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Suggestions for foreign trade enterprises to reduce cost after implementation of RMB cross-border trade settlement

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ABSTRACT: After RMB cross-border trade settlement was implemented, the ability of foreign trade enterprises to evade foreign exchange risk has enhanced to a great extent. In the meantime, with exchange rate fluctuations, foreign trade enterprises have become more sensitive with exchange rate variation. Based on predecessors achievement, this thesis reasonably proposed a cost model applicable to foreign trade enterprises, in which the variables are all related to exchange rate. Therefore, by making exchange rate estimation, this thesis conducted data analysis and modeling, so as to find a way for foreign trade enterprises to predict exchange rate in a reasonable way. The thesis reached the conclusion that foreign trade enterprises can better control their cost based on RMB cross-border settlement.

Keywords: foreign trade enterprises; RMB cross-border settlement; exchange rate

1 INTRODUCTION

RMB cross-border settlement has brought new development opportunities for foreign trade enterprises in cost control. It has reduced currency settlement steps; accelerated capital cycling and turnover which are beneficial for foreign trade enterprises to evade exchange rate risk; reduced exchange loss which is beneficial for foreign trade enterprises to make use of exchange rate difference and interest rate difference, so as to improve the competitiveness of foreign trade enterprises. Based on predecessors' research, this thesis tries to study the influence that exchange rate fluctuations have on the cost control of foreign trade enterprises before and after RMB cross-border settlement was implemented. Its main study methods include combined use of qualitative analysis and quantitative modeling and combined use of theoretical analysis and empirical analysis. To be specific, this thesis will first illustrate the similarities and differences of foreign trade enterprise cost control before and after RMB cross-border settlement was implemented. Second, it will respectively use qualitative analysis and quantitative modeling to test foreign trade enterprise cost control before and after RMB cross-border settlement was implemented from the perspective of enterprise profit maximization. Then, it will conduct empirical analysis of exchange rate fluctuation time sequence based on the RMB central parity data published by SAFE (State Administration of Foreign Exchange), so as to provide technical preparation for foreign trade enterprises to control cost based on exchange rate difference. At last, this thesis will further propose a mechanism to predict exchange rate fluctuation based on neural network, and will conduct empirical analysis to verify its effectiveness.

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2 SIMILARITIES AND DIFFERENCES OF FOREIGN TRADE ENTERPRISE COST CONTROL BEFORE AND AFTER IMPLEMENTATION OF RMB CROSS-BORDER SETTLEMENT

Before and after RMB cross-border settlement, the similarities in cost control among foreign trade enterprises mainly include the followings: foreign trade enterprises insist on cost and expense management principles and keep on cost reduction by effective approaches, such as controlling procurement prices of export goods, effectively controlling storage and receivables, accelerating floating capital cycling and turnover, activating investment on fixed assets, reducing office management expense, and reducing em-

ployee's salary/award. Moreover, they also emphasize on enhancing daily management on expense, so as to put effective control of cost and expense into practice.

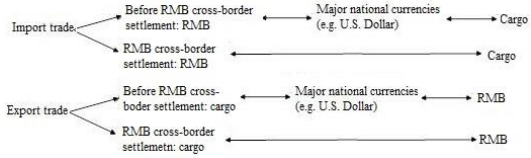
Before and after RMB cross-border settlement was implemented, one of the main differences of cost control among foreign trade enterprises was the ability of foreign trade enterprises to manage and evade risks in exchange rate. Before RMB cross-border settlement was applied, payment and income of foreign trade contract generally used international currencies (e.g. U.S. Dollar) as neutral currency. This mechanism required for several institutions and several steps, leading to low capital circulating speed and accounting speed. In this way, severe risks of capital shrinkage and liability increase were brought by exchange rate fluctuation. Since RMB cross-border settlement was experimented, contract payment and income of foreign trade enterprises can be directly processed with RMB and no second exchange is needed, resulting in institution and step reduction, economized the management cost, higher capital circulating speed and accounting speed, and improved the ability to evade risk in exchange rate.

3 QUALITATIVE ANALYSIS AND QUANTITATIVE MODELING OF FOREIGN TRADE ENTERPRISE COST CONTROL BEFORE AND AFTER IMPLEMENTATION OF RMB CROSS-BORDER SETTLEMENT

3.1 *Qualitative analysis*

Since RMB cross-border settlement was started in July, 2009, the application scale of RMB in cross-border trade has been stably improved. RMB cross-border settlement can play an important role in boosting stable development of foreign trade, assisting foreign-trade enterprises to evade exchange rate fluctuation, and helping control cost.

To compare the changes before and after implementation of Renmimbi cross-border settlement according to currency-cargo flow, the general process of import and export trade of foreign trade enterprises can be simplified as follows:



Before RMB cross-border settlement was implemented, all foreign trade enterprises needed to use international currencies (e.g. U.S. Dollar) as the neutral currency in import and export business, requiring for many institutions and several steps. The contract execution period was long while capital circulation velocity and account transfer speed were low. Thus, foreign trade enterprises were facing severe risks of capital shrinkage or liability increase brought by exchange rate fluctuations. Since RMB cross-border settlement was implemented, foreign trade enterprises can use RMB as the currency for the settlement of import and export business, so as to save currency conversion cost, shorten transaction period, and improve capital usage efficiency. Moreover, for import and export foreign trade enterprises, the implementation of RMB cross-border settlement can provide another option of international settlement currency, and thus can improve enterprise settlement feasibility and effectively reduce international settlement cost for enterprises.

3.2 *Quantitative modeling*

3.2.1 *Selection of variables*

The main aim of foreign trade enterprises to control cost is to pursue profit maximization. Profit is jointly decided by price and cost:

$$\text{Profit} = \text{Price} - \text{Cost} \tag{1}$$

Before and after implementation of RMB cross-border settlement, the main differences of cost control executed by foreign trade enterprises lie in their ability of risk management and evasion. Exchange rate fluctuations with time can lead to changes in foreign trade price and cost, thus can affect profitability of foreign trade enterprises. In view of this, the main variables selected in this thesis include: Profit, Price, Cost, Exchange Rate (ER) and Time (t).

3.2.2 *Cost control optimization model*

Since floating exchange rate system was applied in our country, exchange rate has been in fluctuations with time. ER is function of t, and can be denoted as ER (t). Accordingly, as price and cost of foreign trade are functions of exchange rate, they will change with exchange rate fluctuations. The variables can be respectively expressed as:

$$\text{Price} = f[\text{ER}(t)] \tag{2}$$
$$\text{Cost} = g[\text{ER}(t)] \tag{3}$$

Among which, $f[\cdot]$ and $g[\cdot]$ refer to the functional relations between price and ER (t) and between cost and ER (t).

On this basis, foreign trade enterprises can establish models to optimize the following cost control problems:

$$\max_{\text{ER}(t)} \ \text{Profit} = f[\text{ER}(t)] - g[\text{ER}(t)] \quad \text{s.t.} \quad t \in [T, T+\Delta] \tag{4}$$

In which, the optimization target is to maximize foreign trade enterprise profit. Optimization variable is expressed as ER(t) while constraint condition

$t \in [T, T+\Delta]$ refers to the tolerant time interval for foreign trade enterprises to complete transaction. T refers to the time node of completing foreign trade transaction in the shortest time. $T+\Delta$ refers to the time node of completing foreign trade transaction in the longest time. Foreign trade enterprises may face high risks, such as broken capital link or contract breach, if this time node is exceeded. It can be seen from Formula (4) that within a certain time, foreign trade enterprises can synthesize and consider the price and cost, so as to select the best exchange rate point to finish transaction and accomplish enterprise profit maximization. One of the benefits that RMB cross-border settlement can bring is reducing the number of involved settlement institutions. Besides, it can also shorten contract execution period and bring more room for foreign trade enterprises to reduce operation cost by making use of exchange rate differential, so as to improve enterprise profit.

It shall be noted that the object discussed in this thesis is to obtain exchange rate differential and interest rate differential through RMB cross-border settlement in real trade background, so as to reduce cost and improve profit for foreign trade enterprises. Foreign trade transactions which only aim to obtain arbitrage without any real trade background do not accord related policies and regulations. Thus, they are not included in the study range of this thesis.

3.2.3 *Relations between foreign trade cost and exchange rate fluctuations*

Exchange rate fluctuation can cause changes in cost of foreign trade enterprise. The cost of foreign trade enterprise mainly includes internal operation cost within enterprise and transaction cost among enterprises. To analyze from value chain, from supplier to customer value, cost of foreign trade enterprise involves many steps to complete value-added activities of a whole value chain. Cost control of foreign trade enterprise has gradually developed from single internal cost control within enterprise (e.g. reduce operation fee and reduce procurement price) to cross-organizational cost control (e.g. explore cost performance of a whole supply chain).

In a foreign trade supply chain, logistics, information stream and capital flow will all play their roles. Thus, related cost will be generated. To be specific, cost related to capital flow is closely related to exchange rate fluctuation and interest rate change. Assume cost is generated at time t_1 and the exchange rate at this time is $\mathrm{ER}(t_1)$, the corresponding cost is $\mathrm{Cost}(t_1)= g[\mathrm{ER}(t_1)]$. If cost is generated at time t_2 and the exchange rate at this time is $\mathrm{ER}(t_2)$, the corresponding cost is $\mathrm{Cost}(t_2)= g[\mathrm{ER}(t_2)]$. If cost is generated at different time, the differential can be expressed as:

$$\mathrm{Cost}(t_2)-\mathrm{Cost}(t_1) = g[\mathrm{ER}(t_2)]-g[\mathrm{ER}(t_1)]=\begin{cases} >0, & \text{cost raise} \\ =0, & \text{cost invariability} \\ <0, & \text{cost reduction} \end{cases} \quad (5)$$

3.2.4 *Relations between foreign trade price and exchange rate fluctuations*

Exchange rate fluctuation can cause changes in foreign trade price and indirectly lead to fluctuation in operation cost of foreign trade enterprise. Determination of foreign trade price is generally completed after contract is completed and goods payment is received. Assume contract is completed and payment is received at time t_1, the exchange rate at this time is $\mathrm{ER}(t_1)$ and the corresponding price is $\mathrm{Price}(t_1)=f[\mathrm{ER}(t_1)]$. If contract is completed and payment is received at time t_2, the exchange rate at this time is $\mathrm{ER}(t_1)$ and the corresponding price is $\mathrm{Price}(t_2)=f[\mathrm{ER}(t_2)]$. If contract is completed at different time, change in goods price can be expressed as:

$$\mathrm{Price}(t_2)-\mathrm{Price}(t_1) = f[\mathrm{ER}(t_2)]-f[\mathrm{ER}(t_1)]=\begin{cases} >0, & \text{price raise} \\ =0, & \text{price invariablity} \\ <0, & \text{price reduction} \end{cases} \quad (6)$$

For foreign trade export, higher price can always bring operation cost reduction and enterprise profit gain. For foreign trade import, higher price can always bring higher operation cost and shrinkage in enterprise profit margin.

3.3 *Empirical analysis of time sequence data of exchange rate fluctuations*

From the analysis given above, it can be known that exchange rate is an important variable for cost control of foreign trade enterprise. Selecting the best exchange rate point to conduct transaction is beneficial for foreign trade enterprise to control cost and realize profit maximization. Given this, this thesis first conducted analysis of actual exchange rate data and explored exchange rate prediction mechanism and method, aiming to lay the foundation of active cost control.

3.3.1 *Data source and software programming*

This thesis used central parity data of RMB exchange rate from SAFE (http://www.safe.gov.cn/) and conducted empirical analysis of the time sequence of floating exchange rates before and after implementation of RMB cross-border settlement. The selected time span of exchange rate data is from January 1st, 2015 to March 1st, 2016. Exchange data among RMB, U.S. Dollar, Euro, Japanese yen, Hong Kong Dollar, and Pound were mainly analyzed. The analysis method applied in this thesis contains commonality and expandability which can be directly expanded to analyze other currencies with longer time span. For the convenience of data processing and analysis, this thesis applied Matlab R2015a software to do programming. This software is also called Lab (http://cn.matworks.com/products/matlab/). It contains strong vector and vector data handling capacity, and

thus is widely used by scientific researchers in economy, finance and engineering areas.

3.3.2 *Empirical analysis of relation between exchange rate and time*

Based on the public data given by SAFE, the following graphs in Figure 1 show the central parity fluctuations of RMB exchange rate corresponding to eight foreign currencies with time, including U.S. Dollar, Euro, Japanese yen, Hong Kong Dollar, Pound, Australian Dollar, Canadian Dollar, and Ruble. The horizontal axis of each sub-graph refers to time (that is data, from January 1st, 2015 to March 1st, 2016) while the vertical axis of each sub-graph refers to corresponding central parity of RMB. There're 281 data points in each sub-graph. The author noticed that there were 425 days from January 1st, 2015 to March 1st, 2016. However, the data published by SAFE did not include the data in 144 days (425-281). For example, data from September 3rd, 2015 to September 6th, 2015 were missing. Based the existing data, this thesis continued analysis and further expanded the research work to consider completing the missing data.

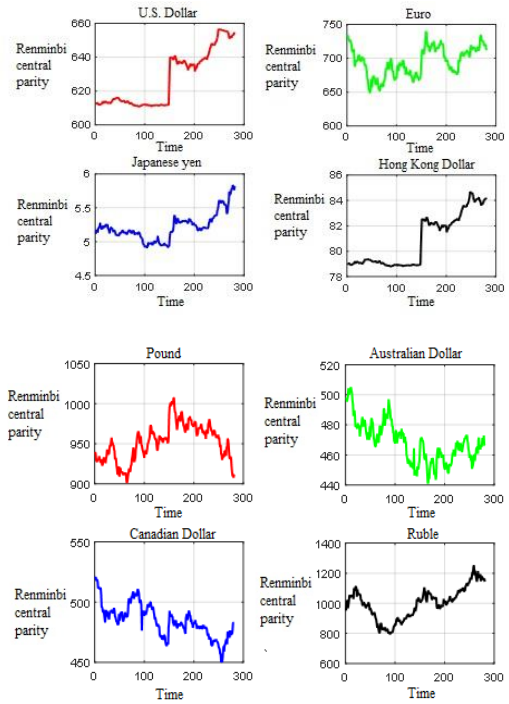


Figure 1. Distribution of daily RMB central parities corresponding to eight foreign currencies (from January 1st, 2015 to March 1st, 2016)

It can be seen from Figure 1 that there was significant fluctuations of each currency with time. However, the changing laws were not completely the same. To analyze on a macro level, the change trends of central parities of RMB exchange rates corresponding to U.S. Dollar and Hong Kong Dollar were similar. In the first 150 days, exchange rates fluctuated within a small range. Around the 150th day, exchange rates between RMB and U.S. Dollar and between RMB and Hong Kong Dollar had fault-type appreciation. After 150 days, these two currencies appreciated in general with partial fluctuations. The fluctuating trends of Japanese yen and U.S. Dollar were also very close. However, the fluctuating laws among U.S. Dollar and other currencies were significant. Euro was in rise and falls while pound rose first and then fell. General situation of Australian Dollar and Canadian Dollar was in falls with partial fluctuations. Ruble was generally in rise with partial fluctuations.

3.3.3 *Empirical analysis of correlations among exchange rate fluctuations of different currencies*

In order to analyze the correlations between RMB central parities corresponding to different currencies with time based on the data published by SAFE, this thesis applied the Pearson Correlation Coefficient shown in the following formula to measure:

$$\rho_{AB} = \frac{E[(A-\mu_A)(A-\mu_B)]}{\sigma_A \sigma_B} \tag{7}$$

In the formula, A and B respectively refer to the data of RMB central parities corresponding to any two different currencies. When A and B are the same (e.g. both are U.S. Dollar), they are autocorrelation coefficients. When A and B are different from each other (e.g. A refers to U.S. Dollar while B refers to Euro), they are interrelation coefficients. μ_A and μ_B respectively refer to the mean value of RMB central parity fluctuations corresponding to currency A and currency B. σ_A and σ_B respectively refer to the standard deviation of RMB central parity fluctuations corresponding to currency A and currency B.

Pearson Correlation Coefficient can satisfy:

(1) $\rho_{AB} \in [-1,1]$;

(2) When ρ_{AB} is higher than 0, it means A and B are in positive correlation; otherwise, they are in negative correlation;

(3) The higher absolute value of ρ_{AB} is, the stronger correlation between A and B will be; otherwise, the correlation will become weaker.

Based on the above relations and analysis of the data published by SAFE, correlation distribution as shown in Table 1 can be obtained. It can be seen from the table that autocorrelation coefficient was always 1 as two currencies were the same (e.g. U.S. Dollar and U.S. Dollar). The correlation coefficient between U.S. Dollar and Hong Kong Dollar was as high as 0.9985, meaning the exchange rate fluctuations of these two were basically the same. The correlation coefficients

Table 1. Correlations among RMB central parities corresponding to different currencies with time

	U.S Dollar	Euro	Japanese yen	Hong Kong Dollar	Pound	Australian Dollar	Canadian Dollar	Ruble
U.S Dollar	1.0000	0.6120	0.8277	0.9985	0.3622	0.8182	0.27882	-0.4625
Euro	0.6120	1.0000	0.6628	0.6113	0.4243	0.4373	0.6295	-0.0199
Japanese yen	0.8277	0.6628	1.0000	0.8145	-0.0227	0.4826	0.7714	-0.1316
Hong Kong Dollar	0.9985	0.6113	0.8145	1.0000	0.3903	0.8340	0.7761	-0.4698
Pound	0.3622	0.4243	-0.0227	0.3903	1.0000	0.8340	0.7761	-0.4698
Australian Dollar	0.8182	0.4373	0.4826	0.8340	0.6132	1.0000	0.5661	-0.7517
Canadian Dollar	0.7882	0.6295	0.7714	0.7761	0.1312	0.5661	1.0000	-0.2919
Ruble	-0.4625	-0.0199	-0.1316	-0.4698	-0.4546	-0.7517	-0.2919	1.0000

between U.S. Dollar and Japanese yen and between Australian Dollar and Canadian Dollar were also as high as 0.8277, 0.8182 and 0.7882. It's worth noting that the correlation coefficients between ruble and other currencies were negative, showing negative correlations which can be collaboratively proved by the exchange rate variation curve as shown in Figure 1.

4 PREDICTION MODEL AND PERFORMANCE OF RMB CENTRAL PARITY

4.1 *Exchange rate prediction model*

Exchange rate prediction has wide application potential and important practice value. Its core concept is to extract internal connection and evolution law of historical data of exchange rate, and take use of predicted future exchange rate status. The key lies in the selection and design of prediction model based on pursuing of high-precision in prediction result.

Set the to-be-evaluated exchange rate value $ER(t+1)$at $t+1$ as explained variable and historical data of exchange rates $ER(1),ER(2)\ldots ER(t)$ as explaining variable. The nature of prediction model is to establish the following functional relation:

$$ER(t+1) = F[ER(1),ER(2)\ldots ER(t)] \quad (8)$$

Commonly-used prediction models are AR (Autoregressive) model and ARMA (Autoregressive Moving Average) model based on regression analysis. The limitation contained in these models that the assumption of the functional relation as shown above is linear. However, the law of actual exchange rate fluctuation is generally non-linear. Simple linear model assumption can lead to unsatisfying prediction accuracy. This thesis aims to explore an exchange rate prediction model based on multi-layer neural network. The advantage of this model lies in its ability to draw non-linear functional relation with good expansibility.

See Figure 2 for the core principle of multi-layer neural network. Its main structure includes input layer, concealed layer, and output layer. Figure 2 shows the schematic diagram of three-layer neural network. In fact, more concealed layers can be set up according to the complexity of concrete problems.

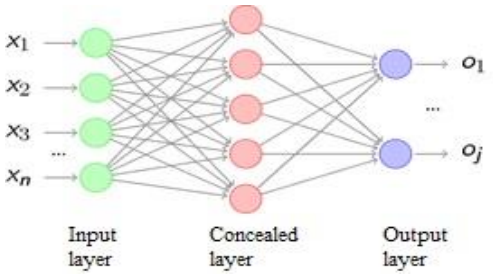


Figure 2. Multi-layer neural network principle model

The operating process of multi-layer neural network is as follows: first, input historical data of exchange rate. Second, train and learn to obtain the wired weight between the first layer and the second layer based on the historical data of exchange rate. Weigh and merge the wired weight as the output of the second layer. Then, take this output as the input of the next layer. Follow the above steps until reaching the final output layer. The multi-layer weighting structure of neural network makes it possible to construct powerful non-linear exchange rate prediction model.

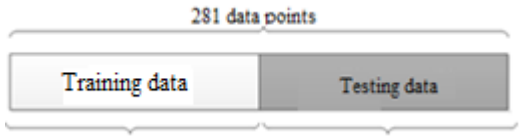


Figure 3. Multi-layer neural network

4.2 *Prediction performance of exchange rate*

Based on neural network model, this thesis applied the first 150 data points among the 281 exchange rate data provided by SAFE as training data to study relevant data of neural network model. The following 131 data were used as testing data to assess model effectiveness.

Figure 4 shows the comparison results between the real data and the prediction data of RMB exchange central parities corresponding to eight foreign currencies. In most cases, the neural network model applied in this thesis can accurately predict the exchange rate change of each currency, thus can verify the effectiveness of the proposed model.

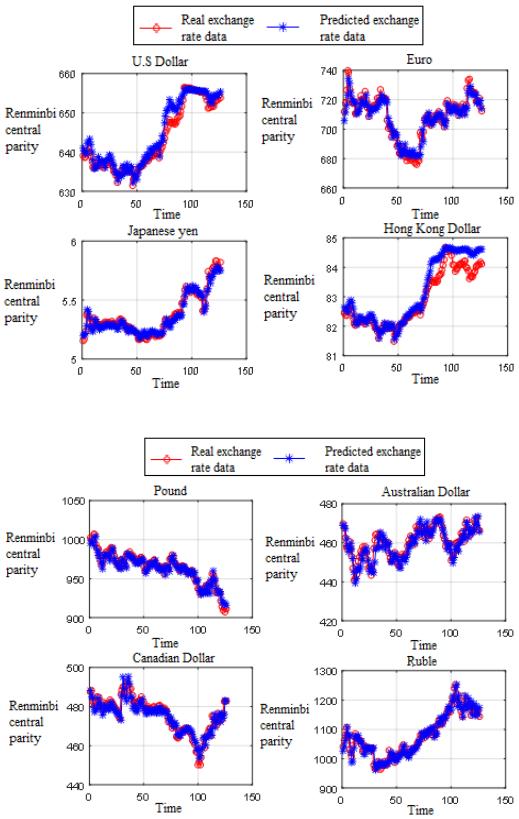


Figure 4. Comparison between the real data and the predicted data of RMB central parities corresponding to eight foreign currencies

To further make quantitative evaluation on the prediction performance of the model applied in this thesis, the following formula can be used to predict the prediction error generated in exchange rate data at t (on that day) by calculating historical exchange rate data:

$$\text{Prediction error}(t) = \frac{\text{Real exchange rate data } (t)\text{-predicted exchange rate data } (t)}{\text{Real exchange rate data } (t)}$$

According to the predicted exchange rate data and real exchange data in successive 134 days as shown in Figure 4, Figure 5 shows the accumulated distribution diagram of prediction error of each currency. It can be seen that the prediction performance of U.S. Dollar was the best of which the prediction error was within 0.5% (0.005) in 90% cases. The prediction performance of Hong Kong Dollar was the second best. Cumulative probability of both U.S. Dollar and Hong Kong Dollar to obtain prediction error within 1% (0.01) was close to 1 while that of Euro, Japanese yen, pound, and Canadian Dollar was 90%. The prediction error corresponding to ruble was high of which the prediction error corresponding to cumulative probability reaching 90% could be close to 3%.

It can be seen from the above empirical analysis of data that although exchange rate was in continuous fluctuations and the fluctuations corresponding to each currency had their own features, they did have something in common: there's internal rule in exchange rate fluctuation and no fluctuation is completely random. Thus, it is possible to accurately predict the fluctuating tendency of exchange rate by technology.

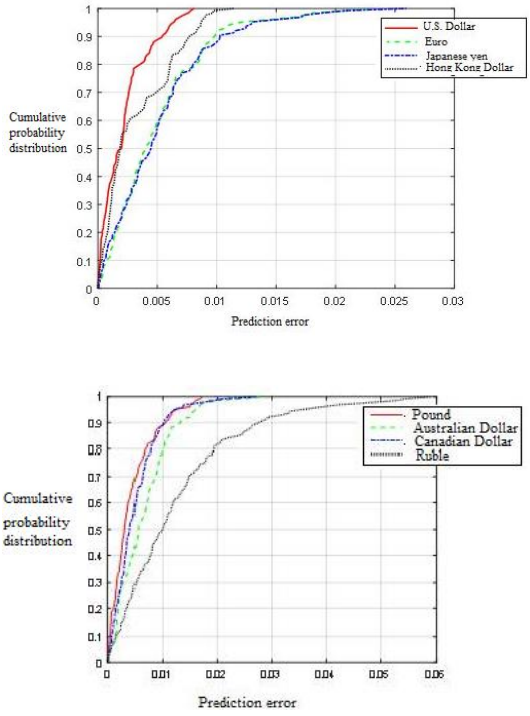


Figure 5. Prediction error distribution of RMB central parities corresponding to eight foreign currencies

5 SUGGESTIONS FOR DEVELOPMENT OF FOREIGN TRADE ENTERPRISES IN RMB CROSS-BORDER SETTLEMENT

5.1 *Deepening the application of RMB cross-border settlement in enterprises*

RMB cross-border settlement is in rapid development. Continuous new policies are being issued by nations to boost its application. Although it is still in early phase, RMB cross-border settlement will definitely be the general trend for enterprises in the future. However, the application of RMB cross- border settlement among enterprises is still rare to see. Our domestic foreign trade enterprises need to constantly cultivate talents; establish awareness of exchange rate risk; and better provide exchange rate for enterprises to choose proper currencies and contract terms.

5.2 *Establish operational hedge means*

Exchange rate can be predicted based on THE previous data and models. Other factors influencing foreign trade enterprise cost, such as interest rate, can also be used to predict exchange rate. The imperfection of this thesis is it doesn't take these factors into consideration which cannot be ignored by enterprises. During long-term trade process of foreign trade enterprises, the enterprises have found their own ways to reduce cost. There are differences among these methods; however, what they share in common are exchange rate and interest rate. In combination of trade practice, reasonable exchange arbitrage and interest arbitrage can be used to increase enterprise profit. To realize this goal, every enterprise needs to establish operational hedge means of their own after making reasonable interest rate prediction, so as to guarantee enterprise profit can be increased by exchange arbitrage and interest arbitrage in practice.

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