

The Short Term and Long Term Relationship between China's Fundamental, Scientific Journal Rates and Gross Domestic Product Sustainability

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Abstract

In this article, China's fundamental scientific journals rates and technical journals rates were used together. According to polynomial distributed lag model, there is no significant relationship between China's gross domestic product and China's fundamental scientific, technical journal rates between the periods of 1985-2009. Moreover, according to Johansen cointegration test and Engle Granger analysis, there is a long term relationship between variables. Granger causality analysis indicated that past values of China's fundamental scientific, technical journal rates can forecast the China's gross domestic product rates at optimal lag1. Variance decomposition analysis and impulse response analysis showed that China's fundamental, scientific journal rates innovation impact on China's GDP rates is more than China's gross domestic product rates innovation impact on China's fundamental scientific journal rates at lag1.

Keywords: China's GDP rates, China's fundamental scientific, technical journal rates, stationary series, polynomial distributed lag regression, Johansen cointegration test, Granger causality analysis, Engle Granger analysis, variance decomposition analysis, impulse response analysis

1. Introduction

Since 1980, China's economic growth performance is more sustainable than many other countries economic growth performance. At the time of new foundation in 1949, Chinese economy was in fragile condition and now it is great success to become from a poor nation to world's second largest as well as fastest growing major economy (Saeed, Jian, Murawwat, Na, 2012). Prof. Dr. Kanane Akamatsu developed what is known today "flying geese theory" in which he splitted countries into different levels of industrialization and economic development into three categories: late developing countries, industrially advanced countries and newly rising countries. The theory indicates that late developing countries can sustain on the technology capital and products of industrially advanced countries, then moving forward to domestic production, and finally around to export to industrially advanced countries. A flying geese theory is apparent here in the sense that Japan is leading both in moving into and out of period of high GDP share of industrial output followed by second wave, Korea, Singapore and Taiwan and then more recently by China (Huang, 2004). Since China has sustainable economic policy, China Treasury has more surplus each year. With increased surpluses, China endeavours to increase research and development funding. According to Tuan, Linda and Zhao(2009), China has become the top FDI destination among all developing countries and remained host to the world's largest share of FDI receipts since its accession to the World Trade Organization in 2001. Numerous studies have examined the role played by FDI in stimulating innovation and leading to increased trade (Bayoumi, Lipworth, 1997; Balasubramanyam, 1996). The results indicate a stronger impact of FDI by trade orientation namely the export oriented FDI and import-substituting FDI (Ahmed, 2008). In terms of secondary industry, China is wielding the clout in global markets. Due to high FDI volume and continuous export process, China has been giving importance to research and development activities. In addition, Chinese universities have been increasing fundamental scientific and journals rates. In this article, by using application of polynomial distributed lag regression, cointegration technique and variance decomposition analysis, impulse response analysis, China's gross domestic product sustainability and China's fundamental scientific, technical journal article rates relation will be measured.

2. Literature Review

New growth theories suggest that education would increase the number of competent workers and facilitate the creation of new technologies, as well as the absorption of high-techs overseas (Jin, Lawrence, 2013).

Marsh (1997) analyzed the industrial strategies of East Asian nations, and found that these nations concentrate heavily on high-tech industries, especially electronics. OEM systems and reverse engineering activities enable NIEs to import technologies and information, to develop in-house expertise, learn by trial-and-error, provide on-the-job training, and to understand the market. East Asian nations are able to learn from the practices of transnational corporations from developed nations, emphasizing quality, delivery and price of products (Hobday, 2000).

Hung et al. (2009) found that Singapore, South Korea and Taiwan have increased their research output at a particularly high rate over the last 10 years; Chuang et al. (2010) found that the research areas in which these three countries have the most significant achievements tend to be related to engineering.

Vinkler (2008) found that in European Community member states, the US and Japan, the correlation between the GDP and number of publications is not significant. This empirical result may imply that grants for scientific research in rich countries are targeted primarily at enhancing future potential growth rather than on immediate industrial requirements (Chu Lee, Hua, & Chuang, Lee, 2011). Vinkler (2008) have found no existence of obvious relevance between technological development indicators (Arco index) and economic performance for developed countries.

Nevertheless, according to the experience of East Asian countries, because of its industrial development often starting from the reverse engineering section (Hobday, 2000), the direction of industry development will determine the direction of basic research, with the basic research which will also make a more direct contribution to economic development (Chu Lee, Hua, & Chuang, Lee, 2011).

3. Methodology

China's fundamental scientific, technical journals and GDP rates were collected from World Bank website. In order to prevent heteroscedasticity problem, Box-Cox transformation was done with $\ln(x)$ monotonic function. China's fundamental scientific and technical journal rates were used together in a time series model. E-views programme was used for observations. China's fundamental scientific, technical journals and GDP rates were measured in polynomial distributed lag in two observations. In first observation, China's fundamental scientific, technical journals were taken as independent variable and in second observation, China's fundamental scientific, technical journals rates were used as dependent variable. If observations are rejected, asymptotic Johansen cointegration analysis will be implemented to find long term relationship between stationary variables. After measuring long term relation, Granger causality analysis will be applied. In addition, variance decomposition analysis will be done to find variables forecast error variance rates. Also, impulse response analysis will be implemented on two parameters and their comparative innovation impact will be scrutinized.

Hypothesis formulation:

H1: China's GDP rates have significant impact on China's fundamental scientific, technical journals rates.

H2: China's fundamental scientific, technical journals rates have significant impact on China's GDP rates.

H3: China's GDP rates and China's fundamental scientific, technical journals rates have long term relation.

H4: There is a causality between China's GDP and China's fundamental scientific, technical journal rates.

Linear regression analysis was not used. Because in times series model, generally linear regression analysis gives spurious results. In time series model, there are volatilities and polynomial model is more convenient for time series. Lag values are distributed in polynomial way and that distribution reduces multicollinearity case between independent variables. Since independent variables have tendency to have significant correlation, using polynomial distribution regression model is necessary to minimize equation modeling problems.

$$Y_t = a + w_0x_t + w_1x_{t-1} + w_2x_{t-2} + \dots + w_nx_{t-n} + \text{error term}$$

The equation represent polynomial lagged distribution. Almon lag finite lag model was choosen.

$$w_i = \sum_{j=0}^n a_j i^j$$

$i=0, \dots, k$.

In e-views programme, polynomial distributed function PDL (x, k, d) function was used.

x represent independent variable.

k is the lags in the model.

d is the degree of polynomial.

Wald Lag Exclusion test applied and lag1 was choosen as threshold.AIC test has been implemented and lag1 was choosen. There was near singular matrix error which indicates that determinant between some of the variables is near zero. When variables determinant is near zero, it can be indicated that there is multicollinearity between variables. Thus, polynomial distribution lag test can not be done with lag1.According to Wald lag exclusion test, lag 2 can be choosen as threshold. Akaike information criteria was done and lag2 was choosen as optimal lag. Polynomial degree was choosen as 2. PDL (journal, 2, 2) and PDL (gdp, 2, 2) functions were used seperately and it has been found that PDL (journal, 2, 2) does not have significant impact on China's economic growth and PDL (gdp, 2, 2) does not have significant impact on China's fundamental, scientific journal rates.

Table 1. Almon's polynomial distributed lag regression

Dependent Variable: GDP				
Method: Least Squares				
Sample (adjusted): 3 25				
Included observations: 23 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	18.50884	0.308957	59.90747	0.0000
PDL01	0.247243	0.459719	0.537813	0.5970
PDL02	-0.398479	0.257874	-1.545248	0.1388
PDL03	0.103595	0.687429	0.150700	0.8818
R-squared	0.980467	Mean dependent var		27.62826
Adjusted R-squared	0.977383	S.D. dependent var		0.883231
S.E. of regression	0.132829	Akaike info criterion		-1.042745
Sum squared resid	0.335225	Schwarz criterion		-0.845268
Log likelihood	15.99157	F-statistic		317.9072
Durbin-Watson stat	0.471981	Prob(F-statistic)		0.000000

Table 2. Almon's polynomial distributed lag regression

DependentVariable (JOURNAL)	Coefficient	Std. Error	t-Statistic	Prob.
C	-20.44489	1.005574	-20.33156	0.0000
PDL01	-0.009277	0.227686	-0.040745	0.9679
PDL02	-0.292345	0.259955	-1.124599	0.2755
PDL03	0.286301	0.230198	1.243719	0.2296
R-squared	0.987351	Meandependent var		9.704091
Adjusted R-squared	0.985243	S.D. dependent var		0.877153
S.E. of regression	0.106554	Akaikeinfo criterion		-1.477371
Sumsquaredresid	0.204366	Schwarz criterion		-1.278999
Loglikelihood	20.25108	F-statistic		468.3640
Durbin-Watson stat	0.634073	Prob(F-statistic)		0.000000

Since both H1 and H2 hypothesis rejected, H3 hypothesis can be analyzed which is about to measuring long term relationship between China's gross domestic product and China's fundamental scientific, technical journals rates. Johansen cointegration analysis will be used for analysis. Before embarking Johansen cointegration test, Augmented Dickey Fuller Test should be applied to China's GDP and Chinese universities' fundamental scientific and technical journal rates. Johansen cointegration test can be done between I (1) series. Augmented Dickey Fuller test was applied and it has been found that both series are non-stationary. When their first

differences were taken, series became I (1). Series autocorrelations do not have linear decaying graphs and variables correlations shapes do not have ellipsoid trend and correlation shapes are close to circle which indicates that there is no multicollinearity between stationary variables. Coefficient stability test was applied and it has been found that there is no structural break during the observation period. AR polynomial root graph indicates that roots are inside the unit circle. Moreover, series first differences were taken by *genr* function.

$$\text{genr } gdp1 = gdp - gdp(-1) \quad (1)$$

$$\text{genr } journal1 = journal - journal(-1) \quad (2)$$

Table 3. First difference transformation of GDP unit root problem and unit root test of JOURNAL

Null hypothesis: GDP has a unit root			
Exogenous: None			
Lag Length: 1 (Automatic based on SIC, MAXLAG=5)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		2.665327	0.9969
Test critical values:	1% level	-2.669359	
	5% level	-1.956406	
	10% level	-1.608495	
*MacKinnon (1996) one-sided p-values.			

Table 4. First difference transformation of GDP unit root problem and unit root test of JOURNAL

Null Hypothesis: D(GDP) has a unit root			
Exogenous: Constant			
Lag Length: 0 (Automatic based on SIC, MAXLAG=5)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.002391	0.0496
Test critical values:	1% level	-3.752946	
	5% level	-2.998064	
	10% level	-2.638752	
Null Hypothesis: JOURNAL has a unit root			
Exogenous: None			
Lag Length: 0 (Automatic based on SIC, MAXLAG=5)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		7.548860	1.0000
Test critical values:	1% level	-2.664853	
	5% level	-1.955681	
	10% level	-1.608793	

Table 5. First difference transformation of JOURNAL unit root problem

Null Hypothesis: D(JOURNAL) has a unit root			
Exogenous: Constant			
Lag Length: 0 (Automatic based on SIC, MAXLAG=5)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.337600	0.0000
Test critical values:	1% level	-3.752946	
	5% level	-2.998064	
	10% level	-2.638752	

After *genr* function implemented, series became stationary. After Wald lag exclusion test, Akaike information criteria analysis was done and lag length found as 1. Johansen cointegration test is asymptotic analysis which is used for measuring long term relationship between series. According to Johansen cointegration analysis, both series have long term stable equilibrium relationship. For stationary series, at lag1, unrestricted cointegration trace test indicates that there are 2 cointegrating equations at the 0.05 level. Hypothesis 3 was accepted.

Table 6. Johansen cointegration analysis between stationary GDP1 and JOURNAL1 series

Series: GDP1 JOURNAL1				
Lags interval (in first differences): 1 to 1				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.397046	16.06616	15.49471	0.0410
At most 1 *	0.200976	4.936026	3.841466	0.0263

In addition to cointegration analysis, pairwise Granger causality analysis was applied. Optimal lag length for first difference series were found as 1. It has been found that at lag1, fundamental scientific, technical journals does Granger cause China's gross domestic product which means that past values of those journals can be used to forecast future China's GDP rates. It has also been found that China's GDP does not Granger cause China's fundamental scientific, technical journal rates. It can be indicated that there is a unidirectional relationship between variables. For that reason, Hypothesis 4 was accepted.

Table 7. Optimal lag order selection

VAR Lag Order Selection Criteria						
Endogenous variables: GDP1						
JOURNAL1						
Exogenous variables: C						
Sample: 1 25						
Included observations: 19						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	52.74297	NA*	1.64e-05	-5.341365	-5.241951*	-5.324540*
1	56.96020	7.102708	1.61e-05*	-5.364232*	-5.065988	-5.313757
2	59.48318	3.718065	1.92e-05	-5.208755	-4.711682	-5.124631
3	63.54854	5.135201	2.00e-05	-5.215636	-4.519734	-5.097862
4	65.23237	1.772451	2.80e-05	-4.971829	-4.077097	-4.820405
5	69.23998	3.374826	3.29e-05	-4.972629	-3.879068	-4.787555

Table 8. Granger causality test between stationary GDP1 and JOURNAL1 series

Lag1	F statistics	p value
JOURNAL1 does not Granger Cause GDP1	23	5.96924
GDP1 does not Granger Cause JOURNAL1	0.36555	0.55224

Granger causality analysis equation represented as follows.

$$Y_t = a_0 + a_1 y_{t-1} + a_2 y_{t-2} + \dots + a_m y_{t-m} + \dots + b_q x_{t-q} + \text{residual}_t$$

Since both of the two variables are in disequilibrium position, Engle Granger analysis was used. In Granger causality analysis, it has been identified that past values of China's basic scientific, technical journal rates can predict China's GDP rates. For that reason, China's GDP rates will be taken as dependent variable and China's fundamental, technical journal rates taken as independent variable. Regression analysis was implemented to non-stationary variables and residual series were found. In order to find long term relation between variables, residuals should not have unit root problem. Residual series were analysed in Augmented Dickey Fuller test and p value was found as 0.0324. That means there is no unit root problem in residual series and non-stationary variables have long term relationship. China's fundamental, technical journals have negative adjustment effect on China's gross domestic product.

Table 9. Engle Granger unit root analysis

Engle Granger analysis		
Residual Unit Root Test		
Exogenous: None		
Lag Length: 1 (Automatic based on SIC, MAXLAG=5)		
	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.158936	0.0324
Test critical values:		
1% level	-2.669359	
5% level	-1.956406	
10% level	-1.608495	
*MacKinnon (1996) one-sided p-values.		

Table 10. Error correction model

Error Correction:	D(GDP1)	D(JOURNAL1)
CointEq1	-0.670587 (0.19478) [-3.44277]	-0.106287 (0.22767) [-0.46685]
D(GDP1(-1))	0.257986 (0.21366) [1.20743]	0.334800 (0.24974) [1.34059]
D(JOURNAL1(-1))	-0.142821 (0.13566) [-1.05277]	-0.681369 (0.15857) [-4.29702]
C	0.003937 (0.01414)	-0.010503 (0.01653)

Moreover, variance decomposition analysis was used for I(1) series. China's fundamental scientific, technical journals are responsible for around %13.92206 of the error in the variance of China's GDP until 8 variance periods. After 8 variance periods, there is stabilization. In addition, China's GDP is responsible for around %0.953360 of the error in the variance of China's fundamental scientific and technical journals rates until 13 variance periods. After 13 variance periods, there is stabilization.

Table 11. Variance decomposition of GDP1

	S.E.	JOURNAL1	GDP1
1	0.066424	9.219370	90.78063
2	0.074894	14.11814	85.88186
3	0.076629	13.89490	86.10510
4	0.077107	13.92251	86.07749
5	0.077232	13.92152	86.07848
6	0.077266	13.92198	86.07802
7	0.077275	13.92204	86.07796
8	0.077277	13.92206	86.07794
9	0.077278	13.92206	86.07794
10	0.077278	13.92206	86.07794
11	0.077278	13.92206	86.07794
12	0.077278	13.92206	86.07794
13	0.077278	13.92206	86.07794
14	0.077278	13.92206	86.07794
15	0.077278	13.92206	86.07794
16	0.077278	13.92206	86.07794
17	0.077278	13.92206	86.07794
18	0.077278	13.92206	86.07794
19	0.077278	13.92206	86.07794

20	0.077278	13.92206	86.07794
21	0.077278	13.92206	86.07794
22	0.077278	13.92206	86.07794
23	0.077278	13.92206	86.07794

Table 12. Variance decomposition of JOURNAL1

	S.E.	JOURNAL1	GDP1
1	0.077736	100.0000	0.000000
2	0.078785	99.18548	0.814515
3	0.078894	99.09261	0.907386
4	0.078908	99.05807	0.941929
5	0.078912	99.04977	0.950235
6	0.078913	99.04747	0.952532
7	0.078913	99.04686	0.953138
8	0.078913	99.04670	0.953301
9	0.078913	99.04666	0.953344
10	0.078913	99.04664	0.953356
11	0.078913	99.04664	0.953359
12	0.078913	99.04664	0.953359
13	0.078913	99.04664	0.953360
14	0.078913	99.04664	0.953360
15	0.078913	99.04664	0.953360
16	0.078913	99.04664	0.953360
17	0.078913	99.04664	0.953360
18	0.078913	99.04664	0.953360
19	0.078913	99.04664	0.953360
20	0.078913	99.04664	0.953360
21	0.078913	99.04664	0.953360
22	0.078913	99.04664	0.953360
23	0.078913	99.04664	0.953360

In addition, according to impulse response analysis, when one standard deviation shock is given, China's fundamental, scientific journal rates innovation impact on China's GDP response rates is more volatile than China's gross domestic product rates innovation impact on China's fundamental scientific journal response rates.

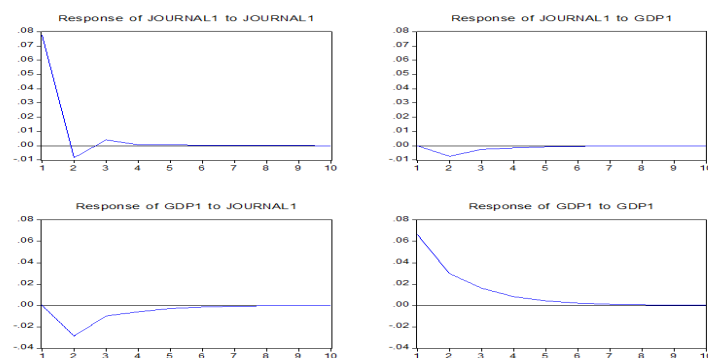


Figure 1. Response to nonfactorized one S.D. innovations

4. Conclusion

According to polynomial distributed Almon's lag model, China's GDP rates do not have significant impact on China's fundamental scientific, technical journal rates and also China's fundamental scientific, technical journal

rates do not have significant impact on China's GDP rates between the periods of 1985-2009. Moreover, Johansen cointegration test and Engle Granger test unearthed that China's GDP rates and fundamental scientific, technical journal rates have long term stable equilibrium relationship. Research result supports Chu Lee, Hua, Chuang, Lee (2011)'s indication which is about the direction of industry development to the direction of basic research, with the basic research which will also make a more direct contribution to economic development. Significant long term relationship between China's gross domestic product and basic scientific, technical journal rates also supports Hobday's indication. Hobday (2000) indicated that East Asian nations are able to learn from the practices of transnational corporations from developed nations, emphasizing quality, delivery and price of products. After China can learn from the practices of transnational corporations and give more importance to technology investment, China can publish more industry based technical journals and applied those journals into practice for export. By that policy, China's economic growth can increase in the long term. Business cycles are important for countries economic growth sustainability. International markets are so volatile and business cycles risks are case for every country. If international market import demand diminishes tremendously, China's government surplus reserves and economic growth can decrease and that circumstance can lead less funding for Chinese universities' fundamental scientific, technical journals. Although China's GDP is responsible for 0.953360% of error for China's technical journals variance, for policy implication, in order to minimize variation, Chinese government needs to prepare rolling budgets and transfer some of the Chinese treasury surplus to China's research institutions. Risk management for research institutions funding is necessary for sustainable research performance. In addition, it has been found that China's basic scientific, technical journals are responsible for 13.92206% error for China's GDP variance. In addition, when impulse response analysis applied, it was found that China's fundamental scientific journal rates innovation impact on China's GDP rates is more than China's GDP rates innovation impact on China's fundamental, scientific journal rates. It has been found that Granger causality analysis, Engle Granger analysis, variance decomposition analysis and impulse response analysis has similar result. According to variance decomposition analysis and impulse response analysis result, Chinese government had provided substantial amount of funding for Chinese universities' basic science and technical faculties. It can be indicated that some of the fundamental scientific and technical journals were converted to industry application and used for export. In order to have more innovative export based economic development and more sustainable long term relationship between China's GDP and fundamental scientific, technical journal rates, Chinese government has to give more subsidy to China's basic science and technical faculties. By that policy, more jobs can be created, reverse engineering intensity can be minimized and more innovative products can increase and poverty rates can diminish in China.

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