The Effect of Market-Oriented Government Fiscal Expenditure on the Evolution of Industrial Structure: Evidence from Shenzhen, China

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Abstract: For looking at the effect of public fiscal expenditure of local government on industry, three contradictory points of view: improving effect, impeding effect, and no effect, have been previously discussed in the literature. However, there is no general agreement yet. As the most mature region of China’s socialist market economy with Chinese characteristics, the effect of Shenzhen’s market-oriented fiscal expenditure on the evolution of its industrial structure is worth investigating. This study applies Shenzhen’s fiscal expenditure data and industrial value-added data from 1980 to 2017 to a Bayesian Structure Time Series Model (BSTS). Empirical results show that in Shenzhen, market-oriented public fiscal expenditure presents a significant effect on the evolution of industrial structure. In addition, the promotion effect of different types of public fiscal expenditure on secondary industry is significant but largely subsides later. However, the promotion effect on tertiary industry is comparatively stable. This study suggests that Shenzhen government should apply different types of public fiscal expenditure at least five years in advance to promote the growth of secondary industry and apply fiscal expenditure to promote the tertiary industry when needed.

Keywords: fiscal expenditure; evolution of industrial structure; Bayesian Structure Time Series Model (BSTS); Shenzhen

1. Introduction

Since the financial crisis in 2008, the impact of governments on the economy has drawn increasing attention [1]. Several studies on fiscal budget and expenditure show that central government needs to reduce concentrated expenditure [2]. Local government’s fiscal expenditure on local industry and economy [3] and moderate fiscal regulation are quite necessary [4,5]. Some research shows that fiscal expenditure can significantly improve the upgrading of industrial structures [4–7]. Wang et al., and Chu and Jian find that from the aggregate perspective, expenditure policy impedes the upgrading of industrial structure, and from the structural effect perspective, expenditures of governmental investment and public administration are not conducive to structural adjustment [8,9]. Others believed that fiscal expenditure has a negative impact on industrial evolution [8–11]. The current literature shows that there is no consensus on the impact of government public fiscal expenditure on industrial structure. There are three contradictory points of view: improving effect, impeding effect, and no effect [4–11]. Therefore, further research is still needed.

Shenzhen is the most mature region of China’s socialist market economy with Chinese characteristics. After forty-year development, Shenzhen has developed from a small farming town into an international innovative city. In 2017, GDP of Shenzhen reached 2.24 trillion RMB, ranking third place amongst all cities in China. GDP per capita reached the average level of cities for developed
countries. Based on the Petty-Clark principle, with the increase of income per capita, the employed population will first move from primary industry to secondary industry employment; when the level of income per capita further increases, employed population will largely move to tertiary industry employment. Such a pattern becomes more significant when the economy develops continuously. From comparing the effect of service industry and manufacturing industry, Qu and Lyu find that when the contribution of service industry to GDP increases, the impact of technical innovation in manufacturing industry on GDP decreases [12]. However, the impact of innovation in the service industry remains constant. The service industry is known as the “economy stabilizer”. But from the externality perspective of the whole economic system, technical improvement of the service industry is weaker than that of the manufacturing industry. In the process of industrial structure evolution, growth of the manufacturing industry and the service industry should be in equilibrium to better achieve sustainable development in the economy. With the continuing development of the Shenzhen economy, the Shenzhen municipal government improves local regulation constantly at the same time. Through adjusting and optimizing its fiscal expenditure structure, the Shenzhen government enlarges the effect of public finance on macroeconomic regulation and improves the promoting ability of market-oriented regional economic transition efficiently. In this context, it is important to investigate the impact of Shenzhen’s public fiscal expenditure on the evolution process of its industrial structure.

This study incorporates Shenzhen public fiscal expenditure data and industrial value-added data since the Economic Reform and Open-up in China and analyzes the effect of Shenzhen public fiscal expenditure on the industrial structure evolution based on the Bayesian Structure Time Series Model (BSTS). Furthermore, the study also investigates the influence of different types of public fiscal expenditure on the growth of the secondary and tertiary industry (since the primary industry occupies a very small proportion of the Shenzhen economy, and therefore has no research significance).

The rest of this paper is organized as follows: Section 2 is a literature review, which mainly introduces the measurement of the fiscal expenditure category, the measurement of industrial sustainable development, and other factors. Section 3 sets up the BSTS model and explains the data collection and statistics. Section 4 discusses the research results. Section 5 concludes.

2. Literature Review

The impact of local government’s fiscal expenditure on local industry and economy becomes more significant over time [3]. The mechanism of how fiscal expenditure influences industrial value-added and economic development can be explained by the aggregate demand effect of fiscal expenditure [13]. Aggregate demand effect of fiscal expenditure means that the fiscal expenditure could influence aggregate demand under the fiscal policy guidance, thus promoting the increases of different industries’ trough aggregate demand, and finally acting on the development of different industries and the evolution of the whole industrial structure. From the public financial expenditure perspective, different fiscal expenditure presents various effects on the supply and demand of different industries and further affects the industrial structure. From the total expenditure amount perspective, different industries react differently to the change of their fiscal multiplier. He, Zhang, Zhang estimate the influence of fiscal policy on the outputs and employment in China. Analyses of an input-output table show that such fiscal policy has a fiscal multiplier of about 0.84 in the short term [14]. A dynamic structural model shows that the fiscal expenditure will lead to increases of household consumption and firm investment constantly, and that the fiscal multiplier is approximately 1.1 in the relatively long term. In addition, the fiscal multiplier also depends on the economic periodical condition, policy circumstances, and capital allocation of inter-department. Therefore, public fiscal expenditure could accelerate GDP and affect industrial structure adjustment through the fiscal multiplier. Research shows that local fiscal expenditure could have a positive effect [6,7] or a negative effect [10,11] on industrial evolution. Thus, how market orientated fiscal expenditure works needs further investigation.
Barakat and Lin et al. find that although moderate fiscal regulation is quite necessary, market regulation is much more beneficial to industrial development [4,5]. Local fiscal expenditure, especially in China, largely helps firm investments and technical innovation, and promotes the growth of the local economy [15]. Current research mostly focuses on the relation between fiscal system and industrial structure evolution, especially on the effect of government on promoting industrial structure and the impact of fiscal policy on industry [16]. Lichtenberg suggests that in 1987, local financial expenditure presents a guiding role in the evolution process of industrial structure [17]. Taking the R&D department as the example, fiscal expenditure can promote the development of local emerging industries. Kaplinsky and Readman further research the actual decision-making process of fiscal policy and its impact under the evolution process of industrial structure [18]. They find that when a local government allocates fiscal expenditure on projects with a shorter investment period, a faster renewal period, and smaller investment amounts, processes of optimizing industrial system and industrial structure will be impeded. Therefore, local government should consider about the impact of fiscal expenditure on the optimization of long-term industrial structure when making a fiscal investment decision. Also, local governments should focus on projects which could promote the optimization of a local industrial structure. Feldmand and Kelley suggest that R&D expenditure can accelerate the industrial structure optimization process and fiscal expenditure may play a positive role in promoting the development of an industrial structure [19]. Therefore, most scholars point out that local fiscal expenditure can promote the optimization process of an industrial structure. However, local government still needs to consider the local marketization level and circumstances of the local industrial investment target to avoid the negative shock towards industrial structure under the guidance of investment policy during the industrial structure transition process. Crow et al. find that when fiscal expenditure is restricted, such as the reconstruction after natural disasters, local reconstruction power will increase [20]. However, since local fiscal expenditure contains a certain extent of fluctuation, the process of industrial structure transition will be negatively shocked when the level of marketization is relatively low. Therefore, local fiscal expenditure can present a significant promotion effect on the evolution of the local industrial structure. However, when a local government frames their fiscal expenditure policy, they should pay more attention to the influence of the local marketization level on the industrial structure evolution.

Wang et al. analyze the impact of fiscal expenditure on the upgrading of industrial structure through regression and impulse response models, and find that fiscal expenditure has a significant promotion effect on the upgrading of an industrial structure [8]. Chu and Jian investigate the impact of Chinese fiscal policy on an industrial structure from two both aggregate and structure perspectives [9]. In various studies on fiscal expenditure, measurements of fiscal expenditure are found to be different. Fiorito and Kollintzas categorize consumer spending of government into public goods and special goods provided by private sectors [21]. Forni, Monteforte, and Sessa suggest that the government expenditure includes purchasing goods and service, public employment subsidy and transfer payment [22]. Ganelli categorizes government expenditure into government employment expenditure and non-employment expenditure [23]. Categorization of government’s fiscal expenditure out of China mainly focuses on the expenditure related to the government’s own operations. However, the fiscal expenditure categorization of the Chinese government is quite different because their scope of fiscal expenditure is different. In China, measurement of public fiscal expenditure can be categorized as agricultural spending, education and medical spending, and social security spending from different industrial forms of expenditure [24]. It can also be categorized into economic spending, social spending and maintaining spending [25]; alternatively, it can be categorized into management spending, productive spending, and service public spending from different fields [15]. Therefore, measurements of market-oriented fiscal expenditure are different under different economic developing stages and different government regulation functions.

Industrial structure is a very important indicator to measure the economic development level, and the industry evolution is partly due to the central and local government’s fiscal expenditures [26].
Shenzhen is a relatively developed area of the domestic market mechanism used in China. According to the 2018 Shenzhen government report, government expenditure has significantly improved the development of the economy both in scale and in structure through both the industrial scale and industrial structure effect [27]. In different developing periods, the Shenzhen government promulgated different policies on the growth of its economy and the evolution and transition of its industrial structure. The Shenzhen local government supports firms with various ownership structures through a multiple fiscal subsidy policy to promote its industrial structure. The Shenzhen government also provides special support for specific fields or economic actions including infrastructure and public services to optimize its investment environment. These multi-dimensional policies are finally reflected in its fiscal expenditure structure. Therefore, it is logical and feasible to reclassify fiscal expenditures according to different dimensions of economic and industrial policies on the basis of government functions, especially government functions in economic development and industrial restructuring. Combined with the actual situation of Shenzhen's financial expenditure, fiscal expenditure can be categorized into infrastructure spending, industrial development spending, public service spending, and other spending. Incorporating such a categorization method and investigating the effects of different fiscal expenditures on industrial structures of secondary industry and tertiary industry would provide a significant contribution both in theory and in practice.

Quantitative models are quite widely used in analyzing the impact of fiscal expenditure on the evolution of an industrial structure. Several studies apply mathematic models to investigate the performance of fiscal expenditure [3] and apply econometric models for empirical research. In addition, some studies use the Vector Autoregression model (VAR) [28] and panel model to research the impact of public fiscal expenditure on economic growth [1]. Scotton and Varian, and Schmitt and Atwater apply the BSTS model to forecast time series data [29,30]. The BSTS model using the Bayesian method to estimate model parameters can effectively solve the problem of excessive parameterization caused by the limited length of macroeconomic data, thus improving the performance of prediction. Therefore, this study applies the BSTS model to analyze the effect of public fiscal expenditure on the evolution of industrial structure, which eliminates both internal and external influences.

3. Research Design

This section explains the Bayesian Structure Time Series Model (BSTS) and the variables inside the model, as well as data collection and descriptions.

3.1. Variable Explanations

To analyze the effect of total fiscal expenditure and categorized expenditure on the evolution of an industrial structure, how to measure the industrial structure and fiscal expenditure needs to be investigated.

Generally, the evolution process of an industrial structure can be divided into three stages: (1) the developing stage that focuses on heavy industry; (2) the balanced adjustment stage of industrial structure; and (3) the stage that industrial structure gradually becomes advanced and reasonable [26,31]. Within the first stage, the Chinese economy is at an initial level where productivity is relatively low and the industrial structure is relatively simple and closed. Increases to secondary industry are much higher during this time than to primary and tertiary industries. Heavy industry develops rapidly. The second stage is the stage of the balanced adjustment of the industrial structure. The national economic characteristics began to change from a closed economy to an open economy. The central government combined planning and market methods to adjust the imbalance of industrial structure and promoted the growth of light industry and tertiary industry. The third stage is the stage where the industrial structure gradually becomes reasonable and advanced. A portion of the tertiary industry further increases and coherently grows with the secondary industry. Therefore, if we define the secondary industry value-added as g2 and the tertiary industry value-added as g3, the evolution of Shenzhen’s industrial structure can then be defined as the third stage within which the ratio between
the tertiary industry production value and the secondary industry production value \((g3/g2)\) changes continuously \([32–35]\).

We can define total fiscal expenditure as \(p\), thus public finance expenditure can be classified into infrastructure expenditure (InfExp), industrial development expenditure (EcoExp), public service expenditure (SevExp), and other expenditure \([15, 24, 25]\). Infrastructure expenditure, also named as government construction expenditure, includes spending on purchasing and constructing buildings, purchase of office supplies, and professional equipment, spending on infrastructure construction, purchasing and renewal of internet and software, and purchasing of business vehicles. Within infrastructure expenditure, public infrastructure with a public goods attribute, such as the construction of roads and schools, could not only help to build up a soft environment that affects economic growth and industrial structure, but also forms the annual solid asset investing scope that would be counted into GDP and acts on economic growth directly. In addition, some infrastructure projects with industrial attributes, such as the purchase of large scientific equipment and construction of industrial parks, will not only attract investment but also act on guiding, promoting, and adjusting the industrial structure evaluation. According to the investment management system of Shenzhen government, from the 1980s, almost all infrastructure expenditure in Shenzhen are arranged and disbursed by development and the reform department. Other government departments could not manage the infrastructure expenditure. Thus, the scope and classification of infrastructure expenditure are quite clear.

Industrial development expenditure mainly reflects the government’s expenditures on fulfilling various industrial policies, as well as the construction, subsidies, and funding of non-public welfare and non-public projects in related industries. Most targets of Industrial development expenditure are firms and institutions with industrial attributes. The structure of financial expenditure in Shenzhen has always had obvious characteristics of construction financial expenditure. In the early days of Shenzhen’s special economic zone development, the fiscal expenditure amount was only thirty million RMB in total. This came with the condition that since the expenditure demanded in each development area was quite large and contradiction between income and expenditure is very serious, the Shenzhen government still had to allocate nearly three million RMB as well for the potential transformation of enterprises, supplement of working capital, and development of agricultural production. This portion of fiscal expenditure directly acts on market entities such as enterprises. In addition, within different time periods, Shenzhen shows obvious propensity towards optimization of and upgrades to its industrial structure under industrial policy guidance based on the demand of economic development and industrial structure adjustment. Related fiscal expenditure also reflects such a feature. Such expenditure mainly includes expenditure on science and technology, expenditure on culture and sports, expenditure on energy conservation and environmental protection, expenditure on information technology for resource exploration, expenditure on business services, financial expenditure, aid expenditure, and expenditure on grain and oil reserves.

Public service expenditure mainly reflects the spending that government uses to support and secure the political power running and public safety, education, medical treatment, environment protection, and social security. It represents the government’s function on a public service field. Related expenditure does not directly act on promoting economic development and industrial structure adjustment. Instead, it acts on economic growth by improving the economic environment.

3.2. BSTS Model

In this paper, we construct a Bayesian Structure Time Series Model (BSTS) to analyze the promotion effect of total fiscal expenditure \((p)\) on the evolution of industrial structure. We define \(x = \ln(p)\) as the independent variable. Variable \(g3\) and \(g2\) represent the tertiary industries revenues and secondary industries revenues, respectively. We further define \(y = g3/g2\) as the dependent variable. The BSTS model is constructed as follows:

\[
y_t = Z_t^T \alpha_t + \beta^T X_{1,t} + \varepsilon_{1,t}
\] (1)
In Formula (1) and (2), \( \varepsilon_t \sim N(0, \delta_t^2) \) and \( \mu_t \sim N(0, Q_t) \) are residuals. Formula (1) connects two groups of observations under four different conditions: (1) \( x(1,t) = \ln(p) \) and \( y_t = g_3/g_2 \); (2) \( x(1,t) = \lnfExp \) and \( y_t = g_2 \) or \( y_t = g_3 \); (3) \( x(1,t) = \eecoExp \) and \( y_t = g_2 \) or \( y_t = g_3 \); (4) \( x(1,t) = \seseExp \) and \( y_t = g_2 \) or \( y_t = g_3 \) to respectively investigate the effect of total fiscal expenditure on the evolution of industrial structure and the effects of infrastructure spending, industrial development spending, and public service spending on industrial added value in the secondary industry and tertiary industry. Equation (2) describes the state of the system and is used to describe the change of variable \( \alpha \) in the time dimension. \( Z_t \) is the d-dimension output variable, \( T_t \) is the transform matrix of \( d \times d \), \( R_t \) is the control matrix of \( d \times q \), \( \varepsilon_t \) is the standard error, \( \delta_t \) is the noise variance, \( \mu_t \) is the systematic error of q-dimension with interference matrix \( Q_t = q \times q \). Among these variables, we require \( q \leq d \).

Since \( x \) and \( y \) are both multivariable systems, we define the state variable of dependent variable \( y \) as random walk characteristics, that is, the state variable \( \alpha \) satisfies Formula (3):

\[
\alpha_{t+1} = \alpha_t + \varepsilon_t .
\]

### 3.3. Data Collection and Description

Table 1 summarizes the data collected from the Shenzhen Statistics Bureau and Shenzhen Financial Bureau from 1980 to 2017. An important part of the data is Shenzhen fiscal expenditure (FisExp), includes InfExp, EcoExp, and SevExp (other expenditures are miscellaneous expenditures that cannot be categorized into the above three categories, so relevant research is not done). Data we applied also includes revenue of the secondary industry and tertiary industry and other annual data of Shenzhen.

| Variables            | Mean  | Std. Dev. | Min   | Max       | Unit         |
|----------------------|-------|-----------|-------|-----------|--------------|
| Infrastructure Exp(InfExp) | 3856  | 4355      | 0     | 14904     | million RMB  |
| Industrial Development Exp(EcoExp) | 14689 | 30768     | 3     | 149595    |              |
| Public Servant Exp(SerExp) | 50434 | 88016     | 18    | 360985    |              |
| Other Exp(others) | 1928  | 3965      | 0     | 20841     |              |
| Total Exp(p)       | 70908 | 116000    | 40    | 459380    |              |
| g2                  | 224   | 279       | 0     | 927       | billion RMB  |
| g3                  | 264   | 368       | 0     | 1315      |              |

The process of the Shenzhen economy. Since the founding of Shenzhen Special Economic Zone in 1979, accompanied with the high-speed and stable development of economy, its industrial structure has also continued to move towards advances and rationalization. The periodical characteristics of its industrial structure evolution is quite significant. From the industrial structure evolution track, the evolution of industrial structure is roughly in line with the stage characteristics of economic growth. From Figure 1, we can find that the tertiary industries in Shenzhen had a relatively high proportion initially, and then the proportions of the secondary and tertiary industries took the lead alternately, showing X-type characteristics.
Generally, the Shenzhen industry evolution process can be divided into three stages. The first stage is from 1980 to 1990, the “three-plus-one trading-mix” (means custom manufacturing with materials, designs or samples supplied and compensation trade) and labor concentrated processing industry were the major industries in Shenzhen. Starting from the 1980s, Shenzhen benefited from industrial transfer of a large portion of Hong Kong manufacturing industries that moved to the mainland of China. At that time, Shenzhen largely developed the “three-plus-one trading-mix” export processing industry and formed the “processing trade” industrial structure. In 1979, the industrial ratio of three major industries in Shenzhen was 37:20:43. Whereas with the development of “three-plus-one trading-mix” firms, the proportion of the tertiary industry increased continuously and the industrial ratios changed to 4:45:51 in 1990.

The second stage is from 1990 to 2000. Shenzhen stepped into the initial industrial policy stage which was mainly guided by high technology industry, based on advanced industry and maintained by tertiary industry. The early processing trade industry in Shenzhen was mainly market-driven and spontaneous. In the 8th Five-Year Plan for National Economic and Social Development (short for 8th Five-Year Plan later) period, Shenzhen started to focus on industrial planning and built an industrial system which was guided by the high technology industry based on advanced industries. The accumulated effect of the high technology industry was initially obvious. In 1995, the end of “8th Five-Year Plan”, the industrial ratio of three major industries became 1:50:49 and the proportion of manufacturing industry was about 40%. In the “9th Five-Year Plan” period, the Shenzhen government took further steps towards “building Shenzhen as high technology industry production base” and “accelerating the development of advanced and high technology industry, enlarging the degree of technical transformation.” From then on, the Shenzhen economy grew continuously and the speed of advancing its industrial structure became even faster. In 2000, the industrial ratio further became 0.7:49.7:49.6, where the proportion of manufacturing industry was about 44%. Secondary industry and tertiary industry involving finance, real estate, wholesale, and retail industries developed rapidly. Also, the development process of the industrial structure was accelerated. Industry became an important pillar of the Shenzhen local economy.

The third stage is from 2000 to 2010. Shenzhen mainly developed high technical manufacturing industry and gradually upgraded to a high technology industry, logistics industry, finance industry, and cultural innovation industry. At the end of this stage in 2010, the three main industries ratio was adjusted to 0:46:54. In general, the proportions of primary and secondary industries decreased at the same time. Proportion of tertiary industry raised continuously. Since 2010, strategic emerging industries and future industries have gradually become the engine that promotes the Shenzhen economy. The strategic emerging industries which mainly include a new era information technology industry, cultural innovation industry, internet industry, new materials industry, and biological industry, have developed rapidly, from 3878.2 billion RMB in 2012 to 7847.7 billion RMB in 2016, an increase of 102.4 percent.
4. Results and Discussion

4.1. Testing and Estimation

First, to avoid heteroscedasticity, \( g, gp, g^2, g^3, g^2 + g^3 \) and \( p \) are logarithmically transformed and recorded as \( \ln(g), \ln(gp), \ln(g^2), \ln(g^3), \ln(g^2 + g^3), \ln(p) \). Also, to receive consistent and efficient regression results, an Augmented Dickey-Fuller (ADF) unit root test is used for testing stationarity. Results are presented in Table 2. It is obvious that the ADF statistics of \( \ln(gp), \ln(g^3) \) and \( \ln(g^2 + g^3) \) are all statistically significant at a 1% significance level. ADF statistics of \( \ln(g), \ln(g^2) \) and \( \ln(p) \) are statistically significant at a 5% significance level. They are all stationary series of I(0), which can be used for a Granger causality test.

Table 2. Augmented Dickey-Fuller (ADF) unit root test.

| Variables | Type of Test | ADF Statistics | Critical Value 1% | Critical Value 5% | Critical Value 10% | \( p \)-Value | Unit Root |
|-----------|--------------|----------------|-------------------|-------------------|-------------------|-------------|-----------|
| \( \ln(g) \) | Trend        | −4.0934        | −3.5              | −3.18             | 8.53 \times 10^{-12} | No          |
| \( \ln(gp) \) | Trend        | −6.4404        | −3.5              | −3.18             | 6.562 \times 10^{-9} | No          |
| \( \ln(g^2) \) | Trend       | −4.13677       | −3.5              | −3.18             | 2.07 \times 10^{-11} | No          |
| \( \ln(g^3) \) | Trend       | −4.27657       | −3.5              | −3.18             | 1.519 \times 10^{-9} | No          |
| \( \ln(g^2 + g^3) \) | Trend       | −4.7624        | −3.5              | −3.18             | 8.13 \times 10^{-12} | No          |
| \( \ln(p) \) | Trend        | −3.9146        | −2.93             | −2.60             | 1.69 \times 10^{-7}  | No          |

The AIC information standard shows that the lag of a VAR model with 5 periods is the best option and that the optimal lag is selected. Based on the relation between fiscal expenditure and the secondary industry and tertiary industry, the Granger causality test analysis is performed as follows: \( \ln(p) \rightarrow \ln(g^2), \ln(p) \rightarrow \ln(g^3), \ln(p) \rightarrow \ln(g^2 + g^3), \) and \( \ln(p) \rightarrow g^2/g^3). Test results are shown in Table 3 and the Granger causality exists in the following relations of \( \ln(p) \rightarrow \ln(g^3), \ln(p) \rightarrow \ln(g^2 + g^3), \) and \( \ln(p) \rightarrow g^2/g^3). \n
Table 3. Granger causality test.

| Tested Relationship | Lag | Statistics | DF1 | DF2 | \( p \)-Value | Granger Causality |
|---------------------|-----|------------|-----|-----|---------------|------------------|
| \( \ln(p) \rightarrow \ln(gp) \) | 2   | 0.267      | 2   | 30  | 0.767         | No               |
| \( \ln(p) \rightarrow \ln(g^2) \) | 1   | 0.784      | 1   | 36  | 0.382         | No               |
| \( \ln(p) \rightarrow \ln(g^3) \) | 4   | 4.426      | 4   | 18  | 0.011         | Yes              |
| \( \ln(p) \rightarrow \ln(g^2 + g^3) \) | 1   | 2.176      | 1   | 36  | 0.014         | Yes              |
| \( \ln(p) \rightarrow g^2/g^3 \) | 1   | 6.103      | 1   | 36  | 0.018         | Yes              |

4.2. Estimated Effect of Total Fiscal Expenditure on the Evolution of Industrial Structure

For example, the effect of fiscal expenditure \( x = \ln(p) \) on \( y = g^3/g^2 \) in 2000 is shown in Figure 2. Given the circumstances from 1996 to 1999, the average and cumulative contribution of fiscal expenditure \( x \) in 2000 to the evolution of industrial structure in Shenzhen during 2000–2017 are presented in Table 4.
Bayesian one-sided tail-area probability is 0.045, which means the causality effect can be considered statistically significant and unlikely to be caused by random fluctuations. The probability of achieving this effect by chance is very small (Bayesian one-sided tail-area probability is 0.045), which means the causality effect can be considered as being statistically significant.

Through summing up the individual data of g3/g2 during 2000–2017, we can get the overall value of 1.099 with a 95% confidence interval of [14.99, 20.09]. Subtracting this from the observed response yields an estimate of the intervention of fiscal expenditure Ln(p). The estimation is 0.096 with a 95% confidence interval of [0.83, 1.12]. This means that fiscal expenditure in 2000 has a positive effect on the growth of the highly industrialized variable observed during 2000–2017. The effect is statistically significant and unlikely to be caused by random fluctuations. The probability of achieving this effect by chance is very small (Bayesian one-sided tail-area probability is 0.045), which means the causality effect can be considered as being statistically significant.

Similarly, the average and cumulative impact of Ln(p) on g3/g2 during 2000–2017 is presented in Table 4. Through summing up the individual data of g3/g2 during 2000–2017, we can get the overall value of 1.099 with a 95% confidence interval of [14.99, 20.09]. Subtracting this from the observed response yields an estimate of the intervention of fiscal expenditure Ln(p). The estimation is 0.096 with a 95% confidence interval of [0.83, 1.12]. This means that fiscal expenditure in 2000 has a positive effect on the growth of the highly industrialized variable observed during 2000–2017. The effect is statistically significant and unlikely to be caused by random fluctuations. The probability of achieving this effect by chance is very small (Bayesian one-sided tail-area probability is 0.045), which means the causality effect can be considered as being statistically significant.

Similarly, the average and cumulative impact of Ln(p) on g3/g2 during 2000–2016 is presented in Table 4. The relative impact of Ln(p) on g3/g2 in 2000–2016 is shown in Figure 3.
with a relative promoting effect of 37.4%; the second peak appeared in 2012, with a relative promoting effect of 19.5% and then decreased to about 10%.

Table 5. Average and cumulative influence of Ln(p) on g3/g2 during 2000–2016.

| Year | Absolute Impact | Relative Impact | p-Value |
|------|----------------|----------------|---------|
| 2000 | 0.091          | 0.091          | 0.045 * |
| 2001 | 0.101          | 0.100          | 0.047 * |
| 2002 | 0.115          | 0.116          | 0.039 * |
| 2003 | 0.115          | 0.114          | 0.025 * |
| 2004 | 0.166          | 0.172          | 0.008 **|
| 2005 | 0.217          | 0.233          | 0.003 **|
| 2006 | 0.308          | 0.356          | 0.004 **|
| 2007 | 0.326          | 0.374          | 0.001 ***|
| 2008 | 0.270          | 0.283          | 0.005 **|
| 2009 | 0.258          | 0.261          | 0.001 ***|
| 2010 | 0.158          | 0.143          | 0.061   |
| 2011 | 0.178          | 0.161          | 0.032 * |
| 2012 | 0.215          | 0.195          | 0.008 **|
| 2013 | 0.152          | 0.128          | 0.046 * |
| 2014 | 0.119          | 0.095          | 0.074   |
| 2015 | 0.120          | 0.095          | 0.043 * |
| 2016 | 0.075          | 0.056          | 0.118   |

* 10% significant level, ** 5% significant level, *** 1% significant level.

Figure 3. Relative contribution rate of Ln(p) on g3/g2 during 2000–2016.

As discussed above, the proportion of secondary and tertiary industries in Shenzhen has been in a trend of alternating development. It is not until 2008 that the proportion of the tertiary industry gradually opened up a gap compared to the secondary industry. In addition, the contribution rate of financial industry and real estate industry is relatively high in such changes. Since 2002, Shenzhen has issued support policies for the financial industry and increased investment gradually from 2003. With the stock market rising in 2005, the financial industry started to grow rapidly and its proportion in the tertiary industry increased gradually; then, the growth of the secondary industry was promoted, and its contribution rate to economic growth increased. However, since 2008, because of the impact of the global financial crisis, the financial industry and other tertiary industries in Shenzhen became more sensitive to the market. It can also be found from Figure 3 that the influence gradually increased since 2003 and started to decline since 2008. The rise in 2012 was driven by the boom of the real estate industry. Thus, we can find that fiscal expenditure of Shenzhen promotes the evolution of the industrial structure generally. Furthermore, within different developing periods, different types of fiscal expenditure policies and industrial structures present various impacts on different industries in secondary and tertiary industries, which requires further structural analysis.
4.3. Estimated Effect of Different Types of Fiscal Expenditure on Manufactory Industry

Because of the classification method reformation of fiscal revenue and expenditure in 2007, subjects of revenue and expenditure before and after 2007 are not completely the same. To improve the accuracy of empirical procedure, the fiscal expenditure of Shenzhen is divided into two stages of 1980 to 2006 and 2007 to 2017 to discuss the impact of different types of fiscal expenditure on GDP growth of secondary industry, respectively.

For the impact of classified fiscal expenditure on the evolution of secondary industry during 1980–2006, Let E(xi),i = 1,2,3 represent public service expenditure, industrial development expenditure, and construction expenditure, respectively. Based on the observations from 1980–2006, we take E(xi) as the independent variable and g2 as the dependent variable to construct a BSTS model to investigate the impact of different types of financial expenditure on the secondary industry in Shenzhen from 1995 to 2005. Since both E(xi) and g2 are a multi-variable system, we then need to define the dependent variable g2 as a random variable, which means state variable α satisfies Formula (3). The impact of different types of fiscal expenditure E(xi) on g2 is presented in Table 6 and Figure 4. Given the criterion of p < 0.05, the effect of E(xi) on g2 is statistically significant in all inspected years. The relative impact of different types of fiscal expenditure on the development of the secondary industry is mathematically averaged, and the order from large to small is as follows: construction expenditure (101.2%), industrial development expenditure (92.1%), and public service expenditure (45.3%).

Table 6. Relative impact of different fiscal expenditure on the development of secondary industry during 1995–2005.

| Year | Public Service p-Value | Industrial Development p-Value | Construction p-Value |
|------|------------------------|-------------------------------|-----------------------|
| 1995 | 0.420 0.014 | 1.785 0.001 | 2.190 0.001 |
| 1996 | 0.409 0.004 | 1.806 0.001 | 1.924 0.001 |
| 1997 | 0.324 0.008 | 1.793 0.001 | 1.817 0.001 |
| 1998 | 0.377 0.002 | 1.170 0.001 | 1.031 0.002 |
| 1999 | 0.277 0.002 | 0.764 0.001 | 1.039 0.001 |
| 2000 | 0.621 0.002 | 0.692 0.002 | 0.750 0.004 |
| 2001 | 0.745 0.010 | 0.565 0.001 | 0.710 0.001 |
| 2002 | 0.627 0.001 | 0.659 0.001 | 0.647 0.001 |
| 2003 | 0.475 0.001 | 0.398 0.002 | 0.493 0.001 |
| 2004 | 0.255 0.038 | 0.314 0.003 | 0.331 0.036 |
| 2005 | −0.001 0.494 | 0.180 0.007 | 0.198 0.003 |

Figure 4. Relative impact of different fiscal expenditure on the development of secondary industry during 1995–2005.
For the impact of classified fiscal expenditure on the evolution of secondary industry during 2007–2017, similarly, the relative impact of different types of fiscal expenditure E(xi) on g2 during 2007–2017 is shown in Table 7 and Figure 5. At a 5% significance level, the values of E(xi) in individual years are meaningless. After removing the meaningless values, the relative impact of different types of fiscal expenditure on the evolution of secondary industry is mathematically averaged and they are sorted as construction expenditure (34.1%), industrial development expenditure (33.4%), and public service expenditure (32.5%).

Table 7. Relative impact of different fiscal expenditure on the evolution of secondary industry during 2010–2017.

| Year | Public Service | p-Value | Industrial Development | p-Value | Construction | p-Value |
|------|----------------|---------|------------------------|---------|--------------|---------|
| 2010 | 0.446          | 0.004   | 0.450                  | 0.001   | 0.448        | 0.012   |
| 2011 | 0.385          | 0.004   | 0.380                  | 0.001   | 0.435        | 0.001   |
| 2012 | 0.275          | 0.008   | 0.284                  | 0.013   | 0.358        | 0.004   |
| 2013 | 0.231          | 0.002   | 0.250                  | 0.022   | 0.363        | 0.007   |
| 2014 | 0.181          | 0.002   | 0.183                  | 0.005   | 0.198        | 0.023   |
| 2015 | 0.063          | 0.014   | 0.117                  | 0.029   | 0.147        | 0.041   |
| 2016 | 0.116          | 0.001   | 0.065                  | 0.028   | 0.114        | 0.053   |
| 2017 | 0.064          | 0.001   | 0.105                  | 0.083   | 0.077        | 0.107   |

Figure 5. Relative impact of different fiscal expenditure on the evolution of secondary industry during 2010–2017.

4.4. Estimated Effect of Different Type of Fiscal Expenditure on Tertiary Industry

For the impact of classified fiscal expenditure on the development of tertiary industry in 1980-2006, Let E(xi),i = 1,2,3 represent public service expenditure, industrial development expenditure and construction expenditure, respectively. Based on observations during 1980–2006, we take E(xi) as the independent variable and g3 as the dependent variable to construct a BSTS model to explore the impact of different types of fiscal expenditure on the tertiary industry in Shenzhen from 1995 to 2005. Relative impacts of different types of fiscal expenditure E(xi) on g3 are shown in Figure 6 and Table 8. Given the criterion of \( p < 0.05 \), the impact of E(xi) on g3 is not statistically significant in a few inspected years, which is removed in the following analysis. The relative impact of different types of fiscal expenditure on the evolution of the tertiary industry is mathematically averaged, and the order from large to small is construction expenditure (86.3%), industrial development expenditure (67.5%), and public service expenditure (47.9%).

Table 8. Relative impact of different fiscal expenditure on the evolution of tertiary industry during 1995–2005.

| Year | Public Service | p-Value | Industrial Development | p-Value | Construction | p-Value |
|------|----------------|---------|------------------------|---------|--------------|---------|
| 1995 | 0.420          | 0.004   | 1.785                  | 0.001   | 2.190        | 0.001   |
| 1996 | 0.409          | 0.004   | 1.806                  | 0.001   | 1.924        | 0.001   |
| 1997 | 0.324          | 0.008   | 1.793                  | 0.001   | 1.817        | 0.001   |
| 1998 | 0.377          | 0.002   | 1.170                  | 0.001   | 1.031        | 0.002   |
| 1999 | 0.277          | 0.002   | 0.764                  | 0.001   | 1.039        | 0.001   |
| 2000 | 0.621          | 0.014   | 0.692                  | 0.002   | 0.750        | 0.004   |
| 2001 | 0.745          | 0.001   | 0.565                  | 0.001   | 0.710        | 0.001   |
| 2002 | 0.627          | 0.001   | 0.659                  | 0.001   | 0.647        | 0.001   |
| 2003 | 0.475          | 0.001   | 0.398                  | 0.002   | 0.493        | 0.001   |
| 2004 | 0.255          | 0.008   | 0.314                  | 0.003   | 0.331        | 0.036   |
| 2005 | 0.001          | 0.494   | 0.180                  | 0.007   | 0.198        | 0.003   |

Figure 6. Relative impact of different fiscal expenditure on the evolution of tertiary industry during 1995–2005.
Figure 6. Relative impact of different fiscal expenditure on the evolution of tertiary industry during 1995–2005.

Table 8. Relative impact of different fiscal expenditure on the evolution of tertiary industry during 1995–2005.

| Year | Public Service | p-Value | Industrial Development | p-Value | Construction | p-Value |
|------|----------------|---------|------------------------|---------|--------------|---------|
| 1995 | 0.420          | 0.004   | 1.785                  | 0.001   | 2.190        | 0.001   |
| 1996 | 0.409          | 0.004   | 1.806                  | 0.001   | 1.924        | 0.001   |
| 1997 | 0.324          | 0.008   | 1.793                  | 0.001   | 1.817        | 0.001   |
| 1998 | 0.377          | 0.002   | 1.170                  | 0.001   | 1.031        | 0.002   |
| 1999 | 0.277          | 0.002   | 0.764                  | 0.001   | 1.039        | 0.001   |
| 2000 | 0.621          | 0.014   | 0.692                  | 0.002   | 0.750        | 0.004   |
| 2001 | 0.745          | 0.001   | 0.565                  | 0.001   | 0.710        | 0.001   |
| 2002 | 0.627          | 0.001   | 0.659                  | 0.001   | 0.647        | 0.001   |
| 2003 | 0.475          | 0.001   | 0.398                  | 0.002   | 0.493        | 0.001   |
| 2004 | 0.255          | 0.008   | 0.314                  | 0.003   | 0.331        | 0.036   |
| 2005 | -0.001         | 0.494   | 0.380                  | 0.007   | 0.198        | 0.003   |

For the impact of classified fiscal expenditure on the evolution of tertiary industry during 2007–2017, similarly, relative impact of different types of fiscal expenditure $E(x_i)$ on $g_2$ during 2007–2017 is presented in Table 9 and Figure 7. Given the criterion of $p < 0.05$, the values of $E(x_i)$ in individual years are meaningless. After removing the meaningless values, the relative impact of different types of fiscal expenditure on the evolution of the tertiary industry is mathematically averaged, and they are sorted as construction expenditure (44.3%), industrial development expenditure (43.3%), and public service expenditure (43.2%).

Table 9. Relative impact of different types of fiscal expenditure on the evolution of tertiary industry during 2010–2017.

| Year | Public Service | p-Value | Industrial Development | p-Value | Construction | p-Value |
|------|----------------|---------|------------------------|---------|--------------|---------|
| 2010 | 0.741          | 0.002   | 0.733                  | 0.002   | 0.673        | 0.035   |
| 2011 | 0.622          | 0.006   | 0.598                  | 0.002   | 0.610        | 0.001   |
| 2012 | 0.533          | 0.005   | 0.548                  | 0.003   | 0.559        | 0.001   |
| 2013 | 0.415          | 0.027   | 0.411                  | 0.015   | 0.504        | 0.007   |
| 2014 | 0.303          | 0.025   | 0.295                  | 0.020   | 0.310        | 0.012   |
| 2015 | 0.235          | 0.041   | 0.240                  | 0.046   | 0.257        | 0.027   |
| 2016 | 0.172          | 0.050   | 0.021                  | 0.047   | 0.178        | 0.047   |
| 2017 | 0.070          | 0.213   | 0.209                  | 0.006   | 0.085        | 0.158   |
In summary, classified financial expenditure presents an important role in promoting the economic development of the secondary industry and the tertiary industry, which is particularly prominent in the evolution of the tertiary industry. From the perspective of the effect of classified financial expenditure, the impact of expenditure on capital construction and industrial development is more significant in the secondary industry of Shenzhen. It indicates that the financial support policy for the secondary industry should focus on more active and direct instruments of financial expenditure. For the tertiary industry, the effect of these three types of financial expenditure is similar. It suggests that the effect of direct investment and industrial policy in financial support policy is similar with that of public service expenditure in business circumstances on the tertiary industry of Shenzhen, which is dominated by modern service industries. However, from the analysis results of the two stages (1995–2005 and 2010–2017), we can find that the promotion effects of classified fiscal expenditure on the secondary and tertiary industries show a rapid downward trend, indicating that the short-term effect of fiscal expenditure on industrial development is more significant, and that the sustainability and pertinence of expenditure policies need to be increased.

5. Conclusions

This study incorporates Granger causality and the multivariable Bayesian Structural Time Series method to analyze the dynamic relation between total amount and different categorized structures of public fiscal expenditure and the evolution of industrial structure. Results of this study indicate that total public fiscal expenditure of Shenzhen presents a significant promotion effect on an advanced industrial structure, which is consistent with the past studies of Feldman and Kelley [6] and Yan, Wu, and Yang [7]. This effect shows a bimodal distribution in 2007 and 2012, then decreases gradually. The impact of public fiscal expenditure of Shenzhen on the secondary industry is not significant, but there is a promotion effect on the development of tertiary industry and the increase of the aggregate economy. The lagged periods of such promotion effect of public fiscal expenditure is five years. This lag effect result not only consists with the past studies of Gan, Zheng, and Yu [36] but also further explains the stages of fiscal expenditure effect on industrial revolution are five years which could be due to the China’s Five-year Economic Plan. Compare to current literatures, our research extends the research further for the classified fiscal expenditure of Shenzhen on secondary and tertiary industries. Results show that the classified fiscal expenditures of Shenzhen (which includes public service expenditure, industrial development expenditure, and infrastructure expenditure)
have significant promotion effects on the development of secondary industry, but the decreasing trend is obvious. The promotion effect on the development of tertiary industry is also significant, and the general trend decreases mildly. From the perspective of time dimension, in early stage (1995–2005), fiscal expenditure has significant promotion effect on secondary industry. In later stage (2010–2017), fiscal expenditure has significant promotion effect on tertiary industry. From the perspective of categorization, infrastructure expenditure and industrial development expenditure both have significant promotion effects on secondary and tertiary industries; but the effects decrease significantly in the later period. Public service expenditure always presents the weakest effect on the growth of secondary and tertiary industries, but the change is mild.

Therefore, it is quite necessary to suggest that the following fiscal expenditure of Shenzhen should be put into industry at least five years in advance. To support the growth of secondary industry, public finance should enlarge the amounts of industrial growth expenditure and infrastructure expenditure continuously. Also, to help the growth of tertiary industry, public fiscal expenditure needs to increase in appropriate amounts when it is necessary, which is a consistent suggestion for increasing fiscal expenditures on tertiary industry, especially on education and medical care [37]. This study not only analyzes the effect of total fiscal expenditure on the evolution of an industrial structure, but also establishes a new categorization of fiscal expenditure and finds that the fiscal expenditure in different categories has different impacts on the development of secondary industry and tertiary industry. In addition, this study contributes to the literature because this study applies the BSTS model in investigating the effect of fiscal expenditure on industrial structure evolution. However, there are two limitations of this paper. One is that the data collected are annual data from after the Economic Reform and Open-up processes in China. For further research, we can explore the effect of different categories of fiscal expenditure on different industries more deeply if we can get more detailed data such as quarterly or monthly data. Another limitation is the lack of specific policy contents related to the local government expenditures on the secondary and tertiary industries. In future study, we can also carry out more detailed analyses from the specific fiscal expenditure and value-added data in the secondary industry and tertiary industry to discover specific industry expenditure policy recommendations for different industries.

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