses. This section explains the types of orders that exist in the foreign exchange market. It is important for traders to know which type of orders can best suits their trade according to their trading style.

3.6.1 Market Order

Market order is used to buy or sell positions. This order is executed immediately when placed and always get filled. Market order has a disadvantage, which is the lack of control on where this order is filled. When a market order is placed, it will turn to an open position and in the case that price movement is against the trader, it leads to an unrealized loss. Prices in the forex market are changing rapidly and because of this nature the executed price might differ from the last price displayed on the platform. This is called 'slippage'. Slippage might be an advantage for traders or it may work against the trader.

3.6.2 Limit, Take-profit and Stop-Loss Orders

Limit order is an order for buying or selling of currency pairs with a condition set by the traders. Simply, this order limits the maximum price for buying and the minimum price for selling. Unlike the market order, limit order does not always get filled. It will get filled at the price below the order number in case of buying transactions and for the selling transactions, it will get filled at the price above the order. This order is remained pending until the exchange rate reaches a certain level. Pending order might be eliminated without any consequences. For instance, a trader predicts EUR/USD is likely to begin an upswing, by entering a limit buy order at a price higher than the market price, a buy order is executed if the price goes up. Hence, stop-loss order helps FX traders to keep the cost of transaction as low as possible.

Take-profit order is mainly used to maintain profits at the times traders are not able to trade in order to keep their profit. Take-profit order close an open position when the price reaches the certain level that trader defined. For instance, a trader with a long position in NZD/USD at the exchange rate of 0.82859 wish to make profit when the exchange rate reaches 0.82900, the trader can submit the take-profit order and if the market price reaches 0.82900 as the trader predicted, the position will be automatically closed.

Stop-loss order acts the opposite of the take-profit order. Stop-loss order is used as a defensive instrument to close the position when the market is working against the trader. A stop-loss closes a long position if the market price breaks below the specified level and it closes a short position when the price moves above the certain level. For example,

a trader with a long position in USD/CAD at the rate of 1.02921, would submit a stop-loss order at the exchange rate of 1.02700, the position will be automatically closed when the exchange rate reaches 1.02700, therefore the trader is able to restrict the losses. The term 'stopped out' is used by FX traders to describe the position that is closed by the stop-loss order.

3.6.3 GTC, GFD and OCO Orders

'Good till cancelled' or GTC is a type of limit order. It stays as pending until the price limit is reached. GTC orders are not expired by the FX brokers unless the traders physically cancel it. 'Good for day' or GFD order works the same as GTC except that it is effective until the end of the business day. If the limit is not reached, the broker will automatically cancel it at the end of the day.

The last type of order is 'one cancel the other' or OCO order. This order is a combination of two limit orders, either a limit order and stop-loss order or a buy limit order and sell limit order. One of the orders will be canceled once the other one is executed. This order is used in case profit order and stop-loss order are submitted and it is useful when traders are unsure about the direction of the market price.

In fact, there might be more complex types of orders in the foreign exchange market. The orders outlined in this chapter are the major order that FX brokers usually offers. Moreover, different platforms allow the traders to customize orders that suit client needs.

Chapter 4

EMPIRICAL ANALYSIS OF SPREAD FOR TWO TYPES OF FX BROKERS

Foreign exchange activities involve the service of various currency brokers. With so many FX brokers to choose from, it may be a difficult bargaining especially for inexperienced traders to find the ideal broker who can offer the ideal service at a low spread. Market research and comparative study on different currency brokers can contribute to an effective trading decision. For market research, it is important to assess the industry regulation, financial stability and security, transaction costs (including bid-ask spreads and commissions); currency pairs, initial deposit, leverage and margin, forex trading platform, and customer support. Transaction costs can have significant impact on the trader's returns.

Unlike the stock trading which has an organized market, foreign exchange are commonly traded over the counter, making transaction costs vary from one broker to another. Most FX brokers do not charge commission but if there is an organized system that charges commission, then the FX brokers will include that commission in their bid-ask spread for each currency pairs traded. This forms the competitive edge for the brokers as some brokers would always shift the full burden of unorganized regulation to

FX users. In this case, it becomes even more difficult task for FX traders to choose which spread creates a net benefit to the exchange users.

It is expected that fixed spread brokers should offer a lower cost, otherwise traders would be better off dealing with variable spread brokers. The perspective here is that fixed spread brokers take less risk of changing spreads between bid and ask price, giving a riskless fixed spread to the traders. The riskless assumption is not a general one as there are opposing views which have argued for variable bid-ask spreads as more appropriate for traders because the variable spread is much less than the fixed spread in the currency pairs. Moreover, some traders are doubtful in choosing currency pairs which can maximize their trading position. One of the factors considered in choosing a proper currency pair for trade is liquidity. Liquidity indicates the traders which currency pairs are more stable within a short period of time.

This chapter aims to show some empirical evidence of the bid-ask spread relevance in trading decision by comparing the two types of FX brokers; fixed and variable system. At the end, the result shows which type of broker regime offers the lowest spread and cost for the period analyzed. In addition, the liquidity of the selected currency pairs will be jointly analyzed.

4.1 Data and Methodology

For comparing different types of brokers and different currency pairs' liquidity, the market exchange rate is needed. Exchange rates are obtained from OANDA website², a

² www.oanda.com

forex brokerage firm that provides variable spreads for different pair of currencies. Bid and ask prices are extracted from graphs on the trading platform. Bid-ask spreads are then calculated and will be compared with the fixed bid-ask spread system. Samples are measured on an interval basis of 30 minutes for 24 hours through the working days of the week. Having real-time data extracted manually from graphs each half an hour is not an easy task. Because of this, we consider a sample for a week period, covering time from 21:00GMT, 18th September 2011 to midnight of 24th September 2011. Data is entered into the spreadsheet and all the exchange rates are revised afterwards in order to avoid mistakes. Fourteen currency pairs including seven major currencies and seven cross currency pairs are considered. Most traded cross currency pairs are selected as our sample for the purpose of this study and fourteen fixed bid-ask spread data are collected from fourteen well-known brokers from official websites providing the fixed bid-ask spread data. Liquidity is measured for each selected currency pairs in our sample. Finally, the *t*-test statistic for the significance of difference in the mean values are conducted and analyzed appropriately to show reliability of inferences that would be made based on the sample.

There are only a limited number of currencies traded on the FX market. Among them are those considered economically and politically stable, we refer to these sets of currencies as liquid currencies; mostly used to denominate the economic value of tradable goods and services, and show the net position of an economy. Generally, there are eight currencies mostly traded in the FX market, namely U.S dollar (USD), Canadian dollar (CAD), British pound (GBP), Euro (EUR), Swiss franc (CHF), Japanese yen (JPY), Australian dollar (AUD) and New Zealand dollar (NZD). Since currency must be in

pairs, there are mathematically twenty-seven currency pairs. Seven currencies against U.S dollar is considered as major currency pairs and of the remaining twenty pairs, EUR/GBP and EUR/CHF, in addition to CAD/JPY, GBP/JPY, EUR/JPY, AUD/JPY, and NZD/JPY pairs are selected as the most actively traded currency pairs in the foreign exchange market.

4.2 Bid-ask Spread

It is very important to understand how FX brokers price their spreads. One of the key factors to be considered when choosing a broker is the spread. Bid-ask spread is an indicator of the trading cost as well as liquidity. In terms of bid-ask spread, there are two primary types of FX brokers in the market as stated before; brokers that offer a fixed bid-ask spread and the brokers that offer a variable bid-ask spread. The question here is which type of these two brokers offers the lower bid-ask spread? Empirical answer(s) will be provided in this chapter as we make a comparative analysis of these two types of brokers for the period that is analyzed.

We recall that fixed spreads are determined by the FX brokers and it remains the same throughout the opening hours of the foreign exchange market regardless of what happens in the market. This spread type allows the trader to know what kind of strategy to adopt. Strategies are chosen without predicting market variability during certain time and lessen riskiness of currency volatility. Table 4.1 shows major pairs and spread in pips offered by the fixed spread brokers. Table 4.2 also shows the most traded cross pair spreads. In fact, brokers providing fixed spread filter the actual bid and ask price in the market. Therefore, each trade may take place without containing exactly the same spread

in the market. If the spread is lower than what they offer, they make profit by keeping the difference and if the spread is higher in the market, they make a net loss in the spot market. Table 4.1 and Table 4.2 show the fixed ask-bid spread for currency pairs under different forex brokers.

Table 4.1 Fixed Spreads for Major Currency Pairs (in pips)

Forex Broker	EUR/USD	GBP/USD	USD/JPY	USD/CHF	USD/CAD	AUD/USD	NZD/USD
4XP	3	4	3	4	5	4	5
ACM	2.8	2.8	2.8	2.8	4	3	4
Easy-Forex	2	3	2	3	3	3	4
Forex-Metal	2	3	2	3	4	4	4
ForexYard	3	4	3	4	4	4	4
FXGM	4	4	4	4	4	4	4
InstaForex	3	3	3	3	3	3	3
LiteForex	3	3	3	3	3	3	3
Masterforex	2	3	2	3	4	3	5
MF Global	1.9	3.5	1.8	4	4	3	4.5
N2 Capital Markets	3	3	3	3	7	6	6
Real Trade Group	1.5	2	1.5	2.5	2.5	2	3.5
Solidity Brokers	2.6	3.5	2.7	3.7	4.7	3.7	4.7
XForex	3	4	3	4	4	5	5

Source: www.100forexbrokers.com

Our selected fixed spread brokers offer bid-ask spread for major pairs from the lowest, which is 1.5 pip for EUR/USD to the highest bid-ask spread, which is 4.7 pips for NZD/USD.

Table 4.2 Fixed Spreads for Cross Currency Pairs (in pips)

Forex Broker	EUR/JPY	GBP/JPY	AUD/JPY	CAD/JPY	NZD/JPY	EUR/GBP	EUR/CHF
4XP	4	8	6	7	8	3	4
ACM	3	8	6	5	6	2	3.4
Easy-Forex	2	6	7	6	8	3	3
Forex-Metal	4	8	6	10	7	3	3
ForexYard	4	6	6	8	8	4	4
FXGM	4	12	6	7	10	4	4
InstaForex	3	7	10	10	10	3	3
LiteForex	3	7	4	9	14	3	4
Masterforex	3	7	6	6	10	5	4
MF Global	2.6	4.9	3.5	5	4.5	3	3
N2 Capital Market	3	9	5	5	8	5	5
Real Trade Group	3	6	3.5	-	6	1.6	2.5
Solidity Brokers	3.7	7.7	5.7	6.7	7.7	4.7	3.7
XForex	3	7	6	6	12	3	4

Source: www.100forexbrokers.com

These brokers offer considerably wider bid-ask spread for cross currency pairs compared to the major currency pairs. The lowest spread is 1.6 pip for EUR/GBP while the highest is 14 pips which is belong to NZD/JPY.

Variable spread is the difference between the buy and sell price of currencies which changes over a period of time. It can be wider than fixed spread at particular times especially during the volatile market periods. The spread tends to be low during the normal condition of the market because of reduced speculation and volatility. In case of variable spread it is very difficult to predict exchange rate movement when new fiscal and monetary policies are announced. Variable spread brokers provide an actual currency bid and ask price from the foreign exchange market. It is difficult to choose a strategy and predict the market condition in case of variable spread while fixed spread is clear all the times.

In order to have a comparison between fixed spread and variable FX brokers, actual bid and ask prices have been captured from OANDA FX broker that offers variable spread. Appendix A shows the bid-ask spread for major currency pairs, simply the difference between bid price and ask price (Ask-Bid; where Ask>Bid). Appendix B shows the bid-ask spread for cross currency pairs. Table 4.3 and 4.4 show the descriptive statistics for the selected currency pairs.

Table 4.3 Descriptive Statistics for Selected Major Currency Pairs spread (21:00 GMT: 18/09 to 24/09/11)

	EUR/USD	GBP/USD	USD/JPY	USD/CHF	USD/CAD	AUD/USD	NZD/USD
Maximum	0.00200	0.00200	0.20000	0.00150	0.00300	0.00100	0.00200
Minimum	0.00002	0.00019	0.00900	0.00021	0.00012	0.00017	0.00022
Average	0.00020	0.00032	0.01600	0.00039	0.00031	0.00024	0.00036
Median	0.00014	0.00025	0.01100	0.00034	0.00024	0.00019	0.00029
Std. dev.	0.00023	0.00025	0.01800	0.00019	0.00025	0.00017	0.00024

Table 4.4 Descriptive Statistics for Selected Cross Currency Pairs spread (21:00 GMT: 18/09 to 24/09/11)

	EUR/JPY	GBP/JPY	AUD/JPY	CAD/JPY	NZD/JPY	EUR/GBP	EUR/CHF
Maximum	0.20000	0.25000	0.20000	0.30000	0.44200	0.00100	0.00250
Minimum	0.00500	0.02500	0.01000	0.02300	0.02600	0.00011	0.00025
Average	0.03000	0.04300	0.02900	0.03300	0.04800	0.00019	0.00049
Median	0.02300	0.03100	0.02200	0.02800	0.03200	0.00012	0.00042
Std. dev.	0.02427	0.03545	0.02546	0.02353	0.06637	0.00020	0.00026

As shown in Appendices A and B, during certain times, variable bid-ask spread is higher than the fixed bid-ask spread. This is most common during announcement periods. From Table 4.5 and Table 4.6, the average of the spreads shows that variable spread is less than the fixed. Changes in the spread mainly depend on time and currency. For example, when market is closed in New Zealand and Japan, the cross pair NZD/JPY has the

widest spread although at the same time the major pair EUD/USD is mostly traded and it has a spread as low as possible. Generally, spreads are wide at overnight and during weekend. Sometimes, release of data and market event such as Federal authority speeches and interest rate of central bank announcement cause the spread to be wide for a while. To have a better comparison between fixed and variable spread, standard deviation is used in order not to consider times that spread is wide due to special market event. Because of this fact, median is lower than average and considerably lower compared to fixed spread. Table 4.5 and 4.6 show the differences between fixed spread and average variable spread for selected brokers.

Table 4.5 Difference between the Fixed Spread and the Average Variable Spread for Major Pairs Currency (in pips)

	EUR/USD	GBP/USD	USD/JPY	USD/CHF	USD/CAD	AUD/USD	NZD/USD
4XP	1	0.8	1.4	0.1	1.9	1.6	1.4
ACM	0.8	-0.4	1.2	-1.1	0.9	0.6	0.4
Easy-Forex	0	-0.2	0.4	-0.9	-0.1	0.6	0.4
Forex-Metal	0	-0.2	0.4	-0.9	0.9	1.6	0.4
ForexYard	1	0.8	1.4	0.1	0.9	1.6	0.4
FXGM	2	0.8	2.4	0.1	0.9	1.6	0.4
InstaForex	1	-0.2	1.4	-0.9	-0.1	0.6	-0.6
LiteForex	1	-0.2	1.4	-0.9	-0.1	0.6	-0.6
Masterforex	0	-0.2	0.4	-0.9	0.9	0.6	1.4
MF Global	-0.1	0.3	0.2	0.1	0.9	0.6	0.9
N2 Capital Markets	1	-0.2	1.4	-0.9	3.9	3.6	2.4
Real Trade Group	-0.5	-1.2	-0.1	-1.4	-0.6	-0.4	-0.1
Solidity Brokers	0.6	0.3	1.1	-0.2	1.6	1.3	1.1
XForex	1	0.8	1.4	0.1	0.9	2.6	1.4

Table 4.6 Difference between the Fixed Spread and the Average Variable Spread for Cross Pairs Currency (in pips)

	EUR/JPY	GBP/JPY	AUD/JPY	CAD/JPY	NZD/JPY	EUR/GBP	EUR/CHF
4XP	1	3.7	3.1	3.7	3.2	1.1	-0.9
ACM	0	3.7	3.1	1.7	1.2	0.1	-1.5
Easy-Forex	-1	1.7	4.1	2.7	3.2	1.1	-1.9
Forex-Metal	1	3.7	3.1	6.7	2.2	1.1	-1.9
ForexYard	1	1.7	3.1	4.7	3.2	2.1	-0.9
FXGM	1	7.7	3.1	3.7	5.2	2.1	-0.9
InstaForex	0	2.7	7.1	6.7	5.2	1.1	-1.9
LiteForex	0	2.7	1.1	5.7	9.2	1.1	-0.9
Masterforex	0	2.7	3.1	2.7	5.2	3.1	-0.9
MF Global	-0.4	0.6	0.6	1.7	-0.3	1.1	-1.9
N2 Capital Markets	0	4.7	2.1	1.7	3.2	3.1	0.1
Real Trade Group	0	1.7	0.6	-	1.2	-0.3	-2.4
Solidity Brokers	0.7	3.4	2.8	3.4	2.9	2.8	-1.2
XForex	0	2.7	3.1	2.7	7.2	1.1	-0.9

As the difference is calculated as (fixed spread – variable spread) in Tables 4.5 and 4.6, therefore positive numbers show fixed spreads are higher than variable spreads. 70 out of 98 positive values indicate most of the fixed spreads are higher than the variable spread in major pairs currency.

From the cross pairs currency, 81 out of 97 data are positive. An easy look at the tables above suggests most of these negative outcomes are related to the pair EUR/CHF and USD/CHF.

Analyzing our results for both Table 4.5 and 4.6, we can say that variable spreads tend to be lower than the fixed spread and as a result, trading with FX brokers that offers variable spread is possibly the least cost platform for the period investigated as shown in Figure 4.1.

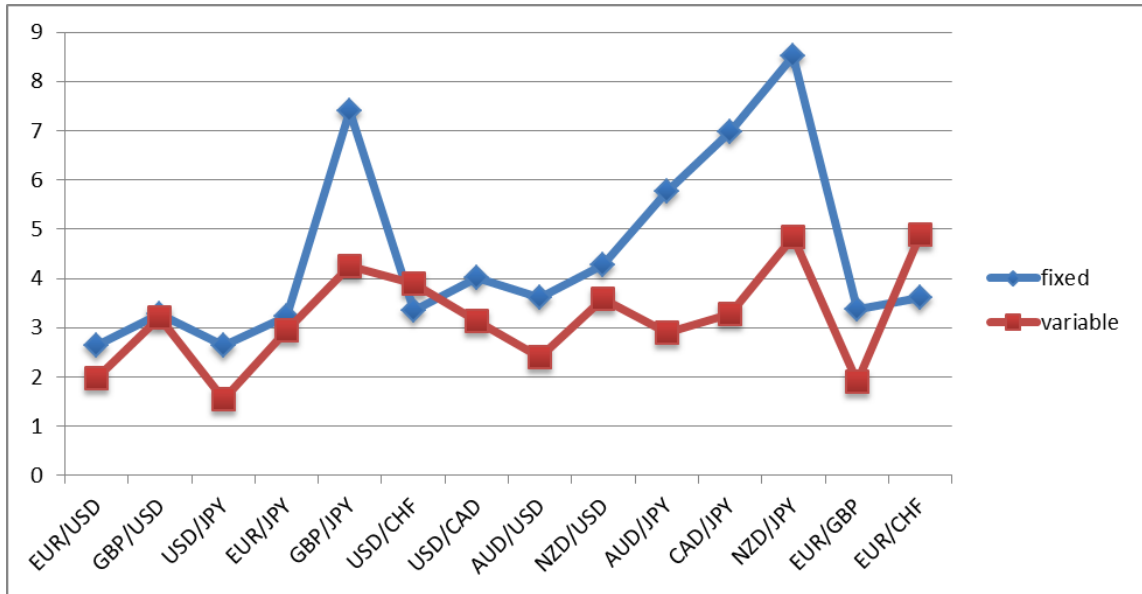


Figure 4.1 Graphical representation of average variable and fixed spread for various pairs of currency (21:00 GMT: 18/09 to 24/09/11)

Some analysts have argued in support of fixed spread brokers as a better trading platform than variable spreads because they offer fixed and clear bid-ask spread with minimum cost risk of trading in the FX market (See Cheung and Wong, 2000; Danielson and Payne, 2002). This might be true only in certain times that variable brokers widen the spread due to some data release and seasoned announcements. The cross trading has a strong case in support of our initial proposition that the variable spread platform offers least cost and better incentive for trading, this would depend on the choice of fixed spread FX broker and choice of currency pair. Trading in CHF/... pairs might give least cost of transaction if we take a fixed spread platform as result shows below average performance of the currency under variable spread position.

Table 4.7 presents the t -test results for the equality of mean variable spread for major and cross currency pairs. This test which is referred as t -test, is used to determine whether two sets of sample, say, EUR/USD and GBP/USD are likely to have come from the same two underlying value that have the same mean. T-test is performed with a two-sample unequal variance test. The numbers show the t -test results conducted by E-views program and the numbers in bracket shows the t -test probability for the equality of mean.

Table 4.7 T-test results for the equality of mean variable spread

	EUR/USD	GBP/USD	USD/JPY	EUR/JPY	GBP/JPY	USD/CHF	USD/CAD	AUD/USD	NZD/USD	AUD/JPY	CAD/JPY	NZD/JPY	EUR/GBP	EUR/CHF
EUR/USD	0.000 (1.000)													
GBP/USD	-5.690 (0.000)	0.000 (1.000)												
USD/JPY	-12.857 (0.000)	-12.753 (0.000)	0.000 (1.000)											
EUR/JPY	-18.816 (0.000)	-18.736 (0.000)	-7.120 (0.000)	0.000 (1.000)										
GBP/JPY	-18.628 (0.000)	-18.574 (0.000)	-10.526 (0.000)	-4.740 (0.000)	0.000 (1.000)									
USD/CHF	-9.843 (0.000)	-3.357 (0.001)	12.697 (0.000)	18.694 (0.000)	18.545 (0.000)	0.000 (1.000)								
USD/CAD	-5.310 (0.000)	0.330 (0.741)	12.759 (0.000)	18.741 (0.000)	18.577 (0.000)	3.696 (0.000)	0.000 (1.000)							
AUD/USD	-2.351 (0.019)	4.138 (0.000)	12.821 (0.000)	18.788 (0.000)	18.609 (0.000)	8.847 (0.000)	3.720 (0.000)	0.000 (1.000)						
NZD/USD	-7.541 (0.000)	-1.702 (0.089)	12.722 (0.000)	18.712 (0.000)	18.558 (0.000)	1.525 (0.128)	-2.026 (0.043)	-6.211 (0.000)	0.000 (1.000)					
AUD/JPY	-17.638 (0.000)	-17.562 (0.000)	-6.662 (0.000)	0.217 (0.828)	4.841 (0.000)	-17.521 (0.000)	-17.567 (0.000)	-17.611 (0.000)	-17.539 (0.000)	0.000 (1.000)				
CAD/JPY	-21.575 (0.000)	-21.494 (0.000)	-8.957 (0.000)	-1.504 (0.133)	3.591 (0.000)	-21.449 (0.000)	-21.498 (0.000)	-21.547 (0.000)	-21.469 (0.000)	-1.688 (0.092)	0.000 (1.000)			
NZD/JPY	-11.326 (0.000)	-11.297 (0.000)	-7.438 (0.000)	-4.174 (0.000)	-1.213 (0.226)	-11.282 (0.000)	-11.299 (0.000)	-11.316 (0.000)	-11.289 (0.000)	-4.257 (0.000)	-3.466 (0.001)	0.000 (1.000)		
EUR/GBP	0.378 (0.705)	6.410 (0.000)	12.863 (0.000)	18.821 (0.000)	18.632 (0.000)	11.046 (0.000)	5.999 (0.000)	2.995 (0.003)	8.402 (0.000)	17.642 (0.000)	21.581 (0.000)	11.328 (0.000)	0.000 (1.000)	
EUR/CHF	-13.208 (0.000)	-7.436 (0.000)	12.611 (0.000)	18.628 (0.000)	18.500 (0.000)	-4.956 (0.000)	-7.713 (0.000)	-12.582 (0.000)	-5.886 (0.000)	17.458 (0.000)	21.381 (0.000)	11.258 (0.000)	-14.353 (0.000)	0.000 (1.000)

The mean variable spread between the currency pairs are mostly statistically different from each other except for EUR/USD against EUR/GBP, GBP/USD against USD/CAD, EUR/JPY against AUD/JPY, EUR/JPY against CAD/JPY, GBP/JPY against NZD/JPY and USD/CHF against NZD/USD.

4.3 Liquidity

A comprehensive analysis of FX trading often needs financial ratios to show the short term marketability of currencies. Currencies with higher demand for economic transactions are more traded. In this section, liquidity ratio will be used to compare currency pairs under the variable spread FX trading, with samples taking for period 21:00GMT: 18/09 to 24/09/11. The term “liquidity” is used enormously in the financial markets due to its important role in showing short term position of a trader. Currencies like other financial assets have some pairs that are very liquid and some not so liquid. Liquidity refers to sell the currency pairs quickly and convert it to cash with a minimum loss. According to Bjornes (2005), “provision of liquidity is important for well-functioning asset markets. Still, the liquidity of the foreign exchange market, perhaps the most important financial market, is a black box.” (p.20)

Depending on the trading style, it is essential to know which currency pairs is the most liquid. Liquid currencies are from countries that have economically and politically stable situation. Generally, liquidity is negatively correlated with the bid-ask spread, meaning that the tightest bid-ask spread provides the highest liquidity and illiquid currency pairs have wider bid-ask spreads.

Ding and Hiltrop (2010) noted that through the mid-1990s, the foreign exchange market was primarily reliant on phone-based technology. They assume that liquidity should increase in FX market as a result of electronic broking services. In currency trading, liquid currencies are highly demanded in sufficient quantities. In fact, online brokers have accelerated the act of finding demand and supply of the liquid currencies. Since the phone technology was limited, traders usually worked with their local brokers, whereas nowadays, geographically differences have been reduced due to online brokers that offer financial services.

Liquidity (LQR) is measured for the selected currency pairs in this section according to equation 4.1.

$$Liquidity = \frac{ask - bid}{\left(\frac{ask + bid}{2}\right)} \quad (4.1)$$

Appendix C presents liquidity of major currency pairs measured with equation 4.1 and appendix D shows the liquidity measured for the most traded currency pairs. Table 4.8 and 4.9 show the descriptive statistical data for the liquidity (LQR) of major currency pairs and cross currency pairs.

Table 4.8 Liquidity (LQR) for Selected Major Currency Pairs (2100GMT: 18/09 to 24/09/11)

	EUR/USD	GBP/USD	USD/JPY	USD/CHF	USD/CAD	AUD/USD	NZD/USD
Maximum	0.00036	0.00032	0.00065	0.00042	0.00075	0.00026	0.00060
Minimum	0.00000	0.00003	0.00003	0.00006	0.00003	0.00004	0.00007
Average	0.00004	0.00005	0.00005	0.00011	0.00008	0.00006	0.00011
Median	0.00003	0.00004	0.00004	0.00010	0.00006	0.00005	0.00009

Table 4.9 Liquidity (LQR) for Selected Cross Currency Pairs (2100GMT: 18/09 to 24/09/11)

	EUR/JPY	GBP/JPY	AUD/JPY	CAD/JPY	NZD/JPY	EUR/GBP	EUR/CHF
Maximum	0.00047	0.00052	0.00063	0.00098	0.00173	0.00029	0.00052
Minimum	0.00001	0.00005	0.00003	0.00007	0.00011	0.00003	0.00005
Average	0.00007	0.00009	0.00009	0.00011	0.00020	0.00005	0.00010
Median	0.00006	0.00006	0.00007	0.00009	0.00013	0.00003	0.00009

The average numbers indicate that the pair EUR/USD with 0.4 pips is the most liquid currency pair; followed by GBP/USD, USD/JPY, and EUR/GBP with average of 0.5 pips for each pair. This is not surprising as international goods are mainly traded in these currencies, making the turnover for these currency pairs high (stable value and high demand). On the other hand, NZD/JPY, NZD/USD, USD/CHF and CAD/JPY are the

most illiquid pairs in the selected currency pairs, with NZD/JPY averaging 2 pips and others having about 1.1 pips.

In order to test for the equality of mean, *t*-test has been conducted for only major pairs currencies. Table 4.10 shows the *t*-test results for the equality of mean, and additionally, the numbers in bracket shows the *t*-test probability with two-tailed distributions for unequal variance data set for major pair currencies. The probability result in bold indicate statistically insignificant difference between the LQR means.

Table 4.10 T-test result for the equality of LQR mean

	EUR/USD	GBP/USD	USD/JPY	USD/CHF	USD/CAD	AUD/USD	NZD/USD
EUR/USD	0.000 (1.000)						
GBP/USD	4.103 (0.000)	0.000 (1.000)					
USD/JPY	3.047 (0.002)	0.163 (0.871)	0.000 (1.000)				
USD/CHF	16.364 (0.000)	13.314 (0.000)	11.107 (0.000)	0.000 (1.000)			
USD/CAD	8.654 (0.000)	5.661 (0.000)	4.937 (0.000)	5.701 (0.000)	0.000 (1.000)		
AUD/USD	6.098 (0.000)	2.255 (0.025)	1.923 (0.055)	10.997 (0.000)	3.788 (0.000)	0.000 (1.000)	
NZD/USD	13.851 (0.000)	11.253 (0.000)	9.946 (0.000)	0.409 (0.683)	5.315 (0.000)	9.461 (0.000)	0.000 (1.000)

Table 4.11 shows the difference between major currency pairs. This table is based on the difference between rows (X) and columns (Y) as (X-Y), for example, the difference of mean between EUR/USD and GBP/USD, which is calculated as EUR/USD - GBP/USD, is (-0.00002), this number is negative since the mean of GBP/USD is greater than mean of EUR/USD.

Table 4.11 Differences between mean of major currency pairs

	EUR/USD	GBP/USD	USD/JPY	USD/CHF	USD/CAD	AUD/USD
EUR/USD	0.00000					
GBP/USD	-0.00002	0.00000				
USD/JPY	-0.00001	0.00000	0.00000			
USD/CHF	-0.00007	-0.00006	-0.00006	0.00000		
USD/CAD	-0.00004	-0.00003	-0.00003	0.00003	0.00000	
AUD/USD	-0.00002	-0.00001	-0.00001	0.00005	0.00002	0.00000
NZD/USD	-0.00007	-0.00006	-0.00006	0.00000	-0.00003	-0.00005

Tables 4.10 and 4.11 suggest that EUR/USD is the most liquid currency pairs among the major pairs currencies because statistically significant. Table 4.11 shows that the major pairs USD/CHF and NZD/USD against EUR/USD have the highest difference in mean. However, GBP/USD and USD/JPY have an equal mean and there is no difference between them in terms of mean. USD/JPY against EUR/USD in addition to AUD/USD against both GBP/USD and USD/JPY have the lowest difference in mean. GBP/USD against USD/JPY is statistically not significant because the probability is more than 10%. GBP/USD against the other major currency pairs is the most liquid currency pairs because the difference shows the negative number and the probability is all zero and in case of AUD/USD it is 2%, which is very close to zero. USD/JPY is the most liquid among USD/CHF, USD/CAD, AUD/USD and NZD/USD currency pairs because the difference of USD/JPY from the other is zero and the probability is all zero except

AUD/USD, which has a 6% probability. USD/CHF is less liquid against USD/CAD and AUD/USD and it is statistically not significant relative to NZD/USD currency pairs since its probability is 68%, which is far more than 10%. As it can be seen from table 4.6 the difference between USD/CHF and both USD/CAD and AUD/USD are positive value that proves USD/CAD and AUD/USD are more liquid than USD/CHF. USD/CAD is more liquid than NZD/USD and less liquid than AUD/USD since the difference between USD/CAD and NZD/USD is a negative number and it is positive number in case of USD/CAD and AUD/USD. Finally, the difference between AUD/USD and NZD/USD is negative; as a result AUD/USD is considered more liquid than NZD/USD.

Chapter 5

CONCLUSIONS

Foreign exchange market is a very large market with over \$4 trillion turnover daily, yet it is a decentralized financial market with numerous traders. The existence of many brokers in this market makes the decision of choosing the right exchange and broker difficult. For traders, an important guide in choosing a broker is to seek for the one that offers the best exchange bid-ask prices which would maximize the trading gains. Conventionally, we have identified two main types of FX brokers, those that offer a fixed spread and those that offer variable spread on currency exchange.

This study attempts to review the process of currency trading, and makes a comparison of the fixed and variable bid-ask spread patterns offered by FX brokers. In addition to currency liquidity feature, the type of spread offered by the FX brokers have a significant role on the cost of transaction; a wider bid-ask spread implies higher transaction costs for the traders.

To investigate the efficiency of trading based on the fixed and variable bid-ask spread methods offered by FX brokers, half-hourly daily sets of currency exchange data was generated from FX trading platform for a period of one week, covering time from 21:00GMT, 18th September 2011 to midnight of 24th September 2011, making it a total of 244 observations. Fourteen currency pairs including seven major currencies pairs and

seven cross currency pairs were considered. Also, fixed bid-ask spread data were collected for fourteen currency pairs from various brokers' websites. From the data collected, we computed the Liquidity ratio (LQR) for each pair of currency in our sample data.

Using test of equality, the *t*-test was used to check for consistency among the means of the currency pairs. The average variable spreads are then compared with their corresponding currency pair fixed spread.

Based on our empirical investigation, we have been able to establish that on average, variable spread brokers tend to have a bid-ask spread lower than the spread of fixed brokers. However, some currency pairs show that the fixed spread brokers have lower spread than the variable spread brokers, as in the case of EUR/CHF and USD/CHF. The implication of this in FX trading is that, risk of volatile bid-ask price of currencies is returned with lower cost of transaction under the variable spread system. In other words, there is a risk incentive for trading with a variable spread broker. Following this finding, we can infer that risk lovers are better-off under the variable spread trading with lower cost of transaction but uncertain future benefit, whereas the risk averse trader would be more satisfied trading with fixed spread brokers since they are concerned with predictable future of their trading position.

In addition to the type of broker traders choose to transact with, another determining factor of cost of placing orders (as synonymous with the bid-ask spread) have been identified as the liquidity feature of currency pairs. The liquidity feature of currency

pairs comes from the speed of turnover of the pair. If a currency has high demand, we expect that the rate of turnover will be high and lower cost of transaction would be meaningful following the inverse relationship between price and demand volume of the currency in the FX market. From our finding, the currency pairs with the USD are most liquid. EUR/USD is the most liquid of all the pairs chosen followed by GBP/USD and USD/JPY. This is because internationally traded goods and services are exchanged mainly in USD and EUR. We also found that, the most uncommonly traded currency pair is the NZD/JPY based on our sample.

Under this study, we test for the statistical significance of liquidity as a determinant of cost of placing an order. This tells us that the more illiquid a currency pair is, the higher the cost of transaction. Additionally, descriptive statistics results show that the major currency pairs are expected to cost less than the cross currency pairs based on our sample.

Also, we identify that choosing between fixed and variable spread brokers would depend on the risk taking characteristic of the trader, liquidity of currency, and purpose of trading. Another important factor that determines choice of trading is seasoned announcements and speculations on economic uncertainty of the 'large' countries. For instance, if we foresee possible economic downturn in the USA, we would expect that the value of USD might fall against other currencies and so, demand for USD may drop.

This would make the liquidity of currency pairs with USD drop too, with cost of trading USD falling as well. In this case, it would be more efficient trading with brokers that offer variable spreads.

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APPENDICES

Appendix A: Spread for Major Currency Pairs

Date and Time	EUR/USD	GBP/USD	USD/JPY	USD/CHF	USD/CAD	AUD/USD	NZD/USD
09/18 21:00	0.00200	0.00200	0.200	0.00100	0.00100	0.00100	0.00200
09/18 21:30	0.00100	0.00200	0.060	0.00100	0.00100	0.00100	0.00150
09/18 22:00	0.00080	0.00100	0.060	0.00100	0.00100	0.00100	0.00150
09/18 22:30	0.00100	0.00100	0.060	0.00100	0.00100	0.00100	0.00150
09/18 23:00	0.00100	0.00100	0.060	0.00100	0.00100	0.00100	0.00150
09/18 23:30	0.00063	0.00100	0.060	0.00100	0.00100	0.00100	0.00120
09/19 0:00	0.00040	0.00100	0.030	0.00100	0.00100	0.00040	0.00120
09/19 0:30	0.00036	0.00050	0.020	0.00050	0.00050	0.00036	0.00050
09/19 1:00	0.00017	0.00050	0.020	0.00050	0.00050	0.00030	0.00050
09/19 1:30	0.00014	0.00035	0.011	0.00030	0.00035	0.00018	0.00029
09/19 2:00	0.00014	0.00035	0.011	0.00030	0.00035	0.00018	0.00029
09/19 2:30	0.00014	0.00035	0.011	0.00040	0.00035	0.00018	0.00029
09/19 3:00	0.00014	0.00035	0.011	0.00040	0.00035	0.00020	0.00029
09/19 3:30	0.00014	0.00035	0.011	0.00040	0.00035	0.00020	0.00029
09/19 4:00	0.00015	0.00035	0.011	0.00040	0.00035	0.00020	0.00029
09/19 4:30	0.00013	0.00035	0.011	0.00040	0.00035	0.00018	0.00029
09/19 5:00	0.00013	0.00035	0.011	0.00040	0.00035	0.00018	0.00029
09/19 5:30	0.00013	0.00035	0.011	0.00040	0.00035	0.00018	0.00029
09/19 6:00	0.00013	0.00035	0.011	0.00040	0.00035	0.00018	0.00029
09/19 6:30	0.00013	0.00035	0.011	0.00040	0.00035	0.00018	0.00029
09/19 7:00	0.00013	0.00035	0.011	0.00040	0.00035	0.00018	0.00029
09/19 7:30	0.00013	0.00030	0.011	0.00040	0.00035	0.00018	0.00029
09/19 8:00	0.00014	0.00030	0.011	0.00040	0.00035	0.00018	0.00029
09/19 8:30	0.00014	0.00023	0.011	0.00040	0.00035	0.00018	0.00029
09/19 9:00	0.00012	0.00023	0.011	0.00028	0.00023	0.00018	0.00029
09/19 9:30	0.00012	0.00023	0.011	0.00028	0.00023	0.00018	0.00029
09/19 10:00	0.00012	0.00023	0.011	0.00028	0.00023	0.00018	0.00029
09/19 10:30	0.00015	0.00023	0.011	0.00028	0.00023	0.00018	0.00029

09/19 11:00	0.00012	0.00023	0.011	0.00028	0.00023	0.00019	0.00029
09/19 11:30	0.00014	0.00023	0.011	0.00028	0.00023	0.00019	0.00029
09/19 12:00	0.00012	0.00022	0.011	0.00025	0.00023	0.00019	0.00029
09/19 12:30	0.00012	0.00022	0.011	0.00025	0.00023	0.00019	0.00029
09/19 13:00	0.00012	0.00022	0.011	0.00025	0.00023	0.00019	0.00029
09/19 13:30	0.00009	0.00022	0.009	0.00025	0.00023	0.00019	0.00029
09/19 14:00	0.00012	0.00021	0.009	0.00025	0.00023	0.00019	0.00029
09/19 14:30	0.00012	0.00021	0.009	0.00025	0.00013	0.00019	0.00029
09/19 15:00	0.00012	0.00021	0.009	0.00025	0.00023	0.00019	0.00029
09/19 15:30	0.00012	0.00021	0.014	0.00025	0.00023	0.00019	0.00029
09/19 16:00	0.00013	0.00021	0.014	0.00025	0.00023	0.00019	0.00029
09/19 16:30	0.00015	0.00021	0.011	0.00025	0.00023	0.00019	0.00073
09/19 17:00	0.00012	0.00021	0.011	0.00025	0.00023	0.00019	0.00028
09/19 17:30	0.00012	0.00021	0.011	0.00025	0.00023	0.00019	0.00028
09/19 18:00	0.00012	0.00021	0.011	0.00025	0.00023	0.00019	0.00028
09/19 18:30	0.00012	0.00021	0.011	0.00025	0.00023	0.00019	0.00028
09/19 19:00	0.00012	0.00021	0.011	0.00025	0.00023	0.00019	0.00028
09/19 19:30	0.00012	0.00021	0.011	0.00025	0.00023	0.00019	0.00028
09/19 20:00	0.00012	0.00021	0.011	0.00025	0.00027	0.00019	0.00028
09/19 20:30	0.00012	0.00021	0.011	0.00025	0.00027	0.00019	0.00028
09/19 21:00	0.00013	0.00021	0.011	0.00025	0.00012	0.00019	0.00028
09/19 21:30	0.00013	0.00021	0.011	0.00025	0.00019	0.00019	0.00028
09/19 22:00	0.00015	0.00023	0.011	0.00025	0.00019	0.00019	0.00028
09/19 22:30	0.00018	0.00035	0.018	0.00030	0.00050	0.00025	0.00050
09/19 23:00	0.00018	0.00035	0.018	0.00040	0.00050	0.00025	0.00050
09/19 23:30	0.00018	0.00035	0.018	0.00040	0.00050	0.00030	0.00050
09/20 0:00	0.00018	0.00035	0.018	0.00040	0.00050	0.00030	0.00050
09/20 0:30	0.00030	0.00020	0.012	0.00050	0.00035	0.00050	0.00029
09/20 1:00	0.00020	0.00040	0.012	0.00050	0.00035	0.00020	0.00060
09/20 1:30	0.00018	0.00029	0.012	0.00031	0.00024	0.00020	0.00060

09/20 2:00	0.00015	0.00029	0.012	0.00031	0.00024	0.00020	0.00030
09/20 2:30	0.00015	0.00029	0.012	0.00031	0.00024	0.00020	0.00030
09/20 3:00	0.00015	0.00029	0.012	0.00031	0.00024	0.00020	0.00030
09/20 3:30	0.00013	0.00029	0.012	0.00031	0.00024	0.00020	0.00030
09/20 4:00	0.00014	0.00029	0.012	0.00031	0.00024	0.00020	0.00030
09/20 4:30	0.00014	0.00029	0.010	0.00031	0.00024	0.00018	0.00030
09/20 5:00	0.00013	0.00029	0.010	0.00031	0.00024	0.00018	0.00030
09/20 5:30	0.00013	0.00029	0.010	0.00031	0.00024	0.00018	0.00030
09/20 6:00	0.00015	0.00029	0.010	0.00031	0.00024	0.00018	0.00030
09/20 6:30	0.00017	0.00029	0.010	0.00031	0.00024	0.00018	0.00030
09/20 7:00	0.00013	0.00029	0.010	0.00031	0.00024	0.00019	0.00050
09/20 7:30	0.00014	0.00029	0.010	0.00031	0.00024	0.00019	0.00050
09/20 8:00	0.00014	0.00029	0.010	0.00031	0.00024	0.00019	0.00050
09/20 8:30	0.00014	0.00024	0.010	0.00025	0.00024	0.00019	0.00022
09/20 9:00	0.00014	0.00024	0.010	0.00022	0.00024	0.00018	0.00022
09/20 9:30	0.00012	0.00022	0.010	0.00022	0.00024	0.00018	0.00022
09/20 10:00	0.00012	0.00022	0.010	0.00022	0.00024	0.00018	0.00025
09/20 10:30	0.00012	0.00022	0.010	0.00022	0.00024	0.00018	0.00025
09/20 11:00	0.00100	0.00019	0.010	0.00022	0.00024	0.00018	0.00025
09/20 11:30	0.00012	0.00019	0.010	0.00022	0.00024	0.00018	0.00025
09/20 12:00	0.00012	0.00019	0.010	0.00022	0.00024	0.00018	0.00025
09/20 12:30	0.00012	0.00019	0.010	0.00022	0.00024	0.00018	0.00025
09/20 13:00	0.00012	0.00019	0.010	0.00022	0.00024	0.00018	0.00025
09/20 13:30	0.00012	0.00019	0.010	0.00022	0.00024	0.00018	0.00025
09/20 14:00	0.00012	0.00019	0.010	0.00022	0.00024	0.00018	0.00025
09/20 14:30	0.00100	0.00150	0.100	0.00100	0.00100	0.00100	0.00100
09/20 15:30	0.00012	0.00019	0.012	0.00050	0.00024	0.00019	0.00025
09/20 16:00	0.00013	0.00019	0.012	0.00050	0.00019	0.00019	0.00025
09/20 16:30	0.00012	0.00019	0.012	0.00050	0.00019	0.00019	0.00025
09/20 17:00	0.00012	0.00019	0.012	0.00050	0.00019	0.00019	0.00025

09/20 17:30	0.00012	0.00020	0.011	0.00030	0.00019	0.00017	0.00025
09/20 18:00	0.00012	0.00020	0.010	0.00030	0.00019	0.00017	0.00025
09/20 18:30	0.00012	0.00020	0.010	0.00030	0.00019	0.00017	0.00025
09/20 19:00	0.00012	0.00020	0.010	0.00030	0.00019	0.00017	0.00025
09/20 19:30	0.00013	0.00020	0.010	0.00030	0.00019	0.00017	0.00025
09/20 20:00	0.00013	0.00020	0.010	0.00030	0.00019	0.00017	0.00025
09/20 20:30	0.00015	0.00020	0.010	0.00030	0.00019	0.00017	0.00025
09/20 21:00	0.00015	0.00020	0.010	0.00030	0.00019	0.00017	0.00025
09/20 21:30	0.00015	0.00020	0.010	0.00030	0.00019	0.00017	0.00025
09/20 22:00	0.00015	0.00020	0.010	0.00030	0.00019	0.00017	0.00025
09/20 22:30	0.00018	0.00035	0.018	0.00030	0.00050	0.00025	0.00050
09/20 23:00	0.00030	0.00035	0.018	0.00030	0.00050	0.00025	0.00050
09/20 23:30	0.00026	0.00035	0.018	0.00150	0.00057	0.00025	0.00050
09/21 0:00	0.00030	0.00035	0.018	0.00150	0.00050	0.00025	0.00050
09/21 0:30	0.00015	0.00020	0.011	0.00021	0.00035	0.00018	0.00029
09/21 1:00	0.00015	0.00020	0.011	0.00021	0.00035	0.00018	0.00029
09/21 1:30	0.00015	0.00032	0.011	0.00021	0.00024	0.00018	0.00029
09/21 2:00	0.00015	0.00032	0.011	0.00021	0.00024	0.00018	0.00029
09/21 2:30	0.00015	0.00032	0.011	0.00021	0.00024	0.00018	0.00029
09/21 3:00	0.00015	0.00032	0.010	0.00021	0.00024	0.00018	0.00029
09/21 3:30	0.00016	0.00032	0.021	0.00040	0.00024	0.00018	0.00029
09/21 4:00	0.00016	0.00032	0.010	0.00040	0.00024	0.00018	0.00029
09/21 4:30	0.00014	0.00032	0.012	0.00040	0.00024	0.00018	0.00029
09/21 5:00	0.00014	0.00032	0.012	0.00040	0.00024	0.00018	0.00029
09/21 5:30	0.00014	0.00032	0.012	0.00040	0.00024	0.00018	0.00029
09/21 6:00	0.00014	0.00032	0.012	0.00040	0.00024	0.00018	0.00029
09/21 6:30	0.00014	0.00032	0.012	0.00070	0.00024	0.00018	0.00029
09/21 7:00	0.00014	0.00032	0.012	0.00050	0.00024	0.00018	0.00029
09/21 7:30	0.00014	0.00032	0.012	0.00050	0.00024	0.00018	0.00029
09/21 8:00	0.00014	0.00032	0.012	0.00050	0.00024	0.00018	0.00029

09/21 8:30	0.00013	0.00023	0.010	0.00041	0.00024	0.00018	0.00023
09/21 9:00	0.00012	0.00021	0.010	0.00041	0.00024	0.00018	0.00023
09/21 9:30	0.00012	0.00021	0.010	0.00034	0.00024	0.00018	0.00023
09/21 10:00	0.00012	0.00021	0.010	0.00034	0.00024	0.00018	0.00023
09/21 10:30	0.00015	0.00200	0.010	0.00034	0.00024	0.00018	0.00023
09/21 11:00	0.00012	0.00025	0.010	0.00034	0.00024	0.00018	0.00023
09/21 11:30	0.00012	0.00025	0.010	0.00034	0.00024	0.00018	0.00023
09/21 12:00	0.00012	0.00025	0.010	0.00034	0.00024	0.00018	0.00023
09/21 12:30	0.00012	0.00025	0.010	0.00034	0.00024	0.00018	0.00023
09/21 13:00	0.00012	0.00025	0.010	0.00034	0.00300	0.00018	0.00023
09/21 13:30	0.00012	0.00025	0.010	0.00034	0.00050	0.00018	0.00023
09/21 14:00	0.00012	0.00025	0.010	0.00034	0.00050	0.00018	0.00022
09/21 14:30	0.00012	0.00025	0.010	0.00034	0.00040	0.00018	0.00022
09/21 15:00	0.00012	0.00024	0.010	0.00034	0.00040	0.00018	0.00022
09/21 15:30	0.00012	0.00020	0.011	0.00030	0.00019	0.00018	0.00024
09/21 16:00	0.00100	0.00150	0.300	0.00100	0.00100	0.00100	0.00100
09/21 17:00	0.00012	0.00020	0.010	0.00030	0.00019	0.00018	0.00024
09/21 17:30	0.00012	0.00020	0.011	0.00030	0.00019	0.00018	0.00024
09/21 18:00	0.00012	0.00020	0.011	0.00030	0.00019	0.00018	0.00024
09/21 18:30	0.00014	0.00023	0.010	0.00030	0.00019	0.00019	0.00024
09/21 19:00	0.00014	0.00023	0.010	0.00030	0.00019	0.00019	0.00024
09/21 19:30	0.00014	0.00023	0.011	0.00032	0.00020	0.00019	0.00025
09/21 20:00	0.00014	0.00023	0.011	0.00032	0.00020	0.00019	0.00025
09/21 20:30	0.00020	0.00050	0.020	0.00050	0.00030	0.00030	0.00050
09/21 21:00	0.00017	0.00035	0.015	0.00042	0.00026	0.00024	0.00040
09/21 21:30	0.00022	0.00035	0.015	0.00042	0.00027	0.00026	0.00040
09/21 22:00	0.00020	0.00030	0.015	0.00042	0.00027	0.00024	0.00040
09/21 22:30	0.00024	0.00035	0.018	0.00042	0.00050	0.00025	0.00050
09/21 23:00	0.00030	0.00035	0.020	0.00050	0.00050	0.00030	0.00050
09/21 23:30	0.00035	0.00035	0.020	0.00050	0.00050	0.00050	0.00050

09/22 0:00	0.00025	0.00035	0.016	0.00050	0.00050	0.00030	0.00050
09/22 0:30	0.00018	0.00035	0.014	0.00070	0.00030	0.00020	0.00040
09/22 1:00	0.00018	0.00035	0.012	0.00040	0.00030	0.00020	0.00040
09/22 1:30	0.00018	0.00035	0.011	0.00040	0.00030	0.00019	0.00040
09/22 2:00	0.00018	0.00035	0.011	0.00040	0.00030	0.00019	0.00029
09/22 2:30	0.00018	0.00035	0.012	0.00040	0.00030	0.00019	0.00029
09/22 3:00	0.00014	0.00035	0.011	0.00035	0.00024	0.00019	0.00029
09/22 3:30	0.00015	0.00029	0.015	0.00035	0.00024	0.00019	0.00029
09/22 4:00	0.00018	0.00029	0.015	0.00035	0.00024	0.00019	0.00029
09/22 4:30	0.00030	0.00029	0.015	0.00035	0.00024	0.00070	0.00070
09/22 5:00	0.00017	0.00029	0.011	0.00035	0.00024	0.00020	0.00029
09/22 5:30	0.00014	0.00029	0.011	0.00035	0.00040	0.00020	0.00029
09/22 6:00	0.00014	0.00029	0.011	0.00035	0.00040	0.00020	0.00029
09/22 6:30	0.00014	0.00029	0.011	0.00035	0.00025	0.00027	0.00029
09/22 7:00	0.00014	0.00029	0.011	0.00035	0.00025	0.00020	0.00029
09/22 7:30	0.00014	0.00029	0.011	0.00035	0.00025	0.00020	0.00029
09/22 8:00	0.00014	0.00029	0.011	0.00035	0.00025	0.00020	0.00029
09/22 8:30	0.00013	0.00029	0.011	0.00035	0.00025	0.00018	0.00025
09/22 9:00	0.00013	0.00023	0.011	0.00035	0.00025	0.00018	0.00024
09/22 9:30	0.00013	0.00023	0.009	0.00035	0.00025	0.00018	0.00024
09/22 10:00	0.00013	0.00023	0.009	0.00035	0.00025	0.00018	0.00024
09/22 10:30	0.00012	0.00021	0.015	0.00035	0.00025	0.00018	0.00024
09/22 11:00	0.00012	0.00021	0.010	0.00030	0.00027	0.00018	0.00024
09/22 11:30	0.00015	0.00021	0.012	0.00030	0.00027	0.00022	0.00024
09/22 12:00	0.00015	0.00021	0.012	0.00030	0.00027	0.00022	0.00024
09/22 12:30	0.00015	0.00021	0.012	0.00030	0.00027	0.00022	0.00024
09/22 13:00	0.00012	0.00021	0.012	0.00027	0.00027	0.00019	0.00024
09/22 13:30	0.00012	0.00021	0.012	0.00040	0.00027	0.00019	0.00024
09/22 14:00	0.00012	0.00021	0.012	0.00040	0.00027	0.00019	0.00024
09/22 14:30	0.00100	0.00150	0.100	0.00100	0.00100	0.00100	0.00100

09/22 15:30	0.00015	0.00024	0.012	0.00032	0.00019	0.00025	0.00037
09/22 16:00	0.00012	0.00024	0.012	0.00032	0.00019	0.00023	0.00037
09/22 16:30	0.00015	0.00024	0.012	0.00032	0.00019	0.00022	0.00037
09/22 17:00	0.00015	0.00024	0.012	0.00032	0.00019	0.00025	0.00037
09/22 17:30	0.00012	0.00023	0.010	0.00032	0.00019	0.00023	0.00032
09/22 18:00	0.00012	0.00023	0.010	0.00032	0.00019	0.00023	0.00032
09/22 18:30	0.00015	0.00023	0.010	0.00032	0.00019	0.00020	0.00032
09/22 19:00	0.00014	0.00023	0.012	0.00032	0.00019	0.00023	0.00034
09/22 19:30	0.00014	0.00023	0.012	0.00032	0.00019	0.00023	0.00034
09/22 20:00	0.00014	0.00023	0.012	0.00035	0.00019	0.00023	0.00034
09/22 20:30	0.00017	0.00027	0.012	0.00035	0.00019	0.00025	0.00034
09/22 21:00	0.00015	0.00024	0.012	0.00035	0.00019	0.00025	0.00034
09/22 21:30	0.00015	0.00024	0.012	0.00035	0.00019	0.00025	0.00034
09/22 22:00	0.00015	0.00024	0.012	0.00035	0.00019	0.00025	0.00034
09/22 22:30	0.00020	0.00035	0.018	0.00050	0.00050	0.00025	0.00050
09/22 23:00	0.00025	0.00035	0.018	0.00050	0.00050	0.00025	0.00050
09/22 23:30	0.00020	0.00050	0.018	0.00070	0.00050	0.00028	0.00050
09/23 0:00	0.00035	0.00050	0.025	0.00070	0.00050	0.00028	0.00050
09/23 0:30	0.00002	0.00040	0.014	0.00045	0.00029	0.00023	0.00039
09/23 1:00	0.00020	0.00040	0.014	0.00045	0.00029	0.00023	0.00039
09/23 1:30	0.00020	0.00035	0.011	0.00040	0.00024	0.00020	0.00030
09/23 2:00	0.00018	0.00035	0.011	0.00040	0.00024	0.00020	0.00040
09/23 2:30	0.00020	0.00035	0.012	0.00040	0.00024	0.00022	0.00040
09/23 3:00	0.00017	0.00035	0.012	0.00040	0.00024	0.00022	0.00040
09/23 3:30	0.00017	0.00035	0.012	0.00040	0.00024	0.00022	0.00040
09/23 4:00	0.00017	0.00035	0.012	0.00040	0.00024	0.00022	0.00040
09/23 4:30	0.00017	0.00035	0.012	0.00040	0.00024	0.00022	0.00040
09/23 5:00	0.00017	0.00035	0.012	0.00040	0.00024	0.00022	0.00032
09/23 5:30	0.00017	0.00035	0.012	0.00040	0.00024	0.00022	0.00032
09/23 6:00	0.00017	0.00035	0.012	0.00040	0.00024	0.00022	0.00032

09/23 6:30	0.00017	0.00035	0.012	0.00040	0.00024	0.00022	0.00032
09/23 7:00	0.00014	0.00035	0.012	0.00040	0.00024	0.00019	0.00029
09/23 7:30	0.00014	0.00035	0.012	0.00040	0.00024	0.00019	0.00029
09/23 8:00	0.00014	0.00028	0.012	0.00040	0.00024	0.00019	0.00029
09/23 8:30	0.00014	0.00028	0.012	0.00040	0.00024	0.00019	0.00029
09/23 9:00	0.00017	0.00022	0.012	0.00034	0.00024	0.00019	0.00024
09/23 9:30	0.00014	0.00022	0.012	0.00034	0.00024	0.00019	0.00024
09/23 10:00	0.00014	0.00022	0.012	0.00034	0.00024	0.00019	0.00024
09/23 10:30	0.00014	0.00022	0.012	0.00034	0.00024	0.00019	0.00024
09/23 11:00	0.00014	0.00022	0.012	0.00034	0.00024	0.00019	0.00024
09/23 11:30	0.00012	0.00022	0.012	0.00034	0.00024	0.00019	0.00024
09/23 12:00	0.00012	0.00022	0.011	0.00034	0.00024	0.00019	0.00024
09/23 12:30	0.00012	0.00022	0.011	0.00034	0.00024	0.00019	0.00024
09/23 13:00	0.00013	0.00022	0.011	0.00034	0.00024	0.00019	0.00024
09/23 13:30	0.00013	0.00022	0.011	0.00034	0.00024	0.00019	0.00024
09/23 14:00	0.00014	0.00022	0.014	0.00034	0.00024	0.00019	0.00024
09/23 14:30	0.00014	0.00022	0.014	0.00034	0.00024	0.00019	0.00024
09/23 15:00	0.00014	0.00022	0.014	0.00034	0.00024	0.00019	0.00024
09/23 15:30	0.00013	0.00022	0.012	0.00034	0.00024	0.00019	0.00024
09/23 16:00	0.00013	0.00020	0.010	0.00030	0.00019	0.00018	0.00025
09/23 16:30	0.00012	0.00020	0.010	0.00030	0.00019	0.00018	0.00025
09/23 17:00	0.00013	0.00020	0.010	0.00030	0.00019	0.00018	0.00025
09/23 17:30	0.00013	0.00020	0.010	0.00030	0.00019	0.00018	0.00025
09/23 18:00	0.00013	0.00020	0.010	0.00030	0.00019	0.00018	0.00025
09/23 18:30	0.00014	0.00024	0.012	0.00034	0.00019	0.00018	0.00032
09/23 19:00	0.00014	0.00038	0.012	0.00034	0.00019	0.00020	0.00032
09/23 19:30	0.00015	0.00025	0.012	0.00036	0.00023	0.00020	0.00032
09/23 20:00	0.00015	0.00025	0.012	0.00036	0.00023	0.00020	0.00032
09/23 20:30	0.00015	0.00025	0.012	0.00036	0.00019	0.00022	0.00032
09/23 21:00	0.00015	0.00025	0.012	0.00036	0.00019	0.00025	0.00032

09/23 21:30	0.00015	0.00025	0.014	0.00036	0.00019	0.00025	0.00040
09/23 22:00	0.00100	0.00100	0.100	0.00100	0.00100	0.00100	0.00100
09/23 22:30	0.00100	0.00100	0.100	0.00100	0.00100	0.00100	0.00100
09/23 23:00	0.00100	0.00100	0.100	0.00100	0.00100	0.00100	0.00100
09/23 23:30	0.00100	0.00100	0.100	0.00100	0.00100	0.00100	0.00100
09/24 0:00	0.00000	0.00000	0.000	0.00000	0.00000	0.00000	0.00000

Appendix B: Spread for Cross Currency Pairs

Date and Time	EUR/JPY	GBP/JPY	AUD/JPY	CAD/JPY	NZD/JPY	EUR/GBP	EUR/CHF
09/18 21:00	0.200	0.200	0.200	0.100	0.442	0.00100	0.00250
09/18 21:30	0.130	0.200	0.200	0.100	0.400	0.00100	0.00150
09/18 22:00	0.130	0.130	0.080	0.100	0.200	0.00100	0.00100
09/18 22:30	0.130	0.130	0.080	0.100	0.200	0.00100	0.00100
09/18 23:00	0.130	0.140	0.080	0.100	0.200	0.00100	0.00100
09/18 23:30	0.090	0.140	0.080	0.100	0.200	0.00100	0.00100
09/19 0:00	0.090	0.140	0.080	0.100	0.200	0.00100	0.00100
09/19 0:30	0.043	0.070	0.040	0.035	0.060	0.00030	0.00070
09/19 1:00	0.030	0.070	0.040	0.035	0.060	0.00030	0.00050
09/19 1:30	0.028	0.039	0.028	0.028	0.035	0.00011	0.00050
09/19 2:00	0.028	0.039	0.028	0.028	0.035	0.00011	0.00050
09/19 2:30	0.021	0.031	0.021	0.028	0.035	0.00011	0.00035
09/19 3:00	0.021	0.031	0.021	0.028	0.035	0.00011	0.00035
09/19 3:30	0.021	0.031	0.021	0.028	0.035	0.00011	0.00035
09/19 4:00	0.021	0.031	0.021	0.028	0.035	0.00011	0.00035
09/19 4:30	0.021	0.031	0.021	0.028	0.035	0.00011	0.00035
09/19 5:00	0.021	0.031	0.021	0.028	0.035	0.00011	0.00035
09/19 5:30	0.021	0.031	0.021	0.028	0.035	0.00011	0.00035
09/19 6:00	0.021	0.031	0.021	0.028	0.035	0.00011	0.00035
09/19 6:30	0.021	0.031	0.021	0.028	0.035	0.00011	0.00035
09/19 7:00	0.021	0.031	0.021	0.028	0.035	0.00011	0.00038
09/19 7:30	0.021	0.031	0.021	0.028	0.035	0.00011	0.00035
09/19 8:00	0.021	0.031	0.021	0.028	0.035	0.00011	0.00035
09/19 8:30	0.021	0.026	0.021	0.024	0.035	0.00012	0.00031
09/19 9:00	0.021	0.026	0.021	0.024	0.028	0.00012	0.00026
09/19 9:30	0.021	0.026	0.021	0.024	0.028	0.00012	0.00026

09/19 10:00	0.021	0.026	0.021	0.024	0.028	0.00012	0.00026
09/19 10:30	0.021	0.026	0.021	0.024	0.028	0.00012	0.00026
09/19 11:00	0.021	0.026	0.021	0.024	0.028	0.00012	0.00026
09/19 11:30	0.021	0.026	0.021	0.024	0.028	0.00012	0.00026
09/19 12:00	0.021	0.026	0.021	0.024	0.028	0.00012	0.00026
09/19 12:30	0.021	0.026	0.021	0.024	0.028	0.00012	0.00026
09/19 13:00	0.021	0.026	0.021	0.024	0.028	0.00012	0.00026
09/19 13:30	0.021	0.026	0.021	0.024	0.028	0.00012	0.00026
09/19 14:00	0.021	0.026	0.021	0.024	0.028	0.00012	0.00026
09/19 14:30	0.021	0.026	0.021	0.024	0.028	0.00012	0.00026
09/19 15:00	0.021	0.026	0.021	0.024	0.028	0.00012	0.00026
09/19 15:30	0.030	0.026	0.021	0.024	0.028	0.00012	0.00026
09/19 16:00	0.030	0.026	0.021	0.024	0.028	0.00012	0.00026
09/19 16:30	0.023	0.026	0.021	0.024	0.028	0.00012	0.00026
09/19 17:00	0.023	0.026	0.021	0.024	0.028	0.00012	0.00026
09/19 17:30	0.023	0.026	0.021	0.024	0.028	0.00012	0.00026
09/19 18:00	0.023	0.026	0.021	0.024	0.028	0.00012	0.00026
09/19 18:30	0.023	0.043	0.021	0.024	0.028	0.00012	0.00026
09/19 19:00	0.023	0.043	0.021	0.024	0.028	0.00012	0.00026
09/19 19:30	0.005	0.043	0.021	0.024	0.028	0.00012	0.00026
09/19 20:00	0.023	0.043	0.021	0.024	0.028	0.00012	0.00026
09/19 20:30	0.023	0.043	0.021	0.024	0.028	0.00012	0.00026
09/19 21:00	0.023	0.043	0.021	0.024	0.028	0.00012	0.00026
09/19 21:30	0.023	0.043	0.021	0.024	0.028	0.00012	0.00026
09/19 22:00	0.023	0.043	0.021	0.024	0.028	0.00012	0.00026
09/19 22:30	0.030	0.070	0.040	0.035	0.050	0.00020	0.00030
09/19 23:00	0.030	0.070	0.040	0.035	0.050	0.00020	0.00060
09/19 23:30	0.030	0.070	0.040	0.035	0.050	0.00020	0.00060
09/20 0:00	0.030	0.070	0.040	0.035	0.050	0.00020	0.00060
09/20 0:30	0.025	0.039	0.028	0.028	0.035	0.00020	0.00060

09/20 1:00	0.035	0.039	0.028	0.028	0.060	0.00020	0.00060
09/20 1:30	0.035	0.031	0.022	0.028	0.060	0.00020	0.00060
09/20 2:00	0.023	0.031	0.022	0.028	0.040	0.00012	0.00060
09/20 2:30	0.023	0.031	0.022	0.028	0.040	0.00012	0.00060
09/20 3:00	0.023	0.031	0.022	0.023	0.040	0.00012	0.00040
09/20 3:30	0.023	0.031	0.022	0.023	0.040	0.00012	0.00040
09/20 4:00	0.023	0.031	0.022	0.023	0.040	0.00012	0.00040
09/20 4:30	0.023	0.031	0.022	0.023	0.040	0.00012	0.00040
09/20 5:00	0.023	0.031	0.022	0.023	0.040	0.00012	0.00040
09/20 5:30	0.023	0.031	0.022	0.023	0.040	0.00012	0.00040
09/20 6:00	0.023	0.031	0.022	0.023	0.040	0.00012	0.00040
09/20 6:30	0.023	0.031	0.022	0.023	0.040	0.00012	0.00040
09/20 7:00	0.023	0.031	0.022	0.023	0.040	0.00012	0.00040
09/20 7:30	0.023	0.031	0.022	0.023	0.040	0.00012	0.00040
09/20 8:00	0.023	0.031	0.022	0.023	0.040	0.00012	0.00040
09/20 8:30	0.023	0.025	0.020	0.023	0.030	0.00012	0.00028
09/20 9:00	0.023	0.025	0.020	0.023	0.030	0.00012	0.00028
09/20 9:30	0.021	0.025	0.020	0.023	0.030	0.00012	0.00025
09/20 10:00	0.021	0.025	0.020	0.023	0.030	0.00012	0.00025
09/20 10:30	0.021	0.025	0.020	0.023	0.030	0.00012	0.00025
09/20 11:00	0.100	0.025	0.020	0.023	0.030	0.00100	0.00100
09/20 11:30	0.025	0.025	0.020	0.023	0.030	0.00012	0.00028
09/20 12:00	0.021	0.025	0.020	0.023	0.030	0.00012	0.00028
09/20 12:30	0.021	0.025	0.020	0.023	0.030	0.00012	0.00028
09/20 13:00	0.021	0.025	0.020	0.023	0.030	0.00012	0.00028
09/20 13:30	0.021	0.025	0.020	0.023	0.030	0.00012	0.00028
09/20 14:00	0.021	0.025	0.020	0.023	0.030	0.00012	0.00028
09/20 14:30	0.100	0.150	0.150	0.100	0.200	0.00100	0.00100
09/20 15:30	0.040	0.028	0.020	0.023	0.030	0.00012	0.00060
09/20 16:00	0.040	0.028	0.020	0.023	0.030	0.00012	0.00060

09/20 16:30	0.040	0.028	0.020	0.023	0.030	0.00012	0.00060
09/20 17:00	0.040	0.028	0.020	0.023	0.030	0.00032	0.00060
09/20 17:30	0.018	0.028	0.020	0.023	0.030	0.00012	0.00040
09/20 18:00	0.018	0.028	0.020	0.023	0.030	0.00012	0.00040
09/20 18:30	0.018	0.043	0.020	0.023	0.030	0.00012	0.00040
09/20 19:00	0.018	0.043	0.020	0.023	0.030	0.00012	0.00040
09/20 19:30	0.018	0.043	0.020	0.023	0.030	0.00012	0.00040
09/20 20:00	0.018	0.043	0.020	0.023	0.030	0.00012	0.00040
09/20 20:30	0.018	0.043	0.020	0.023	0.030	0.00012	0.00040
09/20 21:00	0.018	0.043	0.020	0.023	0.030	0.00012	0.00040
09/20 21:30	0.018	0.043	0.020	0.023	0.030	0.00012	0.00040
09/20 22:00	0.018	0.043	0.020	0.023	0.030	0.00012	0.00040
09/20 22:30	0.030	0.070	0.040	0.035	0.050	0.00020	0.00040
09/20 23:00	0.030	0.070	0.040	0.035	0.050	0.00020	0.00040
09/20 23:30	0.030	0.070	0.040	0.035	0.050	0.00020	0.00100
09/21 0:00	0.030	0.070	0.040	0.035	0.050	0.00020	0.00100
09/21 0:30	0.028	0.039	0.028	0.028	0.035	0.00015	0.00070
09/21 1:00	0.028	0.039	0.010	0.028	0.035	0.00015	0.00070
09/21 1:30	0.028	0.031	0.028	0.028	0.035	0.00015	0.00045
09/21 2:00	0.028	0.031	0.028	0.028	0.035	0.00015	0.00045
09/21 2:30	0.028	0.031	0.028	0.028	0.035	0.00015	0.00045
09/21 3:00	0.028	0.031	0.028	0.028	0.035	0.00015	0.00045
09/21 3:30	0.028	0.031	0.028	0.028	0.035	0.00015	0.00045
09/21 4:00	0.028	0.031	0.028	0.028	0.035	0.00015	0.00045
09/21 4:30	0.028	0.031	0.028	0.028	0.035	0.00015	0.00045
09/21 5:00	0.028	0.031	0.028	0.028	0.035	0.00015	0.00045
09/21 5:30	0.028	0.031	0.028	0.028	0.035	0.00015	0.00045
09/21 6:00	0.028	0.031	0.028	0.028	0.035	0.00015	0.00045
09/21 6:30	0.028	0.031	0.028	0.028	0.035	0.00015	0.00150
09/21 7:00	0.028	0.031	0.028	0.028	0.035	0.00015	0.00070

09/21 7:30	0.028	0.031	0.028	0.028	0.035	0.00015	0.00070
09/21 8:00	0.028	0.031	0.028	0.028	0.035	0.00015	0.00064
09/21 8:30	0.028	0.025	0.021	0.028	0.030	0.00012	0.00070
09/21 9:00	0.028	0.025	0.021	0.028	0.030	0.00012	0.00070
09/21 9:30	0.028	0.025	0.021	0.028	0.030	0.00012	0.00042
09/21 10:00	0.028	0.025	0.021	0.028	0.030	0.00012	0.00042
09/21 10:30	0.028	0.250	0.021	0.028	0.030	0.00100	0.00042
09/21 11:00	0.028	0.029	0.021	0.028	0.030	0.00012	0.00042
09/21 11:30	0.028	0.029	0.021	0.028	0.027	0.00012	0.00042
09/21 12:00	0.022	0.029	0.021	0.028	0.027	0.00012	0.00042
09/21 12:30	0.022	0.029	0.021	0.028	0.027	0.00012	0.00042
09/21 13:00	0.022	0.029	0.021	0.300	0.027	0.00012	0.00042
09/21 13:30	0.022	0.029	0.021	0.030	0.027	0.00012	0.00042
09/21 14:00	0.022	0.029	0.021	0.030	0.027	0.00012	0.00042
09/21 14:30	0.022	0.029	0.021	0.030	0.027	0.00012	0.00042
09/21 15:00	0.022	0.029	0.021	0.030	0.027	0.00012	0.00042
09/21 15:30	0.019	0.029	0.021	0.030	0.027	0.00012	0.00040
09/21 16:00	0.100	0.150	0.150	0.100	0.200	0.00100	0.00100
09/21 17:00	0.019	0.029	0.021	0.030	0.027	0.00012	0.00040
09/21 17:30	0.019	0.029	0.021	0.030	0.027	0.00012	0.00040
09/21 18:00	0.019	0.029	0.021	0.030	0.027	0.00012	0.00040
09/21 18:30	0.019	0.043	0.021	0.030	0.027	0.00012	0.00040
09/21 19:00	0.019	0.043	0.021	0.030	0.027	0.00012	0.00040
09/21 19:30	0.019	0.043	0.021	0.030	0.027	0.00013	0.00040
09/21 20:00	0.021	0.043	0.021	0.030	0.027	0.00013	0.00040
09/21 20:30	0.030	0.043	0.021	0.030	0.061	0.00020	0.00070
09/21 21:00	0.026	0.043	0.021	0.030	0.027	0.00020	0.00077
09/21 21:30	0.026	0.043	0.021	0.030	0.027	0.00020	0.00057
09/21 22:00	0.026	0.043	0.021	0.030	0.027	0.00020	0.00057
09/21 22:30	0.030	0.070	0.040	0.035	0.050	0.00020	0.00080

09/21 23:00	0.030	0.070	0.040	0.035	0.050	0.00020	0.00080
09/21 23:30	0.050	0.070	0.030	0.035	0.050	0.00020	0.00080
09/22 0:00	0.050	0.070	0.030	0.035	0.050	0.00020	0.00080
09/22 0:30	0.030	0.040	0.024	0.035	0.050	0.00020	0.00080
09/22 1:00	0.030	0.040	0.024	0.035	0.050	0.00020	0.00080
09/22 1:30	0.030	0.034	0.024	0.035	0.050	0.00020	0.00080
09/22 2:00	0.025	0.032	0.024	0.035	0.035	0.00020	0.00050
09/22 2:30	0.025	0.032	0.024	0.035	0.035	0.00020	0.00047
09/22 3:00	0.022	0.032	0.022	0.035	0.035	0.00020	0.00050
09/22 3:30	0.022	0.032	0.022	0.035	0.035	0.00020	0.00050
09/22 4:00	0.022	0.032	0.022	0.035	0.035	0.00020	0.00050
09/22 4:30	0.045	0.032	0.050	0.035	0.100	0.00020	0.00050
09/22 5:00	0.022	0.032	0.032	0.035	0.035	0.00020	0.00050
09/22 5:30	0.022	0.032	0.032	0.035	0.035	0.00020	0.00050
09/22 6:00	0.022	0.032	0.032	0.035	0.035	0.00020	0.00050
09/22 6:30	0.022	0.032	0.032	0.035	0.035	0.00020	0.00050
09/22 7:00	0.022	0.032	0.032	0.035	0.035	0.00020	0.00050
09/22 7:30	0.022	0.032	0.032	0.035	0.035	0.00020	0.00050
09/22 8:00	0.022	0.032	0.032	0.035	0.035	0.00020	0.00050
09/22 8:30	0.022	0.032	0.021	0.027	0.035	0.00012	0.00041
09/22 9:00	0.022	0.025	0.021	0.024	0.027	0.00012	0.00038
09/22 9:30	0.023	0.025	0.021	0.024	0.027	0.00012	0.00038
09/22 10:00	0.024	0.025	0.021	0.024	0.027	0.00012	0.00030
09/22 10:30	0.024	0.025	0.021	0.024	0.027	0.00012	0.00030
09/22 11:00	0.024	0.025	0.021	0.024	0.027	0.00012	0.00030
09/22 11:30	0.027	0.025	0.023	0.024	0.027	0.00015	0.00045
09/22 12:00	0.027	0.025	0.023	0.024	0.027	0.00015	0.00045
09/22 12:30	0.027	0.025	0.023	0.024	0.027	0.00015	0.00045
09/22 13:00	0.022	0.025	0.023	0.024	0.027	0.00012	0.00045
09/22 13:30	0.022	0.025	0.023	0.024	0.027	0.00012	0.00045

09/22 14:00	0.022	0.025	0.023	0.024	0.027	0.00012	0.00045
09/22 14:30	0.100	0.150	0.150	0.100	0.200	0.00100	0.00100
09/22 15:30	0.025	0.027	0.023	0.024	0.032	0.00015	0.00052
09/22 16:00	0.025	0.027	0.023	0.024	0.032	0.00015	0.00050
09/22 16:30	0.024	0.027	0.027	0.024	0.032	0.00013	0.00050
09/22 17:00	0.024	0.027	0.027	0.024	0.032	0.00013	0.00050
09/22 17:30	0.021	0.027	0.024	0.024	0.032	0.00013	0.00042
09/22 18:00	0.021	0.027	0.024	0.024	0.032	0.00013	0.00042
09/22 18:30	0.021	0.043	0.024	0.024	0.032	0.00013	0.00042
09/22 19:00	0.024	0.043	0.024	0.024	0.032	0.00013	0.00039
09/22 19:30	0.024	0.043	0.024	0.024	0.032	0.00013	0.00042
09/22 20:00	0.024	0.043	0.024	0.024	0.032	0.00013	0.00045
09/22 20:30	0.027	0.043	0.024	0.024	0.032	0.00013	0.00045
09/22 21:00	0.024	0.043	0.024	0.024	0.032	0.00013	0.00045
09/22 21:30	0.024	0.043	0.024	0.024	0.032	0.00013	0.00045
09/22 22:00	0.024	0.043	0.024	0.024	0.032	0.00013	0.00045
09/22 22:30	0.030	0.070	0.040	0.035	0.050	0.00020	0.00065
09/22 23:00	0.040	0.070	0.040	0.035	0.050	0.00020	0.00065
09/22 23:30	0.030	0.070	0.045	0.035	0.050	0.00020	0.00065
09/23 0:00	0.030	0.070	0.031	0.035	0.050	0.00020	0.00065
09/23 0:30	0.028	0.040	0.028	0.035	0.045	0.00015	0.00060
09/23 1:00	0.028	0.040	0.028	0.035	0.045	0.00015	0.00060
09/23 1:30	0.022	0.035	0.022	0.035	0.040	0.00014	0.00050
09/23 2:00	0.022	0.035	0.012	0.035	0.040	0.00014	0.00050
09/23 2:30	0.022	0.035	0.022	0.035	0.040	0.00014	0.00050
09/23 3:00	0.025	0.035	0.022	0.035	0.040	0.00014	0.00050
09/23 3:30	0.025	0.035	0.022	0.035	0.040	0.00014	0.00050
09/23 4:00	0.025	0.035	0.022	0.035	0.040	0.00014	0.00050
09/23 4:30	0.025	0.035	0.022	0.035	0.040	0.00014	0.00050
09/23 5:00	0.025	0.035	0.022	0.035	0.040	0.00014	0.00050

09/23 5:30	0.025	0.035	0.022	0.035	0.040	0.00014	0.00050
09/23 6:00	0.025	0.035	0.022	0.035	0.040	0.00014	0.00050
09/23 6:30	0.025	0.035	0.022	0.035	0.040	0.00014	0.00050
09/23 7:00	0.025	0.035	0.022	0.035	0.040	0.00014	0.00050
09/23 7:30	0.025	0.035	0.022	0.035	0.040	0.00014	0.00050
09/23 8:00	0.025	0.035	0.022	0.030	0.040	0.00013	0.00050
09/23 8:30	0.025	0.035	0.022	0.030	0.040	0.00013	0.00040
09/23 9:00	0.022	0.027	0.022	0.030	0.030	0.00012	0.00040
09/23 9:30	0.022	0.027	0.022	0.030	0.030	0.00012	0.00040
09/23 10:00	0.022	0.027	0.022	0.030	0.030	0.00012	0.00040
09/23 10:30	0.022	0.027	0.022	0.030	0.030	0.00012	0.00040
09/23 11:00	0.022	0.027	0.022	0.030	0.030	0.00012	0.00040
09/23 11:30	0.022	0.027	0.022	0.030	0.030	0.00012	0.00040
09/23 12:00	0.021	0.027	0.022	0.030	0.030	0.00012	0.00040
09/23 12:30	0.021	0.027	0.022	0.030	0.030	0.00012	0.00040
09/23 13:00	0.021	0.027	0.022	0.030	0.030	0.00012	0.00040
09/23 13:30	0.021	0.027	0.022	0.030	0.030	0.00013	0.00040
09/23 14:00	0.021	0.025	0.022	0.030	0.030	0.00013	0.00040
09/23 14:30	0.021	0.025	0.022	0.030	0.030	0.00013	0.00040
09/23 15:00	0.021	0.025	0.022	0.030	0.030	0.00013	0.00040
09/23 15:30	0.021	0.025	0.022	0.030	0.030	0.00013	0.00040
09/23 16:00	0.019	0.025	0.022	0.030	0.030	0.00012	0.00040
09/23 16:30	0.019	0.025	0.022	0.030	0.030	0.00012	0.00040
09/23 17:00	0.019	0.025	0.022	0.030	0.030	0.00012	0.00040
09/23 17:30	0.019	0.025	0.022	0.030	0.030	0.00012	0.00040
09/23 18:00	0.019	0.025	0.022	0.030	0.030	0.00012	0.00040
09/23 18:30	0.019	0.043	0.022	0.030	0.030	0.00013	0.00040
09/23 19:00	0.019	0.043	0.022	0.030	0.030	0.00013	0.00040
09/23 19:30	0.019	0.043	0.022	0.030	0.030	0.00013	0.00044
09/23 20:00	0.019	0.043	0.022	0.030	0.030	0.00013	0.00044

09/23 20:30	0.019	0.043	0.022	0.030	0.030	0.00013	0.00044
09/23 21:00	0.019	0.043	0.022	0.030	0.030	0.00013	0.00044
09/23 21:30	0.026	0.043	0.022	0.030	0.030	0.00013	0.00044
09/23 22:00	0.100	0.200	0.150	0.100	0.400	0.00100	0.00100
09/23 22:30	0.100	0.200	0.150	0.100	0.400	0.00100	0.00100
09/23 23:00	0.100	0.200	0.150	0.100	0.400	0.00100	0.00100
09/23 23:30	0.100	0.200	0.150	0.100	0.400	0.00100	0.00100
09/24 0:00	0.000	0.000	0.000	0.000	0.000	0.00000	0.00000

Appendix C: Liquidity Measure (LQM) for Major Currency Pairs

Date and Time	EUR/USD	GBP/USD	USD/JPY	USD/CHF	USD/CAD	AUD/USD	NZD/USD
09/18 21:00	0.00036	0.00016	0.00033	0.00029	0.00026	0.00024	0.00030
09/18 21:30	0.00036	0.00032	0.00065	0.00028	0.00026	0.00024	0.00060
09/18 22:00	0.00018	0.00032	0.00019	0.00028	0.00026	0.00024	0.00045
09/18 22:30	0.00015	0.00016	0.00019	0.00028	0.00026	0.00024	0.00045
09/18 23:00	0.00018	0.00016	0.00019	0.00028	0.00025	0.00024	0.00045
09/18 23:30	0.00018	0.00016	0.00019	0.00028	0.00025	0.00024	0.00045
09/19 0:00	0.00012	0.00016	0.00019	0.00028	0.00025	0.00024	0.00036
09/19 0:30	0.00007	0.00016	0.00010	0.00028	0.00025	0.00010	0.00036
09/19 1:00	0.00007	0.00008	0.00006	0.00014	0.00013	0.00009	0.00015
09/19 1:30	0.00003	0.00008	0.00006	0.00014	0.00013	0.00007	0.00015
09/19 2:00	0.00003	0.00006	0.00004	0.00009	0.00009	0.00004	0.00009
09/19 2:30	0.00003	0.00006	0.00004	0.00009	0.00009	0.00004	0.00009
09/19 3:00	0.00003	0.00006	0.00004	0.00011	0.00009	0.00004	0.00009
09/19 3:30	0.00003	0.00006	0.00004	0.00011	0.00009	0.00005	0.00009
09/19 4:00	0.00003	0.00006	0.00004	0.00011	0.00009	0.00005	0.00009
09/19 4:30	0.00003	0.00006	0.00004	0.00011	0.00009	0.00005	0.00009
09/19 5:00	0.00002	0.00006	0.00004	0.00011	0.00009	0.00004	0.00009
09/19 5:30	0.00002	0.00006	0.00004	0.00011	0.00009	0.00004	0.00009
09/19 6:00	0.00002	0.00006	0.00004	0.00011	0.00009	0.00004	0.00009
09/19 6:30	0.00002	0.00006	0.00004	0.00011	0.00009	0.00004	0.00009
09/19 7:00	0.00002	0.00006	0.00004	0.00011	0.00009	0.00004	0.00009
09/19 7:30	0.00002	0.00006	0.00004	0.00011	0.00009	0.00004	0.00009
09/19 8:00	0.00002	0.00005	0.00004	0.00011	0.00009	0.00004	0.00009
09/19 8:30	0.00003	0.00005	0.00004	0.00011	0.00009	0.00004	0.00009
09/19 9:00	0.00003	0.00004	0.00004	0.00011	0.00009	0.00004	0.00009
09/19 9:30	0.00002	0.00004	0.00004	0.00008	0.00006	0.00004	0.00009
09/19 10:00	0.00002	0.00004	0.00004	0.00008	0.00006	0.00004	0.00009
09/19 10:30	0.00002	0.00004	0.00004	0.00008	0.00006	0.00004	0.00009

09/19 11:00	0.00003	0.00004	0.00004	0.00008	0.00006	0.00004	0.00009
09/19 11:30	0.00002	0.00004	0.00004	0.00008	0.00006	0.00005	0.00009
09/19 12:00	0.00003	0.00004	0.00004	0.00008	0.00006	0.00005	0.00009
09/19 12:30	0.00002	0.00003	0.00004	0.00007	0.00006	0.00005	0.00009
09/19 13:00	0.00002	0.00003	0.00004	0.00007	0.00006	0.00005	0.00009
09/19 13:30	0.00002	0.00003	0.00004	0.00007	0.00006	0.00005	0.00009
09/19 14:00	0.00002	0.00003	0.00003	0.00007	0.00006	0.00005	0.00009
09/19 14:30	0.00002	0.00003	0.00003	0.00007	0.00006	0.00005	0.00009
09/19 15:00	0.00002	0.00003	0.00003	0.00007	0.00003	0.00005	0.00009
09/19 15:30	0.00002	0.00003	0.00003	0.00007	0.00006	0.00005	0.00009
09/19 16:00	0.00002	0.00003	0.00005	0.00007	0.00006	0.00005	0.00009
09/19 16:30	0.00002	0.00003	0.00005	0.00007	0.00006	0.00005	0.00009
09/19 17:00	0.00003	0.00003	0.00004	0.00007	0.00006	0.00005	0.00022
09/19 17:30	0.00002	0.00003	0.00004	0.00007	0.00006	0.00005	0.00009
09/19 18:00	0.00002	0.00003	0.00004	0.00007	0.00006	0.00005	0.00009
09/19 18:30	0.00002	0.00003	0.00004	0.00007	0.00006	0.00005	0.00009
09/19 19:00	0.00002	0.00003	0.00004	0.00007	0.00006	0.00005	0.00009
09/19 19:30	0.00002	0.00003	0.00004	0.00007	0.00006	0.00005	0.00009
09/19 20:00	0.00002	0.00003	0.00004	0.00007	0.00006	0.00005	0.00009
09/19 20:30	0.00002	0.00003	0.00004	0.00007	0.00007	0.00005	0.00009
09/19 21:00	0.00002	0.00003	0.00004	0.00007	0.00007	0.00005	0.00009
09/19 21:30	0.00002	0.00003	0.00004	0.00007	0.00003	0.00005	0.00009
09/19 22:00	0.00002	0.00003	0.00004	0.00007	0.00005	0.00005	0.00008
09/19 22:30	0.00003	0.00004	0.00004	0.00007	0.00005	0.00005	0.00008
09/19 23:00	0.00003	0.00006	0.00006	0.00009	0.00013	0.00006	0.00015
09/19 23:30	0.00003	0.00006	0.00006	0.00011	0.00013	0.00006	0.00015
09/20 0:00	0.00003	0.00006	0.00006	0.00011	0.00013	0.00007	0.00015
09/20 0:30	0.00003	0.00006	0.00006	0.00011	0.00013	0.00007	0.00015
09/20 1:00	0.00006	0.00003	0.00004	0.00014	0.00009	0.00012	0.00009
09/20 1:30	0.00004	0.00006	0.00004	0.00014	0.00009	0.00005	0.00018

09/20 2:00	0.00003	0.00005	0.00004	0.00009	0.00006	0.00005	0.00018
09/20 2:30	0.00003	0.00005	0.00004	0.00009	0.00006	0.00005	0.00009
09/20 3:00	0.00003	0.00005	0.00004	0.00009	0.00006	0.00005	0.00009
09/20 3:30	0.00003	0.00005	0.00004	0.00009	0.00006	0.00005	0.00009
09/20 4:00	0.00002	0.00005	0.00004	0.00009	0.00006	0.00005	0.00009
09/20 4:30	0.00003	0.00005	0.00004	0.00009	0.00006	0.00005	0.00009
09/20 5:00	0.00003	0.00005	0.00003	0.00009	0.00006	0.00004	0.00009
09/20 5:30	0.00002	0.00005	0.00003	0.00009	0.00006	0.00004	0.00009
09/20 6:00	0.00002	0.00005	0.00003	0.00009	0.00006	0.00004	0.00009
09/20 6:30	0.00003	0.00005	0.00003	0.00009	0.00006	0.00004	0.00009
09/20 7:00	0.00003	0.00005	0.00003	0.00009	0.00006	0.00004	0.00009
09/20 7:30	0.00002	0.00005	0.00003	0.00009	0.00006	0.00005	0.00015
09/20 8:00	0.00003	0.00005	0.00003	0.00009	0.00006	0.00005	0.00015
09/20 8:30	0.00003	0.00005	0.00003	0.00009	0.00006	0.00005	0.00015
09/20 9:00	0.00003	0.00004	0.00003	0.00007	0.00006	0.00005	0.00007
09/20 9:30	0.00003	0.00004	0.00003	0.00006	0.00006	0.00004	0.00007
09/20 10:00	0.00002	0.00004	0.00003	0.00006	0.00006	0.00004	0.00007
09/20 10:30	0.00002	0.00004	0.00003	0.00006	0.00006	0.00004	0.00008
09/20 11:00	0.00002	0.00004	0.00003	0.00006	0.00006	0.00004	0.00008
09/20 11:30	0.00018	0.00003	0.00003	0.00006	0.00006	0.00004	0.00008
09/20 12:00	0.00002	0.00003	0.00003	0.00006	0.00006	0.00004	0.00008
09/20 12:30	0.00002	0.00003	0.00003	0.00006	0.00006	0.00004	0.00008
09/20 13:00	0.00002	0.00003	0.00003	0.00006	0.00006	0.00004	0.00008
09/20 13:30	0.00002	0.00003	0.00003	0.00006	0.00006	0.00004	0.00008
09/20 14:00	0.00002	0.00003	0.00003	0.00006	0.00006	0.00004	0.00008
09/20 14:30	0.00002	0.00003	0.00003	0.00006	0.00006	0.00004	0.00008
09/20 15:30	0.00003	0.00003	0.00003	0.00014	0.00006	0.00004	0.00008
09/20 16:00	0.00002	0.00003	0.00004	0.00014	0.00006	0.00005	0.00008
09/20 16:30	0.00002	0.00003	0.00004	0.00014	0.00005	0.00005	0.00008
09/20 17:00	0.00002	0.00003	0.00004	0.00014	0.00005	0.00005	0.00008

09/20 17:30	0.00002	0.00003	0.00004	0.00014	0.00005	0.00005	0.00008
09/20 18:00	0.00002	0.00003	0.00004	0.00008	0.00005	0.00004	0.00008
09/20 18:30	0.00002	0.00003	0.00003	0.00008	0.00005	0.00004	0.00008
09/20 19:00	0.00002	0.00003	0.00003	0.00008	0.00005	0.00004	0.00008
09/20 19:30	0.00002	0.00003	0.00003	0.00008	0.00005	0.00004	0.00008
09/20 20:00	0.00002	0.00003	0.00003	0.00008	0.00005	0.00004	0.00008
09/20 20:30	0.00002	0.00003	0.00003	0.00008	0.00005	0.00004	0.00008
09/20 21:00	0.00003	0.00003	0.00003	0.00008	0.00005	0.00004	0.00008
09/20 21:30	0.00003	0.00003	0.00003	0.00008	0.00005	0.00004	0.00008
09/20 22:00	0.00003	0.00003	0.00003	0.00008	0.00005	0.00004	0.00008
09/20 22:30	0.00003	0.00003	0.00003	0.00008	0.00005	0.00004	0.00008
09/20 23:00	0.00003	0.00006	0.00006	0.00008	0.00013	0.00006	0.00015
09/20 23:30	0.00005	0.00006	0.00006	0.00008	0.00013	0.00006	0.00015
09/21 0:00	0.00005	0.00006	0.00006	0.00042	0.00014	0.00006	0.00015
09/21 0:30	0.00005	0.00006	0.00006	0.00042	0.00013	0.00006	0.00015
09/21 1:00	0.00003	0.00003	0.00004	0.00006	0.00009	0.00004	0.00009
09/21 1:30	0.00003	0.00003	0.00004	0.00006	0.00009	0.00004	0.00009
09/21 2:00	0.00003	0.00005	0.00004	0.00006	0.00006	0.00004	0.00009
09/21 2:30	0.00003	0.00005	0.00004	0.00006	0.00006	0.00004	0.00009
09/21 3:00	0.00003	0.00005	0.00004	0.00006	0.00006	0.00004	0.00009
09/21 3:30	0.00003	0.00005	0.00003	0.00006	0.00006	0.00004	0.00009
09/21 4:00	0.00003	0.00005	0.00007	0.00011	0.00006	0.00004	0.00009
09/21 4:30	0.00003	0.00005	0.00003	0.00011	0.00006	0.00004	0.00009
09/21 5:00	0.00003	0.00005	0.00004	0.00011	0.00006	0.00004	0.00009
09/21 5:30	0.00003	0.00005	0.00004	0.00011	0.00006	0.00004	0.00009
09/21 6:00	0.00003	0.00005	0.00004	0.00011	0.00006	0.00004	0.00009
09/21 6:30	0.00003	0.00005	0.00004	0.00011	0.00006	0.00004	0.00009
09/21 7:00	0.00003	0.00005	0.00004	0.00020	0.00006	0.00004	0.00009
09/21 7:30	0.00003	0.00005	0.00004	0.00014	0.00006	0.00004	0.00009
09/21 8:00	0.00003	0.00005	0.00004	0.00014	0.00006	0.00004	0.00009

09/21 8:30	0.00003	0.00005	0.00004	0.00014	0.00006	0.00004	0.00009
09/21 9:00	0.00002	0.00004	0.00003	0.00011	0.00006	0.00004	0.00007
09/21 9:30	0.00002	0.00003	0.00003	0.00011	0.00006	0.00004	0.00007
09/21 10:00	0.00002	0.00003	0.00003	0.00010	0.00006	0.00004	0.00007
09/21 10:30	0.00002	0.00003	0.00003	0.00010	0.00006	0.00004	0.00007
09/21 11:00	0.00003	0.00032	0.00003	0.00010	0.00006	0.00004	0.00007
09/21 11:30	0.00002	0.00004	0.00003	0.00010	0.00006	0.00004	0.00007
09/21 12:00	0.00002	0.00004	0.00003	0.00010	0.00006	0.00004	0.00007
09/21 12:30	0.00002	0.00004	0.00003	0.00010	0.00006	0.00004	0.00007
09/21 13:00	0.00002	0.00004	0.00003	0.00010	0.00006	0.00004	0.00007
09/21 13:30	0.00002	0.00004	0.00003	0.00010	0.00075	0.00004	0.00007
09/21 14:00	0.00002	0.00004	0.00003	0.00009	0.00013	0.00004	0.00007
09/21 14:30	0.00002	0.00004	0.00003	0.00010	0.00013	0.00004	0.00007
09/21 15:00	0.00002	0.00004	0.00003	0.00010	0.00010	0.00004	0.00007
09/21 15:30	0.00002	0.00004	0.00003	0.00010	0.00010	0.00004	0.00007
09/21 16:00	0.00002	0.00003	0.00004	0.00008	0.00005	0.00004	0.00007
09/21 17:00	0.00002	0.00003	0.00003	0.00008	0.00005	0.00004	0.00007
09/21 17:30	0.00002	0.00003	0.00003	0.00008	0.00005	0.00004	0.00007
09/21 18:00	0.00002	0.00003	0.00004	0.00008	0.00005	0.00004	0.00007
09/21 18:30	0.00002	0.00003	0.00004	0.00008	0.00005	0.00004	0.00007
09/21 19:00	0.00003	0.00004	0.00003	0.00008	0.00005	0.00005	0.00007
09/21 19:30	0.00003	0.00004	0.00003	0.00008	0.00005	0.00005	0.00007
09/21 20:00	0.00003	0.00004	0.00004	0.00009	0.00005	0.00005	0.00008
09/21 20:30	0.00003	0.00004	0.00004	0.00009	0.00005	0.00005	0.00008
09/21 21:00	0.00004	0.00008	0.00007	0.00014	0.00008	0.00007	0.00015
09/21 21:30	0.00003	0.00006	0.00005	0.00012	0.00006	0.00006	0.00012
09/21 22:00	0.00004	0.00006	0.00005	0.00012	0.00007	0.00006	0.00012
09/21 22:30	0.00004	0.00005	0.00005	0.00012	0.00007	0.00006	0.00012
09/21 23:00	0.00004	0.00006	0.00006	0.00012	0.00012	0.00006	0.00016
09/21 23:30	0.00006	0.00006	0.00007	0.00014	0.00012	0.00007	0.00016

09/22 0:00	0.00006	0.00006	0.00007	0.00014	0.00012	0.00012	0.00016
09/22 0:30	0.00005	0.00006	0.00005	0.00014	0.00012	0.00007	0.00016
09/22 1:00	0.00003	0.00006	0.00005	0.00019	0.00007	0.00005	0.00012
09/22 1:30	0.00003	0.00006	0.00004	0.00011	0.00007	0.00005	0.00013
09/22 2:00	0.00003	0.00006	0.00004	0.00011	0.00007	0.00005	0.00012
09/22 2:30	0.00003	0.00006	0.00004	0.00011	0.00007	0.00005	0.00009
09/22 3:00	0.00003	0.00006	0.00004	0.00011	0.00007	0.00005	0.00009
09/22 3:30	0.00003	0.00006	0.00004	0.00010	0.00006	0.00005	0.00009
09/22 4:00	0.00003	0.00005	0.00005	0.00010	0.00006	0.00005	0.00009
09/22 4:30	0.00003	0.00005	0.00005	0.00010	0.00006	0.00005	0.00009
09/22 5:00	0.00006	0.00005	0.00005	0.00010	0.00006	0.00017	0.00022
09/22 5:30	0.00003	0.00005	0.00004	0.00010	0.00006	0.00005	0.00009
09/22 6:00	0.00003	0.00005	0.00004	0.00010	0.00010	0.00005	0.00009
09/22 6:30	0.00003	0.00005	0.00004	0.00010	0.00010	0.00005	0.00009
09/22 7:00	0.00003	0.00005	0.00004	0.00010	0.00006	0.00007	0.00009
09/22 7:30	0.00003	0.00005	0.00004	0.00010	0.00006	0.00005	0.00009
09/22 8:00	0.00003	0.00005	0.00004	0.00010	0.00006	0.00005	0.00009
09/22 8:30	0.00003	0.00005	0.00004	0.00010	0.00006	0.00005	0.00009
09/22 9:00	0.00002	0.00005	0.00004	0.00010	0.00006	0.00004	0.00008
09/22 9:30	0.00002	0.00004	0.00004	0.00010	0.00006	0.00004	0.00008
09/22 10:00	0.00002	0.00004	0.00003	0.00010	0.00006	0.00005	0.00008
09/22 10:30	0.00002	0.00004	0.00003	0.00010	0.00006	0.00005	0.00008
09/22 11:00	0.00002	0.00003	0.00005	0.00010	0.00006	0.00005	0.00008
09/22 11:30	0.00002	0.00003	0.00003	0.00008	0.00007	0.00005	0.00008
09/22 12:00	0.00003	0.00003	0.00004	0.00008	0.00007	0.00006	0.00008
09/22 12:30	0.00003	0.00003	0.00004	0.00008	0.00007	0.00006	0.00008
09/22 13:00	0.00003	0.00003	0.00004	0.00008	0.00007	0.00006	0.00008
09/22 13:30	0.00002	0.00003	0.00004	0.00007	0.00007	0.00005	0.00008
09/22 14:00	0.00002	0.00003	0.00004	0.00011	0.00007	0.00005	0.00008
09/22 14:30	0.00002	0.00003	0.00004	0.00011	0.00007	0.00005	0.00008

09/22 15:30	0.00003	0.00004	0.00004	0.00011	0.00007	0.00005	0.00008
09/22 16:00	0.00003	0.00004	0.00004	0.00009	0.00005	0.00006	0.00012
09/22 16:30	0.00002	0.00004	0.00004	0.00009	0.00005	0.00006	0.00012
09/22 17:00	0.00003	0.00004	0.00004	0.00009	0.00005	0.00006	0.00012
09/22 17:30	0.00003	0.00004	0.00004	0.00009	0.00005	0.00006	0.00012
09/22 18:00	0.00002	0.00004	0.00003	0.00009	0.00005	0.00006	0.00010
09/22 18:30	0.00002	0.00004	0.00003	0.00009	0.00005	0.00006	0.00010
09/22 19:00	0.00003	0.00004	0.00003	0.00009	0.00005	0.00005	0.00010
09/22 19:30	0.00003	0.00004	0.00004	0.00009	0.00005	0.00006	0.00011
09/22 20:00	0.00003	0.00004	0.00004	0.00009	0.00005	0.00006	0.00011
09/22 20:30	0.00003	0.00004	0.00004	0.00010	0.00005	0.00006	0.00011
09/22 21:00	0.00003	0.00004	0.00004	0.00010	0.00005	0.00006	0.00011
09/22 21:30	0.00003	0.00004	0.00004	0.00010	0.00005	0.00006	0.00011
09/22 22:00	0.00003	0.00004	0.00004	0.00010	0.00005	0.00006	0.00011
09/22 22:30	0.00003	0.00004	0.00004	0.00010	0.00005	0.00006	0.00011
09/22 23:00	0.00004	0.00006	0.00006	0.00014	0.00012	0.00006	0.00016
09/22 23:30	0.00005	0.00006	0.00006	0.00014	0.00012	0.00006	0.00016
09/23 0:00	0.00004	0.00008	0.00006	0.00019	0.00012	0.00007	0.00016
09/23 0:30	0.00007	0.00008	0.00008	0.00019	0.00012	0.00007	0.00016
09/23 1:00	0.00000	0.00007	0.00005	0.00012	0.00007	0.00006	0.00012
09/23 1:30	0.00004	0.00007	0.00005	0.00012	0.00007	0.00006	0.00012
09/23 2:00	0.00004	0.00006	0.00004	0.00011	0.00006	0.00005	0.00010
09/23 2:30	0.00003	0.00006	0.00004	0.00011	0.00006	0.00005	0.00013
09/23 3:00	0.00004	0.00006	0.00004	0.00011	0.00006	0.00006	0.00013
09/23 3:30	0.00003	0.00006	0.00004	0.00011	0.00006	0.00006	0.00013
09/23 4:00	0.00003	0.00006	0.00004	0.00011	0.00006	0.00006	0.00013
09/23 4:30	0.00003	0.00006	0.00004	0.00011	0.00006	0.00006	0.00013
09/23 5:00	0.00003	0.00006	0.00004	0.00011	0.00006	0.00006	0.00013
09/23 5:30	0.00003	0.00006	0.00004	0.00011	0.00006	0.00006	0.00010
09/23 6:00	0.00003	0.00006	0.00004	0.00011	0.00006	0.00006	0.00010

09/23 6:30	0.00003	0.00006	0.00004	0.00011	0.00006	0.00006	0.00010
09/23 7:00	0.00003	0.00006	0.00004	0.00011	0.00006	0.00006	0.00010
09/23 7:30	0.00003	0.00006	0.00004	0.00011	0.00006	0.00005	0.00009
09/23 8:00	0.00003	0.00006	0.00004	0.00011	0.00006	0.00005	0.00009
09/23 8:30	0.00003	0.00005	0.00004	0.00011	0.00006	0.00005	0.00009
09/23 9:00	0.00003	0.00005	0.00004	0.00011	0.00006	0.00005	0.00009
09/23 9:30	0.00003	0.00004	0.00004	0.00009	0.00006	0.00005	0.00008
09/23 10:00	0.00003	0.00004	0.00004	0.00009	0.00006	0.00005	0.00008
09/23 10:30	0.00003	0.00004	0.00004	0.00009	0.00006	0.00005	0.00008
09/23 11:00	0.00003	0.00004	0.00004	0.00009	0.00006	0.00005	0.00008
09/23 11:30	0.00003	0.00004	0.00004	0.00009	0.00006	0.00005	0.00008
09/23 12:00	0.00002	0.00004	0.00004	0.00009	0.00006	0.00005	0.00008
09/23 12:30	0.00002	0.00004	0.00004	0.00009	0.00006	0.00005	0.00008
09/23 13:00	0.00002	0.00004	0.00004	0.00009	0.00006	0.00005	0.00008
09/23 13:30	0.00002	0.00004	0.00004	0.00009	0.00006	0.00005	0.00008
09/23 14:00	0.00002	0.00004	0.00004	0.00009	0.00006	0.00005	0.00008
09/23 14:30	0.00003	0.00004	0.00005	0.00009	0.00006	0.00005	0.00008
09/23 15:00	0.00003	0.00004	0.00005	0.00009	0.00006	0.00005	0.00008
09/23 15:30	0.00003	0.00004	0.00005	0.00009	0.00006	0.00005	0.00008
09/23 16:00	0.00002	0.00004	0.00004	0.00009	0.00006	0.00005	0.00008
09/23 16:30	0.00002	0.00003	0.00003	0.00008	0.00005	0.00005	0.00008
09/23 17:00	0.00002	0.00003	0.00003	0.00008	0.00005	0.00005	0.00008
09/23 17:30	0.00002	0.00003	0.00003	0.00008	0.00005	0.00005	0.00008
09/23 18:00	0.00002	0.00003	0.00003	0.00008	0.00005	0.00005	0.00008
09/23 18:30	0.00002	0.00003	0.00003	0.00008	0.00005	0.00005	0.00008
09/23 19:00	0.00003	0.00004	0.00004	0.00009	0.00005	0.00005	0.00010
09/23 19:30	0.00003	0.00006	0.00004	0.00009	0.00005	0.00005	0.00010
09/23 20:00	0.00003	0.00004	0.00004	0.00010	0.00006	0.00005	0.00010
09/23 20:30	0.00003	0.00004	0.00004	0.00010	0.00006	0.00005	0.00010
09/23 21:00	0.00003	0.00004	0.00004	0.00010	0.00005	0.00006	0.00010

09/23 21:30	0.00003	0.00004	0.00004	0.00010	0.00005	0.00006	0.00010
09/23 22:00	0.00003	0.00004	0.00005	0.00010	0.00005	0.00006	0.00013
09/23 22:30	0.00018	0.00016	0.00033	0.00028	0.00024	0.00026	0.00032
09/23 23:00	0.00019	0.00016	0.00033	0.00028	0.00024	0.00026	0.00032
09/23 23:30	0.00019	0.00016	0.00033	0.00028	0.00024	0.00026	0.00032
09/24 0:00	0.00019	0.00016	0.00033	0.00028	0.00024	0.00026	0.00032

Appendix D: Liquidity Measure (LQM) for Cross Currency Pairs

Date and Time	EUR/JPY	GBP/JPY	AUD/JPY	CAD/JPY	NZD/JPY	EUR/GBP	EUR/CHF
09/18 21:00	0.00047	0.00041	0.00047	0.00032	0.00157	0.00029	0.00041
09/18 21:30	0.00047	0.00041	0.00063	0.00032	0.00173	0.00029	0.00052
09/18 22:00	0.00031	0.00041	0.00063	0.00032	0.00157	0.00029	0.00031
09/18 22:30	0.00031	0.00027	0.00025	0.00032	0.00079	0.00029	0.00021
09/18 23:00	0.00031	0.00027	0.00025	0.00032	0.00079	0.00029	0.00021
09/18 23:30	0.00031	0.00029	0.00025	0.00032	0.00079	0.00029	0.00021
09/19 0:00	0.00021	0.00029	0.00025	0.00032	0.00079	0.00029	0.00021
09/19 0:30	0.00021	0.00029	0.00025	0.00032	0.00079	0.00029	0.00021
09/19 1:00	0.00010	0.00014	0.00013	0.00011	0.00024	0.00009	0.00015
09/19 1:30	0.00007	0.00014	0.00013	0.00011	0.00024	0.00009	0.00010
09/19 2:00	0.00007	0.00008	0.00009	0.00009	0.00014	0.00003	0.00010
09/19 2:30	0.00007	0.00008	0.00009	0.00009	0.00014	0.00003	0.00010
09/19 3:00	0.00005	0.00006	0.00007	0.00009	0.00014	0.00003	0.00007
09/19 3:30	0.00005	0.00006	0.00007	0.00009	0.00014	0.00003	0.00007
09/19 4:00	0.00005	0.00006	0.00007	0.00009	0.00014	0.00003	0.00007
09/19 4:30	0.00005	0.00006	0.00007	0.00009	0.00014	0.00003	0.00007
09/19 5:00	0.00005	0.00006	0.00007	0.00009	0.00014	0.00003	0.00007
09/19 5:30	0.00005	0.00006	0.00007	0.00009	0.00014	0.00003	0.00007
09/19 6:00	0.00005	0.00006	0.00007	0.00009	0.00014	0.00003	0.00007
09/19 6:30	0.00005	0.00006	0.00007	0.00009	0.00014	0.00003	0.00007
09/19 7:00	0.00005	0.00006	0.00007	0.00009	0.00014	0.00003	0.00007
09/19 7:30	0.00005	0.00006	0.00007	0.00009	0.00014	0.00003	0.00008
09/19 8:00	0.00005	0.00006	0.00007	0.00009	0.00014	0.00003	0.00007
09/19 8:30	0.00005	0.00006	0.00007	0.00009	0.00014	0.00003	0.00007
09/19 9:00	0.00005	0.00005	0.00007	0.00008	0.00014	0.00003	0.00006
09/19 9:30	0.00005	0.00005	0.00007	0.00008	0.00011	0.00003	0.00005
09/19 10:00	0.00005	0.00005	0.00007	0.00008	0.00011	0.00003	0.00005
09/19 10:30	0.00005	0.00005	0.00007	0.00008	0.00011	0.00003	0.00005

09/19 11:00	0.00005	0.00005	0.00007	0.00008	0.00011	0.00003	0.00005
09/19 11:30	0.00005	0.00005	0.00007	0.00008	0.00011	0.00003	0.00005
09/19 12:00	0.00005	0.00005	0.00007	0.00008	0.00011	0.00003	0.00005
09/19 12:30	0.00005	0.00005	0.00007	0.00008	0.00011	0.00003	0.00005
09/19 13:00	0.00005	0.00005	0.00007	0.00008	0.00011	0.00003	0.00005
09/19 13:30	0.00005	0.00005	0.00007	0.00008	0.00011	0.00003	0.00005
09/19 14:00	0.00005	0.00005	0.00007	0.00008	0.00011	0.00003	0.00005
09/19 14:30	0.00005	0.00005	0.00007	0.00008	0.00011	0.00003	0.00005
09/19 15:00	0.00005	0.00005	0.00007	0.00008	0.00011	0.00003	0.00005
09/19 15:30	0.00005	0.00005	0.00007	0.00008	0.00011	0.00003	0.00005
09/19 16:00	0.00007	0.00005	0.00007	0.00008	0.00011	0.00003	0.00005
09/19 16:30	0.00007	0.00005	0.00007	0.00008	0.00011	0.00003	0.00005
09/19 17:00	0.00006	0.00005	0.00007	0.00008	0.00011	0.00003	0.00005
09/19 17:30	0.00006	0.00005	0.00007	0.00008	0.00011	0.00003	0.00005
09/19 18:00	0.00006	0.00005	0.00007	0.00008	0.00011	0.00003	0.00005
09/19 18:30	0.00006	0.00005	0.00007	0.00008	0.00011	0.00003	0.00005
09/19 19:00	0.00006	0.00009	0.00007	0.00008	0.00011	0.00003	0.00005
09/19 19:30	0.00006	0.00009	0.00007	0.00008	0.00011	0.00003	0.00005
09/19 20:00	0.00001	0.00009	0.00007	0.00008	0.00011	0.00003	0.00005
09/19 20:30	0.00006	0.00009	0.00007	0.00008	0.00011	0.00003	0.00005
09/19 21:00	0.00005	0.00009	0.00007	0.00008	0.00011	0.00003	0.00005
09/19 21:30	0.00005	0.00009	0.00007	0.00008	0.00011	0.00003	0.00005
09/19 22:00	0.00005	0.00009	0.00007	0.00008	0.00011	0.00003	0.00005
09/19 22:30	0.00005	0.00009	0.00007	0.00008	0.00011	0.00003	0.00005
09/19 23:00	0.00007	0.00015	0.00013	0.00011	0.00020	0.00006	0.00006
09/19 23:30	0.00007	0.00015	0.00013	0.00011	0.00020	0.00006	0.00012
09/20 0:00	0.00007	0.00015	0.00013	0.00011	0.00020	0.00006	0.00012
09/20 0:30	0.00007	0.00015	0.00013	0.00011	0.00020	0.00006	0.00012
09/20 1:00	0.00006	0.00008	0.00009	0.00009	0.00014	0.00006	0.00012
09/20 1:30	0.00008	0.00008	0.00009	0.00009	0.00024	0.00006	0.00012

09/20 2:00	0.00008	0.00006	0.00007	0.00009	0.00024	0.00006	0.00012
09/20 2:30	0.00006	0.00006	0.00007	0.00009	0.00016	0.00003	0.00012
09/20 3:00	0.00006	0.00006	0.00007	0.00009	0.00016	0.00003	0.00012
09/20 3:30	0.00006	0.00006	0.00007	0.00007	0.00016	0.00003	0.00008
09/20 4:00	0.00006	0.00006	0.00007	0.00007	0.00016	0.00003	0.00008
09/20 4:30	0.00006	0.00006	0.00007	0.00007	0.00016	0.00003	0.00008
09/20 5:00	0.00006	0.00006	0.00007	0.00007	0.00016	0.00003	0.00008
09/20 5:30	0.00006	0.00006	0.00007	0.00007	0.00016	0.00003	0.00008
09/20 6:00	0.00006	0.00006	0.00007	0.00007	0.00016	0.00003	0.00008
09/20 6:30	0.00006	0.00006	0.00007	0.00007	0.00016	0.00003	0.00008
09/20 7:00	0.00006	0.00006	0.00007	0.00007	0.00016	0.00003	0.00008
09/20 7:30	0.00006	0.00006	0.00007	0.00007	0.00016	0.00003	0.00008
09/20 8:00	0.00006	0.00006	0.00007	0.00007	0.00016	0.00003	0.00008
09/20 8:30	0.00006	0.00006	0.00007	0.00007	0.00016	0.00003	0.00008
09/20 9:00	0.00006	0.00005	0.00006	0.00007	0.00012	0.00003	0.00006
09/20 9:30	0.00006	0.00005	0.00006	0.00007	0.00012	0.00003	0.00006
09/20 10:00	0.00005	0.00005	0.00006	0.00007	0.00012	0.00003	0.00005
09/20 10:30	0.00005	0.00005	0.00006	0.00007	0.00012	0.00003	0.00005
09/20 11:00	0.00005	0.00005	0.00006	0.00007	0.00012	0.00003	0.00005
09/20 11:30	0.00024	0.00005	0.00006	0.00007	0.00012	0.00029	0.00021
09/20 12:00	0.00006	0.00005	0.00006	0.00007	0.00012	0.00003	0.00006
09/20 12:30	0.00005	0.00005	0.00006	0.00007	0.00012	0.00003	0.00006
09/20 13:00	0.00005	0.00005	0.00006	0.00007	0.00012	0.00003	0.00006
09/20 13:30	0.00005	0.00005	0.00006	0.00007	0.00012	0.00003	0.00006
09/20 14:00	0.00005	0.00005	0.00006	0.00007	0.00012	0.00003	0.00006
09/20 14:30	0.00005	0.00005	0.00006	0.00007	0.00012	0.00003	0.00006
09/20 15:30	0.00005	0.00005	0.00006	0.00007	0.00012	0.00003	0.00012
09/20 16:00	0.00010	0.00006	0.00006	0.00007	0.00012	0.00003	0.00012
09/20 16:30	0.00010	0.00006	0.00006	0.00007	0.00012	0.00003	0.00012
09/20 17:00	0.00010	0.00006	0.00006	0.00007	0.00012	0.00003	0.00012

09/20 17:30	0.00010	0.00006	0.00006	0.00007	0.00012	0.00009	0.00012
09/20 18:00	0.00004	0.00006	0.00006	0.00007	0.00012	0.00003	0.00008
09/20 18:30	0.00004	0.00006	0.00006	0.00007	0.00012	0.00003	0.00008
09/20 19:00	0.00004	0.00009	0.00006	0.00007	0.00012	0.00003	0.00008
09/20 19:30	0.00004	0.00009	0.00006	0.00007	0.00012	0.00003	0.00008
09/20 20:00	0.00004	0.00009	0.00006	0.00007	0.00012	0.00003	0.00008
09/20 20:30	0.00004	0.00009	0.00006	0.00007	0.00012	0.00003	0.00008
09/20 21:00	0.00004	0.00009	0.00006	0.00007	0.00012	0.00003	0.00008
09/20 21:30	0.00004	0.00009	0.00006	0.00007	0.00012	0.00003	0.00008
09/20 22:00	0.00004	0.00009	0.00006	0.00007	0.00012	0.00003	0.00008
09/20 22:30	0.00004	0.00009	0.00006	0.00007	0.00012	0.00003	0.00008
09/20 23:00	0.00007	0.00015	0.00013	0.00011	0.00020	0.00006	0.00008
09/20 23:30	0.00007	0.00015	0.00013	0.00011	0.00020	0.00006	0.00008
09/21 0:00	0.00007	0.00015	0.00013	0.00011	0.00020	0.00006	0.00021
09/21 0:30	0.00007	0.00015	0.00013	0.00011	0.00020	0.00006	0.00021
09/21 1:00	0.00007	0.00008	0.00009	0.00009	0.00014	0.00004	0.00014
09/21 1:30	0.00007	0.00008	0.00003	0.00009	0.00014	0.00004	0.00014
09/21 2:00	0.00007	0.00006	0.00009	0.00009	0.00014	0.00004	0.00009
09/21 2:30	0.00007	0.00006	0.00009	0.00009	0.00014	0.00004	0.00009
09/21 3:00	0.00007	0.00006	0.00009	0.00009	0.00014	0.00004	0.00009
09/21 3:30	0.00007	0.00006	0.00009	0.00009	0.00014	0.00004	0.00009
09/21 4:00	0.00007	0.00006	0.00009	0.00009	0.00014	0.00004	0.00009
09/21 4:30	0.00007	0.00006	0.00009	0.00009	0.00014	0.00004	0.00009
09/21 5:00	0.00007	0.00006	0.00009	0.00009	0.00014	0.00004	0.00009
09/21 5:30	0.00007	0.00006	0.00009	0.00009	0.00014	0.00004	0.00009
09/21 6:00	0.00007	0.00006	0.00009	0.00009	0.00014	0.00004	0.00009
09/21 6:30	0.00007	0.00006	0.00009	0.00009	0.00014	0.00004	0.00009
09/21 7:00	0.00007	0.00006	0.00009	0.00009	0.00014	0.00004	0.00031
09/21 7:30	0.00007	0.00006	0.00009	0.00009	0.00014	0.00004	0.00014
09/21 8:00	0.00007	0.00006	0.00009	0.00009	0.00014	0.00004	0.00014

09/21 8:30	0.00007	0.00006	0.00009	0.00009	0.00014	0.00004	0.00013
09/21 9:00	0.00007	0.00005	0.00007	0.00009	0.00012	0.00003	0.00014
09/21 9:30	0.00007	0.00005	0.00007	0.00009	0.00012	0.00003	0.00014
09/21 10:00	0.00007	0.00005	0.00007	0.00009	0.00012	0.00003	0.00009
09/21 10:30	0.00007	0.00005	0.00007	0.00009	0.00012	0.00003	0.00009
09/21 11:00	0.00007	0.00052	0.00007	0.00009	0.00012	0.00029	0.00009
09/21 11:30	0.00007	0.00006	0.00007	0.00009	0.00012	0.00003	0.00009
09/21 12:00	0.00007	0.00006	0.00007	0.00009	0.00011	0.00003	0.00009
09/21 12:30	0.00005	0.00006	0.00007	0.00009	0.00011	0.00003	0.00009
09/21 13:00	0.00005	0.00006	0.00007	0.00009	0.00011	0.00003	0.00009
09/21 13:30	0.00005	0.00006	0.00007	0.00098	0.00011	0.00003	0.00009
09/21 14:00	0.00005	0.00006	0.00007	0.00010	0.00011	0.00003	0.00009
09/21 14:30	0.00005	0.00006	0.00007	0.00010	0.00011	0.00003	0.00009
09/21 15:00	0.00005	0.00006	0.00007	0.00010	0.00011	0.00003	0.00009
09/21 15:30	0.00005	0.00006	0.00007	0.00010	0.00011	0.00003	0.00009
09/21 16:00	0.00005	0.00006	0.00007	0.00010	0.00011	0.00003	0.00008
09/21 17:00	0.00005	0.00006	0.00007	0.00010	0.00011	0.00003	0.00008
09/21 17:30	0.00005	0.00006	0.00007	0.00010	0.00011	0.00003	0.00008
09/21 18:00	0.00005	0.00006	0.00007	0.00010	0.00011	0.00003	0.00008
09/21 18:30	0.00005	0.00006	0.00007	0.00010	0.00011	0.00003	0.00008
09/21 19:00	0.00005	0.00009	0.00007	0.00010	0.00011	0.00003	0.00008
09/21 19:30	0.00005	0.00009	0.00007	0.00010	0.00011	0.00003	0.00008
09/21 20:00	0.00005	0.00009	0.00007	0.00010	0.00011	0.00004	0.00008
09/21 20:30	0.00005	0.00009	0.00007	0.00010	0.00011	0.00004	0.00008
09/21 21:00	0.00007	0.00009	0.00007	0.00010	0.00025	0.00006	0.00014
09/21 21:30	0.00006	0.00009	0.00007	0.00010	0.00011	0.00006	0.00016
09/21 22:00	0.00006	0.00009	0.00007	0.00010	0.00011	0.00006	0.00012
09/21 22:30	0.00006	0.00009	0.00007	0.00010	0.00011	0.00006	0.00012
09/21 23:00	0.00007	0.00015	0.00013	0.00011	0.00020	0.00006	0.00016
09/21 23:30	0.00007	0.00015	0.00013	0.00012	0.00020	0.00006	0.00016

09/22 0:00	0.00012	0.00015	0.00010	0.00012	0.00020	0.00006	0.00016
09/22 0:30	0.00012	0.00015	0.00010	0.00012	0.00020	0.00006	0.00016
09/22 1:00	0.00007	0.00008	0.00008	0.00011	0.00020	0.00006	0.00016
09/22 1:30	0.00007	0.00008	0.00008	0.00011	0.00020	0.00006	0.00016
09/22 2:00	0.00007	0.00007	0.00008	0.00012	0.00020	0.00006	0.00016
09/22 2:30	0.00006	0.00007	0.00008	0.00012	0.00014	0.00006	0.00010
09/22 3:00	0.00006	0.00007	0.00008	0.00012	0.00014	0.00006	0.00010
09/22 3:30	0.00005	0.00007	0.00007	0.00012	0.00014	0.00006	0.00010
09/22 4:00	0.00005	0.00007	0.00007	0.00011	0.00014	0.00006	0.00010
09/22 4:30	0.00005	0.00007	0.00007	0.00011	0.00014	0.00006	0.00010
09/22 5:00	0.00011	0.00007	0.00016	0.00012	0.00041	0.00006	0.00010
09/22 5:30	0.00005	0.00007	0.00010	0.00012	0.00014	0.00006	0.00010
09/22 6:00	0.00005	0.00007	0.00010	0.00012	0.00014	0.00006	0.00010
09/22 6:30	0.00005	0.00007	0.00010	0.00012	0.00014	0.00006	0.00010
09/22 7:00	0.00005	0.00007	0.00010	0.00012	0.00014	0.00006	0.00010
09/22 7:30	0.00005	0.00007	0.00010	0.00012	0.00014	0.00006	0.00010
09/22 8:00	0.00005	0.00007	0.00010	0.00012	0.00014	0.00006	0.00010
09/22 8:30	0.00005	0.00007	0.00010	0.00012	0.00014	0.00006	0.00010
09/22 9:00	0.00005	0.00007	0.00007	0.00009	0.00014	0.00003	0.00008
09/22 9:30	0.00005	0.00005	0.00007	0.00008	0.00011	0.00003	0.00008
09/22 10:00	0.00006	0.00005	0.00007	0.00008	0.00011	0.00003	0.00008
09/22 10:30	0.00006	0.00005	0.00007	0.00008	0.00011	0.00003	0.00006
09/22 11:00	0.00006	0.00005	0.00007	0.00008	0.00011	0.00003	0.00006
09/22 11:30	0.00006	0.00005	0.00007	0.00008	0.00011	0.00003	0.00006
09/22 12:00	0.00007	0.00005	0.00008	0.00008	0.00011	0.00004	0.00009
09/22 12:30	0.00007	0.00005	0.00008	0.00008	0.00011	0.00004	0.00009
09/22 13:00	0.00007	0.00005	0.00008	0.00008	0.00011	0.00004	0.00009
09/22 13:30	0.00005	0.00005	0.00008	0.00008	0.00011	0.00003	0.00009
09/22 14:00	0.00005	0.00005	0.00008	0.00008	0.00011	0.00003	0.00009
09/22 14:30	0.00005	0.00005	0.00008	0.00008	0.00011	0.00003	0.00009

09/22 15:30	0.00005	0.00006	0.00008	0.00008	0.00011	0.00003	0.00009
09/22 16:00	0.00006	0.00006	0.00008	0.00008	0.00013	0.00004	0.00011
09/22 16:30	0.00006	0.00006	0.00008	0.00008	0.00014	0.00004	0.00010
09/22 17:00	0.00006	0.00006	0.00009	0.00008	0.00013	0.00004	0.00010
09/22 17:30	0.00006	0.00006	0.00009	0.00008	0.00013	0.00004	0.00010
09/22 18:00	0.00005	0.00006	0.00008	0.00008	0.00013	0.00004	0.00009
09/22 18:30	0.00005	0.00006	0.00008	0.00008	0.00013	0.00004	0.00009
09/22 19:00	0.00005	0.00009	0.00008	0.00008	0.00013	0.00004	0.00009
09/22 19:30	0.00006	0.00009	0.00008	0.00008	0.00013	0.00004	0.00008
09/22 20:00	0.00006	0.00009	0.00008	0.00008	0.00013	0.00004	0.00009
09/22 20:30	0.00006	0.00009	0.00008	0.00008	0.00013	0.00004	0.00009
09/22 21:00	0.00007	0.00009	0.00008	0.00008	0.00013	0.00004	0.00009
09/22 21:30	0.00006	0.00009	0.00008	0.00008	0.00013	0.00004	0.00009
09/22 22:00	0.00006	0.00009	0.00008	0.00008	0.00013	0.00004	0.00009
09/22 22:30	0.00006	0.00009	0.00008	0.00008	0.00013	0.00004	0.00009
09/22 23:00	0.00007	0.00015	0.00013	0.00012	0.00021	0.00006	0.00013
09/22 23:30	0.00010	0.00015	0.00013	0.00012	0.00021	0.00006	0.00013
09/23 0:00	0.00007	0.00015	0.00015	0.00012	0.00021	0.00006	0.00013
09/23 0:30	0.00007	0.00015	0.00010	0.00012	0.00021	0.00006	0.00013
09/23 1:00	0.00007	0.00009	0.00009	0.00012	0.00019	0.00004	0.00012
09/23 1:30	0.00007	0.00009	0.00009	0.00012	0.00019	0.00004	0.00012
09/23 2:00	0.00005	0.00007	0.00007	0.00012	0.00017	0.00004	0.00010
09/23 2:30	0.00005	0.00007	0.00004	0.00012	0.00017	0.00004	0.00010
09/23 3:00	0.00005	0.00007	0.00007	0.00012	0.00017	0.00004	0.00010
09/23 3:30	0.00006	0.00007	0.00007	0.00012	0.00017	0.00004	0.00010
09/23 4:00	0.00006	0.00007	0.00007	0.00012	0.00017	0.00004	0.00010
09/23 4:30	0.00006	0.00007	0.00007	0.00012	0.00017	0.00004	0.00010
09/23 5:00	0.00006	0.00007	0.00007	0.00012	0.00017	0.00004	0.00010
09/23 5:30	0.00006	0.00007	0.00007	0.00012	0.00017	0.00004	0.00010
09/23 6:00	0.00006	0.00007	0.00007	0.00012	0.00017	0.00004	0.00010

09/23 21:30	0.00005	0.00009	0.00007	0.00010	0.00013	0.00004	0.00009
09/23 22:00	0.00006	0.00009	0.00007	0.00010	0.00013	0.00004	0.00009
09/23 22:30	0.00024	0.00042	0.00050	0.00034	0.00168	0.00029	0.00020
09/23 23:00	0.00024	0.00042	0.00050	0.00034	0.00168	0.00029	0.00020
09/23 23:30	0.00024	0.00042	0.00050	0.00034	0.00168	0.00029	0.00020
09/24 0:00	0.00024	0.00042	0.00050	0.00034	0.00168	0.00029	0.00020