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The profitability of technical analysis in the Taiwan-U.S. forward foreign exchange market

Yun-Shan Dai
Graduate Institute of International Economics, National Chung Cheng University

Wei-Ming Lee
Department of Economics, National Chung Cheng University

Abstract

Based on technical analysis and White's and Hansen's data-snooping-robust tests, we examine the efficiency of the Taiwan-U.S. forward foreign exchange market and find that, unlike the spot market, the forward market is inefficient even under a very high transaction cost, suggesting that the failure of forward rate unbiasedness documented in the literature may be due to forward market inefficiency.

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1. Introduction

Since the breakdown of the Bretton Wood System, numerous studies have examined the efficiency of the foreign exchange market by testing the profitability of technical trading rules; see Menkhoff and Taylor (2007) for a recent review. Due to data reuse in evaluating multiple technical trading rules, the data snooping bias may result in spurious finding of profitability. Some early studies had attempted to alleviate the data snooping bias by using a longer sample period and/or by evaluating the out-of-sample performance, such a bias may remain, however. Fortunately, the reality check (RC) proposed by White (2000) provides a way to test technical analysis profitability without data snooping bias; see also Sullivan, Timmermann, and White (1999) for the U.S. stock market application. As the power of RC can be adversely affected by technical trading rules that perform poorly, Hansen (2005) thus extended RC and proposed a more powerful superior predictive ability (SPA) test. Both of them have been applied for examining major currency markets in Qi and Wu (2006); see also Hsu and Kuan (2005) and Chen, Huang, and Lai (2009) for U.S. and Asian stock markets, respectively, and Park and Irwin (2010) for U.S. futures markets.

In this paper, we examine the profitability of technical trading rules in the Taiwan-U.S. forward foreign exchange market using both the RC and SPA tests. As Taiwan is a small open economy with its economic activity relying heavily on international trade and the Taiwan dollar futures is not available in any financial markets, the forward market thus plays an important role in hedging foreign exchange risk so that whether the forward market is efficient is of interest not only for academics and monetary authorities but also for market participants. However, most of the studies focus on testing the hypothesis of forward rate unbiasedness; see e.g., Chen (2010). It is a joint hypothesis so that rejecting this hypothesis does not necessarily imply inefficiency of the forward market. In view of this, we also test the efficiency of the spot market. Based on a universe of technical trading rules (including moving average, filter, channel breakout, and trading range break) considered by Cheung and Wong (1997), Lee, Pan, and Liu (2001), and Qi and Wu (2006), our empirical results reveal that the spot market is efficient, but the forward market is inefficient even under a very high transaction cost. This result suggests that the failure of forward rate unbiasedness found in early studies may be due to forward market inefficiency. On the other hand, transaction cost has some effect on selecting the best technical trading rule, but not the testing results.

This paper proceeds as follows. In Section 2, we introduce the RC and SPA tests briefly. The empirical results are then reported in Section 3.. Section 4. concludes the paper.

2. The RC and SPA Tests

Let p_t be the spot or forward exchange rate at time t and m be the total number of technical trading rules. As pointed out in many studies that interest-rate differentials do not play a significant role in computing returns (see e.g., Qi and Wu 2006, p. 2140), the return from the kth trading rule at time t is thus computed as

$$r_{k,t} = \big(\ln p_t - \ln p_{t-1}\big)s_{k,t-1} - \big|s_{k,t-1} - s_{k,t-2}\big|\psi,$$

where ψ is a one-way transaction cost and $s_{k,t}$ is a signal function at time t with $1, 0, -1$ indicating, respectively, long, neutral, and short positions. Consider, for example, a five-parameter moving average rule, denoted by $\mathrm{MA}(n_1, n_2, b, d, c)$ with n_1 (n_2) the number of days in a short-term (long-term) moving average: $ma_{n_1,t} = n_1^{-1}\sum_{i=1}^{n_1} p_{t-i+1}$ ($ma_{n_2,t} = n_2^{-1}\sum_{i=1}^{n_2} p_{t-i+1}$), b the multiplicative band, d the number of days for time delay, and c the number of days for holding a position; see also Qi and Wu (2006, p. 2139) for more detail. Let $d = c = 0$. Then

$$s_{k,t} = \begin{cases} 1, & \text{if } ma_{n_1,t-1} > ma_{n_2,t-1}(1+b), \\ -1, & \text{if } ma_{n_1,t-1} < ma_{n_2,t-1}(1-b), \\ 0, & \text{otherwise .} \end{cases}$$

As for ψ, we consider $\psi = 0, 0.5\%$ with the former indicating the absence of transaction cost and the latter being a much higher one considered by Martin (2001).

Given the benchmark rule of no position and the expected return as the performance measure (i.e., $\mu_k = \mathbb{E}[r_{k,t}]$, where $\mathbb{E}$ is the expectation operator), the null hypothesis of the absence of a superior technical trading rule relative to the benchmark rule can be expressed as

$$H_o : \max_{k=1,\dots,m} \mu_k \leq 0. \tag{1}$$

The alternative hypothesis is that the best one among the m technical trading rules does outperform the benchmark rule. To test such a hypothesis, one can apply White's (2000) RC test that employs the stationary bootstrap to estimate the p-value of the test statistic: $\mathrm{RC}_m = \max_{k=1,\dots,m} T^{1/2}\bar{\mu}_k$, where $\bar{\mu}_k = T^{-1}\sum_{t=1}^{T} r_{k,t}$; see e.g., Hsu and Kuan (2005, p. 609) for more detail. However, as shown in Hansen (2005), its power performance is adversely affected by technical trading rules that perform quite poorly.

To overcome the problem above, Hansen (2005) proposed the following test statistic instead of RC_m:

$$\mathrm{SPA}_m = \max\left(\max_{k=1,\dots,m} \frac{\sqrt{T}\bar{\mu}_k}{\hat{\sigma}_k}, 0\right), \tag{2}$$

where $\hat{\sigma}_k^2$ is a consistent estimator of $\mathrm{var}(T^{1/2}\bar{\mu}_k)$. Let $\{r^*_{k,j,1}, \dots, r^*_{k,j,T}\}$, $j = 1, \dots, B$, be the jth resample of $\{r_{k,1}, \dots, r_{k,T}\}$ using the stationary bootstrap. Then the centered returns can be computed as

$$\bar{r}^*_{k,j,t} = r^*_{k,j,t} - \bar{\mu}_k I(\bar{\mu}_k \geq -\hat{\sigma}_k/4T^{1/4}),$$

where I is the indication function. By computing the bootstrapped test statistics:

$$\mathrm{SPA}^*_{m,j} = \max\left(\max_{k=1,\ldots,m} \frac{\sqrt{T}\bar{\mu}^*_{k,j}}{\hat{\sigma}_k}, 0\right), \quad j = 1, \ldots, B,$$

where $\bar{\mu}^*_{k,j} = T^{-1}\sum_{t=1}^{T} \bar{r}^*_{k,j,t}$, the bootstrapped p-value of SPA_m is:

$$\mathrm{SPA}^{\hat{p}}_m = \frac{1}{B}\sum_{j=1}^{B} I(\mathrm{SPA}^*_{m,j} > \mathrm{SPA}_m).$$

Given a significance level α, the rejection rule of the SPA_m test is given by $\mathrm{SPA}^{\hat{p}}_m < \alpha$. Let

$$\bar{r}^{l*}_{k,j,t} = r^*_{k,j,t} - \bar{\mu}_k I(\bar{\mu}_k \geq 0),$$

$$\bar{r}^{u*}_{k,j,t} = r^*_{k,j,t} - \bar{\mu}_k.$$

As $\bar{\mu}^{l*}_{k,j} \leq \bar{\mu}^*_{k,j} \leq \bar{\mu}^{u*}_{k,j}$, where $\bar{\mu}^{\tau*}_{k,j} = T^{-1}\sum_{t=1}^{T} \bar{r}^{\tau*}_{k,j,t}$, $\tau = l, u$, the lower and upper bounds, denoted as $\mathrm{SPA}^{l,\hat{p}}_m$ and $\mathrm{SPA}^{u,\hat{p}}_m$, can be obtained by replacing $\bar{r}^*_{k,j,t}$ with $\bar{r}^{l*}_{k,j,t}$ and $\bar{r}^{u*}_{k,j,t}$, respectively.

3. Empirical Results

To construct a universe of technical trading rules, we collect the technical trading rules (including moving average, filter, channel breakout, and trading range break) considered by Cheung and Wong (1997), Lee et al. (2001), and Qi and Wu (2006) so that $m = 2216$. As for data, we collect daily data, consisting of spot and (10-day, 30-day, 60-day, and 90-day) forward exchange rates for the Taiwan dollar against the U.S. dollar, from the AREMOS database, maintained by the Taiwan Economic Data Center. While all data series have December 31, 2008 as the ending point, they have different starting points (January 2, 1986 for spot series and May 1, 1992 for forward series) due to data availability. Some summary statistics for their daily returns, computed as $(\ln p_t - \ln p_{t-1}) \times 100$, are reported in Table I. Clearly, the mean spot and forward returns are, respectively, negative and positive, yet they are all insignificantly different from zero as shown by the t-ratio results. On the other hand, although the spot returns are more volatile, the forward returns are more leptokurtic. Note also that the unconditional distribution of the spot returns is possibly left skewed, those for the forward returns (with the exception of 60-day forward returns) are possibly right skewed. It can also be seen from the last column of Table I that all of the return series are stationary.

The empirical results for the performance of the best technical trading rule under the mean return criterion, the conventional t test (denoted as t-ratio), the p-value $\mathrm{RC}^{\hat{p}}_m$ of the RC_m test, and the p-value $\mathrm{SPA}^{\hat{p}}_m$ (as well as their lower and upper bounds $\mathrm{SPA}^{l,\hat{p}}_m$ and $\mathrm{SPA}^{u,\hat{p}}_m$) of the SPA_m test are reported in Table II. For the forward

Table I: Summary statistics of daily returns on spot and forward exchange rates.

	Period	Obs.	Mean	t-ratio	S.D.	Skewness	Kurtosis	ADF
10-day	May 1992–Dec. 2008	4463	0.006	1.262	0.263	0.995	33.915	-58.842^{**}
30-day	May 1992–Dec. 2008	4463	0.006	1.274	0.347	0.628	80.859	-76.177^{**}
60-day	May 1992–Dec. 2008	4463	0.006	1.284	0.313	-0.151	53.361	-71.050^{**}
90-day	May 1992–Dec. 2008	4463	0.006	1.220	0.304	0.077	50.490	-69.632^{**}
Spot	Jan. 1986–Dec. 2008	5895	-0.003	-0.719	0.452	-0.530	31.172	-17.532^{**}

Note: Obs. and S.D. stand for the number of observations and the sample standard deviation, respectively. The t-ratio is a test of zero mean and computed using the Bartlett kernel-based variance estimator with Newey and West's (1994) data-dependent bandwidth. ADF is the augmented Dickey-Fuller test with an intercept term and the number of lags determined by the SIC criterion. * and ** denote significance at 5% and 1% levels, respectively.

exchange rates, the best technical trading rule is a moving average and yields positive mean return, regardless of the value of ψ and the length of the forward contract. As the null hypothesis (1) is overwhelmingly rejected for all forward contracts even when $\psi = 0.5\%$, the data snooping bias is taken into account, and $\text{SPA}_m^{u,\hat{p}}$ is considered, it follows that the forward market is inefficient. In particular, the evidence of the profitability of technical analysis is much stronger when the contract length gets longer.

For the spot exchange rates, early studies have provided mixed results about profitability of technical analysis. For example, Cheung and Wong (1997) found that the filter rule can yield a significantly positive mean return, but such a return disappears once a transaction cost is taken into account. Yet Lee et al. (2001) provided evidence that both moving average and channel breakout rules are profitable. Unlike these early findings, the best technical trading rule found here is a moving average (but not the one found profitable in Lee et al. 2001) and its mean return is positive and significant based on the conventional t test. However, as shown by the SPA_m test, the null hypothesis (1) cannot be rejected even when $\psi = 0$ (i.e., transaction cost is absent) and $\text{SPA}_m^{l,\hat{p}}$ is considered. It follows that the impact of data snooping bias is substantial and, after accounting for this bias, such a best rule is unable to make a significantly positive profit so that the spot market is efficient.

As the spot market is more mature and more liquid (as reported in Financial Statistics Monthly, published by the Central Bank of Taiwan, the ratio between the spot and forward trading volumes in, for example, 2008 is roughly 3.6 for the bank-customer market and 7.5 for the interbank market), the results above reveal that a more mature and/or more liquid market can be more efficient so that it reflects past information faster. On the other hand, many studies have provided evidence against the hypothesis of forward rate unbiasedness for the Taiwan-U.S. forward market. As this hypothesis requires that both the spot and forward markets are efficient in some sense, our results suggest that the failure of forward rate unbiasedness may be only due to forward market inefficiency.

Table II: The best technical trading rules and their profitability performance.

	Best Technical Trading Rules	Number of Trades	Daily Return	Annual Return	t-ratio	$\mathrm{RC}_m^{\hat{p}}$	$\mathrm{SPA}_m^{l,\hat{p}}$	$\mathrm{SPA}_m^{\hat{p}}$	$\mathrm{SPA}_m^{u,\hat{p}}$
Without Transaction Cost ($\psi = 0$)									
10-day	MA(1, 2, 0, 0, 0)	3771	0.030%	8.004%	3.951**	0.648	0.016*	0.018*	0.020*
30-day	MA(4, 30, 0, 0, 0)	324	0.029%	7.737%	4.697**	0.242	0.004**	0.004**	0.004**
60-day	MA(5, 30, 0, 0, 0)	304	0.025%	6.670%	6.931**	0.012*	0.000**	0.000**	0.000**
90-day	MA(9, 30, 0, 0, 0)	244	0.026%	6.937%	7.222**	0.004**	0.000**	0.000**	0.000**
Spot	MA(5, 25, 0, 5, 0)	336	0.023%	5.892%	2.297*	0.850	0.130	0.184	0.250
With Transaction Cost ($\psi = 0.5\%$)									
10-day	MA(2, 200, 0, 4, 0)	56	0.005%	1.334%	3.890**	0.676	0.028*	0.028*	0.028*
30-day	MA(2, 200, 0, 4, 0)	52	0.007%	1.868%	4.692**	0.282	0.010*	0.010*	0.010*
60-day	MA(2, 200, 0, 4, 0)	52	0.008%	2.134%	6.890**	0.012*	0.000**	0.000**	0.000**
90-day	MA(2, 200, 0, 4, 0)	56	0.006%	1.601%	7.211**	0.006**	0.000**	0.000**	0.000**
Spot	MA(10, 100, 0, 4, 0)	106	0.009%	2.306%	2.098*	1.000	0.186	0.208	0.250

Note: MA(n_1, n_2, b, d, c) is a moving average rule with n_1 (n_2) the number of days for short-term (long-term) moving average, b the multiplicative band, d the number of days for time delay, and c the number of days for holding a position. The annual return is computed as the mean (daily) return times the average of trading days per year over the sample period. * and ** denote significance at 5% and 1% levels, respectively.

Finally, we briefly discuss the effect of transaction cost. It is clear from Table II that when $\psi = 0$, all of the best technical trading rules tend to have a small value of n_2 so that their numbers of trades are relatively large, especially for that of the 10-day forward contract. When ψ increases from 0 to 0.5%, the best technical trading rules are still moving averages; for the forward contracts, they even have exactly the same parameter values. Unlike the best technical trading rules with $\psi = 0$, they have much larger n_2 and hence the corresponding numbers of trades are much smaller. It follows that longer time is needed to identify a trend when the transaction cost is taken into account. On the other hand, under such a high transaction cost, the mean returns of the best technical trading rules get smaller, but remain positive. As the p-values of SPA_m vary slightly, it may suggest that the transaction cost does not play an important role in determining the significance of technical analysis profitability at least for the foreign exchange markets in Taiwan.

4. Conclusion

In this paper, we examine the profitability of technical trading rules in the Taiwan-U.S. forward foreign exchange market. Based on the SPA_m test, it is found that some significantly profitable trading rule is indeed available for the forward market even when a very high transaction cost is taken into account. By contrast, the spot market, which is more mature and more liquid, is efficient as none of the trading rules can generate significantly positive returns even in the absence of transaction cost. These results may explain why the hypothesis of forward rate unbiasedness is often rejected for the Taiwan-U.S. spot and forward rates in the literature. Finally, it is also found that while transaction cost has some effect on the selection of the best trading rule, it does not alter the testing results.

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