CHEMICAL ENGINEERING TRANSACTIONS
VOL. 46, 2015

A publication of AIDIC
The Italian Association of Chemical Engineering
Online at www.aidic.it/cet

Guest Editors: Peiyu Ren, Yancang Li, Huiping Song

ISBN 978-88-95608-37-2; **ISSN** 2283-9216

DOI: 10.3303/CET1546204

The Empirical Research on the Price Discovery Function of Treasury Bond Future in China

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To explore the price discovery function of the Treasury bond future in China, we adopt the Vector Auto Regressive Model and the Vector Error Correction (VEC) Model to analyse 270 sets of data collected from September 6th, 2013 to October 24th, 2014. The empirical results show that: firstly, the Treasury bond future Granger causes the treasury spot. Although the Treasury bond future is mainly affected by itself, it delivers a huge blow to the treasury spot; secondly, there is a long-term stable co-integration relationship between the Treasury bond future and treasury spot; and especially, the Treasury bond future makes a greater and faster adjustment than the treasury spot. So we can conclude that the Treasury bond future can realize its function of price discovery well in Chinese capital market.

1. Introduction

Five-year Treasury bond future was formally introduced to the Chinese Financial Futures Exchange for trading on September 6, 2013. Its development, however, was not smooth. The whole process of testing-failing-simulating-restarting took 21 years long. The re-launch of Treasury bond future was a milestone event in the history of Chinese capital market. This future not only has a function of hedging but also can speed up the formation of rational liberalized interest rate [1]. It is of great significance for constructions of interest rate liberalization and multilayer capital market system in our country.

The price discovery function of Treasury bond future is a measuring standard of the development of the future market of Treasury bond and also the foundation of the market's existence and development. The existing studies on Treasury bond future mainly focus on the realistic feasibility and stability of the re-launch [2]. But the empirical studies of price discovery function are still rare. The lacking empirical studies are of strong realistic and theoretical significance because they are supportive of the development of Treasury bond future and the improvement of capital market.

2. Literature review

2.1 The connotation of price discovery function

According to the studies of Martin and Garcia [3], Hakkio and Rush [4] and Kawaller et al. [5], price discovery function in futures market is future prices' nature of guiding spot prices. Under complete market efficiency, prices of futures and spots should react in the same way to same market signals and dynamics. But in reality, complete market efficiency does not exist. Strongly efficient market digests information more quickly while weakly efficient market might lag behind. Kumar and Seppi pointed out that future prices react more quickly to information than spot prices and efficiency of futures market is stronger than that of spots market [6].

2.2 Empirical analysis of price discovery function

At the very first beginning, research method of price discovery function had been Multiple Linear Regression (MLR) and then developed to empirical diversified models. Xu Xinzhong et al. adopted linear regression and information share analytic method to compare price discovery functions of copper futures in Shanghai Futures Exchange and London Metal Exchange. The results showed that copper futures in London Metal Exchange have relative advantage in terms of price causal relationship and information share while Shanghai Futures

Please cite this article as: Ding L.R., Chen M.Z., Zou P., 2015, The empirical research on the price discovery function of treasury bond future in china, Chemical Engineering Transactions, 46, 1219-1224 DOI:10.3303/CET1546204

Exchange has also been upgrading [7]. Hua Renhai and Liu Qingfu discovered the leading role of stock index futures in information reflection and transmit and found out that it is the primary driving power in price discovery process based on the Vector Auto Regressive (VAR) Model, London Causality Test, co-integration test and the Vector Error Correction (VEC) Model, etc. [8]. Gu Jing and Ye Delei innovatively adopted recursive co-integration and public factor model to analyze the dynamic changes of price discovery function of stock index futures and furthermore discovered that the function has been enhancing along with the market development [9].

2.3 Empirical study on the price discovery function of Treasury bond future in China

Huang Hai used the Vector Error Correction (VEC) Model to conduct a research on the Lead-Lag relationship between prices of Treasury bond futures and spots. He discovered that the guidance relationship of future prices and spot prices is significant which indicates an effective price discovery function of Treasury bond future [10]. However, Ma Jian, on the basis of the co-movement of futures and spots market prices, adopted London Causality Test to find out a fact that in the Chinese spot market changes occur first. That is not in line with price discovery function of futures [11].

Researches on price discovery of goods and stock index futures are mature but like mentioned above, researches on price discovery of Treasury bond futures are still rare (most of them are emulation trade researches). This paper adopts several types of models to conduct empirical studies on the interactive relationship between Treasury bond futures prices and spots prices based on accessible day-degree data.

3. Empirical analyses

3.1 Data specification and processing

In this paper, FP stands for the closing price of Treasury bond future and SP is the closing price of Treasury bond spot. LNFP is the logarithm sequence of the closing prices of Treasury bond future while LNSP is the logarithm sequence of the closing prices of Treasury bond spot. DLNFP means the first difference of the logarithm sequence of the closing prices of Treasury bond future which is also the daily yield rate of Treasury bond future. DLNSP is the one for spot. Data resource is the Wind and iFinD financial database.

(1) Sample data collection of future prices

This paper selected the closing prices of Treasury bond future dominant contracts (contracts with largest closing positions in all three quarters) from September 6, 2013 to October 24, 2014 as research sample data. Based on the analysis of figure 1, contracts TF1312, TF1403, TF1406, TF1409 and TF1412 are selected.

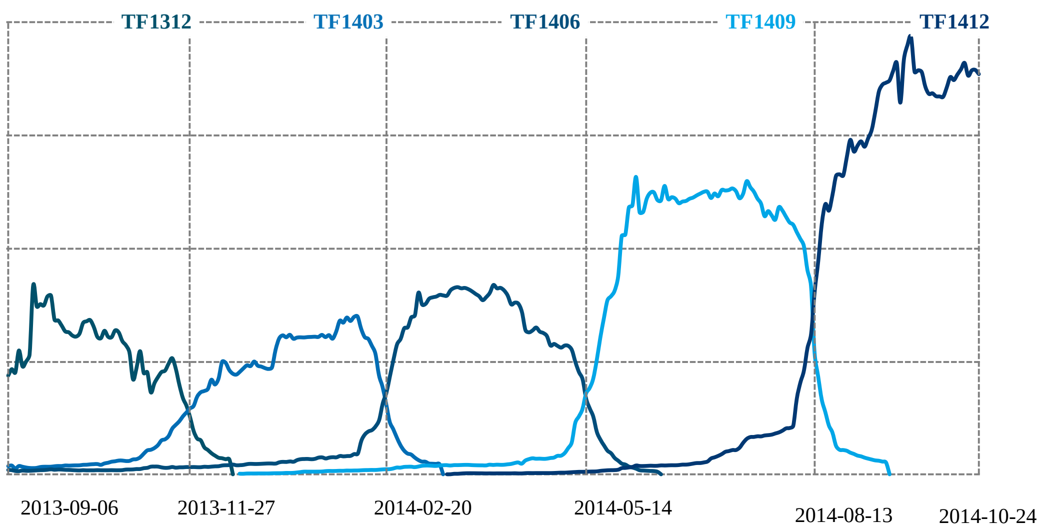

Figure 1: Positions changes of each Treasury bond future contract (unit: board lot)

(2) Sample data collection of spot prices

Standards of spot price data collection are: 1), strong liquidity; 2), high implied repo rate and 3), correspondence with Treasury bond future dominant contract. Based on these standards, following Treasury bond spots are acquired (Figure 2):

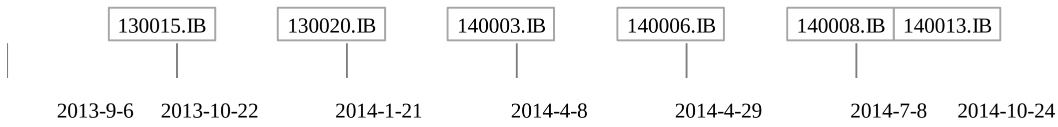

Figure 2: Selection of Treasury bond spots

With the closing price of Treasury bond spots divided by its conversion factor, the paper transforms treasury bonds of different years and expires into final spot data. The reason why the closing prices of spots need to be adjusted is to maintain stability of spot contract prices while CTD bonds have any changes. CTD corresponds with Treasury bond future contract.

3.2 Trend analysis of future and spot prices

By analyzing the closing prices of the selected futures and spots, the following time sequence trend chart of future and spot prices is acquired:

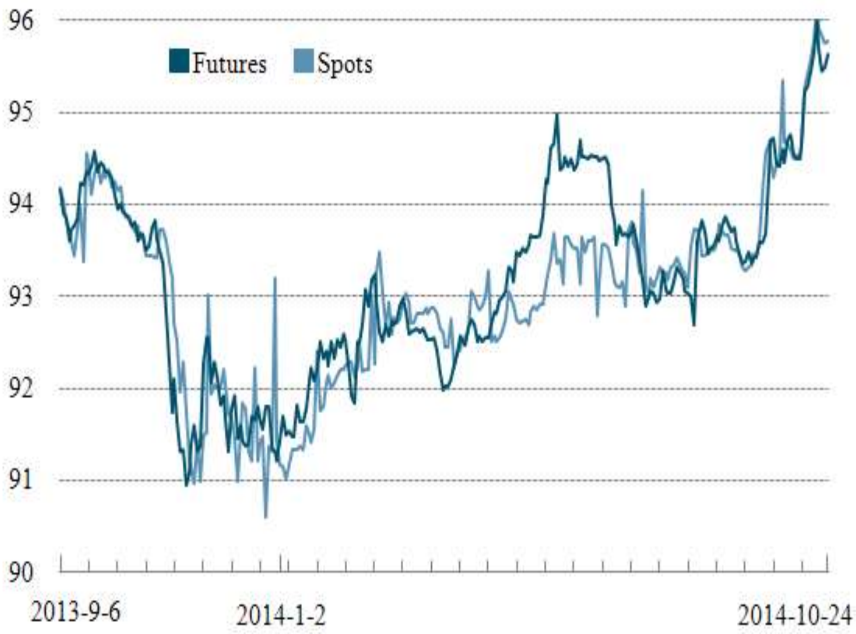

Figure 3: Time sequence trend chart of Treasury bond future and spot prices (unit: yuan)

The price trends of Treasury bond future and spot are highly consistent. Besides, at the majority of time-points, changes of future prices are ahead of trends of spot prices. That indicates better price discovery and prediction functions of Treasury bond future.

3.3 Vector Auto regression Model (VAR)

(1) Stationary test

Table 1: Test results of unit roots

Variable	ADF	5% critical value	P value	Roots of unity
SP	-2.138	-3.427	0.523	existence
FP	-1.959	-3.427	0.620	existence
LNSP	-2.163	-3.427	0.508	existence
LNFP	-1.978	-3.427	0.610	existence
DLNSP	-23.775	-1.942	0.000	inexistence
DLNFP	-15.443	-1.942	0.000	inexistence

Inspection results show that ADF values of the closing prices of futures and spots and their logarithm sequences are all larger than the 5% critical value, which means the sequences are not stable. While under the 5% critical value, the first differences of the logarithm sequences are all first-order single integers. So the sequences are stable.
(2) Estimated results of the Vector Auto Regressive (VAR) Model
According to information principles of AIC and SC, the optimal Lagged difference of the Vector Auto Regressive (VAR) Model is confirmed as 8-order. While selecting 8-order lagged difference, the VAR stability test is also passed.

Table 2: Estimated results

	DLNFP		DLNSP	
	1. Coefficient	2. t-statistic	1. Coefficient	2. t-statistic
DLNFP(-1)	0.264***	[4.131]	0.282***	[3.080]
DLNFP(-2)	-0.251***	[-3.880]	0.284***	[3.069]
DLNFP(-3)	0.334***	[5.189]	0.493***	[5.347]
DLNFP(-4)	0.307***	[4.519]	0.236***	[2.434]
DLNFP(-5)	0.201	[-0.308]	0.398***	[4.061]
DLNFP(-6)	-0.093	[-1.334]	0.231***	[2.324]
DLNFP(-7)	0.011	[0.158]	0.257***	[2.642]
DLNFP(-8)	-0.079	[-1.153]	0.300***	[3.063]
DLNSP(-1)	-0.018	[-0.405]	-0.587***	[-9.359]
DLNSP(-2)	0.095*	[1.917]	-0.388***	[-5.453]
DLNSP(-3)	0.042	[0.811]	-0.399***	[-5.393]
DLNSP(-4)	-0.016	[-0.304]	-0.289***	[-3.880]
DLNSP(-5)	-0.018	[-0.343]	-0.278***	[-3.772]
DLNSP(-6)	-0.110**	[-2.246]	-0.235***	[-3.358]
DLNSP(-7)	-0.022	[-0.460]	-0.054	[-0.804]
DLNSP(-8)	0.047	[1.137]	-0.040	[-0.668]
C	5.66E-05	[0.403]	0.0001	[0.597]

Note: significance levels are 0.01***, 0.05** and 0.1*

The VAR estimation results show that DLNFP lagged by 1 to 4 terms has obvious effects on itself. The lagged DLNSP has weak impact on the DLNFP; DLNSP lagged by 1 to 6 terms has obvious effects on itself and DLNFP lagged by 1 to 8 terms has great impact on DLNSP. Specifically speaking, futures and spots in lagged terms have great influences on themselves respectively. Future lagged by 1 to 8 terms has positive effect on spot. It simultaneously means that future has effective price guidance and discovery functions on spot.
(3) London Causality Test

Table 3: Granger Causality Test

Null Hypothesis:	Obs	F-Statistic	Prob.
DLNSP does not Granger Cause DLNFP	267	2.942	0.055
DLNFP does not Granger Cause DLNSP		5.561	0.004

According to the inspection results and the 5% significance level, the paper concludes that future is the Granger cause of spot but spot is not Granger cause of future. It also means that Treasury bond future helps to analyze the changes of spot.

3.4 Vector error correct model (VECM)
(1) Johansen Co-integration Test

Table 4: Johansen Co-integration Test results

Hypothesized		Trace	0.05		Max-Eigen	0.05	
No. of CE(s)	Eigen value	Statistic	Critical Value	Eigen value	Statistic	Critical Value	Prob.**
None *	0.290	123.040	15.495	0.290	89.295	14.265	0.000
At most 1 *	0.121	33.746	3.841	0.121	33.746	3.841	0.000

From the test results above it can be seen that under the condition of 5% significance level, track test and maximum Eigen value test both prove that the original hypotheses of “0 co-integration vectors” and “at least one co-integration vector” are false. Consequently there exists a long-term stable co-integration relationship between Treasury bond future and spot.
(2) VECM Regressive results
Since there is a co-integration relationship between Treasury bond futures and spots, the Vector error correct model can be established to analyze the impacts of long-term unbalanced error has on short-term changes.

Table 5: Estimation results of Vector error correct model (a part is selected)

	D(DLNSP)		D(DLNFP)	
	Coefficient	t-statistic	Coefficient	t-statistic
CointEq1	0.533***	[-9.354]	-3.008**	[2.246]

Note: significance levels are 0.01***, 0.05** and 0.1*

From the table above it can be seen that the error correction coefficients estimated by two models are both very significant and the difference between their absolute values is big. The error correction of Treasury bond future is bigger than that of Treasury bond spot. That is to say, when a negative ECM emerges, D (LNFP) declines more than D (LNSP). In short term, Treasury bond future adjusts from unbalanced status to balanced status more quickly than spot.

4. Conclusions and suggestions

4.1 Conclusions

(1) The trend chart of the closing prices of Treasury bond future and spot it can be seen that trends of two have strong correlation. The average price of future is higher than spot average price. It accords with the holding period cost theory.
(2) From the Vector Auto Regressive (VAR) Model, the Treasury bond future Granger causes the treasury spot and Treasury bond future is affected by itself. The guidance effect of future on spot is very obvious.
(3) The Vector Error Correction (VEC) Model reveals a long-term stable co-integration relationship between Treasury bond future and spot. In short term current prices of future and spot are both adjusted by error correction term, but future in a faster and stronger way.

4.2 Suggestions

(1) Encourage and improve the spot market of Treasury bond
Banks and insurance companies should be encouraged to enter the future market of Treasury bond. These institutions, normally in possession of large numbers of spot position, will attract more institutional and individual investors to participate in the future market of Treasury bond as well. As a result, the scale and liquidity of the market will be greatly improved.
(2) Encourage institutional investors
On one hand, institutional investors have large amounts of capital, and will contribute to the scale of future market. On the other hand, the future market of Treasury bond is a highly-professional market with high risks, thus institutional investors with good operation standards, professional investment ideas and advanced software and hardware should participate in the future market.
(3) Improve information disclosure
Trades of Treasury bond future are essentially reflections of market information. Normalized and timely information disclosure can not only prevent price feedback of Treasury bond future from being distorted but can simultaneously help regulator supervise market action, further protecting investment interests of investors and promoting the function of treasury bond future and the development of the market.

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