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Foreign Exchange Implementation: Carry

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Abstract

In the current international world, will foreign exchange Carry, a classic hedged strategy in western world, apply well in Chinese market? Plus, as a theory developed from Efficient Market Hypothesis, the compatibility of a western arbitrage strategy and an eastern market will indirectly indicate whether Chinese currency market is efficient enough or not. This work constructs a portfolio based on foreign exchange Carry and practices empirical study. Furthermore, to promote the performance, two different refinements are raised to conclude a more recommended investing suggestion.

Keywords

Carry; Foreign exchange market; Arbitrage strategy; Chinese market.

1. Introduction

1.1. Idea

Foreign exchange carry trade involves selling currencies forward that are at a forward premium or buying currencies forward that are at a forward discount.[1] As a classic arbitrage strategy, it has always been a hot research direction for experts and scholars. Jessica James, Kristjan Kasikov and Aysu Secmen have studied the relationship between uncovered interest parity and the foreign exchange carry trade.[2] Mikova, Teplova and Munir have studied the performance of carry trade on foreign exchange markets.[3] Now, There is still a lot of controversy about the optimization of foreign exchange carry strategy.

This work makes an empirical study of foreign exchange carry strategy, analyzes its performance, and proposes two ways to improve the strategy.

1.2. Highlights

1.2.1. Strategy Overview

In the forex market, it is widely acknowledged that a high-yielding currency is the one with high interest rate. The interest rate of one currency can be explained by the differences between spot and forward exchange rates, that a currency at forward

premium has a relatively low interest rate compared with those currencies at discount.

By establishing short and long positions of currencies with premium and discount, one could make surplus profits with regard to the market.

Therefore, when there is a forward premium, forwards can be shorted; when there is a forward discount, forwards can be longed. Since the forex forwards will eventually reach interest rate parity, this dynamic process is beneficial.

Typically, the portfolio will consist of the three forwards with highest premium and the three forwards with highest discount.

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Instead of using foreign exchange spot, the strategy only includes foreign exchange forwards; and this work re-calculates corresponding indexes daily, which re-constructs this portfolio.

1.2.2. Performance Estimate

1.2.2.1 Returns

Research conducted by Burnside et al. offers some insights of the returns of foreign exchange carry trade. They investigated through data ranging from 1976 – 2009 and brought an annualized return of 4%, with a Sharpe ratio of 0.7.

Returns of carry trade are on average large and non-normally distributed. The most natural interpretation for the high average payoff is that it compensates for potential losses.

Investor risk aversion and overweighting of low probability events (crash-o-phobia) explains the carry premium. Carry strategies have excess kurtosis (fat tails) and show significant declines over a long period of time consistent with poor economic conditions such as during recessions and liquidity crises, which supports that the excess return is compensation for bearing the risk that assets will perform poorly in bad times. [4]

1.2.2.2 Drawdowns

When normalized for volatility, drawdowns are better than for overall fixed income assets.

1.2.2.3 Risk:

a) Market risk:

Currency carry trade returns display both high downside market risk and high crash risk.[4]

b) Sovereign debt risk:

Specifically, in the presence of a financial disruption, net-debtor countries experience a currency depreciation, unlike net-creditor countries. Countries that cannot issue debt in their own currency are riskier. Thus, currency risk premiums are driven by the evolution and currency denomination of net foreign assets.[4]

2. Specification

2.1. Data

2.1.1. Universe

The universe is foreign exchange forwards.

G10 currencies are rather more traded, more stable, and more liquid compared to other choices, and thus the data of their forward contracts are rather more complete.

The specific universe is the forwards of 8 currencies out of G10 currencies: USD, AUD, GBP, NZD, EUR, CAD, CHF, JPY, with respect to CNY. The other 2 currencies are excluded since their performance are inadequate for back-testing.

In addition, since the forwards of foreign currency against USD are more of a liquid and efficient market compared to that against CNY, this work transforms them to forwards of CNY using the spot prices of USD-CNY.

2.1.2. Data Sets and Sources

Table 1 Data Sets and Sources

Data	*Purpose*	*Sources*
Daily foreign exchange forward prices	To calculate profit and to construct portfolio	Bloomberg
Daily foreign exchange spot prices	To construct portfolio	Investing.com
1year treasury bond yielding	To get the risk-free rate in Sharpe ratio	
CFTEX index / SSEC index	To get correlation, beta and alpha with respect to different markets.	http://www.chinamoney. com.cn/ chinese/Investing.com

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2.1.3. Date Range

In-sample: weekdays during 2009/1/1-2017/12/29, 2347 days in total.

Out-of-sample: weekdays during 2018/1/1-2019/12/31, 522 days in total.

2.2. Strategy

2.2.1. Signal Generation

Forex forwards sometimes have a discount and premium, so this work buys and sells multiple forex forwards based on the forecast trend for arbitrage. Here, this work only uses forwards to trade.

Specifically, foreign exchange carry trade strategy is implemented by shorting the forwards when it is at a forward premium (Ft ≥ St) and longing the forwards when it is at a forward discount (Ft < St).[4]

To calculate the expected return, the number of currency units ω_{it} (also included in portfolio construction) is needed, which is given by:[4]

$$\omega_{it} = \begin{matrix} -1/S_{it}, if F_{it} \geq S_{it} \\ 1/S_{it}, if F_{it} < S_{it} \end{matrix} \quad (1)$$

F_{it} and S_{it} are the forward prices and spot prices respectively. The reason why this work is to divide 1 by the value S_{it} is to transform the notional payoff uniformly to CNY.

The payoff of one kind of currency to this strategy measured by CNY at t + 1, denoted z_{it+1}, is:

$$z_{it+1} = \omega_{it}(F_{it+1} - F_{it}) \quad (2)$$

The total expected return at t+1 is:

$$Z_{t+1} = \sum_{i=1}^{8} z_{it+1} \text{ [4]} \quad (3)$$

To calculate PnL, it needs to convert payoffs of different time into present value. Assume that the risk-free rate is r_t, respectively, it results total payoff:[4]

$$Payoff = \sum_{t=0}^{n} Z_{t+1} e^{\frac{-r_t(t+1)}{12}} \quad (4)$$

When Payoff is positive, it is believed the time to trade.

2.2.2. Portfolio Construction

First, this work calculates the deviation of the foreign exchange forwards from foreign exchange spots, and it is called Δr. Then, this work ranks Δr by descending order, go short the forwards of top three Δr and long the forwards of bottom three Δr.

$$\Delta r = \frac{F_t - S_t}{S_t} \quad (5)$$

$$among the top \quad 3: short$$
$$among the bottom \quad 3: long$$

After that, it needs to calculate the share of every kind of forwards during implementation. Forwards are shorted when it is at a forward premium (Ft ≥ St) and long the forwards when it is at a forward discount (Ft < St). The value of ω_{it}, the number of currency units, is given by EQ 1

F_{it} and S_{it} are the forward prices and spot prices respectively. The reason why this work is to divide 1 by the value S_{it} is to transform the profit uniformly to CNY.[4]

This portfolio trades on a daily basis, modify the portfolio monthly and set the sizing to equal weighting.

This strategy is notional hedged.

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2.2.3. Trade Execution

The transaction cost of the strategy is quantified by $\frac{1}{2}|\ bid - ask\ |$.

This is a reasonable estimator of real-life transaction cost. This work is cutting off this value from the payoffs when implementing every single trade. Through this approach, the transaction cost of every trade can be calculated separately and more precisely.

In order to implement the strategy, both parties to the forward contracts take credit risk. And to facilitate the implementation of the strategy, it is assumed that the counterpart will always be found when trading with this strategy. As a result, this paper addressed the greatest inconvenience of foreign exchange forward transactions.

In this strategy, the foreign exchange forward contract instrument will be used. At the same time, due to the characteristic of foreign exchange forward, this work must choose OTC trading.

2.3. Research

2.3.1. Economic Intuition

a) CIP (Covered Interest Parity) and UIP (Uncovered Interest Parity)

Currencies forward is sold that are at a forward premium and buy currencies forward that are at a forward discount. The reason why carry trade is profitable is based on CIP (Covered Interest Parity):

$$1+i_{\$} = \frac{F_t}{S_t}(1 + i_c) \tag{6}$$

where:

F_t is the forward exchange rate at time t; S_t is the current spot exchange rate at time t

$i_{\$}$ is the interest rate in one country (for example, the United States); i_c is the interest rate in another country or currency area (for example, the Eurozone) [5]

That is to say, a currency with lower interest rates will trade at a forward premium in relation to a currency with a higher interest rate, and thus this strategy is equivalent to longing currencies with higher interest rates and shorting currencies with lower interest rates.

Then, payoff at t + 1, denoted Z_{t+1}, is:

$$Z_{t+1} = w_t(F_t - S_{t+1}) \tag{7}$$

That is, the return comes from the difference between F_t and S_{t+1}.

However, if UIP (Uncovered Interest Parity) exists, it results:

$$1+i_{\$} = \frac{E_t(S_{t+1})}{S_t}(1 + i_c) \tag{8}$$

where:

$E_t(S_{t+1})$ is the expected future spot exchange rate at time t + 1

Compared to CIP, this work uses $E_t(S_{t+1})=F_t$, which means the forward exchange rate is an accurate forecaster of the future spot exchange rate, with no payoff. However, in fact UIP anomaly exists. Domestic currency appreciates when domestic nominal interest rates exceed foreign interest rates, which is referred as the forward premium puzzle. Carry trade exploits this puzzle to trade.[4]

b) Compensation for bearing risk

In addition, investor loss aversion and overweighting of low probability events explain the carry premium. Historically, currency carry trade returns display both high downside market risk and high crash risk (the presence of rare disasters such as the “peso problem”). These are risks for which investors should be compensated.[4]

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2.3.2. Analysis

The analysis includes:

a) PnLs, to measure cumulative return;

b) Alpha and Beta (as well as correlation, measured by correlation coefficient) with regard to different markets, to measure excess return and correlations;

c) Volatility (measured by standard deviation of returns), to measure fluctuations;

d) Sharpe Ratio (using earnings of 1-year treasury bond as risk-free rate), to measure the profit per risk unit.

3. Implementation

In the data processing, this paper uses Stata, a software used in statistical processing and econometrics.

3.1. Results

3.1.1. PnL Graph

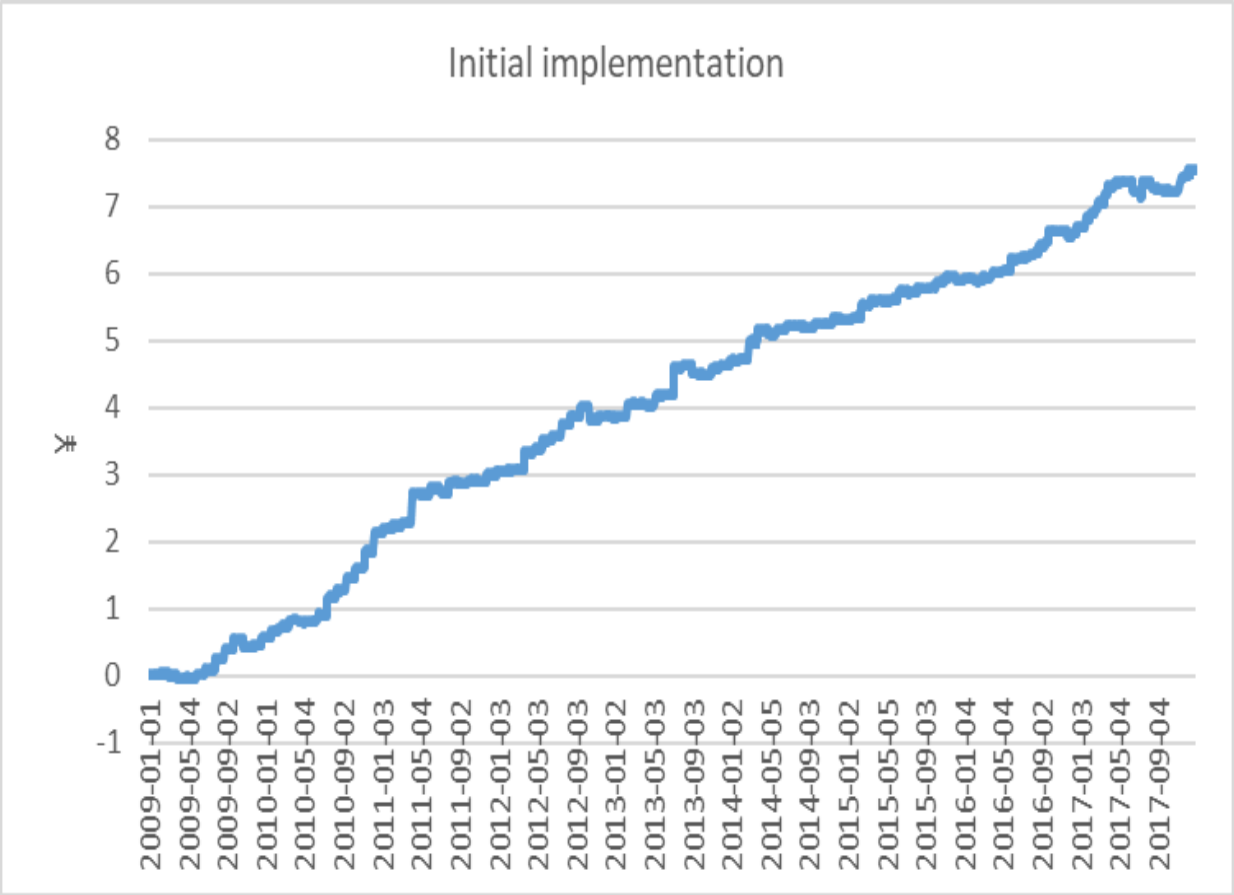

Figure 1. Daily cumulative returns of investment strategies

The total return is measured by CNY. This work keeps a position of 6 yuan all the time, and the strategy brings us profits of 7.563 yuan (present value) in 2347 days. From the PnL graph above, stably increasing payoff with seldom drawdowns shows. This indicates that the strategy works well in back-testing sample.

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3.1.2. Summary Statistics

Table 2 Daily payoffs of investment strategies: January 1st, 2009 to December 29th, 2017 (CFETS/SSEC)

	Mean	Volatility	Sharpe Ratio	Correlation	Beta	Alpha
Equally-weighted carry trade	7.697%	0.0938	0.377	0.0123/ CFETS -0.0478/ SSEC	0.0283/ -0.0099	0.01/ 0.01

The trade offers an annual return of 7.697%, with a relatively low volatility. Its Sharpe ratio is 0.377, a lower one compared to previous study (Brunside et al.). The portfolio showcases a low correlation with CFETS index (indicating revenues of CNY) and SSEC index (indicating revenues of Shanghai stock market). The betas are trivial, and their t-tests are insignificant. This tells that the portfolio can generate stable profits that are not influenced so much by foreign exchange and stock market in China. Alphas are positive, demonstrating a positive excess return of the two markets.

3.1.3. Differences from Expectation

The trade should have a bigger Sharpe ratio, as expected, to be around 0.8 or so, yet it appears to be much lower than 0.8.

The trade shows a very low correlation with Chinese foreign exchange and stock market, where it is found surprising.

3.2. Difficulties

3.2.1. Transaction cost quantification

This work had several approaches to find a parameter of 0 to 1 in order to characterize transaction cost, that is, this work has been trying to figure out a percentage of transaction cost in the total payoffs. Some thesis suggested some reasonable figures, yet it may not work in forwards of CNY. So, it is set to be the absolute value of (bid-ask)/2.

3.2.2. To determine the criteria when ranking the forwards.

Initially this work tries to rank the forwards by the differences between S and F by a simply minus. Yet it is overlooked the fact that each forward has its unique magnitude. A reasonable method is to construct the portfolio by $\Delta r = \frac{F_t - S_t}{S_t}$

4. Refinements

4.1. Implemented

4.1.1. Universe Extension

In the implementation part, the universe consists of 8 currencies (AUD, GBP, NZD, EUR, CAD, CHF, JPY and USD). It's a good start to choose these currencies which are traded in mature foreign exchange markets, but it is not expected to get the best return. And in fact, the rate of return shown in the last part is not good enough. To get better profit, the universe can be extended to more currencies, like emerging-market currencies. These currencies are generally more volatile than developed market currencies and thus can offer stronger and more prominent moves,

which means more trading opportunities. In fact, such opportunities to earn some good profit are just attracting more and more traders to these currency pairs. In the refinement, this work added KRW, HKD and SGD into the portfolio.

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4.1.2. Linear Weighting

In order to further improve the rate of return of the strategy, it is a very appropriate choice to set the sizing to linear weighting. It is believed that for the six kinds of foreign-exchange forwards selected by ranking Δr, commonly used equal weighting does not perfectly reflect the importance of every forward. In fact, within the selected 8 kinds of currency forwards, they still have different Δr value (or sometimes large gaps between Δr value), which suggests a different degree of profit opportunities. Accordingly, in this case, this work adopts sizing as 3:2:1, which is more in line with the economic meaning of Δr value. (That is, to go short the foreign exchange forwards with the biggest three Δr values in a ratio of 3:2:1, and vice versa.)

4.2. Results

4.2.1. Universe Extension

PnL graph:

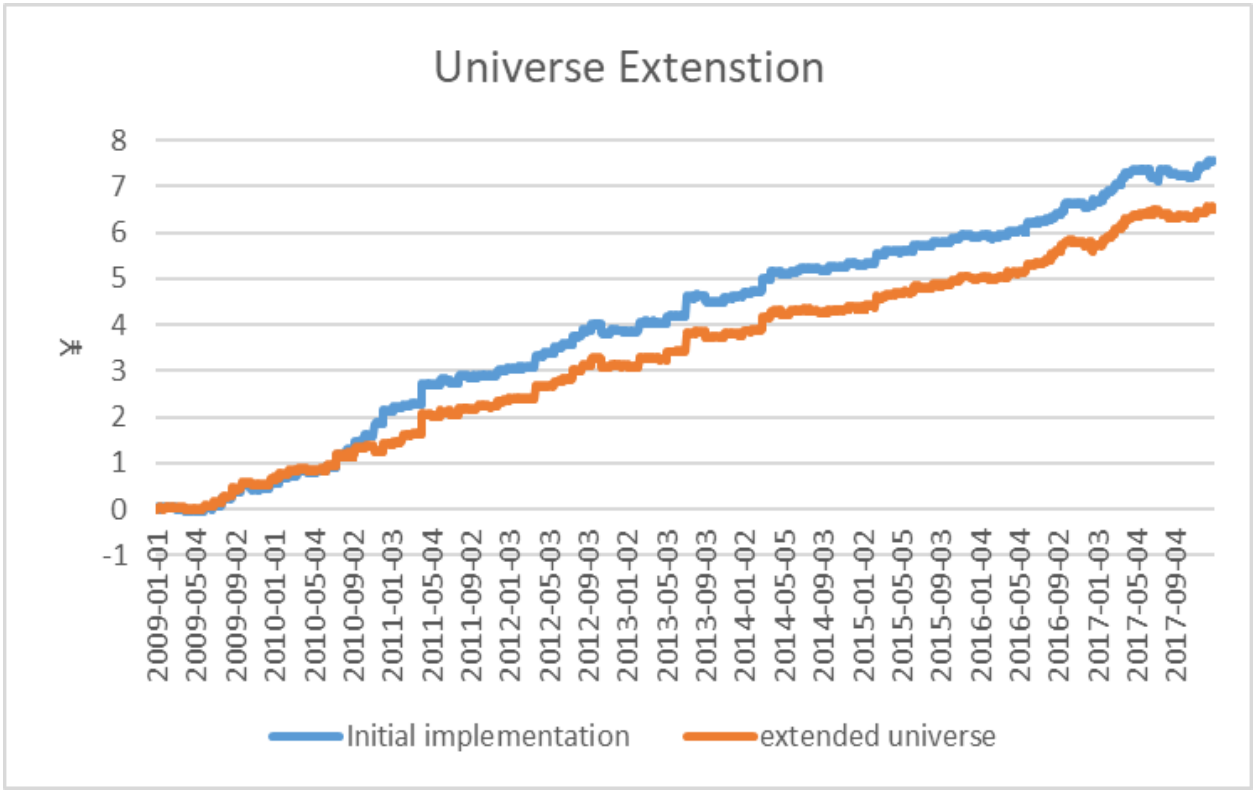

Figure 2. Daily cumulative returns difference between original implementation and the refinement of Universe Extension

Table 3 Daily payoffs of investment strategies: January 1st, 2009 to December 29th, 2017 (CFETS/SSEC)

	Mean	Volatility	Sharpe Ratio	Correlation	Beta	Alpha
Equally-weighted carry trade	6.940%	0.0875	0.264	-0.022/ CFETS -0.060/ SSEC	-0.0485/ -0.0108	0.010/ 0.010

Actually, though there are some overlaps within the 2 PnL graphs (there might be no changes when adding the new currencies), the refinement is not a successful one. By adding KRW, HKD, SGD into the portfolio, the new one generates a cumulative return of 6.5509 yuan and an annual return of 6.940%, smaller ones compared to the initial work. The Sharpe ratio is at a low level. Still, correlations between the portfolio and main markets in China appears to be a trifle and their beta remains insignificant in t-test.

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4.2.2. Linear Weighting

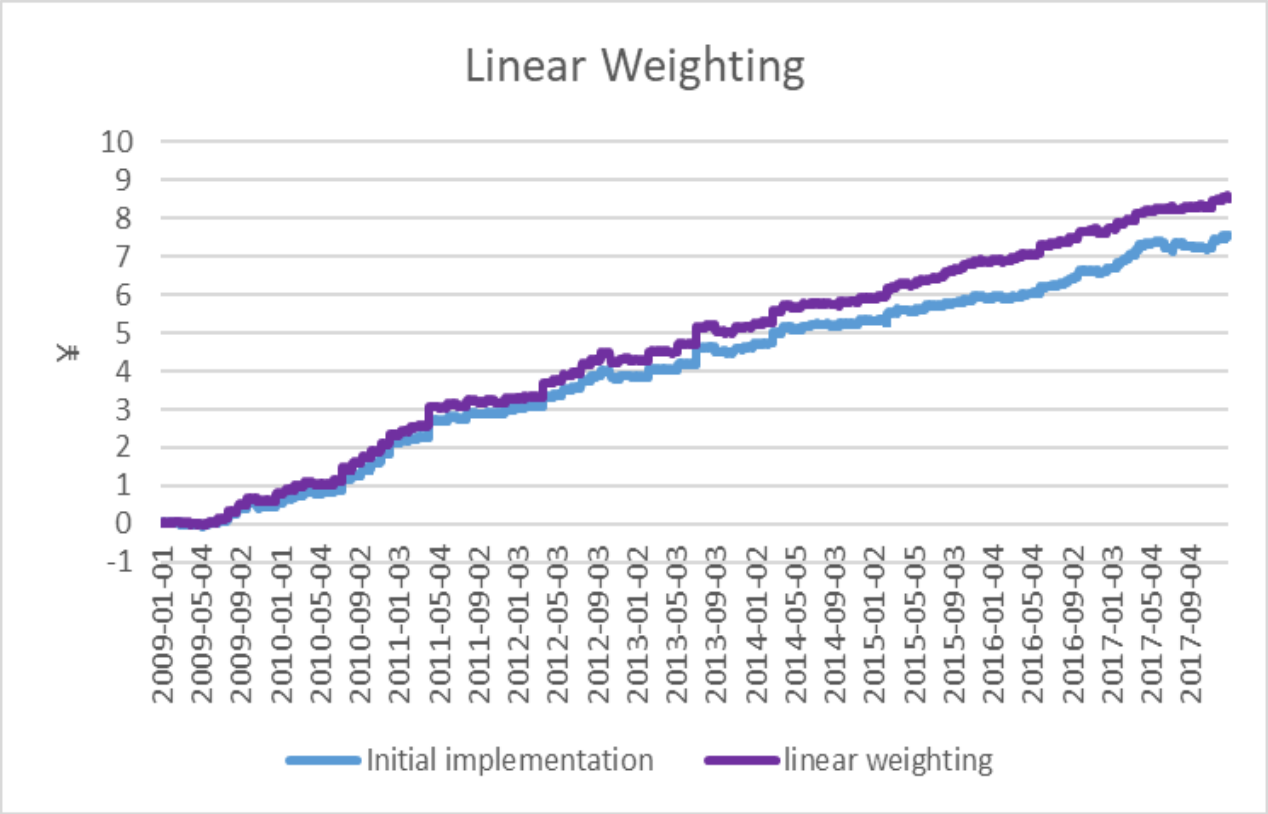

Figure 3. Daily cumulative returns difference between original implementation and the refinement of Linear Weighting

Table 4 Daily payoffs of investment strategies: January 1st, 2009 to December 29th, 2017 (CFETS/SSEC)

	Mean	Volatility	Sharpe Ratio	Correlation	Beta	Alpha
Linearly-weighted carry trade	8.493%	0.2064	0.5132	0.0096 CFETS -0.0740 SSEC	0.0244/ -0.169	0.013/ 0.013

A change in weighting received a decent feedback. By converting equal weighting to linear weighting, one can trade at an annualized return of 8.493%, and a bigger Sharpe ratio of 0.5132. Though the volatility appears to be higher, it doesn't matter that linear weighting is a better weighting strategy in this implementation.

4.3. Proposals

4.3.1. Weighting method optimization

It is found that there are still many risks in the previous portfolio, which is likely to lead to higher volatility and drawdown. Therefore, in order to reduce the uncertainty of the strategy, it is believe that it is a good choice to set the sizing to risk weighting.

Considering the convenience of implementation, this work will use the Sharpe ratio as the corresponding weight for each currency forward in the long and short portfolios selected. Therefore, the fund allocation amount corresponding to each currency forward is as follows:

$$ni = N/2 \bullet SRi/\sum_{i=1}^{3} \mathrm{SR}i \tag{9}$$

(The formula is applied separately in the long portfolio and short portfolio)

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4.3.2. Find a better indicator of Spot prices.

In previous implementations, 1-month forwards are used to indicate future changes of spot prices. Yet actually, it may not work as the best one. A better one well may be the 1-year forward price, or some other forwards with different expire dates. For instance, to find a better indicator of Spot prices, this work trades a linear combination of different forwards. Moreover, to determine and optimize the unknown parameters, it's a good choice to divide the data into training, testing and validation, therefore, this paper can use skills in machine learning to get the best parameter, hence helping generate a better result.

5. Conclusion

5.1. Final Selection

Refinement 2 is the final selection, that is to trade 8 kinds of forwards by linear 3:2:1 weighting.

5.2. Out of Sample Test(s)

5.2.1. PnL Graph

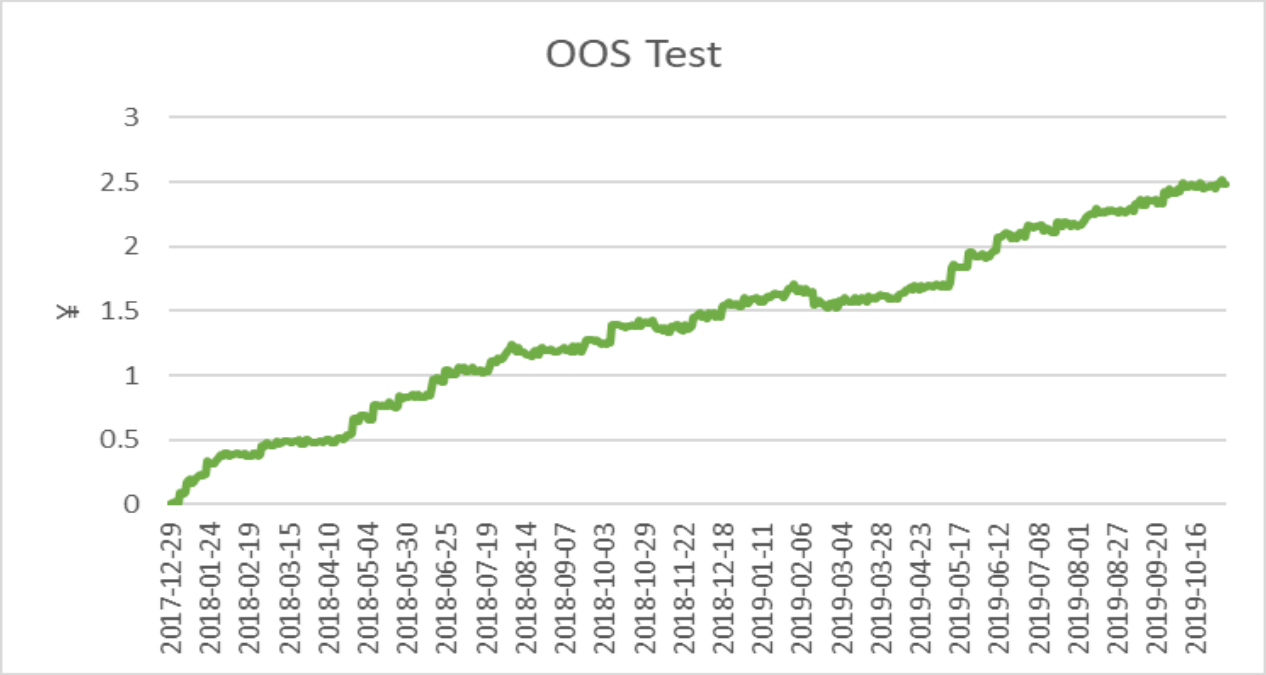

Figure 4. Daily cumulative returns of OOS Test

As expected, the pnl graph shows increasing cumulative profits.

5.2.2. Summary Statistics

Table 5 Daily payoffs of investment strategies: January 1st, 2017 to December 31st, 2019 (CFETS/SSEC)

	Mean	Volatility	Sharpe Ratio	Correlation	Beta	Alpha
Equally-weighted carry trade	10.24%	0.1006	0.8395	0.0853 CFETS 0.1208 SSEC	0.051 0.021	0.009 0.010

The strategy shows some good results. In time period of 2018-2019, annual rate of return reaches 10.24%, and Sharpe ratio comes up to 0.84, a relatively high one, similar to the ratio when the strategy is implemented in the US market.

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5.3. Additional Considerations

5.3.1. Other Investment Concerns

Forward foreign exchange transactions are a type of credit transaction, so the primary concern is credit risk. Forward foreign exchange trading as a flexible transaction using non-standardized contracts in the invisible market can achieve the purpose of postponing or avoiding foreign exchange market risks. However, the resulting cost is its inevitable credit risk. Therefore, in the transaction process, it is very important to find counterparts with higher credit, such as powerful foreign exchange banks.

5.3.2. Business Concerns

It is also necessary to pay special attention to legal risks during operation, which mainly involves foreign exchange control. In the universe, most of the currencies are freely convertible, so there is less legal risk. But once the universe is changed, it must always be paid attention to foreign exchange control and decide whether to use non-delivery forward (NDF) transactions. It should also be noted that, because the trading tool chose is a foreign exchange forward contract, there is a possibility that no suitable counterparty may be found. Although in the previous empirical process assumptions are used to remove this undesirable situation, but in real trading, this paper must find suitable components in advance so that the strategy can be successfully implemented.

5.4. Trading Recommendation

As mentioned above, the strategy is based on “forward premium puzzle”, so this study may need to pay attention to whether this premise holds. By far, much of the empirical wisdom regarding this puzzle is based on the evidence obtained from developed economies, such as the G-7. [6] The work shows from above that the strategy works well with these currencies, and it is recommend to trade.

In contrast to the G-7, however, emerging economies have on average higher inflation and nominal interest rates. Some researches present evidence which suggests that the forward premium puzzle is not a pervasive phenomenon but confined to developed economies. [6] Therefore, the study should be added with more research about the practicability of this strategy in emerging economies.

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