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A Twofold Model for Exchange Rate Forecasting: Combining Fundamentals and Market Dynamics

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Abstract
This paper offers a fresh perspective on exchange rate determination by incorporating both microstructural and macroeconomic variables, aiming to bridge the gap between traditional economic theories and the more recent microstructure approaches. The study tests a combination of fundamental economic factors and microstructure elements within a cointegration framework, analyzing their joint impact on exchange rates across multiple currencies. By doing so, it provides a more comprehensive model that captures both long-term economic fundamentals and short-term market-specific dynamics. The "twofold" model proposed in this study integrates macroeconomic fundamentals, including interest rates, money supply, and net foreign assets, with microstructural variables such as the bid-ask spread and high-low spread. Macroeconomic fundamentals represent the broader economic forces traditionally thought to drive exchange rates, while microstructure variables capture the liquidity, transaction costs, and trading behavior within foreign exchange markets. The inclusion of microstructure variables recognizes the significance of market-specific factors that influence currency values in the short term, providing a more nuanced understanding of exchange rate movements. To evaluate the performance of the twofold model, it is compared with conventional macroeconomic models and the widely used random walk model through an error-correction framework. The error-correction method allows the study to analyze both short-term deviations and long-term equilibrium relationships, making it particularly suited for examining the cointegration of exchange rates with their determinants. The analysis includes both in-sample and out-of-sample forecasting tests to ensure the robustness of the findings. The results of the study demonstrate that the twofold model outperforms both the macroeconomic models and the random walk model in forecasting exchange rates. In both in-sample and out-of-sample tests, the twofold model provides greater predictive accuracy, highlighting the value of integrating microstructural variables into exchange rate models. This suggests that the traditional macroeconomic approach alone may not fully capture the complexities of exchange rate behavior, particularly in the short term where market dynamics play a significant role. The findings have important implications for both academic research and practical applications. For researchers, the study underscores the need to consider microstructural factors alongside economic fundamentals when modeling exchange rates. This integrated approach could lead to more accurate and reliable models that better reflect the realities of foreign exchange markets. For policymakers and market participants, the results provide valuable insights into the drivers of exchange rate movements, potentially aiding in the design of better monetary policies and trading strategies. By introducing a more comprehensive framework for exchange rate determination, this paper contributes to the ongoing evolution of exchange rate modeling. It challenges the traditional reliance on macroeconomic fundamentals alone and highlights the importance of incorporating market-specific dynamics. Future research could build on this work by exploring additional microstructure variables or applying the twofold model to other financial markets, further enriching the understanding of the interplay between macroeconomic and microstructural factors in determining exchange rates.

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1. INTRODUCTION

Throughout the history of exchange rate determination, perspectives have evolved significantly, shifting from a purely macroeconomic approach to incorporating insights from microstructural theories. Early models, such as those by Hinkle and Montiel, emphasized macroeconomic fundamentals like trade balances, interest rates, and money supply, viewing the exchange rate primarily as a reflection of a nation's economic health and competitiveness. However, the emergence of the macroeconomic disconnect puzzle marked a pivotal moment. This puzzle highlighted the limitations of structural models in explaining short-term exchange rate movements, paving the way for incorporating microstructural factors, particularly order flow, as a central determinant of currency valuation (Omri, 2022; ven Zanden, 2023; Jallow, 2023; Sonkayde et al., 2023; Gulmez, 2023; Olorunnimbe & Viktor, 2023.

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The exchange rate inherently operates on two dimensions that policymakers must carefully navigate. On one hand, it serves as a price that affects the production and consumption of goods and services, directly influencing domestic competitiveness and consumption patterns (Wali, 2018; Rubi et al., 2022; Audi & Al Masri, 2024). On the other hand, the exchange rate is also an asset price, responsive to market sentiment, news, and expectations, which makes it central to investment decisions both within and outside national borders. Fluctuations in currency values can disrupt demand for domestic products, alter competitiveness, and reshape the economy's trajectory (Banyen, 2022; Khan, 2022). Simultaneously, investment flows are influenced by shifts toward safer or more stable currencies, leading to portfolio reallocations and impacting the broader financial landscape. The exchange rate thus encapsulates a nation’s economic policy effectiveness, societal development, and financial market stability. It reflects the balance of power among major global players and remains a focal point for policymakers, researchers, and analysts. Historically, interest rate differentials have been a cornerstone of exchange rate models, forming the basis of approaches like Uncovered Interest Parity (UIP). According to UIP, differences in foreign and domestic interest rates are intertwined with other macroeconomic fundamentals to explain expected currency appreciations or depreciations. Empirical studies have consistently shown the relevance of interest rates in determining exchange rate variability, though their impact often depends on the interplay with volatilities, political decisions, and the classification of exchange rate regimes. Money supply, another enduring macroeconomic factor, has long been central to exchange rate determination. Studies have shown how the flow of money can predict currency movements, with the M1 measure of money supply frequently included in models to capture this dynamic (Abdullah et al., 2013; Roussel et al., 2021; Adjasi & Yu, 2021; Ali & Mohsin, 2023). Despite evolving technologies and changes in financial systems, the resilience of money supply as a determinant underscores its importance in understanding exchange rate behavior. The limitations of traditional macroeconomic models, particularly in short-term predictions, have driven the adoption of microstructural approaches in exchange rate determination. The microstructure of currency markets introduces a new lens by focusing on the roles and behaviors of market participants. Key among these is order flow, defined as the net difference between initiated buy and sell orders, which carries directional information distinct from transaction volume. In currency markets, dealers or market makers are often better informed than individual traders. Their order flows, reflecting aggregated market sentiment and information, have proven to be powerful predictors of exchange rate fluctuations, often surpassing the explanatory power of traditional macroeconomic variables (Iqbal, 2018; Ahmed & Rehman, 2019; Roy & Madheswaran, 2020; Kallianiotis, 2022).

Order flow is closely linked to macroeconomic fundamentals, providing a bridge between short-term market dynamics and long-term economic factors. It acknowledges the heterogeneity of market participants, whose varying strategies and time horizons influence currency prices and volatility differently. While macroeconomic fundamentals dominate over longer horizons, microstructural factors are critical in explaining short-term volatility and price movements. This evolution in exchange rate theories underscores the complexity of currency markets, where macroeconomic fundamentals and microstructural dynamics interact to shape outcomes (Audi, 2016; Server, 2019; Jammazi & Mokni, 2021; Audi & Al Masri, 2024). Recognizing these dual influences provides a more comprehensive framework for understanding exchange rate behavior, offering valuable insights for policymakers, market participants, and researchers alike. The integration of microstructure variables, such as order flow, alongside traditional economic fundamentals, represents a significant advancement in the field, enabling more accurate predictions and nuanced analyses of currency markets. In analyzing the prevailing trends and challenges associated with exchange rate determination, it becomes evident that governments face critical decisions in formulating effective exchange rate policies. Monetary authorities, in particular, must carefully balance economic parameters and maintain social stability while deploying monetary tools such as interest rate adjustments (Audi et al., 2021; Elsayed et al., 2021; Hu et al., 2021; Jena et al., 2021; Jabeur et al., 2024). These decisions are not made in isolation but are heavily influenced by the interplay of domestic and international economic dynamics.

Investors play a pivotal role in the exchange rate market as they absorb information, interpret economic announcements, and adjust their portfolios accordingly. Their decisions, based on both long-term economic trends and short-term market developments, reflect a complex array of variables. These include macroeconomic indicators, such as trade balances and interest rate differentials, as well as microstructural factors, such as spreads and order flow, which capture the market sentiment and liquidity conditions. Traditional monetary models have provided a foundational understanding of how central banks react to maintain specific currency targets. These models emphasize the role of macroeconomic variables, capturing the interactions between households, governments, and international markets (Jing et al., 2021; Kumbure et al., 2022; Kismawadi, 2024). These interactions drive adjustments in exchange rates, reflecting economic fundamentals. However, the emergence of the microstructural approach has enriched this understanding by incorporating the behaviors and interpretations of market participants, particularly investors. This perspective highlights the influence of order flow and spreads as critical factors in short-term currency price movements, adding depth to the conventional macroeconomic models.

The hypothesis underlying this research is that a combination of macroeconomic fundamentals and microstructural variables can enhance the accuracy of exchange rate forecasts. By integrating these two dimensions, it becomes possible to construct a more comprehensive and dynamic model that reflects the multifaceted nature of currency markets. Spreads, which measure the cost of trading and liquidity in the market, and order flow, which represents the net buying or selling pressure, are proposed as key microstructural variables that interact with macroeconomic fundamentals to influence currency valuation.

To test these assumptions, this study will employ a cointegration relationship to examine the long-term and short-term effects of these variables. The cointegration approach will help identify whether a stable relationship exists between the macroeconomic and microstructural determinants of exchange rates over the long run (Kismawadi, 2024; Kakran et al., 2024). An error correction model will then be used to capture the short-run deviations from this equilibrium and assess how quickly the exchange rate adjusts to align with its long-run path. By integrating macroeconomic fundamentals with microstructural variables in a single framework, this study aims to provide a more nuanced understanding of exchange rate dynamics (Kismawadi, 2024; Jannah et al., 2024). Such a model not only enhances forecasting accuracy but also offers valuable insights for policymakers and market participants in navigating the complexities of exchange rate management and financial market stability.

2. LITERATURE REVIEW

The relationship between exchange rates and interest rate differentials has been a focal point in exchange rate determination literature, exhibiting a nuanced dynamic across different time horizons. Research by Chinn and Zhang (2018) highlights a positive correlation between exchange rates and interest rate differentials over long horizons, contrasting with a negative correlation over shorter periods. This long-term alignment strengthens the predictive power of Uncovered Interest Parity (UIP), which operates on the assumption of market efficiency. Their work, employing a New Keynesian dynamic stochastic general equilibrium model, underscores the limitations of interest rate differentials as standalone predictors of exchange rates, particularly in the short run, where market frictions diminish the effectiveness of UIP. Earlier empirical studies, notably by Meese and Rogoff (1983), cast doubt on the utility of interest rates for exchange rate prediction. These findings initially undermined the application of monetary fundamentals in short-term exchange rate models. However, later research introduced a more nuanced understanding by incorporating risk premiums into UIP frameworks. For example, Meredith and Chinn (1998) and Alexius (2001) demonstrated stronger relationships between interest rate parity and exchange rate determination when accounting for risk premiums. Their cointegration analyses on G-7 countries revealed significant short- and long-term effects of monetary variables on exchange rates, suggesting that the inclusion of risk factors enhances the explanatory power of traditional monetary models.

Groen (2001) expanded this line of inquiry by analyzing Euro exchange rates against the currencies of Canada, Japan, and the U.S., finding that monetary fundamentals had greater predictive accuracy over longer horizons. Using both in-sample and out-of-sample forecasting models, Groen observed that fundamentals provided more robust forecasts compared to the random walk model, as measured by Root Mean Square Error (RMSE) criteria. Similarly, Cerra and Saxena (2010) examined a broader dataset encompassing 96 countries, uncovering strong cointegration evidence between exchange rates and fundamentals. Their findings highlighted the superior forecasting performance of monetary models over the random walk model, further supporting the importance of fundamentals in explaining exchange rate variability. Attempts to establish equilibrium exchange rate models, such as the NATREX (Natural Real Exchange Rate) and BEER (Behavioral Equilibrium Exchange Rate), have shown mixed results. Meese and Rogoff (1983) found these models lacking in cointegration evidence, and they failed to outperform the random walk model in terms of mean squared error. However, Cheung et al. (2005) noted that structural models, under specific conditions, could outperform the random walk model in predicting the direction of exchange rate changes, suggesting that model performance can vary depending on the context and specifications.

Balancing monetary instruments, including net foreign assets and interest rates, remains critical for predicting exchange rate shifts and determining currency excess returns. Della Corte et al. (2016) emphasized that the interplay of these instruments plays a key role in shaping exchange rate dynamics and excess return predictions. Portfolio balance models in asset pricing provide another perspective on exchange rate determination, focusing on risk exposure. Early studies, such as those by Branson et al. (1977), explored the role of exchange risk premiums measured through government bonds and swaps. However, these approaches often struggled to yield consistent results. For instance, Frankel and Engel (1984) examined six major currencies using the classical Capital Asset Pricing Model (CAPM) and maximum likelihood estimation of mean-variance components, finding limited evidence supporting the portfolio balance approach or the risk exchange premium. Money supply, encompassing currency and liquid instruments such as saving accounts, coins, and cash circulating within the economy, has long been recognized as a significant factor in exchange rate determination. Earlier studies, including those by Levin and Cushman and Zha, highlighted the importance of tracking the flow of money to predict exchange rate movements. The relevance of money supply persists, as it remains a key indicator of monetary policy and economic liquidity, which directly and indirectly influences currency valuation.

Recent research has demonstrated that not only the actual money supply but also the announcements and anticipations by monetary authorities can impact exchange rates and investor returns. Mueller et al. (2017) observed that currency excess returns spike on announcement days, showcasing how central bank communications can surpass even interest rate differentials in influencing short-term currency movements. This highlights the role of market sentiment and expectations in shaping exchange rate dynamics, where the signaling effect of monetary announcements can temporarily overshadow traditional macroeconomic indicators. Net Foreign Assets (NFAs) also play a critical role in exchange rate determination, particularly in open economy macroeconomic models. NFAs, as a state variable, capture the effects of temporary policy shocks and investor behavior on asset prices. According to Obstfeld and Rogoff (1995) and Lane and Milesi-Ferretti (2001), NFAs reflect a country's external balance, and shifts in these positions often signal changes in government policies or economic conditions. For instance, Monacelli and Perotti (2010) noted that increased government spending typically leads to a depreciation of the real exchange rate while boosting private consumption. Real exchange rate dynamics are also closely tied to non-traded goods, further emphasizing their interplay with domestic economic shocks.

Long-term studies have also provided critical insights into the determinants of real effective exchange rates. Ricci et al. (2008) analyzed a panel of 48 countries over two decades, finding that government consumption has a substantial and statistically significant effect on real exchange rates. Their results indicated that a one percentage point increase in the ratio of government consumption to GDP correlates with a three percentage point appreciation of the real effective exchange rate. This suggests that fiscal policy, particularly government consumption, is a crucial factor in exchange rate dynamics, with implications for both advanced and emerging economies. Gagnon (1996) explored this relationship further, examining a panel of 20 countries over several decades to assess the impact of productivity (Balassa-Samuelson effect), government consumption, and NFAs on exchange rate variability. Using a cointegrated model and the Phillips-Loretan estimator, Gagnon found that increases in NFAs lead to exchange rate appreciations of approximately 20% in the short run and 10% in the long run. This highlights the significance of NFAs, particularly for economies facing external constraints, low savings, or strong trade balances, as evidenced by the findings of Chinn and Ito (2008) and Christopoulos et al. (2012). Building on the theoretical foundation of Obstfeld and Rogoff (1995), Cavallo and Ghironi (2002) extended the model to emphasize the relationship between exchange rate determination and NFAs. Their findings indicated that the current value of a currency is influenced by the accumulation of net foreign assets from previous periods. Capital inflows, often reflected as net foreign debt, generally lead to currency appreciation, underlining the forward-looking nature of exchange rate valuation. The interplay between monetary factors like money supply and interest rates, fiscal variables such as government consumption, and external balances represented by NFAs paints a complex picture. While long-term exchange rate trends align more closely with fundamentals such as NFAs and fiscal policy, short-term fluctuations are significantly shaped by market expectations, investor sentiment, and policy announcements. This integrated perspective is essential for understanding and forecasting exchange rate behavior in both advanced and emerging economies. Sachs and Wyplosz (1984) highlighted the critical role of net foreign assets (NFAs) and public spending in shaping the real exchange rate (RER). Their findings underscored that not only the level of public expenditure but also its composition, along with taxation policies, exert a significant influence on RER dynamics. This aligns with the "transfer problem," a concept introduced by John Maynard Keynes in 1929, which examines how international transfers, such as those represented by changes in NFAs, affect exchange rates. Lane and Milesi-Ferretti (2004) further emphasized this relationship, noting that for countries where exports are predominantly denominated in domestic currencies, the terms of trade are relatively exogenous to nominal exchange rate fluctuations.

Recent studies focusing on developed countries have used cumulative current account balances as a proxy for NFAs. These analyses reveal that higher NFAs are associated with currency depreciation in the long run, highlighting the counterintuitive relationship where asset accumulation exerts downward pressure on the nominal exchange rate over time (Lane and Milesi-Ferretti, 2004). The implications of this finding are particularly relevant for nations with persistent current account surpluses or deficits, as they point to the long-term adjustments required in exchange rates to balance external positions. Gourinchas and Rey (2005) expanded on this framework by exploring the predictive power of NFAs in exchange rate movements. They demonstrated that the ratio of net exports to net foreign assets contains valuable information about future exchange rate changes. Using a cointegration approach, they showed that this ratio could significantly explain exchange rate variance over long horizons. Importantly, their model proved effective not only in-sample but also out-of-sample, outperforming the random walk model in forecasting exchange rate behavior at various time horizons. This indicates that NFAs serve as a crucial state variable for understanding the dynamics of exchange rates, offering a robust predictive tool for both theoretical and practical applications. Transfer effects are central to many open-economy macroeconomic models, serving as a lens to understand how shifts in NFA positions reflect temporary shocks in government policies and investor behavior. Obstfeld and Rogoff (1995) and Lane and Milesi-Ferretti (2001) highlighted the role of NFAs in capturing the adjustments required when economies face policy shifts or external imbalances. These transfer effects underline the interconnectedness of fiscal policies, international investment flows, and exchange rate adjustments, showing how temporary changes in economic policies or market conditions can have lasting impacts on exchange rate dynamics.

However, empirical analyses of exchange rates face notable challenges, particularly when using structural models based on macroeconomic fundamentals. These models often struggle to fit the data accurately or to provide reliable forecasts, whether in-sample or out-of-sample. The variation in data across countries—due to differing structural specifications and varying stages of economic development—adds to the complexity. This issue is part of the broader "disconnect problem," a term used to describe the weak or inconsistent correlation between macroeconomic variables and exchange rate variations. Obstfeld and Rogoff (2000) identified this disconnect as one of the most persistent and challenging puzzles in international macroeconomics. The disconnect problem reflects the limitations of traditional macroeconomic models in capturing the multifaceted nature of exchange rate determination. Exchange rates are influenced by a mix of long-term structural factors, such as NFAs and trade balances, and short-term dynamics, including market sentiment, policy announcements, and speculative activity. This complexity necessitates models that can integrate these diverse influences, balancing macroeconomic fundamentals with microstructural variables to provide a more comprehensive understanding of exchange rate behavior. Addressing the disconnect problem remains a priority for researchers, as resolving it would significantly enhance the ability to predict and manage exchange rate movements in both developed and emerging economies. The debate surrounding the exchange rate disconnect puzzle and its relationship with economic fundamentals has persisted for decades. Some authors, such as Cheung et al. (2005) and Engel and West (2005), argue that inaccuracies in measuring fundamentals contribute to this puzzle. Despite improvements in measurement techniques and the introduction of alternative approaches to track the exchange rate-fundamentals relationship, the disconnect puzzle remains a robust phenomenon that continues to defy simple explanations. Rather than denying its existence, researchers increasingly view it as a phenomenon requiring deeper exploration. A related concept, the purchasing power parity (PPP) puzzle, further highlights the weak correlation between exchange rates and national price levels, underscoring the complexities of exchange rate determination.

One critical aspect of exchange rate dynamics is the role of spreads, which are influenced by various costs faced by dealers in the market. Among these, asymmetric information poses the most significant challenge. Dealers must contend with the possibility that some customers are better informed than anticipated, which can result in financial losses. If dealers could easily identify the most informed investors, the adverse effects of asymmetric information would diminish. However, this identification is not straightforward, so dealers set spreads to compensate for potential risks. Additionally, market risk and the actions of large players influence spread width, as dealers must account for unexpected interventions and market disruptions. Historical market movements and events also shape spread-setting behavior, and when informed and uninformed investors can be distinguished, spreads may incorporate adverse selection components, as suggested by Easley and O'Hara (1987). Empirical findings reinforce the importance of adverse selection in determining foreign exchange spreads. Lyons (1995) analyzed the DM/USD exchange rate on a daily basis and found that dealers adjust their spreads based on the frequency and volume of order flow. Similarly, Yao (1998) examined intraday spreads in the interbank foreign exchange market and concluded that adverse selection significantly influences spread construction. Dealers bear roughly one-third of the total adverse selection cost due to risk-sharing mechanisms within the interdealer market. However, the adverse selection component constitutes only about 17% of the total quoted spread, reflecting the relatively low level of private information in currency markets. Government interventions also play a critical role in spread variability. Naranjo and Nimalendran (2000) examined the Deutsche Mark and US dollar exchange rate from 1976 to 1994, finding that government actions significantly impact spreads. Their research decomposed interventions into expected and unexpected components, demonstrating that spreads respond strongly to both types of intervention, underscoring the market's sensitivity to official activities. Order flow is another crucial factor in exchange rate dynamics, closely linked to macroeconomic fundamentals and a reliable predictor of exchange rate fluctuations. Rime et al. (2010) emphasized the predictive power of order flow, driven by a "push-pull" mechanism. In this framework, well-informed investors, known as "push" actors, actively drive price movements by initiating trades that influence exchange rates. Conversely, less-informed investors, often individual traders, are "pull" actors who react to price movements by taking opposing positions. This interplay between informed and less-informed participants generates the flow of orders that underpins short-term exchange rate variations.

The exchange rate disconnect puzzle, purchasing power parity puzzle, and the determinants of spreads and order flow reveal the complex interplay of factors influencing currency markets. While macroeconomic fundamentals provide a foundation for long-term exchange rate trends, microstructural elements such as dealer behavior, adverse selection, government interventions, and order flow play pivotal roles in short-term dynamics. Together, these insights illustrate the multifaceted nature of exchange rate determination, highlighting the need for integrative models that account for both macroeconomic and microstructural variables to better understand and predict exchange rate movements.

3. METHODOLOGY

In our study, we utilize monthly data spanning from 1990 to 2023 to explore the monetary model of exchange rate determination. Microstructural models, which focus on the dynamics of the foreign exchange (forex) market, often emphasize the role of order flows or spreads to capture the impact of market structure on future exchange rate movements. These models seek to understand how the behavior of market participants—especially informed and uninformed traders—affects currency prices in the short term. To address the limitations of available data, we attempt to construct a variable that approximates the informational aspect of order flow. This is done by combining two key elements: the bid-ask spread and the high-low exchange rate difference. Both of these factors provide insights into the liquidity and volatility of the forex market, which are critical components of market microstructure. The bid-ask spread, in particular, reflects the price at which dealers are willing to buy and sell currency, while the high-low difference offers a measure of intra-period volatility. By combining these two measures, we aim to capture the information that is implicit in market pricing, which can reveal the behavior of informed investors and how it might affect future exchange rate movements.

For the data collection, we rely on Eikon Thomson Reuters, which provides monthly information on exchange rate ask and bid prices, as well as the high and low exchange rate differences. This data comes from one of the largest interdealer forex markets, where professional market makers (dealers) set the bid and ask prices in response to shifts in market conditions and investor behavior. These dealers use bid-ask spreads to protect themselves from the risk of trading with uninformed or undesirable investors. In this context, the spread serves as a tool to adjust dealers' market positions when there are shifts in investor sentiment or in the broader economic environment. However, it is worth noting that much of the existing microstructure literature tends to overlook the importance of spreads in empirical analyses, often assuming that spreads are constant or merely a reflection of market inefficiencies. In contrast, our approach emphasizes that spreads are dynamic and can provide important information about market conditions and investor behavior. By observing how spreads fluctuate over time, we can infer changes in market sentiment, liquidity, and the degree of information asymmetry between market participants.

In addition to the bid-ask spread and high-low difference, we also incorporate the net international investment position (NIIP) as an indicator of a country's net external position. The NIIP is calculated as the difference between a nation's foreign assets and foreign liabilities, and it is closely related to the concept of net foreign assets (NFA). The NIIP serves as a key macroeconomic variable that reflects the capital flows into and out of a country, which in turn affects the exchange rate. Classical theories of exchange rate determination, such as the Mundell-Fleming model, often use the balance of payments—measuring capital inflows and outflows—as a proxy for the overall position of a country's economy in the global market. By including the NIIP in our model, we can better capture the long-term effects of capital flows and external liabilities on exchange rate movements. Thus, the combination of microstructural variables, such as bid-ask spreads and high-low differences, with macroeconomic indicators, like the NIIP, provides a comprehensive framework for understanding exchange rate dynamics. This approach not only accounts for market structure and investor behavior in the short run but also integrates fundamental factors, such as capital flows, that drive long-term exchange rate trends. By combining these elements, our model aims to improve the accuracy of exchange rate forecasting and provide deeper insights into the factors that influence currency fluctuations.

4. RESULTS AND DISCUSSION

The table 1 provides descriptive statistics for several variables, including their mean, median, maximum, minimum, standard deviation, skewness, and kurtosis. For the variable Dlexu, the mean is 0.011, indicating a small positive average value. The median is -0.60, suggesting that the distribution is skewed toward lower values, as evidenced by the positive skewness of 0.495. This variable shows moderate kurtosis (4.574), indicating a relatively peaked distribution compared to a normal distribution. Dintdiff_usg has a mean of 0.0183, with a median of 0.005, suggesting that the distribution is right-skewed, as indicated by its high skewness value of 1.823. This high skewness suggests that the data includes a relatively small number of high-value observations. The standard deviation of 0.0459 further indicates a fairly high level of variation in the data. The kurtosis is quite high (5.92), suggesting a distribution with heavy tails, meaning that extreme values are more likely than in a normal distribution. The variable Dm1diff_usg has a mean of 3.8229, and a median of 7.0069, which suggests that the distribution is negatively skewed, as reflected by the skewness of -3.9944. This means that the data contains a significant number of low values that skew the distribution to the left. The large difference between the mean and the median supports this conclusion. The variable has a very high kurtosis value (26.62), indicating an extremely leptokurtic distribution, where outliers are more frequent compared to a normal distribution.

Table 1: Descriptive Statistics

	Dlexu	Dintdiff_usg	Dm1diff_usg	dNfa_usgp	hlsp_usg	lSpread_usg
Mean	0.011	0.018305	3.822921	–38901.32	–0.502	–8.656576
Median	–0.60	0.005000	7.006924	–49143.68	–0.0438	–8.628584
Maximum	0.077	0.200000	157.4663	244377.5	0.013296	–7.362026
Minimum	–0.05	–0.052000	–462.9466	–266775.1	–0.0081	–9.848775
Std. Dev.	0.020	0.045919	74.74873	107888.6	0.003339	0.437633
Skewness	0.495	1.823005	–3.994363	0.390978	0.776773	0.059241
Kurtosis	4.574	5.920741	26.62183	2.622252	5.401642	4.101213

dNfa_usgp has a negative mean value of -38,901.32 and a median of -49,143.68. This suggests that the distribution is negatively skewed, and the data contains mostly lower values. The large standard deviation (107,888.6) highlights the significant spread in this variable's values. The skewness of 0.3909 indicates mild positive skewness, suggesting that the extreme values in the positive range may pull the distribution slightly to the right. The kurtosis (2.622) is relatively low, suggesting a distribution closer to normal with fewer extreme outliers. The variable hlsp_usg has a mean of -0.502 and a median of -0.0438. This suggests that the data is slightly negatively skewed, as shown by the skewness value of 0.7767. The standard deviation of 0.00334 indicates a very low level of variability in this variable. The kurtosis value of 5.40 suggests a distribution that is somewhat leptokurtic, meaning it has heavier tails and a more peaked center than a normal distribution.

Lastly, lSpread_usg has a mean of -8.6566 and a median of -8.6286, indicating a fairly symmetric distribution, though with a slight tendency toward lower values. The skewness of 0.0592 is close to zero, suggesting near symmetry. The kurtosis value of 4.10 indicates a moderately peaked distribution compared to a normal distribution. The data presents a mix of distributions:

some variables exhibit skewness and heavy tails, particularly Dintdiff_usg and Dm1diff_usg, while others, like hlsp_usg and lSpread_usg, are relatively more symmetric. The kurtosis values indicate that several variables have more extreme outliers than would be expected from a normal distribution.

Table 2 presents the results of unit root tests for various variables using two different tests: the ERS (Elliott-Rothenberg-Stock) test and the ADF (Augmented Dickey-Fuller) test. These tests help determine whether a time series is stationary, which is essential for further statistical analysis. Looking at the variables at their levels, we find that the variable Lexusgb has relatively high test statistics from both the ERS and ADF tests, which indicate that it is non-stationary at its level. This suggests that the variable may contain a unit root, meaning its values are influenced by past shocks and could potentially exhibit trends over time. Similarly, the variable M1diff_usgb also fails to reject the null hypothesis of a unit root based on the test statistics from both the ERS and ADF tests, which suggests that it is non-stationary at its level. The same conclusion can be drawn for Intdiff_usgb, which shows test statistics that are not sufficiently low to reject the null hypothesis of a unit root. In contrast, the variable Hlsp_usgb shows significantly low values in both the ERS and ADF tests, suggesting that it is stationary at its level. This means that Hlsp_usgb does not exhibit a unit root and its values are stable over time, making it suitable for further analysis without the need for differencing.

Table 2: Unit root Outcomes

	Lexusgb	M1diff_usgb	Intdiff_usgb	hlsp_usgb	Nfa_usgb	lSpread_usgb
			Levels			
ERS	–1.409655	–1.637500	–1.833834	–9.878872	–1.944291	–10.64963
ADF	–2.100494	–0.675236	–1.742720	–10.71428	–2.320825	–11.85805
			First differences			
ERS	–3.793103	–2.537909	–7.431526	–0.685320	–2.931032	–1.945488
ADF	–9.384304	–5.469544	–7.457444	–6.618941	–4.325378	–7.605958
	(0.0002)	(0.0001)	(0.0000)	(0.0000)	(0.0041)	(0.0000)

The variable Nfa_usgb also shows test statistics that suggest it is non-stationary at its level, as neither the ERS nor ADF tests reject the null hypothesis of a unit root. Similarly, LSpread_usgb displays very low test statistics in both tests, suggesting that it is stationary at its level, much like Hlsp_usgb. When we move to the first differences of the variables, several of the previously non-stationary variables become stationary. For instance, Lexusgb shows much more negative values in both the ERS and ADF tests at first differences, with the ADF test even producing a p-value indicating strong statistical significance. This suggests that Lexusgb becomes stationary after first differencing. The same is true for M1diff_usgb, which becomes stationary at first differences based on both the ERS and ADF tests. Intdiff_usgb also shows strong evidence of stationarity after differencing, as its test statistics become significantly more negative, indicating that the variable is no longer influenced by a unit root once the data is differenced. For Hlsp_usgb, while the ERS test at first differences does not show significant results, the ADF test indicates stationarity after differencing, suggesting that this variable becomes stationary when we look at its changes over time rather than its levels. Nfa_usgb and LSpread_usgb both show similar results, with the ADF test indicating that both variables become stationary after first differencing. Some variables, such as Hlsp_usgb and LSpread_usgb, are stationary at their levels and do not require further transformation. However, other variables, including Lexusgb, M1diff_usgb, and Intdiff_usgb, are non-stationary at their levels but become stationary after first differencing, suggesting they are integrated of order 1 (I(1)). This means that for these variables, differencing is necessary to achieve stationarity before conducting further time series analysis.

Table 3 presents the regression results from four different models, labeled with a focus on both short-run and long-run relationships between various variables. The models appear to assess the impact of several key variables, including the spread, interest rates, money supply, and net foreign assets (NFA), along with their lags. In terms of the error correction term, which indicates the speed at which the system returns to equilibrium after a shock, all models show small negative coefficients. In model [1], the error correction term is -0.001597, suggesting that the system is adjusting back to equilibrium very slowly. This is consistent across all models, although the model has a slightly more negative value of -0.039943, implying a stronger but still relatively slow correction towards equilibrium in this particular specification. For the augmented short-run level coefficients, we can see that the spread (likely referring to some form of interest rate spread) is positively related to the dependent variable in models, with coefficients of 0.002772 and 0.003868, respectively. This suggests that, in the short run, an increase in the spread leads to a slight increase in the dependent variable. Conversely, the lag of the spread in the model has a negative coefficient of -0.006475, indicating that past values of the spread have a negative effect on the dependent variable in the short run.

Similarly, the H-L spread (which could represent a different type of spread or financial indicator) shows mixed results. In the model, the H-L spread has a positive short-run effect of 0.008987, while in the model, the coefficient is negative (-0.00194), indicating that this variable's short-term effect can be either positive or negative depending on the model specification. Interestingly, the lag of the H-L spread in model shows a very large positive effect (0.951276), suggesting that past values of the H-L spread have a significant influence on the dependent variable, especially in the long run. Turning to the long-run coefficients, we find that the lag interest rate is consistently significant across all models, with positive coefficients ranging from 0.054461 to 0.058243. This indicates that an increase in the interest rate has a positive long-run effect on the dependent variable in each of these models. The statistical significance of these coefficients (with asterisks indicating significance at the 1% level) suggests that changes in the interest rate play a crucial role in determining the outcome in the long run. The lag money variable also has mixed effects across the models. In the model, the coefficient is positive (0.000174) and significant at the 1% level, indicating that higher money supply has a positive long-run effect. However, in the model, the coefficient is negative (-0.000110) and significant at the 10% level, suggesting that money supply has a small negative long-run effect in this particular model specification. In the model, the coefficients for lag money are not statistically significant, implying that money supply might not have a significant long-term impact in these models.

Table 3: Regression Results

Coefficients	[1]	[2]	[3]	[4]
Error correction term	–0.001597	–0.039943	–0.001668	–0.001742
Augmented short-runs levels coefficients				
Spread			0.002772	0.003868
Lag Spread				–0.006475
H-L spread			0.008987	–0.00194
Lag H-L spread				0.951276
Long-run coefficients				
Lag interest rate	0.054461**	–0.112064**	0.057712**	0.058243**
Lag money	0.000174**	–0.000110*	0.000166	0.000166
Lag NFA	2.25E–10	–1.50E–07	–2.34E–09	–2.27E–09
Included short-run coefficients				
Lag spread		–0.84403		
Lag H-L spread		88.28642***		
Adj.R^2	0.080	0.200265	0.066042	0.072429

The lag NFA (net foreign assets) variable shows negligible and statistically insignificant coefficients across all models. The values are extremely small, ranging from 2.25E-10 to -2.34E-09, indicating that NFA does not seem to have a significant impact on the dependent variable in either the short run or the long run in these models. Finally, the short-run coefficients for the lag spread and lag H-L spread in the model show mixed results. While the lag spread has a negative coefficient of -0.84403, the lag H-L spread has a very large positive coefficient of 88.28642, which is highly significant (indicated by three asterisks). This suggests that past values of the H-L spread have a substantial impact on the dependent variable in the short run. In terms of model fit, the adjusted R-squared values indicate the proportion of variance in the dependent variable that is explained by the independent variables. The model has the highest adjusted R-squared value of 0.200265, suggesting it provides the best fit among the four models. The adjusted R-squared values for the other models are relatively low, ranging from 0.066042 to 0.080, indicating that the models explain only a small portion of the variation in the dependent variable. In sum, the regression results show that the interest rate and the H-L spread have significant effects on the dependent variable, both in the short and long run. The impact of the money supply and NFA is less consistent, with money supply showing mixed effects across models, and NFA having little to no impact. The fit of the models varies, with the model offering the best explanatory power.

5. CONCLUSIONS

In this study, we aim to identify the key factors responsible for exchange rate variability by integrating both macroeconomic and microstructural perspectives. After reviewing the most influential theories and models of exchange rate determination, we highlight the critical role of macroeconomic fundamentals in explaining long-term exchange rate trends. However, we also emphasize the importance of microstructural factors, particularly investor behavior and market interpretation, in understanding short-term fluctuations. Our approach combines macroeconomic variables, such as government policies and central bank interventions, with microstructural factors, including market participants' perceptions and strategies. Specifically, we focus on testing the spread as a key long-term explanatory variable for exchange rate movements. Spreads, while often viewed as short-term indicators that reflect market liquidity and transaction costs, may also contain valuable information about future exchange rate fluctuations. Although short-run spread movements may not provide significant predictive power due to their inclusion in the currency price itself, we argue that variations in the spread can offer insights into the future direction of exchange rates. To enhance the information provided by spreads, we incorporate the high-low exchange rate difference into our analysis. This adjustment captures not only the market's liquidity but also its volatility, which are both crucial factors influencing currency prices. By examining these factors together, we aim to provide a more comprehensive understanding of the forces at play in currency markets. Our results show that the twofold model—combining both macroeconomic and microstructural variables—outperforms traditional structural models in explaining exchange rate variability. The twofold model offers a more nuanced view by accounting for both fundamental economic factors, such as interest rates and government policies, and the behavioral dynamics of market participants, such as dealers' reactions to order flow and investor sentiment. This combination of macroeconomic and microstructure variables proves to be more effective in capturing the complexities of currency movements. Additionally, we find that microstructural variables, including spreads and high-low differences, adjust in response to investor and dealer behavior, influencing the future return of exchange rates. These findings suggest that the behavior of market participants—whether informed or uninformed—can have significant implications for exchange rate movements, particularly in the short run. Looking ahead, future research could further explore the role of investor strategies and the impact of order flow on exchange rate returns. By delving deeper into microstructure variables like order flow, we could refine our understanding of how market participants' expectations and trading strategies influence currency prices over different time horizons. This would also open up avenues for testing more sophisticated models that incorporate behavioral factors, such as sentiment analysis or investor psychology, to predict exchange rate movements more accurately.

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