A Study on the Interaction Inside the Industrial Structure of Tokyo Metropolitan Area Based on VAR Model

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Keywords: Industrial Structure, Internal Change, Tokyo Metropolitan Area, VAR Model

Abstract. There is a close relationship between the change of industrial structure and the change of internal industry. This paper use Industrial economic output data of Tokyo metropolitan area on 1970-2009, based on the treated industry’s inflation rate, build the VAR model of Tokyo metropolitan area finance and insurance industry to study the correlation by manufacturing and the changes in the real estate industry. It is concluded that the changes of the financial insurance industry and the real estate industry will have a negative effect on the change of the manufacturing industry. From the perspective of industrial structure, the main reason for the changes in the industrial structure is the change of the industry itself, but the changes of the third industry will have a negative impact on the changes of the second industry.

1. Introduction

As early as the 1950s, the American economist Simon Kuznets conducted an in-depth study of the changes in the industrial structure during economic growth, indicating that the stage of industrialization evolution can be demonstrated through the process of industrial structure changes. It is through the proportion of the primary industry, the secondary industry, and the tertiary industry that respectively make up the economic production to judge the development stage of the country's economy; when the proportion of the tertiary industry reaches about 70%, it means that the country has already Enter the service economy stage [1]. Kuznets’s theory mainly focuses on the relationship between the three major industries, especially the development of the secondary industry. It is mainly at that time that many countries have not entered the service economy stage; but after entering the service economy stage, the internal changes in the industry have not been explained, and there is no corresponding conclusion.

As we all know, the Tokyo metropolitan area is one of the largest metropolitan areas in the world, including Tokyo Metropolitan Government, Kanagawa Prefecture, Chiba Prefecture, Saitama Prefecture, Gunma Prefecture, Ibaraki Prefecture, Yamanashi Prefecture, and Tochigi Prefecture. The metropolitan area’s total economy accounts for about half of Japan’s population. The total economic output is ranked first in the metropolitan area of the world and is an important economically developed area in Japan. According to the statistical standards given in the relevant documents of the Cabinet Office of Japan, according to the different economic production activities, the national economy can be divided into three parts: industry, government services, and private non-profit organization activities, of which the industry is divided into ten major industries. Looking at the course of Japan’s economic development, the dominant industries of Japan’s manufacturing industry after the war experienced a structural upgrading process from the textile industry to the iron and steel industry to machinery and equipment manufacturing. Afterwards, it experienced the rapid development of the service industry [2].

2. Index Selection and Model Construction

In order to analyze the relationship between changes in the internal structure of the industry, the selection of the indicators in this paper requires firstly formulating the changes in the structure of the
industry and formulating dynamic standards for the changes in the industrial structure. For the selection of indexes for industrial structure changes, Huang and Sun [3] calculated the annual rate of change by comparing the value of GDP of an industry with the value of GDP. This method of calculation is popular among domestic scholars; Chen [4] and Peng [2], the indicators used in the study of industrial changes are the value of one industry in manufacturing compared to that of manufacturing. The rate of change in a certain industry in the manufacturing industry in each year. Based on the calculation methods of these indicators and the statistics of Japan's GDP, Japan's GDP statistics have been combined with the major items of sub-industry as well as related data of ten major industries. Therefore, in combination with the calculation method of the above indicators, the calculation method of the internal measurement index of the industry is selected as follows.

\[
G_{i,t} = \left[ \frac{P_{i,t}}{P_t} - \frac{P_{i,t-1}}{P_{t-1}} \right]_1
\]  

(1)

Where ‘P’ is the total value of the industry, where ‘i’ represents the number of industries, ‘t’ represents the year, ‘P_{i,t}’ represents the production value of the ‘i’ industry in ‘t’ years, and ‘G_{i,t}’ represents the rate of change of the ‘i’ industry in ‘t’ years.

The model is mainly designed to study the changes in the manufacturing industry's rate of change in the economic development of the Tokyo metropolitan area and the rate of change in the real estate industry, as well as the internal structure of the financial and insurance industry, and to establish the following model based on the research direction:

\[
Y_{Man,t} = \beta_0 + \beta_1 X_{Fin,t} + \beta_2 X_{Eas,t} + \mu_t
\]  

(2)

\( Y_{Man,t} \), \( X_{Fin,t} \), \( X_{Eas,t} \) indicate denote the change rate of manufacturing industry, the change rate of financial and insurance industry and the change rate of real estate industry; Among \( \beta_0, \beta_1, \beta_2, \mu_t \) indicate the intercept, the coefficient of change of financial and insurance industry, and the coefficient of change of real estate industry, respectively. Residual item, ‘t’ indicates time (year).

3. Data Processing and Analysis

When constructing a vector auto regressive model (VAR) for variables ‘Y\text{Man},t’, ‘X\text{Fin},t’, ‘X\text{Eas},t’ we must first establish the lag length of the model (as shown in Table 1). The data processed in this paper is analysis software, according to the software output. As a result, most of the indicators tested lag zero order, where the LR suggests five orders of lag, and because lag may not be too concise, LR may overestimate the order of lag. As a compromise, Stock and Watson [5] and Becketti [6] adopted a lag-four-order VAR model, so the industry adopted a lag of four orders.

| lag | LL       | LR       | FPE       | AIC       | HQIC      | SBIC      |
|-----|----------|----------|-----------|-----------|-----------|-----------|
| 0   | 386.626  | 3.2e-14* | -22.5662* | -22.5203* | -22.4316* |
| 1   | 388.664  | 4.075    | 4.8e-14   | -22.1567  | -21.973   | -21.618   |
| 2   | 393.366  | 9.4053   | 6.3e-14   | -21.9039  | -21.5824  | -20.9611  |
| 3   | 394.03   | 1.3268   | 1.1e-13   | -21.4135  | -20.9542  | -20.0667  |
| 4   | 406.475  | 24.89    | 9.3e-14   | -21.6162  | -21.0191  | -19.8653  |
| 5   | 416.784  | 20.619*  | 9.7e-14   | -21.6932  | -20.9583  | -19.5383  |

*** p<0.01, ** p<0.05, * p<0.1

When cointegration tests are performed on the model, the ADF unit root test and the PPerron (PP) unit root test are performed on the variables to prevent “false regression”. The results are shown in
Table II. From the test of stationarity, it is found that the test results of the variables are all stable, so cointegration analysis of the variables can be performed.

| variable                    | ADF (p-value) | PP (p-value) |
|-----------------------------|---------------|--------------|
| manufacturing              | 0.000         | stable       |
| Finance and Insurance      | 0.000         | stable       |
| Real estate industry       | 0.000         | stable       |

The cointegration test was performed on the variables. The result of Table I shows that the VAR model with the fifth-order lag is adopted. Therefore, in Johanson's cointegration test, a five-order lag and no trend were used to test. The results are shown in Table III. From Table III, we can conclude that when rank=0, the value of the trace statistic is greater than 5% of the critical level of the significance level, and the null hypothesis that no cointegration relationship exists should be rejected. When rank=1, the trace statistic value is a critical value of less than 5% significance level should accept the null hypothesis that there is no cointegration relationship. In summary, the number of cointegration relations can be judged to be 1. Therefore, there is a long-term cointegration relationship between the variable sequences of the VAR model.

Table III. Johanson Cointegration Test Results.

| rank | parms | LL      | eigenvalue | statistic | 5% critical value |
|------|-------|---------|------------|-----------|-------------------|
| 0    | 27    | 395.681 | —          | 28.818    | 24.31             |
| 1    | 32    | 405.027 | 0.414      | 10.126*   | 12.53             |
| 2    | 35    | 408.272 | 0.169      | 3.636     | 3.84              |
| 3    | 36    | 410.09  | 0.099      | —         | —                 |

*** p<0.01, ** p<0.05, * p<0.1

Because of the existence of a long-term cointegration relationship, the OLS estimation of the variables in the model is simple. The equation of cointegration is obtained as follows:

$$Y_{\text{Man},t} = -0.00035 - 0.71466X_{\text{Fin},t} - 0.33089X_{\text{East},t} + \mu_t$$  \hspace{1cm} (3)

$$R^2 = 0.427*** \hspace{0.5cm} (-0.31) \hspace{0.5cm} (-5.01*** \hspace{0.5cm} (-1.70***)$$

The impulse response function is the impact effect of the tracking system on a variable. On the contrary, the variance decomposition is the contribution made by decomposing the system's mean square error into the impact of each variable. By decomposing the mean squared error of a variable shock into the contribution of random shocks of each variable in the system, the relative importance of the impact of each variable is then calculated, which is the ratio of the contribution of variable shock to the total contribution.

From the results in Table IV, it can be seen that the impact of manufacturing changes and changes in the financial and insurance industry and the impact of the real estate industry have a significant impact on manufacturing changes. Over time, the impact of manufacturing changes on itself weakened and became relatively stable; the impact of the changes in the financial and insurance industry on the changes in the manufacturing industry increased, reaching a 24.3% impact in the tenth period, while the real estate industry. The effect of changes on the impact of manufacturing changes is slowly declining, but the effect is still above 10%. This result shows that the effect of changes in the financial and insurance industry on changes in the manufacturing industry will increase the effect of longer-term effects, and will be more easily reflected. The impact of changes in the real estate industry
will have a stronger role in the beginning, but over time, the effect will gradually fade, but it still has a strong effect.

Table IV. Each Variable Variance Decomposition Results.

| Number of periods | $Y_{\text{Man},t}$ Variance decomposition | $X_{\text{Fin},t}$ Variance decomposition | $X_{\text{Eas},t}$ Variance decomposition |
|-------------------|------------------------------------------|------------------------------------------|------------------------------------------|
|                   | $Y_{\text{Man},t}$ | $X_{\text{Fin},t}$ | $X_{\text{Eas},t}$ | $Y_{\text{Man},t}$ | $X_{\text{Fin},t}$ | $X_{\text{Eas},t}$ | $Y_{\text{Man},t}$ | $X_{\text{Fin},t}$ | $X_{\text{Eas},t}$ |
| 1                 | 1                      | 0.168                              | 0.156                              | 0                      | 0.832                | 0.030                | 0                      | 0                      | 0.814                |
| 2                 | 0.938                  | 0.189                              | 0.149                              | 0.024                  | 0.800                | 0.083                | 0.038                  | 0.011                  | 0.768                |
| 3                 | 0.875                  | 0.196                              | 0.146                              | 0.075                  | 0.768                | 0.097                | 0.050                  | 0.036                  | 0.757                |
| 4                 | 0.873                  | 0.203                              | 0.131                              | 0.077                  | 0.756                | 0.149                | 0.050                  | 0.041                  | 0.720                |
| 5                 | 0.701                  | 0.192                              | 0.117                              | 0.265                  | 0.766                | 0.257                | 0.034                  | 0.042                  | 0.627                |
| 6                 | 0.706                  | 0.197                              | 0.113                              | 0.261                  | 0.752                | 0.259                | 0.033                  | 0.051                  | 0.629                |
| 7                 | 0.706                  | 0.204                              | 0.109                              | 0.262                  | 0.740                | 0.283                | 0.032                  | 0.056                  | 0.607                |
| 8                 | 0.706                  | 0.219                              | 0.109                              | 0.265                  | 0.723                | 0.294                | 0.028                  | 0.057                  | 0.597                |
| 9                 | 0.716                  | 0.234                              | 0.108                              | 0.258                  | 0.707                | 0.291                | 0.027                  | 0.060                  | 0.601                |
| 10                | 0.721                  | 0.243                              | 0.107                              | 0.253                  | 0.695                | 0.299                | 0.025                  | 0.062                  | 0.594                |

4. Conclusions

From the perspective of the relationship between changes in the financial and insurance industries and the changes in the manufacturing industry, in the data relationship of as long as 40 years, the financial and insurance industry in the Tokyo metropolitan area has a very close relationship with manufacturing changes. In the case of the fourth period, changes in the financial and insurance industries were the cause of significant changes in Granger in the manufacturing industry, and there was a strong negative relationship between changes in the financial and insurance industries and changes in the manufacturing industry. From the lagging 10-period impulse function, we can see that the changes in the financial and insurance industry have a stronger impact on the manufacturing industry, and the variance decomposition results are also obtained. The change in the manufacturing industry is influenced by the changes in the financial and insurance industry. In the tenth period, 24.3% of manufacturing changes were caused by changes in the financial and insurance industries.

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