EPJ manuscript No.
(will be inserted by the editor)

Price response functions and spread impact in foreign exchange markets

Juan C. Henao-Londono [a] and Thomas Guhr

Fakultät für Physik, Universität Duisburg-Essen, Lotharstraße 1, 47048 Duisburg, Germany

Received: date / Revised version: date

Abstract To be done

PACS. 89.65.Gh Econophysics – 89.75.-k Complex systems – 05.10.Gg Statistical physics

1 Introduction

Basic description:

The foreign exchange market is the most volatile and liquid of all financial markets in the world [13]. It is also the largest financial market in the world [12]. Its importance in the world economy is prominent. It affects employment, inflation, international capital flows, among others [9]. The foreign exchange market is a decentralized market without common trading floor [9,12,2]

In the foreign exchange market, the trading day begins in the markets of Australia and Asia. Then the markets of Europe open and finishes late in the afternoon in New York [9]. The markets does not formally closes during the week. Thus, using the New York time as reference, the market opens on Sunday at 18h00 and closes on Friday at 18h00 (?).

The term "pip" (Price Increment Point) is commonly used in the foreign exchange market in place of the word 'tick'. Pips arise as a matter of convention. A pip refers to the incremental value in the fifth non-zero digit position from the left. Note that it is not related to the position of the decimal point. For example, one pip in a USD/JPY value of 113.57 would be 0.01, while one pip for EUR/USD of 1.0434 would be 0.0001 [11,9].

The foreign exchange market has attracted a lot of attention in the last 20 years. Electronic trading has changed an opaque market to a fairly transparent with transactions costs that are a fraction of their former level. The large amount of data that is now available to the public make possible different kinds of analysis to this data. A lot of research is currently carry out in different directions [14, 9,3,7,12,13,5,2,8,10,4].

Previous works (general):

In [11] they found that smaller volumes cause larger bid-ask spreads for technical reasons to do with measurement, whereas in [6,7] claim that larger bid-ask spreads caused smaller volumes due to trader behavior.

In [1], they found the spreads to be between two and four times larger for emerging market currencies than for developed country currencies.

In [3], they found the Electronic Broking Services (EBS) reduces spreads significantly, but dealers with information advantage tend to quote relatively wider spreads.

In [8], they found that bid-ask spreads increase when the foreign exchange market volatility increases, and decrease when the dealer competition increases.

In [13], they focus in the three major market characteristics, namely efficiency, liquidity and volatility, finding that the market is efficient in weak form.

In [14], they investigate the dynamics of efficiency and long memory of four major traded currencies.

Previous works (specific):

Explanation of our work:

Despite the foreign exchange market is often cited as the world's largest financial market, this description fail to consider the considerable differences in trading volume and liquidity across different currency pairs [4]. These differences can be directly seen in the spread. Furthermore, the bid-ask spread is directly related with the transaction costs to the dealer [2].

Paper distribution:

The paper is organized as follows: in Sect. 2 we present our data set of foreign exchange pairs and briefly describe the physical and trade time. We then analyze the definition of the response functions in Sect. 3, and compute them for the majors pairs in Sect. 4. In Sect. 5 we show how the spread impact the values of the response functions. Our conclusions follows in Sect. 6.

2 Data set

In this study, we analyze foreign exchange pairs from the foreign exchange market.

We selected the foreign exchange market because ...

The foreign exchange financial data was obtained from HistData.com. We used a tick-by-tick database in generic

[a] *e-mail:* juan.henao-londono@uni-due.de

ASCII format for different years and currency pairs. The data comprises the date time stamp (YYYYMMDD HH-MMSSNNN), the best bid and best ask quotes prices in the Eastern Standard Time (EST) time zone. No information about the size of each transaction is provided. Also, the identity of the participants is not given.

3 Response functions

In Sect. 3.1 we establish the fundamental quantities used in the price response definitions. In Sect. 3.2 we describe the physical time scale and the trade time scale. We introduce the price response functions used in literature in Sect. 3.3.

3.1 Key concepts

Due to the lack of prices information in the data, we consider a basic definition of the price given by [5,10]

$$S_i\left(t\right) = \frac{a_i\left(t\right) + b_i\left(t\right)}{2} \tag{1}$$

Order book ref [9]
Spread ref [2]
Midpoint ref [2]

3.2 Time definition

3.2.1 Trade time scale

3.2.2 Physical time scale

3.3 Response function definitions

4 Price response function implementations

In Sect. 4.1 we analyze the responses functions in trade time scale and in Sect. 4.2 we analyze the responses functions in physical time scale.

4.1 Response functions in trade time scale

4.2 Response functions in physical time scale

5 Spread impact in price response functions

As we showed in 1, due to the difference in the position of the decimal points between foreign exchange rates, we need to introduce a "scaling factor" with the purpose of bringing the pip to the left of the decimal point. For example, the scaling factor for the USD/JPY is 100 and that for the EUR/USD is 10000.

The pip bid-ask spread is defined as [11]:

$$\text{pip}_{spread} = \left(a\left(t\right) - b\left(t\right)\right) \cdot \text{scaling factor} \tag{2}$$

6 Conclusion

7 Author contribution statement

TG proposed the research. JCHL developed the method of analysis. The idea to analyze the spread impact was due to JCHL. JCHL carried out the analyisis. All the authors contributed equally to analyze the results and write the paper.

One of us (JCHL) acknowledges financial support from the German Academic Exchange Service (DAAD) with the program "Research Grants - Doctoral Programmes in Germany" (Funding programme 57381412)

Appendix A Foreign exchange pairs used to analyze the spread impact

References

1. Craig Burnside, Martin Eichenbaum, and Sergio Rebelo. The returns to currency speculation in emerging markets. Working Paper 12916, National Bureau of Economic Research, February 2007.
2. Jeng-Hong Chen. Teaching the bid-ask spread and triangular arbitrage for the foreign exchange market. *American Journal of Business Education (AJBE)*, 11:55–62, 10 2018.
3. Liang Ding and Jonas Hiltrop. The electronic trading systems and bid-ask spreads in the foreign exchange market. *Journal of International Financial Markets, Institutions and Money*, 20(4):323 – 345, 2010.
4. Martin D.D. Evans and Dagfinn Rime. Microstructure of foreign exchange markets. *Available at SSRN 3345289*, 2019.
5. James Glattfelder, Alexandre Dupuis, and Richard Olsen. Patterns in high-frequency fx data: Discovery of 12 empirical scaling laws. *arXiv.org, Quantitative Finance Papers*, 11, 01 2008.
6. Harald Hau, William Killeen, and Michael Moore. The euro as an international currency: explaining puzzling first evidence from the foreign exchange markets. *Journal of International Money and Finance*, 21(3):351–383, June 2002.
7. Harald Hau, William Killeen, and Michael Moore. How has the euro changed the foreign exchange market? *Economic Policy*, 17(34):149–192, April 2002.
8. Roger D. Huang and Ronald W. Masulis. Fx spreads and dealer competition across the 24-hour trading day. *Capital Markets: Market Microstructure*, 1999.
9. Michael King, Carol Osler, and Dagfinn Rime. *Foreign Exchange Market Structure, Players and Evolution.* 08 2012.
10. M. Kremer, A. P. Becker, I. Vodenska, H. E. Stanley, and R. Schäfer. Economic and political effects on currency clustering dynamics. *Quantitative Finance*, 19(5):705–716, 2019.
11. Frank McGroarty, Owain ap Gwilym, and Stephen Thomas. Microstructure effects, bid–ask spreads and volatility in the spot foreign exchange market pre and post-emu. *Global Finance Journal*, 17(1):23 – 49, 2006.

12. LUKAS MENKHOFF, LUCIO SARNO, MAIK SCHMELING, and ANDREAS SCHRIMPF. Information flows in foreign exchange markets: Dissecting customer currency trades. *The Journal of Finance*, 71(2):601–634, 2016.
13. Anna Serbinenko and Svetlozar Rachev. Intraday spot foreign exchange market. analysis of efficiency, liquidity and volatility. *Investment Management and Financial Innovations*, 6:35–45, 01 2009.
14. Syed Jawad Hussain Shahzad, Jose Areola Hernandez, Waqas Hanif, and Ghulam Mujtaba Kayani. Intraday return inefficiency and long memory in the volatilities of forex markets and the role of trading volume. *Physica A: Statistical Mechanics and its Applications*, 506:433 – 450, 2018.