

Co-integration Analysis of the Relation between Direct Financing and Economical Development

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Abstract The empirical analysis of the relation between direct financing in the capital market and economical development in China was carried out with co-integration test and error correction model based on the annual data from 1981 to 2005. The results indicated that there is long/short run and stationary positive relation between direct financing and gross domestic product (GDP). It's found that direct financing promoted Chinese economical development through Granger causality test, but it's incorrect in reverse.

Key words Economical development, Direct financing, ADF test, Co-integration, Granger causality

1 Introduction

Financing structure in corporation has changed greatly with the advancing of the reformation of investment and financing and reconstruction of stock system in Chinese corporation in recent years. Direct financing in corporation has been the important way for the corporation to obtain external capital. Direct financing may be described as a special action which formed directly between capital provider and demander through certain financial instruments, and such action has no relation with banks while capital demander raises money through the shape of issuing shares or bond, or the shape of non-bond, such as internal loan and funds raising from internal group members. It's well known that direct financing is more propitious to spread risk, avoid risk concentration to banking system effectively so as to decrease the whole social risk comparing with indirect financing, so direct financing plays important role in keeping away and dissolving financial risk, improving economical development quality.

It's considered commonly in literatures that it's to advantage in economical development as expediting reformation in financial market and increasing proportion of direct financing. Many theoretical researches about this were carried out by Chinese scholars. Zhou[1] concluded that GDP would decrease a little with increasing direct financing as she analyzed the relation between direct financing and economical development using co-integration modeling technology and error correction model based on the annual data from 1981 to 2002. Chen[2] found that positive relation between the quantum of direct financing and GDP when empirical analyzing the relation between direct financing and economical development based on the annual data from 1986 to 2001. Tu[3] concluded that the elastic coefficient of direct financing and GDP was just -0.255821 and showed negative correlation, and increment of direct financing had a little expediting effect on GDP when they analyzed quantitatively the relation between the economical development and financing way using Johansen maximum likelihood estimation based on the annual data from 1981 to 2000.

It's concluded from the above research results that their conclusions were not all the same, and even some were conflicting as different historical data and analysis methods were adopted. So it's necessary to empirical analyze the relation between economical development and direct financing based on the newly data so as to obtain relatively reliable conclusion through relatively integrated analyze and provide reference for the correlative department to make decision. Whether they are uniformity integrated serial, which is the precondition of co-integration of two variables, is estimated firstly using unit root test in this paper. Test of whether there is co-integration relation between these two variables is carried out using co-integration modeling technology and error correct model based on the former estimation, and whether causality is formed is judged using Granger causality check.

2 Co-integration between Direct Financing and Economical Development

2.1 Data Selection and Variable Set

As bonds were issued in 1981 in China, annual data from 1981 to 2005 are selected to analyze quantitatively the relation between direct financing and economical development in Chinese capital market. Variable *GDP* is selected to represent Gross Domestic Product, which reflects macro-economy amount and its change reflects economical development. *S* represents direct financing and which is the balance of marketable securities in the end of each year, including bond and stock. Logarithmic values of variables, *lnGDP* and *lnS* are adopted to eliminate the heteroscedasticity among economical variables data, which has no effect on the co-integration relation between the original variables and may increase the fitness of model, distinctiveness of each variable and fitness effect.

2.2 Unit Root Test of Serials *lnGDP* and *lnS*

Commonly, time series is undulatory and may lead to *Spurious Regressions* and nonsense of each statistical test. So unit root test of the time series is necessary before make the computation model so as to ascertain the stability of each series. It may predict initially the trend of the time series of *lnGDP* and *lnS* through analyzing the variables data, so unit root test including trend for each series is carried out separately. ADF test is used in this paper, and the test results are shown in Table 1.

Table 1 ADF Test Results of Each Time Series

Variable	Test Type(<i>c, t, *</i>)	ADF Statistic	Critical Value		
			1%	5%	10%
<i>lnGDP</i>	(<i>c, t, 0</i>)	-2.443459	-4.4167	-3.6219	-3.2474
<i>lnS</i>	(<i>c, t, 0</i>)	-2.115663	-4.4167	-3.6219	-3.2474
$\Delta \ln GDP$	(<i>c, t, 0</i>)	-2.889320	-3.7667	-3.0038	-2.6417
$\Delta \ln S$	(<i>c, t, 0</i>)	-3.094864	-3.7667	-3.0038	-2.6417
$\Delta^2 \ln GDP$	(<i>c, 0, 0</i>)	-4.297144	-3.7856	-3.0114	-2.6457
$\Delta^2 \ln S$	(<i>c, 0, 0</i>)	-4.018620	-3.7856	-3.0114	-2.6457

(*c* is constant, *t* is trend and * is intercept, Δ is 1st difference and Δ^2 is 2nd difference)

It can be seen from Table 1 that *lnGDP*, *lnS*, $\Delta \ln GDP$ and $\Delta \ln S$ are all undulatory series under 1% confidence level, while $\Delta^2 \ln GDP$ and $\Delta^2 \ln S$ are stationary series. So it can be determinant that these two variables are both two-order integrated serials, and which satisfies the co-integration condition of two variables, and there may be co-integration relation between these two variables.

2.3 Test of Co-integration Relation between Two Variables

The above unit root test indicates that there may be co-integration relation between variables *lnGDP* and *lnS*. Test is carried out to distinguish whether there is co-integration relationship between these two variables, and this test is a two steps test method for co-integration which is named EG test as proposed by Engle and Granger in 1987. The test method and process is as follows:

First step, equation estimating using Ordinary Least Square (OLS) method:

$$\ln GDP = \alpha + \beta \ln S + \varepsilon$$

If $\hat{\alpha}$ and $\hat{\beta}$ are the estimation values of regression coefficient, the estimation value of model residual may be expressed as:

$$\hat{\varepsilon} = \ln GDP - \hat{\alpha} - \hat{\beta} \ln S$$

Second step, co-integration test of error series $\{\hat{\varepsilon}\}$. $\hat{\varepsilon}$ is *n*-order integrated series if $\hat{\varepsilon}$ is stationary series after *n*-difference, and it may be regarded that there is co-integration relation between time series of *lnGDP* and *lnS*.

The following regression results may be obtained after analyzing the actual annual data of *GDP* and *S* from 1981 to 2005 with Eviews software according to the above method:

$$\ln GDP = 6.191731 + 0.540996 \ln S \quad (1)$$

(21.62524) (15.18943)
(0.0000) (0.0000)

$$R^2=0.909348, \text{ Adjusted } R^2=0.905407, F=230.7187$$

So the error series $\{\hat{\varepsilon}\}$ may be expressed as the following functional equation:

$$\hat{\varepsilon} = \ln GDP - 6.191731 - 0.540996 \ln S$$

In Equation 1, the numbers in upper and lower bracket are the statistic of regression coefficient *t* and

its corresponding probability. It can be seen from each value of test statistic that the equation fits well.

The error series $\{\hat{\varepsilon}\}$ should be integrated if there is co-integration relation between $\ln GDP$ and $\ln S$ according Engle-Granger test method. So ADF unit root test of error series $\{\hat{\varepsilon}\}$ is carried out, and the test results are shown in Table 2:

Table 2 Unit Root Test Results of Error

ADF Test Statistic	-3.233074	1% Critical Value*	-2.6700
		5% Critical Value	-1.9566
		10% Critical Value	-1.6235

It can be regarded that error series $\{\hat{\varepsilon}\}$ is stationary series in 1% significance level and which indicates that there is co-integration relation between $\ln GDP$ and $\ln S$, or GDP and S , as the test statistic value -3.233074 is smaller than the critical value -2.6700 in 1% significance level. The co-integration coefficient is 0.540996, seen from Equation 1, which indicates that there is positive going long run equipoise relation between economical development and direct financing, and GDP will increase 0.540996 percent when direct financing increases one percent in capital market.

2.4 Error Correction Model

Long run equipoise relation between variables may be found through co-integration analysis, but the regulating speed is unable to be obtained when these variables depart from their common random trend. This problem may be solved using error correction model. The error correction model can be made with a group of variables with co-integration relation according to Granger law. So error correction model including correction term should be made based on co-integration test so as to study the short run dynamic regulating relation among the above each variable.

The error correction model is expressed as follows if residual in Equation 1 is μ_t and it may explain the relation among each variable better when residual μ_t is introduced as unbalance error in error correction model.

$$\Delta \ln GDP_t = 0.320348 \Delta \ln S_t - 0.268519 \mu_{t-1} \quad (2)$$

(5.374091) (-1.612647)

$$R^2 = 0.9422, D-W = 1.83, S.E = 0.062452$$

The regression coefficients in error correction model shown in Equation 2 all pass the significance test, and the value of $D-W$ is 1.83, which indicates that there is no autocorrelation in error term μ_t . There is positive relation between the increment of GDP and direct financing ($\Delta \ln GDP_t$ and $\Delta \ln S_t$) in capital market seen from error correction model, that is to say there is positive relation between short run adjustment of direct financing and short run adjustment of GDP, and the elastic coefficient is 0.320348, which indicates the promoting effect of increment of direct financing on increment of GDP is relative large; the coefficient of error correction is negative, which accords with reverse correction mechanism. The coefficient of μ_{t-1} reflects the adjustment of departing from long run equilibrium, and indicates the adjustment of direct financing and unbalance error of GDP in former year to the economical development in this year with 0.268519 ratio. The absolute value of error correction coefficient is relative smaller, which shows the departure of short run fluctuation to long run equilibrium is slight and the adjustment extent is small, and indicates that the promoting effect of direct financing on GDP is relative stationary in China at present.

3 Causality Tests of Variables

The above analysis shows that there is co-integration relation between direct financing and GDP, or these two variables have long run equilibrium relation. But further Granger causality test of these two variables is needed to make sure whether this long run equilibrium relation is causality, or whether direct financing in capital market promotes economical development and economical development drives the direct financing or both exist. The approach of Granger causality test is that if there are two economic variables X and Y , and former information of X and Y is given, the predictive effect of Y is better than the predictive effect that just the former information of Y is given, that is to say, if variable X improves the predictive precision of variable Y , there is Granger causality of variable X to Y . Two variable models are made as follows according to the Granger causality analysis method:

$$GDP_t = \alpha_0 + \sum_{i=1}^m \alpha_i GDP_{t-i} + \sum_{i=1}^m \beta_i S_{t-i} + \mu_t \quad (3)$$

$$S_t = \gamma_0 + \sum_{j=1}^m \gamma_j S_{t-j} + \sum_{j=1}^m \lambda_j GDP_{t-j} + \nu_t \quad (4)$$

μ_t and ν_t are irrelevant error items in above equations.

In the above models, it indicates that one way Granger causality existing from S and GDP if the estimated coefficient of delay item S in Equation 3 is unequal to zero in statistics as a set ($\sum \beta_i \neq 0$) and the estimated coefficient of delay item GDP in Equation 4 is equal to zero in statistics as a set ($\sum \lambda_i = 0$). In reverse, one way Granger causality existing from GDP and S if $\sum \beta_i = 0$ and $\sum \lambda_i \neq 0$. And bidirectional Granger causality existing between these two variables if $\sum \beta_i \neq 0$ and $\sum \lambda_i \neq 0$. F statistics and its corresponding probability used for test can be calculated with Eviews software. The results are shown in Table 3 after repeating test when the selected order of delay in model 3 and model 4 is 2.

Table 3 Results of Granger causality test

Former hypothesis	Delay order	F -statistics	Probability	Conclusion
No Granger causality of S to GDP	2	13.5019	0.00085	refused
No Granger causality of GDP to S	2	1.55728	0.25045	accepted

It can be seen from the test results that one way causality existing from GDP to direct financing S in China from 1981 to 2005, and S is Granger causality of GDP , while the probability of the latter isn't the former's causality is relative large, which indicates that direct financing scale in capital market promotes Chinese economical development, but economical development isn't the causality of enlarging the scale of direct financing in capital market.

4 Conclusions

Unit root test of time series of direct financing S in capital market and GDP is carried out according to the numerical economic model, and co-integration analysis, error correction model test and Granger causality test of the two variables' relation are carried out based on the passed test, and the following conclusions can be obtained:

- (1) Unit root test result shows that direct financing S and GDP are two-order integrated time series, and co-integration relation exists and direct financing promotes Chinese economical development.
- (2) Error correction model shows that adjusting magnitude is relative small, and the increment of direct financing in short run also promotes Chinese economical development.
- (3) Granger causality test result shows that one way causality existing from GDP to direct financing S in China, and S is Granger causality of GDP , but it's incorrect in reverse.

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