Analysing EUR/USD Exchange Rate Dynamics during the 2008 Financial Crisis with Principal Component Regression Approach

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Abstract

Following the Bretton Woods collapse, unpredictable exchange rates destabilized international trade and hampered global economic coordination. This study unveils a data-driven method that integrates two key trading approaches: Chartists and fundamentalists. Using Principal Component Analysis (PCA) and Bai-Perron breakpoints, we condensed 17 economic indicators like GDP and money supply into 4 uncorrelated variables to regress against the 1-step ahead exchange rate. We applied this forecasting method to the 2008 financial crisis in the US, focusing on the EUR/USD rate from 1999 to 2012 entailed a long stable exchange period prior 2008 crisis and a short post-crisis period after 2010. Our findings revealed that prior to the crisis when markets were efficient, weak predictability economic variables on forecasting the next period exchange rate. As exchange rates often follow a random walk, which means movement from the current rate is random and unpredictable.

During financial crises, some economic indicators become significant predictors, suggesting that economic woes can be transmitted through currency markets. These findings align with our understanding of the 2008 crisis and support the validity of the proposed method. Compared to common time-series models, our approach demonstrated reliable forecasting performance. This analysis offers valuable insights for navigating the complexities of foreign exchange management in an uncertain world. The observed changes in exchange rates may signal of prorogation of economic adjustments. Consequently, multinational companies and international traders can leverage insights to predict exchange rate movement, thereby mitigating exposure to exchange rate risks through implementing hedging strategies or financial policies.

Keywords: EUR/USD Exchange rates; principal component analysis, switching regime, breakpoint regression

Introduction

The dismantling of the Bretton Woods system ushered in an era of unprecedented uncertainty in the realm of exchange rate determination, profoundly impacting global trade dynamics. The volatility of exchange rates poses significant challenges for policymakers and businesses engaged in international commerce, as fluctuating exchange rates can amplify financial risks and disrupt cross-border transactions. As underscored by Nicita (2013) and other researchers, heightened exchange rate variability has the potential to adversely impact international trade patterns, necessitating the adoption of prudent risk management strategies for firms navigating the complexities of the global marketplace.

Forecasting exchange rates has long been a formidable endeavour, with researchers exploring a diverse array of models and perspectives. Attempts to unravel the intricacies of exchange rate movements range from the simplicity of univariate time series models, such as the Box-Jenkins Autoregressive Integrated Moving Average (ARIMA) models, to more intricate multivariate models that incorporate economic fundamentals as primary drivers of exchange rate fluctuations. According to Clark and MacDonald (1998), exchange rates can be explained through a reduced-form relationship, encompassing economic fundamentals and their dynamic effects. However, challenges to established theories, such as Purchasing Power Parity (PPP) and Uncovered Interest Parity (UIP), have emerged, with researchers questioning the validity of these models in predicting exchange rate movements. Li (2004), for instance, has highlighted the limitations of PPP and UIP due to their unrealistic assumptions, while Ghalayini (2014) further emphasizes the inadequacy of interest rate parity in comprehensively explaining exchange rate variability.

In light of the limitations of many structural models in forecasting, we posit that traders dynamically respond to market changes, making time-varying coefficient models more adept at capturing exchange rate movements. Our study focuses on two globally significant currencies—the US Dollar and the Euro—both holding substantial portions of foreign exchange reserves and enjoying widespread international usage. Spanning a 14-year period from 1999 to 2012, we examine the components that are of impact to the movement of the EUR/USD exchange rate across pre-, during, and post-global financial crisis periods.

Our main goal is to establish a statistical methodology to compress key economic indicators for predicting exchange rates with a smaller set of uncorrelated components for investigating their linkage with the exchange rate during an economic turbulent time. Our approach is distinct in that it does not adhere to any specific theoretical tenets like the usual fundamental analysis; instead, it relies solely on historical data. This unique approach aims to provide practitioners with a more profound insight into the factors influencing the USD-EUR exchange rate, particularly during the economic downturn in the United States and Europe around 2008. This period was marked by a financial crisis triggered by the bursting of the real estate price bubble in both regions.

The structure of the study is as follows next section provides a comprehensive review of relevant literature. Section 3 details the research methodology employed in the study. Section 4 presents and analyzes the empirical results. Finally, Section 5 concludes the study by summarizing key findings and implications.

Literature Review

The advent of technological advancements has facilitated global commerce, enabling merchants to reach a wider audience and fostering the growth of cross-border financial transactions. This surge in international trade has simultaneously increased exchange rate risk exposure, necessitating effective risk management strategies for foreign exchange portfolio managers. Accurate exchange rate forecasting plays a pivotal role in business decision-making, particularly in determining pricing strategies and hedging against foreign exchange risks (Bahmani-Oskooee & Hegerty, 2007).

The uncertainty associated with the dissolution of the Bretton Woods system[1] prompted researchers to seek reliable methods for exchange rate forecasting for better management of foreign exchange exposure. Traditionally, two main approaches have been employed: fundamental analysis and technical analysis. Fundamental analysis utilizes long-run equilibrium relationships such as the purchasing power parity (PPP) and interest rate parity theory. Many undertook research on the merits and setbacks of these modeling approaches, for example, Balassa (1964), Ca' Zorzi et. al., Mućk and Rubaszek (2016), and Taylor (2002). On factors for forecasting a return to long-run equilibrium exchange rate, for example, interest rates, Meese and Rogoff (1983), and monetary supply, Frenkel (1976).

The literature extensively explores the intricate relationship between fundamental forces and exchange rates, identifying key factors that exert significant influence on these dynamic movements. A comprehensive understanding of these factors, including money supply, public debt, interest rates, unemployment rates, and inflation, is crucial for unravelling the complexities of exchange rate dynamics.

The role of money supply as a pivotal determinant of exchange rates has been a subject of significant inquiry. Frenkel's (1976) model underscores the crucial impact of money supply, while Bilson (1978) delves deeper, proposing a proportional depreciation of the exchange rate in response to an increase in money supply. Building on this, Kia's (2012) contribution solidifies the understanding that money supply exerts a long-term negative influence on real exchange rates.

Public debt, representing a government's indebtedness to both domestic and foreign lenders, emerges as another critical factor shaping exchange rates. Alam and Taib (2013) elucidate the relationship, highlighting that an escalation in public debt often leads to a depreciation of the domestic currency. This stems from the perception of increased risk among investors, resulting in decreased demand for the domestic currency and subsequent depreciation.

The interplay between exchange rates and interest rates has garnered significant attention. Commonly, studies establish a negative correlation between exchange rates and interest rate differentials. Nagakawa's (2002) confirmation of this relationship, linking changes in real exchange rates to real interest rate differentials, adds empirical weight. Hacker et al. (2014) nuanced exploration employing wavelet analysis, further discerns the temporal dynamics of this relationship across various currency pairs.

While not directly impacting exchange rates, unemployment rates wield indirect influence through their effects on consumer spending and economic growth. Galati and Ho (2001) shed light on the negative correlation between rising unemployment rates and exchange rates. The explanation lies in reduced consumer spending, leading to diminished economic growth and a subsequent decrease in demand for the domestic currency, contributing to exchange rate depreciation.

[1] Please refer to the history section on IMF website for details. https://www.imf.org/external/about/history.htm

Inflation, the general increase in prices, emerges as another significant factor with a negative correlation to exchange rates. Common economic textbooks such as McConnell, et al. (2021) succinctly explain how higher inflation rates render domestic goods less competitive globally, driving up demand for imports and, consequently, causing exchange rate depreciation.

In contrast to fundamental analysts who study economic factors, technical analysts focus on identifying profitable trading opportunities based on past price patterns and volume data in the exchange rate. While some technical analysts posit that exchange rate movements follow predictable patterns, they are not concerned with the underlying economic mechanisms driving these changes nor do they seek to explain the theoretical reasons behind these movements. The heavy reading into past patterns as Frankel and Froot (1986) attributed the overvaluation of the USD in the 1980s to the neglect of economic fundamentals and overreliance on technical analysis.

In summary, the past research has provided a comprehensive understanding of the multifaceted factors influencing exchange rates. The intricate roles played by money supply, public debt, interest rates, unemployment rates, and inflation collectively shape exchange rate movements, intricately weaving the tapestry of the global economic landscape. However, fundamentalist forecasting often hinges on subjective judgment based on theoretical tenets, while chartist forecasting employs technical analysis and assumes an underlying stochastic trend which can be revealed from the study of past patterns and trends.

To address the issue of exchange rate forecast regime uncertainty, a hybrid approach incorporating both chartist and fundamentalist models is warranted. Our statistical approach utilizes a data-adaptive procedure that does not subscribe to any theoretical tenets that bind the variables in specific structural forms. It also incorporated multiple breakpoints that were determined by a Bai and Perron test (2003) for multiple structural breaks at unknown points.

Methodology and Procedures

This study intricately investigates the interplay between the EUR/USD exchange rate and pertinent economic variables spanning a 14-year period, encompassing quarterly data from January 1999 to December 2012. An Era Marked by Financial Challenges Confronting Europe and the United States.

The analysis embraces a comprehensive set of 17-time series representing exogenous variables, including GDP for both the US and the Euro-Zone, inflation rates, unemployment figures, money supply metrics, current account balances, nominal interest rate differentials, purchasing power parity, and US public debt data. The macroeconomic variables are extracted from FRED – St Louis Fed economic database and USD/EURO quotations are obtained from OANDA.

The selection of the 17 variables is grounded in prior research, as elaborated earlier. However, these variables are likely to exhibit shared long-run stochastic trends, as suggested by PPP or IPT, which may introduce serious multicollinearity issues and potentially undermine the accuracy of the estimated original regression results. To address this challenge, we employed Principal Component Analysis (PCA) to condense the 17 variables into a more manageable set of uncorrelated factors. This data compression technique transforms the original variable set into a space defined by orthogonal dimensions, commonly known as the principal component space. This approach allows us to work with a smaller number of uncorrelated synthetic variables, referred to as principal components, overcoming the multicollinearity concerns associated with the original set of variables.

Let $\boldsymbol{C}$ be the variance-covariance matrix of the original 17 variables, it is a 17×17 symmetric matrix with all diagonal elements positive dimension it is a positive definite matrix, mathematically there are 17 eigenvectors, $\boldsymbol{p_i}$, and their corresponding eigenvalues, λ_i with i =1 to 17 such that

$$\boldsymbol{C}\, p_i = \lambda_i\, p_i$$

and

$$\boldsymbol{C}\,\boldsymbol{P} = \boldsymbol{\Lambda}\,\boldsymbol{P}$$

where the columns of matrix $\boldsymbol{P}$ are the $\boldsymbol{p_i}$ and $\boldsymbol{\Lambda}$ is a diagonal matrix of λ_i sorted in descending order with i =1 to 17.

The data matrix is denoted by $\boldsymbol{X}$, where each row represents a data point and each column represents a variable. The project data matrix under the transformation by matrix $\boldsymbol{P}$ is given by $\boldsymbol{Z}^* = \boldsymbol{X}\,\boldsymbol{P}$, which has a diagonal variance-covariance matrix, as

$\boldsymbol{Var}\,(\boldsymbol{Z}^*) = \boldsymbol{P^T C\, P} = \boldsymbol{P^T \Lambda\, P}$ is diagonal. Therefore, the transformed variables are uncorrelated.

Furthermore, to achieve data reduction, we retained only the columns in $\boldsymbol{Z}^*$ corresponding to eigenvalue above 1 that condensed the initial 17 exogenous variables into four principal components, elucidating a remarkable 97.402% of the total variance. The final results are shown in Table 1 below.

Table 1: Variables Included In Each Principal Component

Component 1	Component 2	Component 3	Component 4
US_Current_Acc	IRD	EU Unemployment	EU_Current_Acc
EU_GDP	US Unemployment		
US_GDP			
PPP			
US_CPI			
EU_CPI			
EU_M3			
EU_M1			
EU_M2			
US_M3			
US_M2			
US_Public_Debt			
US_M1			

The extracted components are designated as below:

Component 1, EIMS: "Economic Indicators entail GDP, CPI of both US and EU, US debt and current account & various Money Supply measures of both economies"

Component 2, USUNEIRD: "US Unemployment & Interest Rate Differential (IRD)"

Component 3, EURUNE: "EU Unemployment"

Component 4, EURCA: "EU Current Account"

The convergence of shared stochastic trends among variables has resulted in their aggregation under a singular principal component, often interchangeably referred to as a component or, in some literature, as factors. The label assigned to the component effectively characterizes the primary economic factors encapsulated by its composition. By utilising these principal components in subsequent analyses, we can focus on the most pivotal features within the data. This strategic approach enhances both the interpretability and effectiveness of our model.

Component 1: Economic Indicators & Money Supply

The first principal component includes crucial variables like the consumer price index (CPI), money supply, current account balance, public debt, and GDP that relate to the EUR/USD exchange rate through the purchasing power parity (PPP). These variables reflect PPP concepts in both static and dynamic dimensions and align with the classical equation of exchange theory. Notably, the link between money supply and price levels remains clear, regardless of changes in money velocity. Additionally, a country's GDP is intertwined with its money demand. Furthermore, Alper and Forni (2011) highlight the connection between public debt and PPP theory by correlating global debt aggregates with the PPP-GDP weighted average of countries. In essence, these interconnected variables come together under the label "Economic Indicators & Money Supply" component due to their common link through PPP-related trends.

Component 2: US Unemployment & Interest Rate Differential (IRD)

The second component, denoted "US Unemployment & IRD," encapsulates the intricate relationship between the interest parity of the two currencies and the anticipation of forthcoming economic developments in the United States. This component aptly captures the influence of US economic factors on the exchange rate through interest rate parity linkage.

Components 3 and 4: Euro Unemployment & Euro Current Account

The final two components, "Euro Unemployment" and "Euro Current Account," exhibit a comparatively lesser impact on exchange rate determination. Empirical findings, notably from Bergin (2006), suggest that fluctuations in the Euro Current Account may be offset by shocks from other variables, such as the Uncovered Interest Parity Shock and Negative Shock Taste. Moreover, Prast and Vor's (2005) empirical study indicates a potential investor's indifference to news pertaining to the Euro area. Despite their potential diminished impact, these components entailed trends distinct from the other components and their inclusion in the regression model, mitigating the risk of omitted variable bias.

The primary focus of this investigation centres around the nominal EUR/USD exchange rate, serving as the exclusive endogenous variable. In the subsequent section, we incorporate the derived principal components into a regression model, permitting random multiple breakpoints identified through a Bai and Perron (2003) test. This approach is particularly well-suited for scrutinizing exchange rate dynamics, considering that shifts in exchange rate regimes frequently arise from policy interventions by central banks and market interaction. The incorporation of multiple breakpoints enhances the model's adaptability, empowering it to encapsulate potential shifts in the intricate relationship between exchange rates and economic variables over time. The regression model can be succinctly articulated as follows:

$$y_t = \beta_0 + \beta_1' D_{t-1} + (\beta_2' + \beta_3' D_{t-1}) Z_{t-1} + \epsilon_t$$

where:

y_t denotes the EUR/USD exchange rate at time t,

Z_{t-1} signifies 1-lag of the vector of principal components at time t,

D_{t-1} encompasses a matrix of dummy variables indicating the prior period exchange rate regime

β_0 represents the constant term, and

β_1, β_2 and β_3 are vectors of coefficients associated with the principal components and dummy variables, respectively.

ϵ_t encapsulates the error term.

This model enables a forward-looking forecast, predicting the EUR/USD exchange rate one step ahead by considering the influence of economic fundamentals and alterations in exchange rate regimes. The integration of multiple breakpoints elevates the precision of our analysis, facilitating a delicate comprehension of how these factors dynamically shape exchange rate movements over the specified period.

Our approach involves constructing a forecasting model that incorporates these four components, utilizing a linear regression framework with a multiple breakpoint model. The design of the regression model aims to address the following hypotheses:

$\boldsymbol{H_{01}}$: Lagged Economic Indicators and money Supply (“EMIS”) will not relate to the EUR/USD Exchange Rate.

$\boldsymbol{H_{02}}$: Lagged US Unemployment & IRD (“USENEIRD”) will not relate to the EUR/USD Exchange Rate.

$\boldsymbol{H_{03}}$: Lagged Euro Unemployment (“EURUNE”) will not relate to the EUR/USD Exchange Rate.

$\boldsymbol{H_{04}}$: Lagged Euro Current Account (“EURCA”) will not relate to the EUR/USD Exchange Rate.

$\boldsymbol{H_{05}}$: Lagged EUR/USD Exchange rate will not relate to the EUR/USD Exchange Rate.

Results and Deductions

The Bai and Perron test (2003) identified two statistically significant structural break points in our study period, namely 2008Q3 and 2010Q4. These breaks points accorded well with the anecdote of the 2008 financial crisis in the US and Europe.

Prior to 2008, a housing bubble had formed, fuelled by risky subprime mortgages and an increase in housing prices. As housing prices started to decline, many homeowners defaulted on their loans. Financial institutions that held mortgage-backed securities faced significant losses. In September 2008, the crisis escalated dramatically with the bankruptcy of Lehman Brothers, the collapse sent shockwaves through the global financial system, leading to a freeze in credit markets. The crisis spread to Europe as well, impacting major financial institutions across the continent. Both the U.S. and Europe implemented regulatory reforms to address the weaknesses exposed by the crisis. Post-2010, over time, the global economy began to recover, though the pace varied across regions. Unemployment rates decreased, and financial markets stabilized.

The estimated regression with the two structural breaks in 2008Q3 and 2010Q4 has a high R-square of 97.6%. This robust result underscores the model's performance in explaining exchange rate dynamics even amidst substantial economic disruptions. The estimated results are shown in Table 2 below.

Table 2: Hypotheses testing results, Breaks: 2008Q3, 2010Q3

Variable	Coefficient	Std. Error	t-Statistic	Prob.
1999Q2 – 2008Q2 -- 37 obs				
Y(-1)	0.911490	0.079925	11.40430	0.0000
USUNEIRD(-1)	0.190901	0.107857	1.769950	0.0850
EURUNE(-1)	-0.033405	0.076691	-0.435578	0.6657
EURCA(-1)	0.006746	0.054984	0.122686	0.9030
EIMS(-1)	0.220207	0.124266	1.772064	0.0846
C	0.259510	0.108912	2.382755	0.0224
2008Q3 – 2010Q2 -- 8 obs				
Y(-1)	1.117840	0.304610	3.669742	0.0008
USUNEIRD(-1)	-0.044877	0.721432	-0.062206	0.9507
EURUNE(-1)	0.239090	0.347959	0.687123	0.4963
EURCA(-1)	0.086398	0.077560	1.113963	0.2725
EIMS(-1)	-4.547339	1.152144	-3.946850	0.0003
C	3.480389	1.653955	2.104282	0.0422
2010Q3 – 2012Q4 -- 10 obs				
Y(-1)	0.112266	0.711966	0.157685	0.8756
USUNEIRD(-1)	-0.957254	0.443972	-2.156113	0.0376
EURUNE(-1)	-1.261202	0.885121	-1.424892	0.1626
EURCA(-1)	0.175227	0.190752	0.918609	0.3643
EIMS(-1)	1.618343	1.423359	1.136988	0.2629
C	1.650174	0.672519	2.453722	0.0190
R-squared	0.976			
Durbin-Watson stat	2.14			

In scrutinizing the model's statistical integrity, a thorough residual analysis was conducted. A Breusch Pagan test (1979) affirmed the absence of heteroscedasticity, supported by a p-value surpassing the 5% significance level. Simultaneously, the Durbin-Watson statistic of 2.14 indicated an absence of significant serial correlation in the residuals. These findings fortify the model's reliability and its efficacy in explicating the EUR/USD exchange rate.

Stable Exchange Market prior to 2008 financial crisis, 1999 to 2008Q2, 38 quarters in total.

Analyzing the coefficient sizes and significance of each regressor in Table 2 yields valuable insights. Notably, we can assert that the 1-lag EUR/USD Exchange Rate holds high significance in predicting the current exchange rate. Furthermore, the current EUR/USD exchange rate demonstrates a marginal relationship with lagged "Economic Indicators & Money Supply" and lagged "US Unemployment Rate & IRD." This observation suggests that the US/EURO exchange markets exhibited relative efficiency during the extended period of stable exchange regimes spanning from 1999 to 2008Q2. This finding aligns with the weak market efficiency hypothesis, indicating that the price of foreign currency, and exchange rates followed a Martingale process.

During the Financial Crisis, 2008Q3 to 2010Q2, 8 quarters in total.

Indications of intervention by U.S. authorities are apparent, aimed at mitigating the repercussions of the economic downturn and heightened inflation triggered by the meltdown of the U.S. financial market. Notably, during the turbulent two-year period of the financial crisis precipitated by the burst of the real estate bubble, the Euro to U.S. exchange rate was significantly influenced by U.S. money supply and related economic indicators. The influence of "Economic Indicators and Money Supply" and the past exchange rate assumes a more dominant role from 2008Q3 to 2010Q2. This period witnessed the manifestation of U.S. inflation and economic downturn in the deterioration of the exchange rate, serving as a conduit through which these economic challenges are exported to Europe via the functioning of the exchange market.

Post Financial Crisis, 2010Q3 - 2012Q4 , 10 quarters in total

In the midst of shifts in economic regimes, the US unemployment rate and the Interest Rate Differential (IRD) stand out as the exclusive indicators exerting a statistically significant impact on the EUR/USD from 2010Q3 onwards. The exchange rate undergoes considerable adjustments, primarily influenced by the production gaps proxied by the US unemployment rate. These adjustments are then transmitted to European financial markets through the interest rate parity existing between the two regions.

Understanding the "Economic Indicators & Money Supply" Component

The inaugural element, centred around "Economic Indicators & Money Supply," encompasses six distinct indicators: PPP, CPI (Inflation), money supply, current account, and GDP. These indicators intricately connect to the PPP theory, with inflation influencing goods prices, the causal link between money supply and relative goods prices, and GDP's correlation with exchange rates through the PPP theory, all validating their significance.

Moreover, the current account's interpretation of deviations from PPP and the interconnection between global debt aggregates and the PPP-GDP weighted average of countries emphasize the robustness of these indicators as predictors of the EUR/USD exchange rate. While this component may exhibit marginal significance or even non-significance in forecasting the one lead ahead exchange rate during periods of economic stability, where the market promptly adjusts to equilibrium levels as predicted by PPP, it played a pivotal role during the exchange overshooting in 2008.

The gradual correction observed in the post-crisis period from 2008 to 2010 underscores the substantial significance of this component in downwardly adjusting the EUR/USD exchange rate during such turbulent times. The results reveal a notable impact during this period, highlighting the crucial role this component played in navigating the exchange rate dynamics amidst economic uncertainties.

Insights from the "US Unemployment & IRD" Component

The second significant component, "US Unemployment & IRD," housing the US Unemployment Rate and Interest Rate Differential, aligns with Keynes(1923)' notion of interest rate parity accounting for credit risks, sovereign risk, and economic risks. The negative relationship demonstrated between the Interest Rate Differential, US Unemployment Rate, and the EUR/USD exchange rate corroborates findings by Hacker et al., (2014), emphasizing their role as economic proxies influencing spot exchange rate changes.

Insignificance of "Euro Unemployment" and "Euro Current Account" Components

Contrary to their counterparts, the "Euro Unemployment" and "Euro Current Account" components prove insignificant in determining exchange rates. Supported by previous studies, Bergin (2006) attributes the insignificance of the Euro Current Account to offsetting effects from variables like Uncovered Interest Parity Shock and Negative Shock Taste. Prast and Vor (2005) further reinforce this, stating investors show no differential reactions to positive or negative news from the Euro-area.

Robustness check: Comparison with Benchmark forecasting method, non-seasonal Holt-Winter method.

The regression model aims to predict the next period's exchange rate using the current exchange rate and factors' status, as such the residuals reflect the forecasting accuracy hence the performance of the model. In assessing the robustness of our regression model, we compare the model results with a benchmark forecasting method that is commonly well accepted by practitioners, a non-seasonal Holt-Winter model.

A meticulous exploration of the parameters' value in the Holt-Winter framework yielded optimal smoothing parameters (α=1 and β=0). This indicated that the US/EURO exchange rate time series adhered to a random walk model, suggesting that changes in the EUR/USD exchange rate could not be predicted by past patterns or economic variables that attest to the efficiency of the US/EURO exchange markets. This result accorded well with our findings on the pre-crisis period. However, our model is sensitive enough to detect the out-of-line behavior of the exchange rates during the financial crisis period and identify the components with variables that are linked to the movement of the exchange rate.

Table 3 illustrates that our proposed model surpasses the benchmark, as evidenced by the conventional error measure, Mean Absolute Errors (MAE). The superior MAE values affirm that our model, incorporating economic fundamentals with adaptability to alternating economic regimes, offers a more accurate explanation of the EUR/USD exchange rate dynamics.

Table 3: Forecasting performance: Proposed model vs. Benchmark

Analysis of forecast error	Proposed Model	Benchmark Model
$\boldsymbol{MAE}$	0.008	0.056

Conclusion

The intricate behavioral dynamics of the EUR/USD exchange rate spanning from 1999 to 2012 reveal a nuanced connection to economic variables rooted in both European and American contexts. Leveraging Principal Component Analysis (PCA) allows researchers to distill essential features from commonly used variables, providing a regression model free from multicollinearity issues and a more parsimonious representation of the original dataset. The incorporation of structural changes at non-predetermined breakpoints further enhances our ability to track shifts in economic interactions throughout the investigation period.

Applying this approach, we scrutinized the narrative of the 2008 financial crisis in the US and Europe, triggered by the burst of overpriced estate assets and propagated through pervasive abuse in subprime mortgages. The Bai and Perron test (2003) identified breakpoints that aligned well with the chronological development of the financial crisis. The results of the estimated regression empirically support the acknowledged understanding of the 2008 financial crisis in the US, providing insightful information without relying on specific theoretical tenets.

Comparing the forecasting accuracy of our model with the popular non-seasonal Holt-Winter model in time-series forecasting underscores the superiority of our approach, enhancing the statistical reliability and the validity of the estimated results.

The significance of this study lies in the promising performance of the PCA-OLS regression with the breakpoint method, successfully encapsulating widely acknowledged economic factors. Addressing multicollinearity through PCA and forecasting exchange rate movements based on economic fundamentals, coupled with the flexibility of incorporating constructs from technical analysis, positions our model as a robust tool.

In essence, the EUR/USD exchange rate tends to appreciate with shocks to money supply, economic conditions, and historical values, while depreciation is associated with shocks to unemployment rates and interest rate differentials. Grounded in both Purchasing Power Parity (PPP), Interest Rate Differential (IRD) theories, and efficient market hypothesis, our model provides nuanced insights into the linkage of past exchange rates and various fundamental factors with the complexities of exchange rate dynamics.

The observed changes in exchange rates serve as vital signals of prorogation of economic adjustments. Consequently, multinational companies and international traders can leverage insights derived from the identified components to model and predict exchange rates, empowering them to formulate effective international financial policies and implement targeted hedging strategies, thereby mitigating exposure to exchange rate risks.

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