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Multiscale analysis of foreign exchange order flows and technical trading profitability

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ABSTRACT

This paper investigates the multiscale (frequency-dependent) relationship between technical trading profitability and feedback trading effects in the Canada/U.S. dollar foreign exchange market. The results suggest that technical trading activities of financial customers drive frequent violations of the FX market microstructure assumption that exchange rate movements are driven by order flow. After controlling for transaction costs, we find that the contribution of financial customers in feedback trading dominates the contribution of non-financial customers, especially at lower frequencies. An additional, novel contribution is that technical indicators constructed from order flows can be profitable.

1. Introduction

In technical analysis, technical trading rules are constructed from historical price (and volume) information. Specifically, traders place their orders by mechanically applying mathematical transformations and rules based on past and present prices. However, this notion contrasts the major assumption underlying foreign exchange (FX) market microstructure theory that exchange rate movements are driven by order flow and not vice-versa (Lyons, 2001). The argument in favor of this assumption stems from the classical equity microstructure literature such as Hasbrouck (1991), Glosten and Milgrom (1985) and O'Hara (1995): in rational markets, *aggregate* order flow should reflect innovations in dispersed information, rather than being the result of "momentum" (or "feedback") trading strategies followed by *some* FX traders.[2] Notwithstanding the theoretical validity of this argument, Schulmeister (2006) finds that currency order flows can in fact be driven by technical trading signals. He uncovers strong feedback effects where a rising exchange rate triggers buy technical trading signals and thereby strengthens the appreciation trend.[3] It is worth noting that in case of any evidence of reverse causality, the linear estimate of the size of price effects would be biased at a given time scale.

Only a few papers have directly tested the causality assumption in FX markets and they focused on a particular data frequency (typically daily). Killeen et al. (2006) find that Granger causality runs from interdealer order flow to price, and not vice versa, for the DM/FRF exchange rate. However, several papers documented statistically significant reverse causality effects. For instance, Sager and Taylor (2008) perform Granger causality tests on the data from Evans and Lyons (2002) and reveal that causality runs from the DM/USD and JPY/USD exchange rate returns to corresponding interdealer order flows. They also present evidence against the causality assumption for customer order flows. This evidence corroborates Marsh and O'Rourke (2005) who argue that commercial order flow is price sensitive. Similarly, Boyer and van Norden (2006) conclude that interdealer order flow responds to the FRF/USD spot rate innovations. They note that the price responsiveness of commercial order flow contrasts with the usual predictions of the microstructure literature. Gradojevic and Neely (2008) demonstrate the ability of the Canada/U.S. dollar returns to predict financial order

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[2] Positive (negative) feedback trading is systematic buying (selling) in response to price increases, and selling (buying) in response to price decreases (Evans and Lyons, 2002).

[3] Alternatively, feedback effects in the FX market can also be caused by liquidity provision. Bjønnes et al. (2005), for example, find that non-financial customers are passive liquidity providers in the SEK/EUR market. In the same vein, D'Souza (2008) documents that, in addition to commercial clients, dealers are key participants in the provision of liquidity in the Canada/U.S. dollar market.

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flows, but not non-financial order flows. Lyons (2001) finds some evidence that falling prices induce additional selling in the JPY market and refers to that phenomenon as "distressed selling". Recently, Gradojevic (2012) showed that reverse causality in FX market microstructure is frequency-dependent. This evidence is consistent with arguments that, in financial markets, the data generating process (DGP) is a complex network of layers with each layer corresponding to a particular frequency. Thus, a successful characterization of such DGP should be estimated with techniques that account for intra- and inter-frequency dynamics (Dacorogna et al., 2001).[4]

The main goal of this paper is to test the strength of the relationship between multiscale feedback effects (i.e., reverse causality in the frequency domain) and technical trading profitability in the Canada/U.S. dollar market. The motivation for this research is to study the behavior of technical traders with different time horizons such as daily, weekly, bi-weekly and monthly. More importantly, this exploration seeks to understand whether the dominance of technical trading is the kind of "irrational" behavior that governs feedback trading. The profitability of moving average, filter and trading range breakout technical indicators is tested on the Canada/U.S. dollar exchange rate, and cumulative financial and non-financial order flows. This paper is novel to the literature because it is the first study, to the authors' best knowledge, to use currency order flows (i.e., proxies for trading volume) for technical trading rule calculations. Also, it is important to emphasize that the analysis presented in this paper differs from the existing literature (e.g., Gradojevic and Neely, 2008; Gradojevic, 2007; Evans and Lyons, 2005; Rime et al., 2010; Schulmeister, 2006) in that it accounts for the wide range of FX trading horizons in the frequency domain. In all, we develop four testable hypotheses that concern the theoretical assumptions of the FX market microstructure model (i.e., the direction of causality), customer type, sampling frequency, technical trading profitability and market regime.

In the first part of the paper, the frequency domain causality tests are performed on Canada/U.S. dollar returns, and financial and non-financial order flows. It is confirmed that, in general, there is very little evidence of a stable causal relationship between order flows and returns running in either direction. The null hypothesis of no predictability of FX returns by spot non-financial order flows is not rejected at weekly and shorter horizons, while it is rejected for financial order flows at horizons between 3 and 8 days. In terms of reverse causality from price to order flows, we document that daily and weekly frequencies exhibit feedback effects for non-financial, whereas, financial order flows are found to be driven by price changes at longer horizons. Next, for both order flow types, we test the hypothesis that technical trading rules constructed at the 'reverse causality frequencies' are more profitable than the trading rules generated from data sampled at other frequencies. Our evidence of very short run technical trading profitability indicates that non-financial customers were engaged in feedback trading primarily at the daily horizon. Also, we present the findings of medium (bi-weekly and monthly) horizon profitability that can be attributed to the technical trading of financial customers.

In general, even after accounting for transactions costs, substantial technical trading excess returns are found for all three time series and the profitability in general increases with the time horizon.[5] Furthermore, the results indicate that technical trading rules are more profitable with non-financial order flows than with financial order flows. This suggests that there is more technical trading information content in the trades of non-financial customers (dominated by Canadian corporations) than in the trades of financial customers (dominated by foreign dealers). Alternatively stated, Canadian-domiciled and corporate customers also engage in short-term trading and their transactions may provide insights regarding the fundamental trends in the Canadian economy, which act as a leading indicator for the exchange rate.

Considering the evidence of a stable increasing trend in technical trading profitability with the trading horizon, it can be concluded that reverse causality effects at a particular frequency imply technical trading profitability of financial customers at such a frequency. These findings suggest that feedback trading effects can be explained by the predominant activity of technical traders acting for financial institutions.

In the next section, the methodology for causality in the frequency domain is reviewed. The data and the construction of technical trading strategies are presented in Section 3. Section 4 discusses the findings. The final section concludes the paper.

2. Causality in the frequency domain

The test for causality in the frequency domain by Breitung and Candelon (2006) originates from Geweke (1982) and Hosoya (1991). Let $z_t = [x_t, y_t]'$ be a two-dimensional time series vector with t = 1,…,T. It is assumed that z_t has a finite-order VAR representation

$$\Theta(L)z_t = \varepsilon_t, \tag{1}$$

where $\Theta(L) = I - \Theta_1 L - \ldots - \Theta_p L^p$ is a 2 × 2 lag polynomial with $L^k z_t = z_{t-k}$. It is assumed that the vector ε_t is white noise with $E(\varepsilon_t) = 0$ and $E(\varepsilon_t \varepsilon_t') = \Sigma$, where Σ is a positive definite matrix. Next, let G be the lower triangular matrix of the Cholesky decomposition $G'G = \Sigma^{-1}$, such that $E(\eta_t \eta_t') = I$ and $\eta_t = G\varepsilon_t$. The system is assumed to be stationary, implying the following MA representation:

$$\begin{aligned} z_t = \Phi(L)\varepsilon_t &= \begin{bmatrix} \Phi_{11}(L) & \Phi_{12}(L) \\ \Phi_{21}(L) & \Phi_{22}(L) \end{bmatrix} \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix} \\ &= \Psi(L)\eta_t = \begin{bmatrix} \Psi_{11}(L) & \Psi_{12}(L) \\ \Psi_{21}(L) & \Psi_{22}(L) \end{bmatrix} \begin{bmatrix} \eta_{1t} \\ \eta_{2t} \end{bmatrix} \end{aligned} \tag{2}$$

where $\Phi(L) = \Theta(L)^{-1}$ and $\Psi(L) = \Phi(L)G^{-1}$. Using this representation, the spectral density of x_t can be expressed as

$$f_x(\omega) = \frac{1}{2\pi}\left\{\left|\Psi_{11}\left(e^{-i\omega}\right)\right|^2 + \left|\Psi_{12}\left(e^{-i\omega}\right)\right|^2\right\}. \tag{3}$$

The measure of causality suggested by Geweke (1982) and Hosoya (1991) is defined as

$$M_{y\to x}(\omega) = \log \frac{2\pi f_x(\omega)}{|\Psi_{11}(e^{-i\omega})|^2} \tag{4}$$

$$= \log\left[1 + \frac{\left|\Psi_{12}\left(e^{-i\omega}\right)\right|^2}{|\Psi_{11}(e^{-i\omega})|^2}\right]. \tag{5}$$

This measure is zero if $|\Psi_{12}(e^{-i\omega})| = 0$ in which case it is said that y does not cause x at frequency ω. To test the hypothesis that y does not cause x at frequency ω the following null hypothesis is used:

$$M_{y\to x}(\omega) = 0. \tag{6}$$

Yao and Hosoya (2000) estimate $M_{y\to x}(\omega) = 0$ by replacing $|\Psi_{11}(e^{-i\omega})|$ and $|\Psi_{12}(e^{-i\omega})|$ from Eq. (5) with estimates obtained from the fitted VAR. However, this approach is not appropriate since

[4] The idea that the causality relationship between two variables may have different characteristics at different time-scales can also be found in Gençay et al. (2001). They use wavelet multiresolution analysis of money growth and inflation, and show that for Argentina, Brazil, Chile, Israel, Mexico and Turkey the nature of the causality changes with wavelet scales (periods between two and 32 months).

[5] The findings that technical trading strategies can be profitable at medium horizons is consistent with Neely and Weller (2003) and Harris and Yilmaz (2009).