What Causes What in China?

Causality Tests based on a Panel VAR Model

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Abstract

This paper examines the causal relationships among gross domestic product (GDP), foreign direct investment (FDI), multinational enterprise imports (MNE imports), MNE exports, domestic enterprises' imports (DE imports) and DE exports in China. Using panel data from China's 29 provinces over the period 1994-2003 and a dynamic panel model, the study finds two pairs of bidirectional causality relations which run between GDP and DE imports and run between MNEs imports and DE exports, respectively. Apart from the positive causality relation from FDI to GDP and the causality relation from MNE exports, the study suggests that there exists a negative causality effect from MNE imports to GDP, whereas DE imports contribute to the growth of GDP of China. The study's evidence does not support the hypothesis that FDI contributes to the growth of GDP on a national level in China. The theory for results is represented. Econometric techniques for dynamic panel model applied to unit roots and SYS GMM. This estimation leads to a consistent and asymptotic estimator.

Keywords: FDI; GDP; imports; exports; causality relation: dynamic panel model; SYS GMM

[1] The author acknowledges Professor Masayuki Hara and Professor Kouji Aoki for their helpful comments and suggestions that made this paper more valuable and reliable.

Section 1: Introduction

A long-standing debate has been concerned with the relationship between GDP, FDI and trade. Does FDI significantly contribute to a host country's economic development? Is GDP one of the important factors that decide spatial location of FDI? Are FDI and trade substitutes or complements? Unfortunately, the answers vary across applied studies that employed different econometric methods based on different countries' data. Using panel data from China's 29 provinces and a dynamic panel VAR (vector autoregression) model, this paper attempts to provide an explicit understanding of the debate concerning *GDP, FDI and trade, what causes what in China?*

Since China is one of the largest recipients of inward FDI in the world (UNCTAD 2003), the causal links among FDI, GDP and trade in China have attracted considerable attention in the economics profession. Using time series quarterly data from China, Liu, Burridge and Sinclair (2002) suggest that there is a bi-directional causality between economic growth, FDI and exports. They do not find substantial evidence supporting a causality relation from imports to GDP and FDI. However, considering China's special policy toward FDI and imports, it may be unacceptable that imports have no influence on the important economic variables such as GDP, FDI and exports in a fast-growing economy. This divergence between their results and reality may come from the quarterly data by which one cannot find the long-run causality relation due to the long-range dependence of economic data (Ghysels, Swanson and Watson 2001 p18). Furthermore, in their paper as an approximation of true GDP quarterly data, the estimated GDP quarterly data is used to derive the conclusion due to the absence of GDP quarterly data, which may lead to an unreliable result.

Using bilateral panel data for China and home country/regions, Liu, Wang and Wei (2001) argue that there exists a virtuous procedure of development for China. The growth of China's imports causes the growth of inward FDI from a home country/region, which, in turns, causes the growth of exports from China to the home country/region. However, their conclusion is not substantial because of the pooled model employed in their study, which ignores the heteroskedasticity of 19 home countries/regions. It is well known that the OLS estimator is seriously biased in a dynamic panel model with individual effects (Hsiao 2003 p73). The latter may describe economic phenomenon more delicately than a pooled model.

Another interesting result is proposed by Zhang and Felmingham (2001), who using national monthly times series data, find a bidirectional causality relation between FDI and exports. Furthermore, based on the magnitude of FDI received by 29 provinces, they divide China's 29 provinces into three groups: the high recipients (Chinese coast), the medium recipients (central China) and the low recipient (western China). Using the corresponding panel data for the three groups, they analyze the causality relation between FDI and exports in China and argue that on the Chinese coast and in western China, there exists a bidirectional causality relation between FDI and exports, while exportss cause FDI in central China. Given the fact that the distribution of FDI is extremely unbalanced across China's 29 provinces, it is appropriate to analyze the causality relation for different recipients of FDI respectively in China. However, similarly with Liu, Wang and Wei (2001), in their paper, a pooled model is employed to derive the result, which also leads to unsubstantial results. For instance, despite extreme variety in the levels of FDI across Chinese coast and western China, their results reveal the same causality relation for these two groups.

In contrast to previous studies regarding causality relations among FDI, GDP and trade, not only does this paper analyze the causality relation between GDP and FDI by using panel data form China's 29 provinces, but it also tries to describe an explicit process for inward FDI in China's economy by dividing exports and imports data of MNEs the corresponding data for DEs. Moreover, in order to avoid an inconsistent estimation caused by the heteroskedasticity across cross-sections, we employ the SYS GMM method, which leads to a consistent and asymptotic efficient estimator in a dynamic panel model. The remainder of this paper is structured as follows: Section 2 describes the econometric method and data of this paper. The results are shown in section 3. Section 4 concludes.

Section 2: Data and Economic Methodology

The GDP, FDI stock, import and export panel data and all kinds of indices that cover China's 29 provinces are from *China Statistical Yearbook* (1993～2004), except price indices of imports and exports which are identical for the 29 provinces and they are from *China Custom*. To remove the influence of inflation, GDP, FDI stock, imports and exports variables are adjusted by using the corresponding GDP deflator, price index of investment in fixed asserts, price index of imports and price index of exports, respectively, from the 29 provinces.

1: Selection of Estimation Method for a Dynamic Panel Model

A causality test with panel data presents a problem associated with dynamic panel data analysis. It is well known that in a dynamic panel model the OLS estimator is biased and inconsistent even if the disturbance terms are not serially correlated due to the presence of a lagged independent variable and an individual effect in the right side of the estimation equation. The fixed effect estimator which applies OLS to the transformed equation will be biased of $O(1/T)$ and its constancy will depend upon T being large; see Nickell (1981). To avoid this problem, Kiviet (1995) proposed a corrected fixed effect estimator that subtracts a consistent estimator of this bias from the original fixed effect estimator. However, the Monte Carlo experiments performed by Judson and Owen (1999) show that the bias in the fixed effect estimator can be sizeable, even when $T = 30$. On the other hand, an alternative transformation was suggested by Anderson and Hsiao (1981) and Holtz-Eakin et al. (1988), who argued that using the orthogonal conditions $E(y_{i,t-2}\Delta v_{it}) = 0$ or $E(\Delta y_{i,t-2}\Delta v_{it}) = 0$, one can get the consistent estimator as long as the v_{it} themselves are not serially correlated. This instrumental variable estimation leads to consistent, but not necessarily efficient, estimates of the parameters in the model because it does not make use of all the available moment conditions (see Ahn and Schmidt, 1995) and it does not take into account the differenced structure on the residual disturbances (Δv_{it}). Arellano and Bond (1991) proposed a generalized method of moments (GMM) procedure that is consistent and more efficient than the Anderson and Hsiao (1982) estimator, when N is infinite and T is fixed. In their literature, the orthogonal conditions $E(y_{i,t-2}\Delta v_{it}) = 0$ are considered and the covariance matrix of the differenced disturbances is used to calculate a one-step estimator and a more efficient two-step estimator. However, as Arellano and Bond (1991) noted, compared with the standard error of the two-step estimator, the one-step's standard error is more reliable. This is partly because simulation studies have suggested very modest efficiency gains from using the two-step version, even in the presence of considerable heteroskedasticity, but more importantly because the dependence of the two-step weight matrix on estimated parameters makes the usual asymptotic distribution approximations less reliable for the two-step estimator.(see Stephen Bond, 2002). An alternative method to address this problem is proposed by Arellano and Bover (1995) who use lagged difference of y_{it} as instruments for equations in levels, in addition to lagged levels of y_{it} as instruments for equations in first differences. Monte Carlo simulations and asymptotic variance calculations show that this extended GMM estimator (hereafter SYS GMM) offers dramatic efficiency in the simulations where the basic first-differenced GMM estimators performs poorly (see Blundell and Bond, 1998). Because the coefficient of the lagged dependent variable increases toward unity and the relative variance of the fixed effect u_i increases. Moreover, as Blundell and Bond noted that, in order to use lagged differenced y_{it} as instruments for level equation, one should consider an additional, but in many cases relatively mild, restriction on the initial conditions process. Even though a few econometricians (See Ziliak 1997, Judson and Owen 1999, Kiviet 1995) have noted that the strategy of exploiting all the moment conditions for GMM estimation is not actually recommended for panel data applications (see Hsiao, 2003). Since the downward bias can be sizeable in a model with a huge number of moment conditions (see Doran and Schmidt, 2005). In a situation where a superior method is no clearm the SYS GMM seems a relatively safe choice (Bun and Kiviet, 2005). In fact, in a sense that we focus on the estimated correct standard errors rather than the magnitudes of the estimated coefficient, the SYS GMM performs very well. In order to avoid the downward bias of the standard error in small samples, following Windmeijer (2005), we adjust the variance of the estimators. To explain the econometric procedure employed in this paper, firstly let us consider a simple model only with the first lagged dependent variable, which does not affect the accuracy of the inferences even in a multivariable model:

$$y_{it} = \gamma y_{i,t-1} + u_i + v_{it} \qquad (3\text{-}1)$$

2: Assumption

$$E\left[u_i\right] = 0, E\left[v_{it}\right] = 0, \quad E\left[v_{it}u_i\right] = 0, \text{ for } i = 1, \ldots, N \quad \text{and} \quad t = 2, \ldots, T \qquad (3\text{-}2)$$

And

$$E\left[v_{it}v_{is}\right] = 0 \quad \text{for} \quad i = 1, \ldots, N \quad \text{and} \quad \forall t \neq s \qquad (3\text{-}3)$$

As for y_{i1}, the restrictions on the initial conditions define a mean stationary process as:

$$E(y_{i1}v_{it}) = 0 \quad y_{i1} = \frac{u_i}{1-\gamma} + \varepsilon_{i1} \quad \text{for} \quad i = 1, \ldots, N \text{ and } t = 2, \ldots, T. \qquad (3\text{-}4)$$

And

$$E\left(\varepsilon_{i1}\right)=E\left(\varepsilon_{i1}u_i\right)=0 \quad \text{for} \quad i=1,\cdots,N \tag{3-5}$$

$$E\left(\varepsilon_{i1}^2\right)=\frac{\delta_v^2}{1-\gamma^2} \tag{3-6}$$

And a covariance stationary process by further specifying

$$E\left(v_{it}^2\right)=\delta_v^2 \quad \text{for}\, i=1,\cdots,N \quad \text{and} \quad t=2,\cdots,T \tag{3-7}$$

Firstly, subtract y_{it-1} from y_{it} to wipe out individual effect u_i and obtain equation (1-2), rewrite it as:

$$\Delta y_{it}=\gamma\Delta y_{i,t-1}+\Delta v_{it} \tag{3-9}$$

The orthogonality conditions for the first difference equation are shown as:

$$E\left[y_{i,t-s}\Delta v_{it}\right]=0;, \text{for} \quad t=3,\ldots,T \quad \text{and} \quad 2\le s\le t-1 \tag{3-8}$$

For the level equation (1-1), given initial condition (3-4):

The orthogonal conditions are given by:

$$E\left[\Delta y_{i,t-1}v_{it}\right]=0, \text{for} \quad t=3,\ldots,T.$$

This can be expressed as:

$$E\left[\mathbf{Z}'_{si}\mathbf{p}_i\right]=0$$

Where

$$\mathbf{p_i}=\begin{bmatrix}\mathbf{\Delta u_i}\\ \mathbf{u_i}\end{bmatrix}$$

$$\mathbf{Z_{si}}=\begin{bmatrix}\mathbf{Z_{di}} & \mathbf{0}\\ \mathbf{0} & \mathbf{Z_{li}}\end{bmatrix}=\begin{bmatrix}\mathbf{Z_{di}} & 0 & 0 & \cdots & 0\\ 0 & \Delta y_{i2} & 0 & \cdots & 0\\ 0 & 0 & \Delta y_{i3} & \cdots & 0\\ \vdots & \vdots & \vdots & \cdots & 0\\ 0 & 0 & 0 & \cdots & \Delta y_{iT-1}\end{bmatrix}$$

$\mathbf{Z_{si}}$ is the instrument of SYS GMM, $\mathbf{Z_{di}}$ and $\mathbf{Z_{li}}$ are the instruments for the first-differenced equation and level equation, respectively. $\mathbf{Z_{di}}$ is defined as follows:

$$\mathbf{Z_{di}} = \begin{bmatrix} y_{i1} & 0 & 0 & \cdots & 0 & \cdots & 0 \\ 0 & y_{i1} & y_{i2} & \cdots & 0 & \cdots & \\ \vdots & \vdots & \vdots & \cdots & \vdots & \cdots & \\ 0 & 0 & 0 & \cdots & y_{i1} & \cdots & y_{iT-2} \end{bmatrix}$$

Then the SYS GMM estimator is given by:

$$\hat{\gamma}_s = \left(\mathbf{q}'_{-1}\mathbf{Z_s} \left(\mathbf{Z'_s}\ \mathbf{Z_s} \right)^{-1} \mathbf{Z'_s}\ \mathbf{q_{-1}} \right) \mathbf{q}'_{-1}\mathbf{Z_s} \left(\mathbf{Z'_s}\ \mathbf{Z_s} \right)^{-1} \mathbf{Z'_s}\ \mathbf{q}$$

Where

$$\mathbf{q_i} = \begin{bmatrix} \Delta \mathbf{y_i} \\ \mathbf{y_i} \end{bmatrix}$$

3: Testing for Serial Autocorrelation in a SYS GMM model

Arellano and Bond (1991) propose a test for the hypothesis that there is no second-order correlation for the disturbance of the first-differenced equation. The test is importsant because the consistency of the GMM estimator relies upon the fact $E[\Delta v_{it} \Delta v_{i,t-2}] = 0$, $E[\Delta v_{it} \Delta v_{i,t-1}] \neq 0$ which is from the initial assumption. Under the null of no autocorrelation the statistic of the test asymptotically distributed as $N(0,1)$, so if the errors in levels were uncorrelated, we would expect AR1 (test for the first order autocorrelation) to be significant, but not AR2 (test for the second order autocorrelation). For more detail we suggest readers consult Arellano and Bond (1991) or Arellano (2003, p121).

The standard test for testing the validity of the moment conditions used in the GMM estimation procedure is the Sargan test of overidentifying restrictions (see Hansen 1982, Arellano and Bond 1991). Under the null that the moment conditions are valid, the statistic is asymptotic chi-squared distributed with $p-k$ degrees of freedom, where p is the number of the instruments and k is the number of estimated parameters.

4: Lag Length in a Panel VAR model

Though the method for selecting the optimal lag length in a GMM framework has been addressed by Andrews and Lu (2001), who resemble the widely used BIC AIC and HQIC model selection criteria and developed a new selection criteria MMSC, which are based on the J statistic for testing overidentifying restrictions. However, it is well known that this widely used likelihood-based selection criteria BIC, HQIC, and AIC (the latter is not consistent) often cannot give us an identical answer to the optimal length of lag. As Gonzalo and Pitarakis (1999) noted, only in a large system dimensions, AIC's well known over-parameterization feature becomes quickly irrelevant. Following Holtz-Eakin et al. (1988 1989), instead of selection criteria we use Arellano and Bond's (1991) autocorrelation test and sequential test to select the optimal lag length. The reason that we select the former as a main tool for selection of lag length is that the optimal selection of lag length should be determined by the fact that the residuals are a white noise process. The latter which is considered by Hall (1994) and Perron (1995) for the choice of lags in unit root tests is consistent with the general-to-specific strategy. The practical process based on these two tests will be discussed with the estimated results in section 4.

Section 3: Empirical Result

1: Testing for Stationarity of Data

As Hsiao (2003 p108) noted that only the roots of all variables fall outside the unit circle, the GMM estimator is consistent and asymptotic normally distributed when $N \to \infty$. Levin and Lin (1993) and Levin, Lin and Chue (2002) have developed a panel unit root test which is based on the assumption that the persistence parameters are common across cross-section. Alternatively, Im, Pesaran and Shin (1997) relax Levin and Lin's strong assumption of homogeneity on the autoregressive parameter and allow the parameter varies freely across cross-section. However, implicit in Im, Pesartan, and Shin's (1997) test is the assumption that T is the same for all cross-sectional and that the same lag length is used for all the ADF regressions for individual series. Maddala and Wu (1999) suggest using Fisher's (1932) results to derive tests that combine the p-value from individual unit root test. Basically, Levin, Lin and Chue's test (1993) is based on pooled regressions, since it allows homogeneity in the autoregressive parameter. On the other hand, MW test and IPS test, which are based on the heterogeneity of the autoregressive parameter, amount to a combination of different independent tests. To my knowledge there has not a unit root test dominating applied research. Considering the heterogeneity of the autoregressive parameter in MW test and IPS test we select them to check data's Stationarity and report all results of these two tests. The former was done based on ADF test and PP test. A few econometricians, for example (Toda and Yamamoto 1995), have suspected the power of unit root test. However, considering that all variables employed in this paper have been changed into their corresponded growth rates the spurious regression may have been controlled within minimum range. The results of unit root test in Table1 show that all variables employed in this paper are stationary at 1% level.

2: Empirical Results

The regression equation consists of six variables. They are GDP, FDI Stock, Multinational Enterprises' Imports (MNE importss), MNE exportss, Domestic Enterprises' Imports (hereafter DE importss) and DE exportss. As mentioned above in regression equations all variables have been changed into their corresponded growth rates, which are denoted by gy, gfs, $gfim$, $gfex$, $gdim$ and $gdex$,respectively. The causality regression equation of GDP is described as follows:

$$gy_{it} = \sum_{i=1}^{p} \gamma gy_{i,t-p} + \sum_{i=1}^{p} \beta_1 gfs_{i,t-p} + \sum_{i=1}^{p} \beta_2 gfim_{i,t-p} +$$

$$\sum_{i=1}^{p} \beta_3 gfex_{i,t-p} + \sum_{i=1}^{p} \beta_4 gdim_{i,t-p} + \sum_{i=1}^{p} \beta_5 gdex_{i,t-p} + u_i + v_{it} \quad \text{(4-1)}$$

Where, u_i v_{it} and other variables are all satisfied with the assumptions from (3-2) to (3-7). The other five causality equations, whose dependent variable is one of independent variables of equation (4-1) respectively, are omitted, since they are symmetric with equation (4-1). Empirical results are reported from Table2 to Table7.

Before considering the empirical results, we probably should discuss the process for selection of lag length, since the empirical results seriously depend upon the lag length of the regression model. As shown by the assumption (3-3) in section 3.1 a strong first order autocorrelation of the residuals in the first-differenced equation would be expected but not the second order autocorrelation. AR test, which consists of residual autocorrelation coefficients, is distributed as $N(0,1)$ under the null of no autocorrelation. Therefore, we would expect a low p-value for AR1 and a high p-value for AR2 if the regression model is correctly specified. The AR test, however, may not give us an explicit answer in the case that differences of the AR p-values among the models with a different lag length is so small that we can not decide which one is true. For example in Table2, the AR1 p-values from lag 4 to lag 1 are 0.075, 0.03, 0.07 and 0.033 respectively. All of them fall inside a widely used range of 10% to 1%. On the other hand, a similar thing also occurred to the AR2 p-value in Table2. In this case we cannot reject any model according to the AR p-value.

Following Holtz-Eakin, Newcy, and Rosen (1988 1999), we use a sequential test to decide the optimal length of lag when AR results are not identical. Sequential test results for *gy* are given in the last row of Table2. In order to do a sequential test firstly we calculate the sum of squared residuals for $p = 4$ and $p = 3$ respectively, say Q_4 and Q_3 and subtract Q_4 from Q_3. The difference, which is shown as 0.027 in the last row of Table2, is below the critical value of x_6^2 (x_6^2 's freedom is 6, since there are six independent variables in the left side of regression equation). Therefore, we accept the restriction that three lags in each variable adequately characterizes the data and then do same process for $p = 2$ until the difference is above the critical value of x_6^2 . The difference between Q_2 and Q_1 is 0.021, which is far below the corresponding critical value of x_6^2, so the optimal lag length is one lag.[2] As a result, the causality test of *gy* is done under a regression model with one lag length.

i): Results for *gy* (growth rate of GDP)

Regression equation for *gy* presents a widely considered problem if FDI contributes to growth. As results show (Table2), the inward FDI in China (denoted by *gfs*), which is widely considered as an engine of China's economy development, does not have a significant effect on GDP on a *national level*. Moreover, its coefficient's sign is minus, which probably indicates that we cannot deny the possibility that the inward FDI in China *crowds out* local domestic enterprises. This *crowding out effect* which arises due to the undeveloped infrastructure, unskilled labor of central region and western region may offset the *crowding in effect* of FDI in eastern region of China, which has a relatively developed economic environment.

Another interesting result is that growth rate of MNE importss (denoted by *gfim*), whose coefficient's sign is minus, has a significant negative effect on growth rate of GDP, whereas growth rate of DE importss (denoted by *gdim*) significantly contributes to GDP growth rate of China. One of the theories that explain the contribution of imports to growth is described as follows: *A developing country can raise the productive ability and develop at a more high growth rate by importsing intermediate goods from developed country*. However, the divergence between the contribution of MNE importss and the ones of DE importss may show

[2] In the regression equation employed in this paper, we cannot perform sequential test for $p = 1$ and $p = 0$. As for other regressions, we follow the same process to decide the optimal lag length when the optimal lag length cannot be decided by AR test.

us that the imports's contribution to GDP in China depends upon some conditions. Noting that MNEs' growth rate of exports (denoted by *gfex*) does not has a significant positive effect on GDP rate, we may conclude: in the presence of that *crowding out effect* is above *crowding in effect,* host country may suffer from MNEs imports rather than benefit from the raised productive ability caused by MNEs imports. In this case, the imports of MNEs significantly reduces the demand to DEs' production. Meanwhile there does not have efficient channels that can significantly transfer MNEs' knowhow and technology to DEs.

ii): Results for *gfs* (growth rate of FDI stock)

As for regression equation of *gfs* , since all p-values of AR1 test with different lag length are above 10% except one lag, we can immediately decide that the optimal lag length is one without doing sequential test. It is not surprising that coefficient of *gy* with a plus sign is significant at 1% level, which means that China's high growth rate of GDP attracts inflow of FDI. This result is consistent with other researchers' conclusion.

Another interesting result is that the coefficient of *gfim* with a plus sign is significant at 1% level. This may indicate that China's preference policy toward MNEs, which allows MNEs imports intermediate goods from international market at a relatively low custom tax, has significantly attracted the inflow of FDI to China as policy-makers expected.

As for the causal link from growth rate of MNE exportss (denoted by *gfex*) to growth rate of FDI, the result of *gfex* 's coefficient shows that MNE exportss has a positive effect on FDI. This may simply indicate that one of the purposes of the inflow of FDI to China, which aims for China's cheap labor source, is to exports cheaper goods to international market. This view has been widely recognized by applied researchers.

It is worth noting that there has a negative causality relation from growth rate of DEs exports (denoted by *gdex*) to growth rate of FDI (denoted by *gfs*). This may be explained as follows: with China's economy developing, DEs, which raises productivity by competing with MNEs, has a *crowding out effect* on the MNEs in China. However, this effect is not substantial because the coefficient of *gdex* is only significant at 10%.

The result of the coefficient of *gdim* presents a problem that the relationship between FDI and imports is substitutive or complementary. However, we cannot obtain an explicit understanding on this problem from this result.

iii): Results for *gfim* (growth of rate of MNE importss)

AR test for *gfim* shows that the optimal lag length of *gfim* regression equation is four. Noting the fact that the fourth lagged coefficient of *gfex* is below 0 at 1% level, we may conclude that the linkage of production process between MNEs and DEs is not strong, namely, DEs cannot provide the intermediate goods which MNEs needs and the latter has to imports it from international market. Another significant result is about the coefficients of *gdex* (growth rate of DEs exports). Though each coefficient of lagged *gdex* is not significant, the null that all coefficients of *gdex* are zero can still be rejected at 1% level, which may indicate there is a positive causality relation from DE exportss to MNE importss because the sum of its coefficient is positive.

iv): Results for *gfex* (growth rate of MNE exportss)

As AR1 and AR2 test results show (Table5), we cannot decide which lag length is optimal for regression *gfex* even we can reject the three-lag model and the four-lag model. It is because AR1 p-value of lag one and lag two are both below 10% and their AR2 p-values are both above outside 10%. According to the sequential test result, the difference between the sum of squared residuals of the one-lag model and two-lag model is 67.819 that is far above the critical x_6^2 value with a freedom 6. It means that we can accept two-lag model. Empirical results of *gfex* regression equation point to two conclusions. The first one is from *gy* and *gfs*. *gy* has a significant coefficient in the first lag and the sum of its coefficients is far above zero. x^2 statistic for *gfs* is significant at 10%. This result may indicate a widely observed fact: more FDI more exports. Another interesting result comes from the coefficient of *gfim* whose sum is below zero and x^2 joint statistic for these coefficients is significant at 1%. According to the exports-oriented policy introduced in1980s, MNEs had to exports most of their goods. In this sense, we would expect a significant coefficient of *gfim* with a plus sign. We do not know what causes this divergence between the theory and the results, though there is still a lagged coefficient whose sign is plus as we expected.

v): Results for *gdim* (growth rate of FEs imports)

According to the *gdim*'s sequential test results, we decide the optimal lag length for *gdim* regression equation is one. It is not surprising that there is a positive causal relation from *gy* to *gdim*. This may simply indicate that an increasingly growing economy needs to imports more intermediate goods or consumption goods to expand production or to satisfy the domestic consumption. Another interesting result comes from the coefficient of *gfs* which shows that inward FDI has a positive effect on DEs imports. One of the possible scenarios for this result is: facing increasing inward FDI, in order to compete with MNEs in China, DEs of China has to imports high-tech intermediate goods which can rise the productive ability in developing country. As for the negative effect from *gfex* to *gdim*, we have not found a reasonable theory for this result.

vi): Results for *gdex* (growth rate of DEs exports)

According to the AR test, the optimal lag length of regression equation *gdex* is two. We obtain three significant results for three variables *gy*, *gfex* and *gdim*. Their respective sums of coefficients are all above zero. The *gy* and *gdim*'s results may hint us that with China's economy development, more and more goods which are produced by using intermediated goods from international market have been exportsed international market. It is not only *made in China* but also *made by China*. It is worth noting that there also has a positive relation from *gfex* to *gdex*, which may mean that the MNE exportss behavior motivates domestic firms to exports their productions into international market. This process of the motivation might be completed with absorbing MNEs' management method and talent who has serving experience in MNEs and so on.

5: Conclusion Remark

In this paper there are six causality regression equations for six variables which yield causal links of $C_6^2 \times 2$ and cover FDI theory, international trade theory and growth theory. Considering one of the attitudea of the paper is to analyze the role of inward FDI in China's economy development, we will focus on the results associated with FDI and ignore some results without FDI, which may be interesting too.

The summary for causality results is shown in Graph1, where broken line and real ling present the negative relation and positive relation, respectively. From the summary, we can find two bidirectional causality relations which occur between *gdim* and *gy*, between *gfim* and *gfex*, respectively.

The causality relation between *gdim* and *gy* can be understood as: increase of DE importss raises the productive ability of DEs and in turns contributes to growth rate of GDP. A fast growing economy needs to imports intermediate and consumption goods to maintain continuous economic growth.

It is not difficult to explain the positive causality relation from *gfex* to *gfim* which simple indicates that MNEs has to imports intermediate goods from international market in order to exports productions, namely, DEs cannot provide the intermediate goods that MNEs needs. The negative causality relation from *gfim* to *gfex* , however, does not support the hypothesis that the increase of MNE importss boost MNE exportss.

We find that two causality relations run from *gfs* to *gfex* and *gdim* . The former indicates the fact that one of the purposes of MNEs in China is to produce cheap goods and then exports it to international market. The causality relation from *gfs* to *gdim* may indicate that DEs has to imports high-tech intermediate goods to compete with MNEs in China. It is worth noting that FDI does not significantly contribute to growth of GDP of China due to FDI's crowding out effect. Moreover, the result that the increase of inflow of FDI to China does not cause the increase of MNE importss may show that China's imports restriction policy significantly functions.

Another interesting conclusion is the negative effect causality relation that runs from *gfim* to *gy* . This negative effect may be caused by the absence of channel from MNEs to DEs. As a result, the negative effect that MNE importss reduces the demand to DEs' production dominates the effect of productive ability caused by MNE importss.

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Table1: Results of Panel Unit Root Tests

	IPS	MW ADF	MW PP
gy	0.004	0.0008	0
gfs	0	0	0
gfim	0	0	0
gfex	0	0	0
gdim	0	0	0
gdex	0	0	0

Graph1: Summary of Causality Results

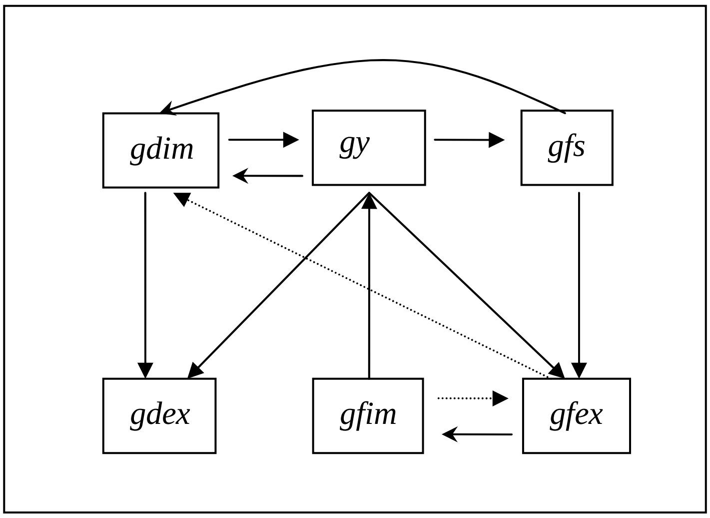

Table2: Test Results of Causality of GDP

Dependent Variable: gy								
Lag	**4**	**sign**	**3**	**sign**	**2**	**sign**	**1*** **
gfs(-1)	-0.00219	-	-0.00061	-	-0.00199	-	-0.00185
gfs(-2)	-0.00069		-0.00115		-0.00157		
gfs(-3)	-0.00091		0.00039				
gfs(-4)	-0.00140***						
gfim(-1)	-0.00017**	-	-0.00024***	+	-0.00008**	-	-0.00009***
gfim(-2)	-0.00008		0.00001		-0.00003		
gfim(-3)	0.00012***		0.00010*				
gfim(-4)	-0.00005						
gfex(-1)	-0.01043	-	-0.00891	-	-0.00377	-	0
gfex(-2)	-0.00778		-0.00685		0.00002		
gfex(-3)	-0.01069		-0.00007				
gfex(-4)	0.00002						
gdim(-1)	0.01520*	+	0.01873***	+	0.01442***	+	0.01682***
gdim(-2)	0.00489		0.00376		0.00318		
gdim(-3)	0.0062		0.01611**				
gdim(-4)	0.00247						
gdex(-1)	0.00368	-	0.01101	+	0.01240*	+	0.00698
gdex(-2)	-0.016		0.00283		0.00388		
gdex(-3)	-0.01184		0.00528				
gdex(-4)	-0.02742*						
x^2 **.gfs**	0.0351		0.884		0.184		
x^2 **.gfim**	0		0.003		0.013		
x^2 **.gfex**	0.506		0.156		0.587		
x^2 **.gdim**	0.542		0		0		
x^2 **.gdex**	0.304		0.505		0.189		
AR1	0.075		0.03		0.07		0.033
AR2	0.958		0.445		0.8		0.246
Hansen	0.941		0.93		0.969		0.962
Seq test			0		0.027		0.021

Table3: Test Results of Causality of FDI

Dependent Variable: gfs							
Lag	4	sign	3	sign	2	sign	1***
gy(-1)	-5.183	+	4.846	-	1.056	+	1.998***
gy(-2)	10.652		-9.124		-0.878		
gy(-3)	-1.338		3.990				
gy(-4)	-2.448						
gfim(-1)	0.00181	+	0.00126	+	0.00349***	+	0.00444***
gfim(-2)	-0.0038**		0.00185		0.00043		
gfim(-3)	-0.00145		-0.00291**				
gfim(-4)	0.0003						
gfex(-1)	-0.0307	-	0.221	+	0.323	+	0.00075**
gfex(-2)	-0.207*		0.0127		-0.00197**		
gfex(-3)	-0.164**		0.00463***				
gfex(-4)	-0.00181***						
gdim(-1)	-0.00072	+	-0.177	-	-0.124	-	-0.163
gdim(-2)	0.192		-0.0680		-0.163		
gdim(-3)	0.288		0.539*				
gdim(-4)	0.175						
gdex(-1)	-0.144	-	-0.151	-	-0.0418	+	-0.277*
gdex(-2)	-0.113		0.0720		0.214		
gdex(-3)	-0.184		-0.117				
gdex(-4)	0.217*						
x^2.gfs	0.515		0.625		0.93		
x^2.gfim	0		0		0		
x^2.gfex	0.003		0		0.094		
x^2.gdim	0.662		0.068		0.522		
x^2.gdex	0.458		0.598		0.345		
AR1	0.24		0.354		0.115		0.092
AR2	0.926		0.497		0.948		0.814
Hansen	1		1		1		0.963

Table4: Test Results of Causality of MNE importss

Dependent Variable: gfim							
Lag	4***	sign	3	sign	2	sign	1
gy(-1)	-12.917		-57.000		-59.902		22.054
gy(-2)	-3.851	-	-104.730	-	60.666	+	
gy(-3)	14.068		67.495				
gy(-4)	-5.118						
gfs(-1)	-0.049		2.8055		4.866		4.0869
gfs(-2)	0.0381	-	1.733	+	1.991	+	
gfs(-3)	-0.00395		2.058				
gfs(-4)	-0.0150						
gfex(-1)	0.2445		-2.440		-8.738		-0.0239
gfex(-2)	0.2251	+	5.994	+	0.0294**	-	
gfex(-3)	0.1701		-0.074**				
gfex(-4)	0.641***						
gdim(-1)	0.285		-0.341		-11.117		-14.692
gdim(-2)	0.341	+	11.764	+	26.298	+	
gdim-3)	0.525		3.280				
gdim(-4)	0.313						
gdex(-1)	0.060		7.091		2.2150		4.694
gdex(-2)	0.868	+	5.967	+	-3.983	-	
gdex(-3)	-0.208		3.337				
gdex(-4)	0.715						
x^2 .gy	0.952		0.187		0.824		
x^2 .gfs	0.498		0.62		0.612		
x^2 .gfex	0		0.004		0.125		
x^2 .gdim	0.587		0.762		0.189		
x^2 .gdex	0		0.796		0.647		
AR1	0.012		0.24		0.15		0.282
AR2	0.845		0.331		0.596		0.342
Hansen	1		1		1		0.963

Table5: Test Results of Causality of MNE exportss

Dependent Variable: gfex							
Lag	**4**	**sign**	**3**	**sign**	**2**	**sign**	**1*****
gy(-1)	-9.673	+	3.843	+	5.816*	+	2.028***
gy(-2)	12.628		4.952		-1.658		
gy(-3)	1.423		-0.675				
gy(-4)	-2.807						
gfs(-1)	0.139	-	-0.484	-	-0.402	+	0.563***
gfs(-2)	-0.960		-0.621		0.467		
gfs(-3)	-0.091		0.260				
gfs(-4)	-0.261						
gfim(-1)	-0.002***	+	-0.006	+	-0.007***	-	-0.004***
gfim(-2)	0.006		0.004		0.006***		
gfim(-3)	0.005		0.002				
gfim(-4)	0.008						
gdim(-1)	0.773	+	0.079	-	0.082	+	0.323
gdim(-2)	0.079		-0.396		-0.080		
gdim-3)	-0.133		-0.084				
gdim(-4)	-0.688						
gdex(-1)	0.212	+	-0.064	-	-0.108	-	-0.483
gdex(-2)	0.708		0.052		-0.074		
gdex(-3)	0.388		-0.257				
gdex(-4)	0.695*						
x^2 **.gy**	0.724		0.018		0.000		
x^2 **.gfs**	0.825		0.146		0.056		
x^2 **.gfim**	0.002		0.000		0.000		
x^2 **.gdim**	0.426		0.038		0.445		
x^2 **.gdex**	0.227		0.854		0.782		
AR1	0.557		0.370		0.099		0.026
AR2	0.486		0.422		0.383		0.541
Hansen	0.957		0.643		0.182		0.168
Seq test					67.819		

Table6: Test Results of Causality of DE importss

Dependent Variable: gdim							
Lag	**4**	**sign**	**3**	**sign**	**2**	**sign**	**1*** **
gy(-1)	13.339*	+	2.600	+	-0.648	+	2.501***
gy(-2)	-6.491		-1.714		3.978*		
gy(-3)	-5.797*		3.189				
gy(-4)	4.546						
gfs(-1)	0.023	+	0.045	+	0.056***	+	0.073**
gfs(-2)	-0.009		-0.006		-0.025*		
gfs(-3)	0.019		0.004				
gfs(-4)	0.028						
gfim(-1)	0.001	-	0.001	-	0.001	-	-0.001
gfim(-2)	0.001		-0.002*		-0.002***		
gfim(-3)	-0.002		0.000				
gfim(-4)	-0.002						
gfex(-1)	-0.110	-	-0.217**	-	-0.274***	-	-0.002***
gfex(-2)	-0.094		-0.059		0.005***		
gfex(-3)	-0.034		-0.002**				
gfex(-4)	0.002						
gdex(-1)	-0.378	-	-0.149	-	-0.204**	-	-0.108
gdex(-2)	-0.115		-0.221		-0.223**		
gdex(-3)	-0.398		-0.226				
gdex(-4)	0.001						
x^2**.gy**	0.042		0.000		0.000		
x^2**.gfs**	0.088		0.000		0.007		
x^2**.gfim**	0.002		0.020		0.000		
x^2**.gfex**	0.000		0.011		0.000		
x^2**.gdex**	0.001		0.156		0.079		
AR1	0.125		0.074		0.038		0.089
AR2	0.458		0.572		0.582		0.474
Hansen	0.999		0.980		0.957		0.520
Seq test			-2.351		4.335		6.145

Table7: Test Results of Causality of DE exportss

Dependent Variable: gdex							
Lag	4	sign	3	sign	2**	sign	1
gy(-1)	-1.411		1.216		2.355**		1.240***
gy(-2)	6.547	+	0.719	+	-0.357	+	
gy(-3)	2.878		0.382				
gy(-4)	-4.073						
gfs(-1)	0.008		0.0154		-0.002		-0.005
gfs(-2)	-0.002	-	0.005	+	-0.005	-	
gfs(-3)	-0.0106		0.027				
gfs(-4)	-0.0357**						
gfim(-1)	-0.001		-0.001		-0.00000612		-0.001
gfim(-2)	-0.003***	-	-0.00061*	-	-0.000641	-	
gfim(-3)	0.001		0.0000519				
gfim(-4)	-0.001						
gfex(-1)	-0.168		-0.0207		0.008		-0.0000528
gfex(-2)	-0.159**	-	-0.0790	-	0.001***	+	
gfex(-3)	-0.125**		-0.000477				
gfex(-4)	-0.001						
gdim(-1)	0.148**		0.220***		0.121**		0.0934*
gdim(-2)	0.236**	+	0.168***	+	0.092*	+	
gdim(-3)	0.094		0.142				
gdim(-4)	0.099						
x^2 .gy	0.048		0.058*		0		
x^2 .gfs	0.003		0.332		0.933		
x^2 .gfim	0.0002		0.0578*		0.278		
x^2 .gfex	0.078		0.0008***		0.016		
x^2 .gdim	0.072		0.0185**		0.023		
AR1	0.211		0.473		0.066		0.114
AR2	0.717		0.572		0.939		0.025
Hansen	0.908		0.402		0.123		0.138