International Journal of Business and Management
Vol. 4, No. 1
January 2009
www.ccsenet.org/journal.html

The Analysis of Simultaneous Multi-Equations Model on the Relationship between Trade and Economic Growth in China

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Abstract

Since reform and opening up, foreign trade has played an important role in promoting the development of China's market economy. The thesis based on the theory of econometrics makes analysis of simultaneous multi-equations model on the relationship between foreign trade and economic growth in China by the data of 1978-2007, and concludes that export indeed played an important role in promoting economic growth, and the positive effect of export exceeds the negative effect of import; the negative effect of import on the economy can be offset through affecting consumption which impacts on economic growth positively; China's economy will have more space for development because of the discover in the thesis that domestic demand has almost the same effect in promoting economy as export.

Keywords: Lagging effect, Endogenous variable, Predetermined variables

China's foreign trade has developed rapidly since the reform and opening up policy with 13.4% of an average annual growth rate. This growth rate is leading the world average, and china has caught up with and even surpassed the major developed countries in terms of scales gradually. At the same time, China's economic development has shown impressive results with 9% of an average annual growth rate. Realistically, Chinese trade promotion strategy for the development has become a model for economic development to a number of countries in the world. Therefore, researching the relationship between China's foreign trade and economic growth has strong practical significance.

1. Introduction

Over the past years, whether or not china's foreign trade promoting economic growth has been the focus of debate in economic area. As a result of different research methods, economists have different conclusions on this question. Chen Jiaqin (1999) said that the import plays a more important role in promoting the economic growth than export by making use of the methods of Elastic Analysis and Causal Analysis; Shen Chengxiang (1999) used the methods of Causal Test, ADF Unit Root Test and Cointegration Test, and found that there is a reversible causal relationship between export and economic growth but no long-term stable relations in China; Song Shaohua, Song Hongming (2001) made use of the methods of Causal Test, ADF Test and concluded that export promotes the economic growth in the short term, but it is invisible in the long term; Bao Qun, Xu Helian and Lai Mingyong (2003) recognized that different ways will lead to different conclusions and only the degree of dependence on foreign trade can reflect the relationship between economic growth and trade openness better than other variables by Correlation Analysis, Regression Analysis, Variable Regression Model. After further study, they found that economic growth depends mainly on the input of elements but not the trade openness.

So many scholars above used different methods to prove their own point of view, but the author think that the study of the following issues are worth considering:

1.1 More scholars in the study of this issue, only considered the impact of import or export separately on the economy, but did not take full account of the impact of the two variables, the export and import, on economic growth together.

1.2 Previous studies only considered the impact of two variables, export and import, on economic growth without considering other variables, such as investment, consumption, government expenditure, and so on so forth.

1.3 The studies above rarely noticed the lagging effect of the variables and only paid attention to the impact of the current variables on economy.

2. Model Specifications

We should consider some aspects researching the relations between foreign trade and economic growth as following:

2.1 The measure of foreign trade

To this point, many economists at home and abroad used to make import or export or their difference as the measure of

foreign trade. However, it is not comprehensive to consider these indicators separately due to import and export constituting one country's foreign trade together. Therefore, we should take into account the import and export at the same time while researching the impact of foreign trade on economic growth.

2.2 The measure of economic growth

There are many indicators to measure a country's economic growth, such as GDP, GNP and economic growth rate, and so on. Which one is more appropriate? The author decided to use GDP as the explained variable to measure economic growth because that the major countries in the world today are using GDP to measure their nations' economic growth, and GNP is lack of time series data relative to GDP.

2.3 The analysis of the factors

In this study, the total amount of exports and imports are considered to be the main factors. In addition, there are many other factors that affect economic growth according to economic theories.

First of all, the consumption has played a significant role in economic growth, and Keynesian theory of consumption recognized that consumption can promote the production.

Secondly, in the early period of classical economics, Adam Smith proposed a theory that the capital (investment) is the motivation of the economic growth. So, investment should be considered into the model.

Finally, the Keynesian multiplier theory said that the government's spending could increase national income in number of times, so government spending should also be taken into account as the factors of the model. Therefore, this thesis makes "Import", "Export", "Consumer", "Investment" and "Government Expenditure" as explanatory variables of the model.

2.4 The design of the model's form

In this thesis, the theoretic gist of the model's design is based on the Keynesian National Income Accounting Identity: GDP = Consumption + Investment + Government Spending + Exports –Imports, but only a single equation model to explore the relationship between foreign trade and economic growth is not enough considering the probable two-way causal link existing in the variables. As a result, establishing simultaneous multi-equations model is a more appropriate choice. Here, the author assumed that the national income GDP as Y_t, Consumption as C_t, Investment as I_t, Government Spending as G_t, Exports as EX_t, and Imports as IM_t.

The establishment of simultaneous multi-equations model is as following:

$$Y_t = C_t + I_t + G_t + EX_t - IM_t \quad (1)$$

$$C_t = \alpha_0 + \alpha_1 IM_t + \alpha_2 C_{t-1} + \upsilon_{1t} \quad (2)$$

$$I_t = \beta_0 + \beta_1 Y_t + \beta_2 I_{t-1} + \upsilon_{2t} \quad (3)$$

Here, α_i and β_i (i =0, 1, 2) are the unknown parameters, and υ_{1t} and υ_{2t} are random disturbances representing the combined effects of those factors which affect the explained variables but not taken into the model. Endogenous variables are Y_t, C_t and I_t, and endogenous variable number M = 3. Predetermined variables are G_t, C_{t-1} and I_{t-1}, and its number K = 3.

Note: the above simultaneous multi-equations accord with the conditions of the Two-Stage Least Squares, and the test is elided.

3. The collection of data

In this thesis, the relative data of china in 1978 - 2007 are shown in the following Tables.

Insert Table 1 here

4. Model identification

In the simultaneous equations model, the first step is to judge the model's identification in order to obtain a reasonable estimate of the parameters. According to the simultaneous equations (1), (2), (3), we can conclude their standard forms are:

$$0 - C_t - I_t + Y_t - G_t - EX_t + IM_t + 0\times C_{t-1} + 0\times I_{t-1} = 0 \quad (4)$$

$$-\alpha_0 + C_t + 0\times I_t + 0\times Y_t + 0\times G_t + 0\times EX_t - \alpha_1\times IM_t - \alpha_2\times C_{t-1} + 0\times I_{t-1} = \upsilon_{1t} \quad (5)$$

$$-\beta_0 + 0\times C_t + I_t - \beta_1 Y_t + 0\times G_t + 0\times EX_t + 0\times IM_t + 0\times C_{t-1} - \beta_2 I_{t-1} = \upsilon_{2t} \quad (6)$$

The matrix (B, Γ) of their Standard forms is:

$$(B, \Gamma) = \begin{pmatrix} 0 & -1 & -1 & 1 & -1 & -1 & 1 & 0 & 0 \\ -\alpha_0 & 1 & 0 & 0 & 0 & 0 & -\alpha_1 & -\alpha_2 & 0 \\ -\beta_0 & 0 & 1 & -\beta_1 & 0 & 0 & 0 & 0 & -\beta_2 \end{pmatrix}$$

Since the equation (4) is an identity, there is no need to judge its identification. The identification of equation (5) and (6) are as following:

4.1 Identification of the equation (5)

First of all, use the order conditioning to judge. Make the number of endogenous variables as $m_{5,}$ and $m_5 = 2$; make the number of predetermined variables as k_5, and $k_5 = 1$. We know that $K\text{-}k_5 = 2$ and $m_5\text{-}1 = 1$, so $K\text{-}k_5 > m_5\text{-}1$. It showed that equation (5) may be over-identification.

Secondly, use the rank conditioning to judge. We draw the second line and its non-zero coefficient which included serials 1,2,7,8 in (B, Γ) away and we could get:

$$(B_0, \Gamma_0) = \begin{pmatrix} -1 & 1 & -1 & -1 & 0 \\ 1 & -\beta_1 & 0 & 0 & -\beta_2 \end{pmatrix}$$

It is clear that this matrix can form 9 non-zero second order (M-1 = 2) determinants, so we can conclude that equation (5) is over-identification referring to the judgment of its order conditioning.

4.2 Identification of the equation (6)

First of all, use the order conditioning to judge. Make the number of endogenous variables as $m_{6,}$ and $m_6 = 2$; make the number of predetermined variables as k_6, and $k_6 = 1$. We know that $K\text{-}k_6 = 2$ and $m_6\text{-}1 = 1$, so $K\text{-}k_6 > m_6\text{-}1$. It showed that equation (6) may be over-identification.

Secondly, use the rank conditioning to judge. We draw the second line and its non-zero coefficient which included serials 1, 4, 9 in (B, Γ) away and we could get:

$$(B_0, \Gamma_0) = \begin{pmatrix} -1 & -1 & -1 & 1 & 0 \\ 1 & 0 & 0 & -\alpha_1 & -\alpha_2 \end{pmatrix}$$

It is clear that this matrix can form 9 non-zero second order (M-1=2) determinants, so we can conclude that equation (6) is over-identification referring to the judgment of its order conditioning.

5. Model Estimation

From the part 4 we know that the model is over-identification, and it is appropriate to use the Two-Stage Least Squares (TSLS) to estimate the parameters. The estimation of equation (2) is as following:

Insert Table 2 here

According to the table we conclude the TSLS form of equation (2) is:

$C_t = 1180.809 + 0.257016IM_t + 0.880683C_{t-1}$

The estimation of equation (3) is as following:

Insert Table 3 here

According to the table we conclude the TSLS form of equation (3) is:

$I_t = 224.9145 - 0.123501Y_t + 1.516373I_{t-1}$

Then we get the TSLS form of the model is:

$$Y_t = C_t + I_t + G_t + EX_t - IM_t \quad (7)$$

$$C_t = 1180.809 + 0.257016IM_t + 0.880683C_{t-1} \quad (8)$$

$$I_t = 224.9145 - 0.123501Y_t + 1.516373I_{t-1} \quad (9)$$

Finally we get this equation from equation (7), (8), (9)

$Y_t = 1251.1992 + 0.7839\,C_{t-1} + 1.3497I_{t-1} + 0.8901G_t + 0.8901\,EX_t - 0.6613IM_t$

6. Conclusion

6.1 Export indeed plays an important role in promoting economic growth, and the positive effect of export exceeds the negative effect of import

This proves that, to some extent, import and export impact on economic growth together rather than separately. This also proves that the Keynesian National Income Accounting Identity $Y_t = C_t + I_t + G_t + EX_t - IM_t$ is right and the form of $Y_t = C_t + I_t + G_t + NX_t$ ($NX_t = EX_t - IM_t$) is wrong because their varying extents of effect. This is to say, import and export impact on economic growth together rather than net export.

6.2 We should not ignore the role of export plays

The export-oriented theory of neo-classical economics found that there is causal effect between export and economic growth in the real economic system. On the one hand, expansion of export helps one country to achieve economies of scale and then promote productivity; on the other hand, expansion of export helps one country to accelerate its technological progress and improve its capital efficiency. From the above analysis we do see the export has strong positive effect on economic growth. However, we also get that import has some certain impact on household consumption which is positive to economy from equation (8). The negative effect of import on the economy can be offset through affecting consumption which impacts on economic growth positively and after that its negative effect will be less. Appropriate import could improve technological progress and productivity, and even some kinds of imported goods serve for export directly, which can affect economic growth through export.

6.3 We should notice the importance of expanding domestic demand besides import and export

The past consumption, investment and current government spending play a significant role in economic growth. We can see that these variables have almost the same impact on economy as export from the estimation, and some even more than import. All of these provide more space for china's economic development.

From the estimation, we get a result that investment has a negative effect on economic growth which conflicts with investment theory of economics. However, this thesis focuses on the import, export and economic growth, and ignores to test that result. The failure of this thesis in this respect may be due to the bad multi-collinearity of investment and national income.

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Table 1.

Year	Y_t	C_t	I_t	G_t	EX_t	IM_t
1978	3605.6	2239.1	1377.9	480	995.486	1113.09
1979	4074	2619.4	1474.2	614	1361.41	1562.06
1980	4551.3	2976.1	1590	659	1809.93	1994.13
1981	4901.4	3309.1	1581	705	2200.7	2201.5
1982	5489.2	3637.9	1760.2	770	2232.1	1928.5
1983	6076.3	4020.5	2005	838	2222.6	2139
1984	7164.4	4694.5	2468.6	1020	2613.9	2741
1985	8792.1	5773	3386	1184	2735	4225.2
1986	10132.8	6542	3846	1367	3094.2	4290.4
1987	11784.7	7451.2	4322	1490	3943.7	4321.6
1988	14704	9360.1	5495	1727	4751.6	5526.8
1989	16466	10556.5	6095	2033	5253.8	5914
1990	18319.5	11365.2	6444	2252	6209.1	53334.5
1991	21280.4	13145.9	7517	2830	7191	6379.1
1992	25863.7	15952.1	9636	3492.3	8494	8058.5
1993	34500.7	20182.1	14998	4499.7	9174.4	10395.9
1994	46690.7	26796	19260.6	5986.2	12100.6	11561.4
1995	58510.5	33635	23877	6690.5	14878	13208.4
1996	68330.4	40003.9	26867.2	7851.6	15104.8	13883.3
1997	74894.2	43579.4	28457.6	8724.8	18279.2	14237
1998	79003.3	46405.9	29545.9	9484.8	18371.2	14023.7
1999	82673.1	49722.7	30701.6	10388.3	19493.1	16569.9
2000	89340.9	54600.9	32499.8	11705.3	24920.3	22509.4
2001	98592.9	58927.4	37460.8	13029.3	26609.8	24355.3
2002	107897.6	62798.5	42304.9	13916.9	32559.1	29517.1
2003	121511.4	67442.5	51382.7	14764	43789.9	41306.2
2004	124969.5	53950	70073	16445.2	59343.9	56068.3
2005	168102	67177	88604	26012.1	76206.8	66015.9
2006	193269.1	76410	109870	30292.7	77594.6	63376.9
2007	224881	89210	137239	36737.6	92787.73	77346.48

Source: Statistical Yearbook of China
http://www.stats.gov.cn/tjsj/ndsj/

Note: The units of Y_t, C_t, I_t, G_t, EX_t and IM_t are 100,000,000 Yuan

Table 2.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1180.809	1536.865	0.768323	0.4492
IMT	0.257016	0.115741	2.220608	0.0353
CT(-1)	0.880683	0.092862	9.483744	0.0000
R-squared	0.961406	Mean dependent var		30767.06
Adjusted R-squared	0.958437	S.D. dependent var		26767.25
S.E. of regression	5457.027	Sum squared resid		7.74E+08
F-statistic	330.0239	Durbin-Watson stat		1.700918
Prob(F-statistic)	0.000000			

Dependent Variable: CT;

Method: Two-Stage Least Squares;

Date: 12/11/08, Time: 23:12;

Sample (adjusted): 1979 2007;

Included observations: 29 after adjustments;

Instrument list: C GT CT (-1) IT (-1).

Table 3.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	224.9145	762.8850	0.294821	0.7705
YT	-0.123501	0.049308	-2.504709	0.0189
IT(-1)	1.516373	0.109298	13.87372	0.0000
R-squared	0.995235	Mean dependent var		27612.49
Adjusted R-squared	0.994869	S.D. dependent var		34476.74
S.E. of regression	2469.620	Sum squared resid		1.59E+08
F-statistic	2715.744	Durbin-Watson stat		0.778090
Prob(F-statistic)	0.000000			

Dependent Variable: IT;

Method: Two-Stage Least Squares;

Date: 12/11/08, Time: 23:22;

Sample (adjusted): 1979 2007;

Included observations: 29 after adjustments;

Instrument list: C GT CT(-1) IT(-1).