An empirical analysis of Expanding Effective Investment to Promote Industrial Development——Take Hubei Province as an example

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Abstract. The industry is the main body of the economy and the leading force of regional economic development. To analyze the influence mechanism of consumption, investment, and export on the industry of Hubei Province, this paper uses the monthly data of Hubei Province from 2011 to 2019 to establish a VAR model. The results show that investment has the most significant impact on the industrial development of Hubei Province. It is necessary to expand effective investment according to the industrial base of Hubei Province, to promote industrial transformation and achieve high-quality development.

1. Introduction

The outline of China's 14th five-year plan proposes to accelerate the cultivation of a complete domestic demand system, expand investment space, and enhance the key role of investment in optimizing the supply structure. This requires expanding effective investment, optimizing investment structure, expanding short-term investment demand from the demand side, increasing effective output, and improving supply efficiency from the supply side. At present, the development of China's industries, especially the emerging industries and high-tech industries, is still relatively insufficient, and there is huge potential investment demand[1].

As one of the important manufacturing provinces in China, the industry is the foundation and pillar of Hubei's economic development. At present, the industrial development of Hubei Province is in a critical period of transforming development momentum and realizing leapfrog development. Expanding effective investment is an important way to promote industrial transformation and upgrading, enhance the stamina of economic development and cultivate new momentum of development. Based on the monthly data of Hubei Province from 2011 to 2019, this paper constructs a Vector Auto Regression (VAR) model to quantitatively analyze the influence mechanism of investment, consumption, and export on Hubei industry and discusses how to select effective investment projects to give full play to the positive role of investment in industrial transformation and upgrading.

2. The framework of the VAR model

Vector Auto-Regressive (VAR) model is an unstructured model, which is mainly used to analyze the dynamic relationship between multiple variables. It can be used to investigate the dynamic impact of the change of random disturbance on the variable system, to reveal the impact of various economic shocks on economic variables. The basic formula of the model is as follows:
\[ y_t = \Phi_1 y_{t-1} + \Phi_2 y_{t-2} + \cdots + \Phi_p y_{t-p} + H x_t + \xi_t, \quad t = 1, 2, \cdots, T \]  

Where \( y_t \) is the k-dimensional endogenous variable vector, \( x_t \) is the d-dimensional exogenous variable vector, \( P \) is the lag order of the endogenous variable, \( \xi_t \) is the random disturbance term, \( \Phi_1, \cdots, \Phi_p \) and \( H \) represent the corresponding coefficient matrix to be estimated, and \( T \) is the number of samples. A VAR (P) model with k time series variables and p-order lag term, which contains k equations. The equation can be expanded as follows:

\[
\begin{bmatrix}
    y_{1t} \\
    y_{2t} \\
    \vdots \\
    y_{kt}
\end{bmatrix} = \Phi_1 \begin{bmatrix}
    y_{1t-1} \\
    y_{2t-1} \\
    \vdots \\
    y_{kt-1}
\end{bmatrix} + \cdots + \Phi_p \begin{bmatrix}
    y_{1t-p} \\
    y_{2t-p} \\
    \vdots \\
    y_{kt-p}
\end{bmatrix} + H \begin{bmatrix}
    x_{1t} \\
    x_{2t} \\
    \vdots \\
    x_{dt}
\end{bmatrix} + \begin{bmatrix}
    \xi_{1t} \\
    \xi_{2t} \\
    \vdots \\
    \xi_{kt}
\end{bmatrix}, \quad t = 1, 2, \cdots, T
\]  

As an unstructured model, the VAR model does not need any prior constraints on variables. There are many coefficients in the var system, and each coefficient can only reflect a local dynamic relationship. In practice, the model mainly uses the Granger causality test and impulse response function to analyze the dynamic response of the economic system.

3. Empirical analysis based on the VAR model

To analyze the dynamic impact of investment consumption and export on Hubei's industrial economy, this paper selects five variables: fixed asset investment \( (I_{nv_i}) \), social retail goods \( (Cons_i) \), total net export \( (Np_{ei}) \), industrial finished products \( (Pd_{ei}) \) and total industrial profits \( (Pf_{ei}) \), and uses the monthly data of Hubei Province from 2011 to 2019 to build a VAR model[2].

3.1. Stability test of variables

From the scatter diagram of monthly data of \( I_{nv_i}, Cons_i, Np_{ei}, Pd_{ei}, \) and \( Pf_{ei} \), it can be found that there are obvious seasonal fluctuations and time trends in each time series. These series are non-stationary series and need a unit root test.

The test results show that the five original time series are unstable and do not meet the conditions of constructing a VAR model. Firstly, the seasonal adjustment method of census X12 is used to eliminate the seasonal factors. Secondly, the long-term trend component and short-term fluctuation component in the sequence are separated by HP Filtering Method. Thirdly, the separated short-term fluctuation series is used to replace the original series to analyze the dynamic response of each variable to the impact.

After seasonal adjustment and HP Filtering, the seasonal fluctuation and time trend of each variable series have been eliminated (Fig. 1). The results of the unit root test also show that the processed five series reject the null hypothesis at the significance level of 1%, which conforms to the modeling conditions and can be used to establish an unconstrained VAR model.
3.2. Lag order

In the case of given variables, the estimation results of the VAR model will be significantly different if different lag periods are selected[3-4]. It is necessary to determine the lag period of endogenous variables according to the actual situation of variables.

There are two ways to judge the lag order of the model. One is to set a reasonable lag according to economic theory, and the lag of monthly data is generally set as 4 or 12. The other is based on six criteria: logl, LR, FPE, AIC, SC, and HQ. Among the six criteria, AIC and SC criteria are the main reference criteria, and the order with the smallest value is the lag order of endogenous variables. If the results of AIC and SC are inconsistent, the LR test should be taken into consideration.

Figure 1: seasonal adjustment, long-term trend, and short-term fluctuation series of each variable
Table 1: judgment standard of optimal lag order

| Lag order | LogL   | LR    | FPE    | AIC    | SC     | HQ     |
|-----------|--------|-------|--------|--------|--------|--------|
| 0         | -2320.069 | 7.61E+15 | 50.50138 | 55.84198 | 52.66282 |
| 1         | -2336.725  | 191.65384 | 5.90E+15 | 50.3345 | 55.02381 | 52.23235 |
| 2         | -2429.941   | 117.1789  | 3.38E+15 | 49.9454 | 50.07566 | 49.99812 |
| 3         | -2492.27    | 1.60E+15  | 49.19882 | 49.98037 | 49.51512 |
| 4         | -2400.988   | 1.49E+15* | 49.11976* | 50.55261 | 49.69966 |
| 5         | -2382.162   | 1.70E+15  | 49.24324 | 51.32738 | 50.08673 |
| 6         | -2372.701   | 2.36E+15  | 49.55402 | 52.28945 | 50.6611 |
| 7         | -2363.955   | 3.36E+15  | 49.8791  | 53.26582 | 51.24977 |
| 8         | -2348.066   | 4.21E+15  | 50.06131 | 54.09933 | 51.69557 |

As shown in Table 1, the results of AIC and SC in the optimal lag order judgment criteria are not consistent. AIC criterion supports the lag order of 4 and SC criterion supports the lag order of 3. In the other criteria, LR test and FPE support four lag periods, and HQ supports three lag periods. Considering the relevant requirements of economic theory on the lag period of monthly data, this paper adopts the VAR model with four lag orders.

![Figure 2: Inverse Roots of AR Characteristic Polynomial](image_url)

Fig. 2 shows that none of the roots lies outside the unit circle. the VAR model satisfies the stability condition.

3.3. Granger Causality test

The results of the Granger causality test (Table 2) show that the joint chi-square statistics of the variables in the output (Pdt) model and the profit (Pft) model are 34.76676 and 24.91786, respectively, with P values of 0.0043 and 0.0916, indicating that the null hypothesis is rejected at the 10% confidence level.

The test results of the output (Pdt) model show that the chi-square statistics of investment (Invt) and consumption (Cons) are 15.91675 and 5.676745 respectively. It shows that under the 10% confidence level, the null hypothesis cannot be rejected. the lag term of the investment (Invt) and consumption (Cons) has a significant impact on the current value of output (Pd). However, the chi-square statistics of net export (Nept) in the equation is 2.564548, which indicates that under the 10% confidence level, the null hypothesis cannot be rejected.
Table 2. Results of Granger causality test.

|         | $Pd_t$ |         | $Pf_t$ |
|---------|--------|---------|--------|
| Excluded| Chi-s q| Prob.   | Excluded| Chi-s q| Prob.   |
| $Pf_t$  | 3.186824 | 0.5271  | $Pd_t$  | 4.003761 | 0.4055  |
| $Cons_t$| 15.91675 | 0.0031  | $Cons_t$| 4.301485 | 0.3667  |
| $Inv_t$ | 5.676745 | 0.0585  | $Inv_t$ | 8.380121 | 0.0786  |
| $Nept_t$| 2.564548 | 0.2774  | $Nept_t$| 7.04825  | 0.1334  |
| ALL     | 34.76676 | 0.0043  | ALL     | 24.91786 | 0.0916  |

The test result of the profit ($Pf_t$) model shows that the chi-square statistic of investment ($Inv_t$) is 8.380121, and the probability value is 0.0786, which indicates that under the 10% confidence level, the null hypothesis can be rejected. However, the probability values of consumption ($Cons_t$) and net export ($Nept_t$) in the equation are 0.3667 and 0.1334 respectively, which indicates that under the 10% confidence level, the null hypothesis cannot be rejected.

3.4. Analysis of impulse response function

The three graphs in Figure 3 show the impulse response of output ($Pd_t$) and profit ($Pf_t$) to 1% of the changes in investment ($Inv_t$) and consumption ($Cons_t$), and the real line in the figure represents the trend of profit and output after being impacted.

Based on the information in the figure, we can draw the following conclusion:

Firstly, after a positive impact of 1% on consumption, output increases rapidly in a given period (12 months), reaches its peak in the second month, increases by 0.12%, then decreases rapidly, and finally tends to zero. This means that the change of consumption will have a significant positive effect on industrial production, but the effect is immediate and transient. The increase of consumption will prompt the enterprise to increase production rapidly. Otherwise, if consumption shrinks, the output will decline rapidly. Over time, the effect will decline rapidly, and by the third month, the impact will be negligible.

Secondly, after the positive impact of 1% on investment, the response of output in a given period (12 months) is stable at first, increases rapidly from the third month, reaches the peak in the sixth month, increases by 0.05%, and then continues to be positive, the impact time can be as long as 11 months. This means that investment also has a positive effect on industrial production. Although there is a time lag of 3-4 months, its impact is persistent. If the investment increases by 1%, the production can be increased after 3-4 months, and reach the maximum value after half a year, with an increase of 0.05%. This effect will last for about one year.
Thirdly, after the positive impact of 1% on investment, the response of profit in a given period (12 months) is a small decline of 0.02% in the second month, rising rapidly from the third month, and reaching the peak in the fourth month, increasing by 0.08%. Then the impact gradually weakens and finally converges to 0. This means that the impact of investment on the profit level of enterprises is also positive. An increase of 1% in investment will gradually increase the profit level of enterprises, reaching the peak in the fourth month, and then the impact will gradually weaken, but the impact will continue for half a year.

4. Conclusion
In the process of China's economic development, fixed asset investment has always been an important force to promote economic development [5]. Although in some stages, excessive investment has also caused economic overheating and other problems, on the whole, investment has played a key role in improving China's social productivity and promoting rapid economic growth.

In this paper, a VAR model was constructed based on the monthly data of Hubei Province from 2011 to 2019 to quantitatively analyze the influence mechanism of investment, consumption, and export on the industry of Hubei province. The results show that compared with consumption and export, investment has the most significant impact. Under the condition of insufficient consumption and uncertainty of foreign trade, moderate expansion of investment is an effective way to promote the industrial transformation and development of Hubei Province. It is necessary to base on the industrial foundation of Hubei, consolidate the foundation, develop the advantages, and promote the construction of major projects.

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