Taking Advantage of the UIP: A Systematic Exploitation

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The Uncovered Interest Rate Parity (UIP) theory, a well-known concept in finance, posits that differences in expected interest rates between two countries should be equal to the expected change in their currency exchange rates. This theory implies that investors should earn the same returns when investing in different currencies, accounting for expected exchange rate movements. However, numerous academic papers have shown that UIP does not hold in the short term, creating a systematic profit opportunity for traders through strategies like carry trades. This paper explores an algorithmic approach to exploit deviations from UIP and presents back tested results to substantiate this claim. This algorithm posits that whenever the foreign country's 3-month bond rate exceeded the domicile's rate by 5%, a trade was simulated where the base money was converted into the foreign country's currency and a 3-month foreign bond was bought. This paper contributes to the broader understanding of exchange rate dynamics and offers promising avenues for future research in the field of finance. It helps take the previous research about the UIP theory and extend it into the future, with evidence from the last twenty years or more on four major currencies in the financial world. This paper starts with the introduction of the paper, followed by the Literature Review, which goes over the important papers that inspired this paper. This leads to the Methods section, which explains how an algorithm that was developed allowed the creation of data which is discussed and shown in the Results section. Discussion, Limitations, and Conclusion help unpack these results and bring the paper to an effective close.

Introduction

The uncovered interest rate parity theory is a well-known postulate in the finance world. However, it holds one of the more interesting positions in this world, since it is probably the only theory that has been proven false in the short term. Explained simply, UIP stands for uncovered interest rate parity, whose premise states that the difference in the expected interest rates between two countries will be equal to the expected change in the exchange rate between their currencies. In other words, investors should earn the same return on their investments in different currencies when adjusted for expected exchange rate movements. For example, imagine France had a higher interest rate than the US by 5%. UIP suggests that France's currency would depreciate and the USA's currency would appreciate by a total change of 5%, thereby eliminating any possible profit that could have resulted from switching through currencies and buying France bonds, i.e., a carry trade. However, papers from Froot and Frankel have proven that the profit opportunity does exist for some time, because of the markets not being as efficient as stated in the UIP process. The specified opportunity existing for some time allows the creation of an algorithmic process to exploit this again and again. This paper will explore such an algorithm and back test it to prove that the deviations from the UIP create a systematic profit opportunity.

The Literature Review provides a summary of the papers that were most relevant to the research, and how they helped to develop this work. It also explains the UIP equation, which is a central concept in this paper. The Methods section describes the algorithm that was used and how these results were derived and presented in this paper. The Results section presents the graphs and other data that support these findings, and explains what they mean. The Discussions and Limitations section discusses the implications of these results and the limitations of the study. Finally, the Conclusion summarizes the main findings and discusses their potential applications.

Literature Review

The uncovered interest parity was first introduced in the paper, "On the Mark: A Theory of Floating Exchange Rates Based on Real Interest Differentials."(Frankel 1978)[1] This paper was written by Jeffrery Frankel, and it was instrumental in popularizing the theory. However, it did not have a concrete equation which could be used to predict the effects of the theory.

Throughout multiple more papers, the UIP equation was refined and formatted. The basic equation is $F = S(\frac{1+i\_domestic}{1+i\_foreign})$. In this equation, according to UIP, beta should be equal to 1.

F represents the expected future exchange rate between the two currencies. S is the current spot exchange rate (the current exchange rate between the two currencies). $i\_domestic$ is the nominal interest rate in the domestic country (the country whose currency was converted from). $i\_foreign$ is the nominal interest rate in the foreign country (the country whose currency was converted to). This can calculate the forward rate of the domestic country, which made this equation an important piece of the financial curriculum.

However, in the short term, researchers began noticing that this theory did not hold in new papers that were published. One of the first papers to prove this was the paper, "Forward Discount Bias: Is it an Exchange Risk Premium?" published in 1989 by Froot and Frankel. The premise alone showed off an anomaly: where high-interest rate currencies tend to appreciate rather than depreciate as predicted. The authors proposed that this anomaly could be explained by an exchange risk premium, suggesting that investors demand compensation for the risk of currency depreciation associated with holding high-interest rate currencies. Their empirical analysis supports the existence of such a premium, highlighting that factors beyond interest rate differentials play a crucial role in shaping exchange rate movements. It also found the beta to be negative most of the time. The few times it was positive, it was much less than 1, disproving UIP entirely.

This topic was revisited in a new paper, called "Describing the New Fama puzzle," by Matthieu Bussiere, Menzie D. Chinn, Laurent Ferrara, Jonas Heipertz, a recent paper in international finance where the coefficient on the interest differential in a regression of exchange rate depreciation on interest differentials becomes large and positive. This paper is puzzling because of its contradiction of UIP. UIP states that the forward premium should equal the interest differential. However, if the coefficient on the interest differential is positive, then the forward premium is less than the interest differential.

The seminal paper by Froot and Frankel (1989)[2] upended prevailing uncovered interest rate parity (UIP) theory by presenting robust statistical evidence that higher nominal interest rate currencies systematically tend to appreciate rather than depreciate as predicted. This contradictory finding sent shockwaves through the field by defying long-held assumptions regarding the relationship between interest differentials and expected currency movements. However, despite invalidating these core axioms empirically, the very failure of UIP laid the foundation for profitable trading strategies to exploit the market inefficiencies. As Bussiere et al. (2018)[3] furthered in "Describing the New Fama Puzzle," the persistent anomalies provided fertile ground for algorithmic models to harvest excess returns. Ironically, the pronouncement of UIP's demise in the short run sparked new life into exchange rate economics by spurring succeeding literature to reconcile empirical deviations. And serendipitously, the imperfections presented an alpha opportunity set. Consequently, the bombshell empirical result yielded a rich interdisciplinary legacy - both theoretically in challenging existing orthodoxy to build better structural models, and practically in enabling arbitrage systems designed to profit from the market's real-world irrationalities. An example of this arbitrage system's results is displayed and discussed in this paper.

Methods

In order to generate these results, official csv data from the FRED was used. FRED stands for Federal Reserve Economic Data, and is a database maintained by the Federal Reserve Bank of St. Louis. This database has more than 816,000 economic time series from various sources. From this website, exchange rates and 3-month bond rates for Germany, New Zealand, Great Britain, and Australia were downloaded. The USA was used as the home country, and the other four countries as the foreign countries which the results of the standard 3-month U.S bonds were compared to. Together, these four G10 currency nations account for over % of world GDP and constitute an informative cross-section spanning European, Oceanic, and British economic spheres. The diversity controls for regional macroeconomic conditions. At the same time, restricting to developed markets ensures data reliability regarding interest rates and exchange rate histories essential for computational analysis. Emerging markets were excluded given higher volatility, capital controls, and political risks that could skew analytics.

The base money for every trade was set to $100 in US dollars, the country of origin. This also allowed for a more accurate comparison to the domicile. Whenever the foreign country's 3-month bond rate exceeded the domicile's rate by 5%, a trade was simulated where the base money was converted into the foreign country's currency and a 3-month foreign bond was bought. The value of the bond was then converted back into US dollars and compared with the value of $100 US dollars invested in a 3-month US bond on the same date. To compare all the results, the algorithm did not skip ahead 3 months, in order for analysis of each trade that the algorithm could have committed. In other words, the algorithm simulated a trade by converting $100 US dollars into the foreign currency, buying a 3-month foreign bond, and then converting the bond back into US dollars at the end of the 3-month period. The algorithm then compared the value of the bond to the value of $100 US dollars invested in a 3-month US bond that was bought at the same time. This allowed the algorithm to compare the performance of the foreign bond to the performance of the US bond. This algorithm ran through each of the 4 currencies, and compared it. Graphs were also generated based on the results of the algorithm based on the historical data from FRED, and the Results section helps explain these results.

Transaction costs are a key element of any bond trade, but with the rise of discount brokerages, have almost been either eliminated or reduced to a flat fee, which is almost negligible in round lots. There is much variation within the costs themselves based upon the brokerage selected, which conclusively led to the ignorance of transaction costs within the calculations of the results presented.

Results

Australia, England, Germany, and New Zealand all have 3-month bonds which have had varying returns compared to the U.S 3-month bond. In this section, the paper will explain these results, juxtaposed against the events happening at the time. These results were validated by running the algorithm over 20+ years, with multiple countries, with data from FRED, ensuring the statistical validity of these results.

For benchmark comparison, the algorithm also tracked the progress of simply investing $100 in a 3-month US Treasury bond over the same time span. By directly contrasting the ending US dollar values, the relative profitability of the foreign bond carry trade versus holding the domestic bond could be evaluated. Repeated iteratively, this approach quantifies outperformance attributable to uncovered interest rate parity deviations even after incorporating currency fluctuations.

Australia vs the U.S.

Referring to Figures 1 and 2, in 1973, the first major financial event in Australia's history, an oil crisis across the world caused a sharp increase in inflation and interest rates. Also, that same year, the Australian dollar was taken off the US dollar peg, which also led to an Australian interest rate boom. This most likely leads to the flurry of trades in the algorithm after 1974. However, the 1987 stock market crash of Australia led to a decline in investor confidence and a flight to safety, which drove up demand for bonds and lowered their yields. It is possible to see the algorithm stop trading after 1987, and finally resume in 1991.

Then, the global financial crisis of 2008 led to a sharp decline in economic activity and a rise in risk aversion, which also drove up demand for bonds and lowered their yields. And finally, the COVID-19 pandemic led to a sharp decline in economic activity and a rise in uncertainty, which also drove up demand for bonds and lowered their yields. These events both reduced the number of trades made.

Germany (foreign bond) vs the US

To better understand these results, we need to take a closer look at what happened in the German economy. As shown in Figures 3 and 4, in 2008, German bond yields fell sharply, as investors became more risk-averse and sought out safe assets like German bonds. The yield of German bonds fell that year. As a result, the algorithm did not trade for a year. German bond yields, however, rose in 2011, as the European debt crisis led to a decline in confidence in the eurozone. This explains the clustered trades around 2010, 2011, and 2012. Finally, the European Central Bank's quantitative easing program started in 2014, which has helped keep bond rates low, explaining why there has been no trades after 2014.

New Zealand (foreign bond) vs the US

To better understand these results, we need to take a closer look at what happened in the New Zealand economy. Referring to Figures 5 and 6, the global financial crisis of 2008 led to a sharp decline in demand for New Zealand bonds, as investors became more risk-averse. The Christchurch earthquake of 2011 led to a decline in economic activity and a rise in government borrowing, which increased demand for New Zealand bonds. Both caused yields to decrease. The Brexit referendum of 2016 led to a decline in confidence in the global economy, which also affected demand for New Zealand bonds. This caused New Zealand bond yields to rise. The COVID-19 pandemic led to a sharp decline in economic activity, which increased demand for safe assets like New Zealand bonds. This caused New Zealand bond yields to fall. Generally, these events did not affect the bond yields too adversely, however, since New Zealand's government deliberately tried to keep the bond yields high.

UK (foreign bond) vs the US

To explain these results, we need to refer to Figures 7 and 8, and provide a short summary of what happened in the UK economy to explain this data. From 2016, the UK's vote to leave the European Union led to a sharp decline in demand for UK bonds, as investors became more uncertain about the UK's economic future. The COVID-19 pandemic also led to a sharp decline in economic activity in the UK in 2020, which increased demand for safe assets like UK bonds. The yield of the UK bonds, for both events, decreased because of this.

The UK government has run a budget deficit for many years. This has helped to increase the supply of UK bonds and keep yields low. The war in Ukraine has also led to increased uncertainty about the global economic outlook, which has also supported demand for safe assets like UK bonds. Bond yields for the UK fell that year.

Discussion

The performance of the trading algorithm across currencies and time periods underscores a consistent ability to extract profits from bond market movements tied to uncovered interest rate parity (UIP) deviations. However, the results also demonstrate that efficacy varies in line with relative volatility driven by macroeconomic events impacting national bond yields. Despite generally positive excess returns affirming UIP failure, outliers like COVID-19 and Brexit did trigger bond fluctuations that momentarily inverted rate spreads and finding profitability. Nonetheless, over extended periods, the algorithm averages out such temporary reversals. On the whole, the backtests provide multi-country confirmation over two decades that bond carry

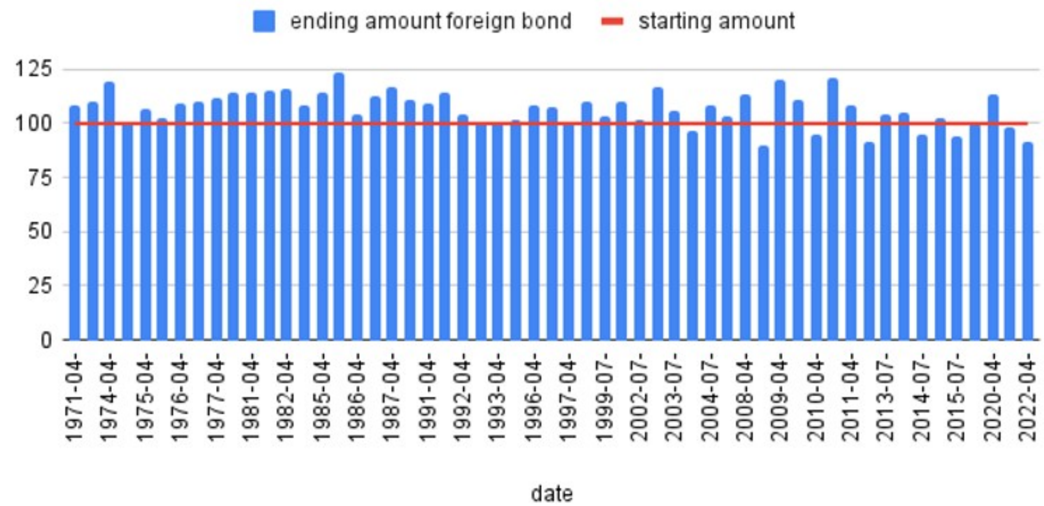

Fig. 1 Comparison Between the Total Money after and Australian Bond Trade and the Starting Amount

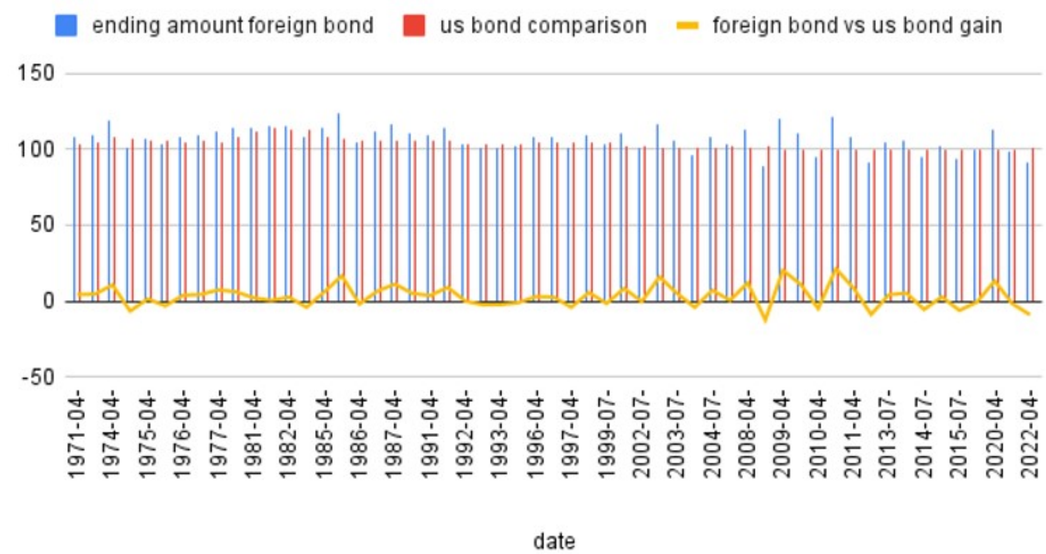

Fig. 2 U.S. Bond vs Austrailian Bond

trades based on interest differentials can generate excess returns, substantiating enduring inefficiencies defying theoretical parity.

This research thus contributes an implementable quantitative strategy that directly capitalizes on empirically documented interest rate anomalies. The paper builds on previous UIP literature by demonstrating outsized returns even in modern times using historical data. Practitioners could adapt the principles of scanning rate differentials, establishing optimized thresholds, and managing risks/exits to potentially improve fixed income portfolio returns. Additionally, by tuning parameters governing trade aggressiveness, stakeholders can tailor algorithms to their risk appetites, whether preferring prudence over profit maximization or vice versa. These applications combined with ubiquitous data availability underscore promising avenues for further exploration into both statistical arbitrage and explanatory modeling of bond market inconsistencies through interdisciplinary approaches synthesizing cutting-edge financial economics and programming.

This research has uncovered that it is possible to make money by switching currencies and buying foreign bonds, in comparison to the investor's domicile bonds. However, it might depend on the duration of the bonds, which were 3 months in this case.

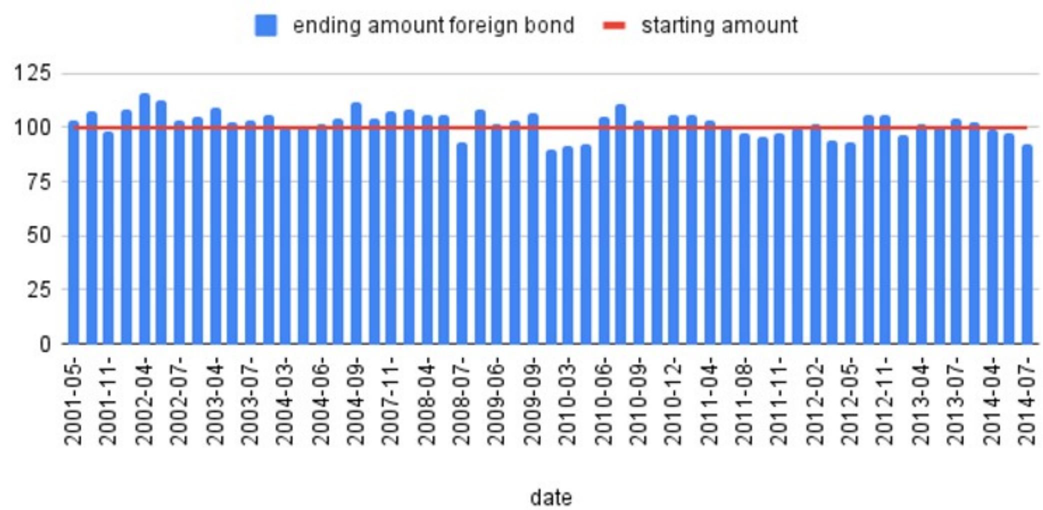

Fig. 3 Comparison Between the Total Money after a German Bond Trade and the Starting Amount

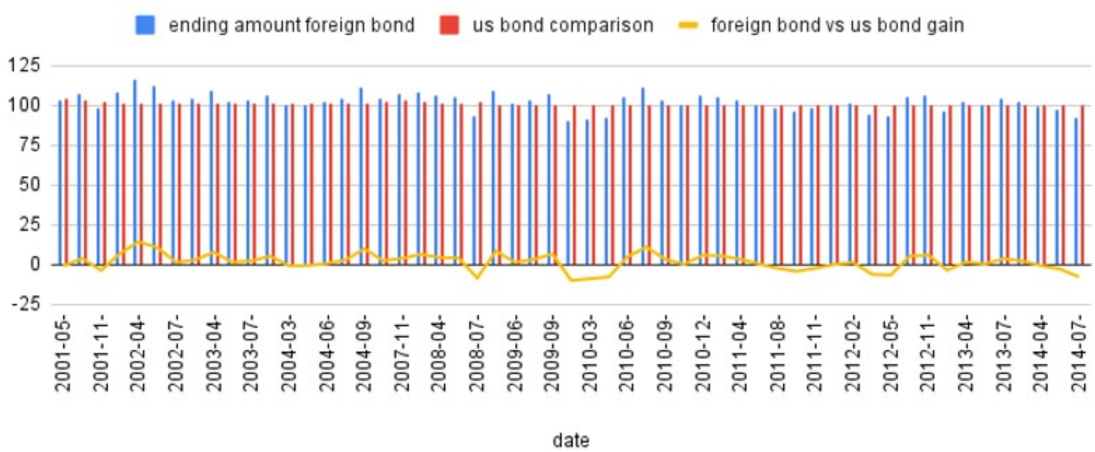

Fig. 4 U.S. Bond vs German Bond

This proves without a doubt that it is possible to earn a profit in short-term bond trading, which proves the UIP does not hold in the short-term.

Limitations

The exclusion of transaction costs gravely overestimates viable profit levels that could be realized in practice after accounting for currency conversion fees, brokerage charges, and various trading overheads. Failure to incorporate these unavoidable expenses for asset speculators casts doubt regarding the implement ability of the proposed algorithm. Follow-on efforts will quantify costs through research of applicable historical fee structures.

Testing the model exclusively on bonds from just four developed nations also prevents broad universalization of results to wider fixed income dynamics beyond these sample currencies. Extending datasets to emerging markets could have gauged exportability amidst less mature economic variables but at the expense of noisy data. Nonetheless, the omission restricts external validity. Additionally, limiting bond tenures to 3 months provides narrowly constrained evidence on the persistence of uncovered interest arbitrage opportunities over longer investment horizons.

In summary, absence of trading costs, small sample size, and short bond maturities collectively indicate only preliminary evidence. These neglected factors likely alter effect magnitudes. However, prior empirical literature does suggest the basic existence of excess returns from bond carry trades exploiting UIP

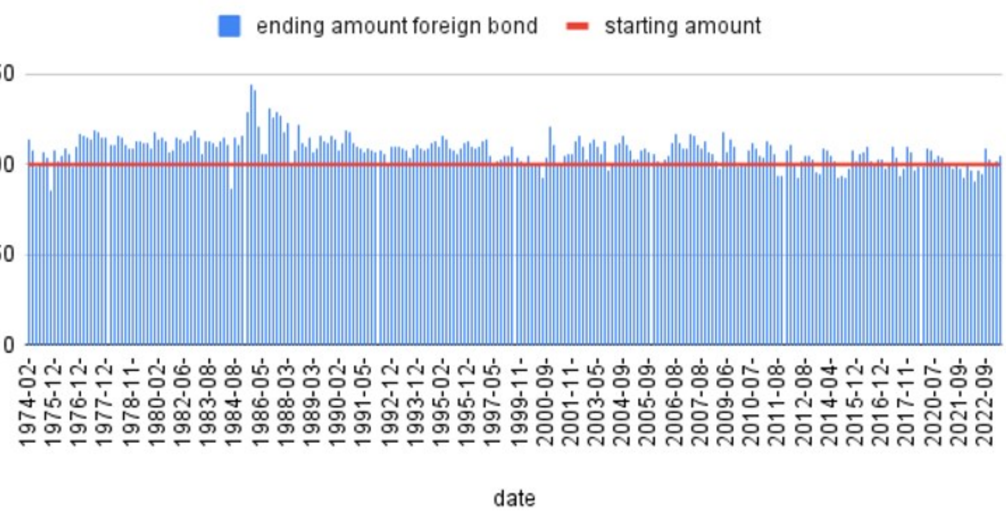

Fig. 5 Comparison Between the Total Money after a New Zeland Bond Trade and the Starting Amount

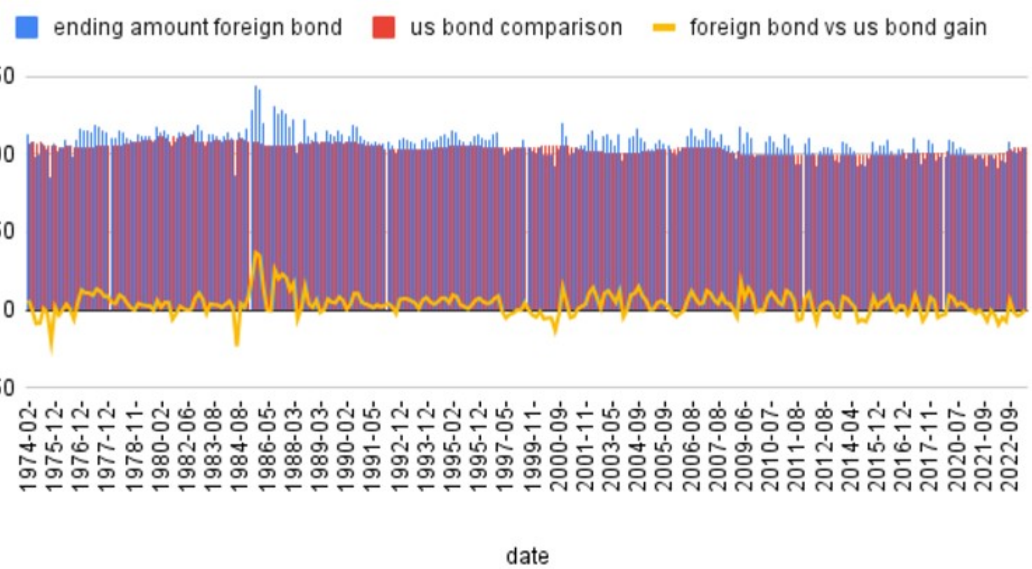

Fig. 6 U.S. Bond vs New Zeland Bond

failings. Therefore while these shortcomings induce uncertainty regarding degree of applicability, they do not necessarily invalidate the elementary premises regarding anomalies in theory versus practice. Nonetheless, readers are cautioned against over extrapolation. Further research directed at the highlighted gaps could greatly strengthen reliability and real-world viability.

Conclusion

This research has uncovered a statistically exploitable alpha stemming from persistent violations of the Uncovered Interest Rate Parity premise across currencies and decades. However, the present analysis remains restricted to retrospective examination without live testing. A logical next phase involves collaborative refinements to transition the algorithm from retroactive academic conceptualization towards pragmatic applications for contemporary traders. Specific opportunities include expand-

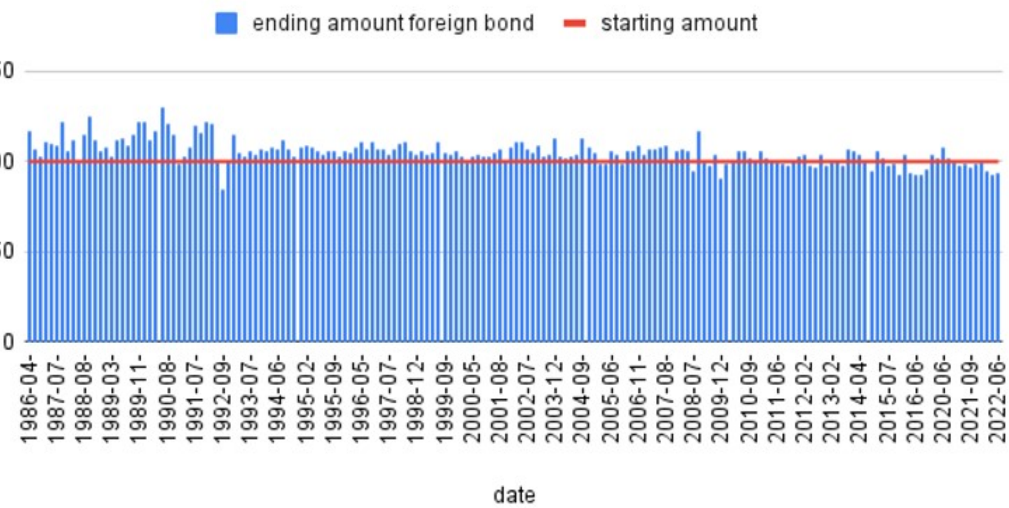

Fig. 7 Comparison Between the Total Money after a UK Bond Trade and the Starting Amount

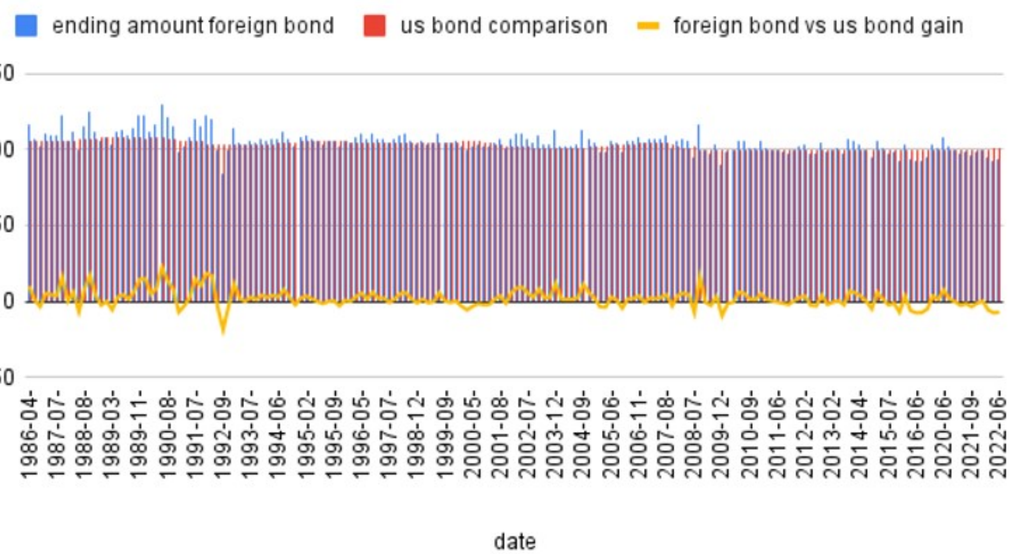

Fig. 8 U.S. Bond vs UK Bond

ing currency pairs and optimization metrics leveraging machine learning techniques to maximize risk-adjusted returns. Practitioner partnerships can provide platforms for calibrated trial runs assessing performance under current exchange rate dynamics. Success holds promise for quantitative funds, brokerages and even retail investors in their portfolio enhancement efforts.

Beyond direct trading implementations, the systematized evidence also carries valuable policy implications. The demonstrated ability to reliably profit from yield anomalies highlight gaps in theoretical models guiding central bank behaviors. Hence, another frontier lies in assisting regulators to account for behavioral dimensions that warp real-world currency fluctuations relative to idealistic axioms. Quantifying the empirical deviations provides target marksmanships for reshaping forecasting frameworks. Moreover, the persistence of mispricing despite market evolution suggests the need to revisit assumptions on market efficiency and information diffusion. Incorporating insights from cognitive sciences on expectations formation could push exchange rate economics closer towards workable abstractions. As the results affirmed, with growing data fueling computing, substantial potential resides at the intersection of academic advances and practical tools to reshape both literature and decision-making towards better financial outcomes.

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