Study on local government public expenditure and multi-factor productivity in china based on instrument variable model

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Abstract

Based on the conventional C-D Production Function Model, this paper adopted Instrument Variable Model to measure the multifactor productivity growth of 223 cities at prefecture level and above in China, and probed into its relationship with local government public expenditure. It is shown that relationship between total public expenditure of local government and city multifactor productivity growth in China is significantly negative, which does not mean that local government public expenditure in China is inefficient, but because a considerable part of it is put into social security, health and medical care, and other public services. Further research by different productivity levels show that the faster productivity grows, the more deeply market-driven is the economics, the weaker is the negative correlation of local government public expenditure and productivity growth. Science & technology and educational expenditure of local government positively affect multifactor productivity growth in China cities significantly, however in varying degrees.

Keywords: instrument variable model, local government public expenditure, multi-factor productivity, decision reference

1 Introduction

Literatures show that there is a close relationship between public expenditure and productivity growth; public expenditure may enhance productivity by technical progress or by improving efficiency of single productive elements such as capital or labour. Many literatures have probed into this problem, such as Arrow, Kenneth and Kurz, Mordecai in [1], who first brought public investment into macroscopical production function model; Barro, who proposed that public service positively affect production in [2]. Adam [3] argued that quality and productivity in delivering and administering public service was of great importance. The United Nations [4] suggested that national accounts should measurement performance of the general government, and International Monetary Fund [5] suggested detailed procedure of government finance statistics. OECD (2000) inspected China's public expenditure problem, and talked about her efficiency of public expenditure in [6]. John Baldwin, Wulong Gu and Ryan Macdonald [7], Sir Tony Atkinson [8], the UK Office for National Statistics [9], Statistics New Zealand [10] and OECD [11] shared their experience and proposals of government performance measurement. Some other scholars, such as Dongping Fu in [12], Zhenye Li in [13], Jiejin Zhu in [14] and Ge Jin in [15] etc [16-21], have also investigated into problems about public expenditure and productivity.

On one hand, cities that assemble kinds of productive elements are cores of economic growth, and on the other hand, investment to cities have been much more than that to rural areas in China, research on relationship between local public expenditure of government and city productivity growth is of more importance. Taking these factors into consideration, this paper probed into relationship between public expenditure of local government and city multifactor productivity.

Reviews of literatures show that though many literatures focus on the relationship between public expenditure and productivity growth, few is focused on local government public expenditure and productivity growth, and few is based on Instrument Varible Models. The paper adopts the Instrument Variable Model to probe into relationship between local government public expenditure and multifactor productivity of prefectural-level and above cities in China.

Based on conventional Cobb-Dauglass Production Function Model, this paper positively analyze with data of 223 cities at prefecture level and above of 30 provinces in China from 1990 to 2009. Because many data are not available, Tibet is excluded. And some cities at prefecture level have become prefecture level city not long ago, there are very few data about them, they are excluded too. According to our analysis, relationship between local government public expenditure and city multifactor productivity in China is significantly negative, which does not mean that local government public expenditure in China is inefficient, but because a considerable part of it is put into social security, health and medical care, and other public services. Further research by different

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productivity levels show that the faster productivity grows, the more deeply market-driven is the economics, the weaker is the negative correlation of local government public expenditure and productivity growth. Science & technology and educational expenditure of local government positively affect multifactor productivity growth in China cities significantly, however in varying degrees.

The paper is organized as follows: in the next section, we show the source and processing of data. Section 3 gives the Instrument Variable Model of multifactor productivity we adopted. Then we test the model in the following section. Section 5 concludes.

2 Variables and Data

Taking availability of data into account, the sample of this paper takes from 223 cities at prefecture level and above of 30 provinces from 1990 to 2009. The reason we choose cities at prefecture level and above is that they are the main body of city function and are of stronger agglomeration effects, so are of better representativeness. Cities at prefecture level and above are more than 223. We choose only 223 ones for the following reasons: Because many data are not available, Tibet is excluded; and some cities at prefecture level have become prefecture level city not long ago, they are excluded too. Excluding cities in Tibet and those upgraded to cities of prefecture level, the number of the remained cities that meet our research criteria is 223.

For these cities at prefecture level and above, *China City Statistical Yearbook* and *Comprehensive Statistical Data and Materials on 50 Years of New China Cities* provide statistical materials for two kinds of concept for city. The first concept of city means city proper, that is to say, the downtown area and the suburb area, while countries and cities of country-level excluded. The other concept of city means the whole city, that is to say, not only the downtown area and the suburb area, but also countries and cities of country-level affiliated with the prefecture level city are included. Here we adopt the first concept; the reason is that countries and cities at country level are not main body of city function, while data for city proper are preferred.

To carry out our research, we need data for output, capital and labor input as well as local government public expenditure of the 223 cities. Data of 1990 to 1998 is taken from *Comprehensive Statistical Data and Materials on 50 Years of New China Cities*, 1999 to 2009 from *China City Statistical Yearbook*. Output data are GDP, labor input data are number of employed persons. Theoretically speaking, capital input shall use data of fixed capital stock per year. Because of availability of data, we took total investment in fixed assets as a replacement. For public expenditure of local government, we take intra-budgetary government expenditure; because it is typically relevant to size of city, we adjust them with GDP, and use the relative indicator of ratio of public expenditure of local government to GDP. Some data for these indicators are missed, and we fill them with Moving Average Method.

This paper will also study relationship between expenditure of local government and multifactor productivity of cities in China by regions. The general processing divides China into three regions by geographic location, that is to say, Eastern Region, Central Region and Western Region. This method is very simple, while of much disadvantage in research. It is well known that productivity level and productivity growth of cities in the same geographic district may differ significantly. Some times, there may even be significant differences among productivity level and productivity growth of the cities in the same province. To avoid this problem, this paper used the cluster analysis method based on productivity growth during the period of 1990 to 2009 to divide 223 cities into groups, and then probe into the relationship of their local government public expenditure and city productivity of each group respectively.

3 Instrument Variable Model of Multifactor Productivity

This paper handles with panel data. According to econometric theory and practice, dynamic models with panel data typically are troubled with endogenous explanatory variable problem. To settle this problem, productivity analysts seek help from Instrument Variable Model. We have tried some other methodologies in our previous research, none of them served well than Instrument Variable Model. Therefore, this paper will also make use of this method.

The key step of Instrument Variable Method is to seek appropriate instruments. Inappropriate instrument variable usually leads to bad, even wrong conclusions. Many econometricians devote to research on choice of better instrument variables. In the fields of productivity measurement with Instrument Variable Model, Anderson & Hsiao in [22], Arrelano & Bond in [23] and Blundell & Bond in [24] and [25] have probed into this problem and suggested practicable instruments respectively. Jian Jin reviewed the Instrument Variable Model of productivity growth measurement in literatures in [26].

Anderson and Hsiao's research is based on the differenced form of the original equation, $y_{it} = \rho y_{i,t-1} + x'_{it}\beta + \alpha_i + \varepsilon_{it}$. Difference cancels the individual fixed effects possibly correlate with the exogenous variables which means $E\left(x'_{it}\alpha_i\right) \neq 0$. But the difference of the lagged endogenous variable $y_{i,t-1} - y_{i,t-2} = \rho\left(y_{i,t-2} - y_{i,t-3}\right) + \left(x'_{i,t-1} - x'_{i,t-2}\right)\beta + \varepsilon_{i,t-1} - \varepsilon_{i,t-2}$ is obviously correlated with the error term $\varepsilon_{it} - \varepsilon_{i,t-1}$. To avoid this problem, Anderson and Hsiao suggested to use level instruments y_{t-2} or the lagged difference instruments $y_{i,t-2} - y_{i,t-3}$

as instruments for the differential regression estimators $y_{i,t-1}-y_{i,t-2}$ and proved that level instruments superior to the latter.

In the same way, Arrelano & Bond (1991) eliminates the individual effects by differencing to get equation:

$$\begin{aligned} y_{it}-y_{i,t-1} &= \rho\left(y_{i,t-1}-y_{i,t-2}\right) \\ &+\left(x'_{it}-x'_{i,t-1}\right)\beta+\varepsilon_{it}-\varepsilon_{i,t-1} \end{aligned}. \quad (1)$$

And under some certain presumption, Arellano & Bond proved that $\left\{x_{i,t-j}, y_{i,t-j} : j \geq 2\right\}$ are efficient instrument variables for this differential form equation. Now for each year, researchers on productivity measurement can find efficient instruments. For $t=T$, Equation (1) changes into $y_{iT}-y_{i,T-1}=\rho\left(y_{i,T-1}-y_{i,T-2}\right)+\left(x'_{iT}-x'_{i,T-1}\right)\beta+\varepsilon_{iT}-\varepsilon_{i,T-1}$, and we have a series of instruments variables $y_{i1}, y_{i2}, \cdots y_{i,T-2}, x'_{i1}, x'_{i2}, \cdots x'_{i,T-1}$.

There is a serious problem. Because making use of information contained in differences only, the estimator suggested by Arellano & Bond is rather inefficient when instruments are weak. Blundell & Bond in [25] proved that both the elasticities of output to capital and to labour are very small and inaccurate.

Aimed at shortcomings of Arellano-Bond estimator, Blundell & Bond in [24] suggest making use of additional level information beside the differences, combining moment restrictions on differential and level instruments, and resulting in a so-called GMM system-estimator. According to Blundell & Bond, for $t=T$, $dy_{i1}, dy_{i2}, \cdots dy_{i,T-1}, dx'_{i1}, dx'_{i2}, \cdots dx'_{i,T}$ are usable instruments.

Once instruments found, we can solve equation and compute productivity growth with Instrument Variable Method.

4 Measurement of productivity and clustering division of cities

The model handled with is as follow:

$$y_{it}=\beta_k k_{i,t-1}+\beta_l l_{i,t-1}+\alpha_i+f_i+\eta_t+\varepsilon_{it}, \quad (2)$$

where k and l are capital and labour input respectively, f_i denotes fixed effects of each city, η_t denotes time tendency faced by all the cities.

At first, we exclude time mean values of all the variables, so that the following processing does not need to deal with time specific dummy variables. Then we drops the individual fixed effects by first order difference, the equation now is:

$$y_{it}-y_{i,t-1}=\beta_k(k_{i,t-1}-k_{i,t-2})+\beta_l(l_{i,t-1}-l_{i,t-2})+(\varepsilon_{i,t}-\varepsilon_{i,t-1}). \quad (3)$$

We solve this model with difference instrument variables method and Eviews 5.1, compute multifactor productivity with surplus method, which is then regressed with adjusted public expenditure of local government.

It is well known that there exists imbalance in economic development of different regions and cities, and productivity in different cities also differs significantly. To find out relationship between local government public expenditure and city productivity in cities of different economic level, we clustered the 223 cities by their productivity growth during the period of 1990 to 2009.

TABLE 1 Cluster of cities by productivity growth rate during 1990 to 2009

Productivity growth rate	Cities included
higher (47 cities)	Beijing, Tianjin, Shijiazhang, Tangshan, Taiyuan, Shenyang, Dalian, Anshan, Changchun, Haerbin, Daqing, Shanghai, Nanjing, Wuxi, Xuzhou, Changzhou, Suzhou, Hangzhou, Ningbo, Wenzhou, Fuzhou, Taizhou, Xiamen, Nanchang, Ji'nan, Qingdao, Zibo, Dongying, Yantai, Zhengzhou, Wuhan, Changsha, Guangzhou, Shenzhen, Zhuhai, Shantou, Foshan, Zhongshan, Dongguan, Chongqing, Chengdu, Panzhihua, Mianyang, Kunming, Yuxi, Xi'An, Urumchi
Lower (80 cities)	Xingtai, Chengde, Cangzhou, Langfang, Hengshui, Jincheng, Shuozhou, Wuhai, Fuxin, Tieling, Chaoyang, Liaoyuan, Tonghua, Baishan, Songyuan, Baicheng, Jixi, Hegang, Shuangyashan, Qitaihe, Mudanjiang, Heihe, Suqian, Quzhou, Tongling, Anqing, Huangshan, Chuzhou, Sanming, Nanping, Jingdezhen, Xinyu, Yingtan, Kaifeng, Hebi, Jiaozuo, Xuchang, Luohe, Sanmenxia, Shangqiu, Xiaogan, Huanggang, Shaoyang, Yiyang, Chenzhou, Huaihua, Zhangjiagang, Chaozhou, Meizhou, Shanwei, Heyuan, Yangjiang, Qingyuan, Yunfu, Wuzhou, Qinzhou, Guigang, Fangchenggang, Sanya, Zigong, Luzhou, Deyang, Guangyuan, Suining, Neijiang, Leshan, Yibin, Nanchong, Liupanshan, Tongchuan, Yan'An, Hanzhong, Weinan, Jiayuguan, Jinchang, Baiyin, Tianshui, Xi'Ning, Yinchuan, Shizuishan
intermediate (96 cities)	Qinhuangdao, Handan, Baoding, Zhangjiakou, Datong, Yangquan, Changzhi, Hohehot, Baotou, Chifeng, Fushun, Benxi, Dandong, Jinzhou, Yingkou, Liaoyang, Panjin, Huludao, Jilin, Siping, Qiqihar, Yichun, Jiamusi, Nantong, Lianyungang, Huaiyin, Yancheng, Yangzhou, Zhenjiang, Taizhou, Jiaxing, Huzhou, Shaoxing, Jinhua, Zhoushan, Hefei, Wuhu, Bengbu, Huainan, Maanshan, Huaibei, Fuyang, Putian, Quanzhou, Zhangzhou, Longyan, Pingxiang, Jiujiang, Zaozhuang, Weifang, Jining, Taian, Dezhou, Weihai, Linyi, Laiwu, Rizhao, Luoyang, Pingdingshan, Anyang, Xinxiang, Puyang, Nanyang, Huangshi, Shiyan, Jingzhou, Yichang, Xiangfan, Ezhou, Jingmen, Zhuzhou, Xiangtan, Hengyang, Yueyang, Changde, Yongzhou, Shaoguan, Jiangmen, Zhanjiang, Maoming, Huizhou, Zhaoqing, Jieyang, Nanning, Liuzhou, Guilin, Beihai, Yulin, Haikou, Guiyang, Zunyi, Qujing, Baoji, Xianyang, Lanzhou, Kramer Iraq

Cities are clustered into three groups. The outcome of the cluster shows that, cities with higher productivity growth rate are mostly with higher economic growth rate, the four municipalities and most of the provincial capital cities are classified into this group, others are most cities in coastal provinces with higher open degree; cities with lower productivity are mostly low-economic-level ones, some of whom are cities in the Western Region, and some had upgraded into prefecture level cities just a few years ago. Most cities of intermediate level productivities are of intermediate economic levels, having a long developing history, some of whom may had experienced some higher productivity growth rate periods, while have slowed down ever since about 15 years ago.

5 Relationships between Public Expenditure of Local Government and City Multifactor Productivity

5.1 FOR 223 CITIES AS A WHOLE

According to the relevant economic theory, besides government public expenditure, there are many other factors such as economic development level, economic structure, education level of the labours, etc., that influence city productivity growth. To control influence of other factors than public expenditure of local government on productivity, we take economic structure, education level of labours and economic development level into accounts. Then we have model of 223 cities as follow:

$$\ln a = \underset{(5.55)}{4.078} - \underset{(-3.49)}{1.354}\ln g + \underset{(2.84)}{0.294}sein + \underset{(2.41)}{0.289}tein - \underset{(-2.02)}{0.030}stu - \underset{(-3.61)}{0.084}\ln pgdp , \quad (4)$$

where a is multifactor productivity growth, g public expenditure of local government, *sein* ratio of the secondary industrial value-added in GDP, *tein* the tertiary industrial value-added in GDP, *stu* number of students enrolment in regular institutions of higher education, and *pgdp* per capita GDP. The secondary and the tertiary industrial value-added in GDP reflects influence of economic structure on city productivity, number of students enrolment in regular institutions of higher education reflects that of education level of the labours, and per capita GDP reflects that of economic development level.

By Equation (4), it seems that relationship between public expenditure of local government and city multifactor productivity in China is negative, public expenditure of local government does not enhance productivity growth. This conclusion is inconsistent with normal economic knowledge.

To find out the reason of the outcome of Equation (4), taking in consideration of the fact that the parts of public expenditure playing a key role in productivity are expenditures on science & technology and education, we regression with science & technology expenditure and education expenditure as independent variables, economic structure, education level of labors and economic development level as controlled variable. It shows that influence of the controlled variables is all insignificant, so they are all dropped out of the model, and we have:

$$\lg a = \underset{(27.75)}{2.112} + \underset{(5.02)}{0.056}\ln sci + \underset{(12.62)}{0.178}\ln edu , \quad (5)$$

where a is still multifactor productivity growth, and *sci* local government expenditure on science & technology fields and *edu* local government expenditure on education.

Equation (5) shows that local government expenditure on science & technology and education enhances multifactor productivity in these 223 cities significantly. Increase of 1 percent in local government expenditure on science & technology leads to multifactor productivity growth of 0.056 percent, and increase of 1 percent in local government expenditure on education leads to multifactor productivity growth of 0.178 percent.

5.2 RELATIONSHIP OF CITIES OF DIFFERENT PRODUCTIVITY LEVEL

We had clustered cities into three groups in accordance with their productivity. Now we shall check influence of public expenditure of local governments on multifactor productivity by group.

For the first group, we have

$$\lg a_1 = \underset{(1.097)}{1.149} - \underset{(-1.99)}{0.712}\lg g_1 + \underset{(4.18)}{0.608}sein_1 + \underset{(2.27)}{0.472}tein_1 - \underset{(-2.02)}{0.040}\lg stu_1 - \underset{(-1.66)}{0.070}\lg pgdp_1 , \quad (6)$$

where the subscript "1" means group one, that is to say, cities with higher multifactor productivity during the period of 1990 to 2009.

Equation (6) shows that for cities with higher productivity, total public expenditure of local governments is negatively correlation with productivity growth; an increase of 1 percent in local government public expenditure leads to a decrease of 0.712 percent in city multifactor productivity. That is obviously contrary to the aim of the government.

Taking into the fact that parts of the government public expenditure are put into social security, social assistance and pension, and that these expenditure has very little to do with city multifactor productivity, we set up another model with science & technology expenditure and education expenditure of the local government as independent variables, economic structure, education level of labours and economic development level as controlled variable, city multifactor productivity still the dependent variable. The regression equation shows that:

$$\lg a_1 = \underset{(0.69)}{0.620} - \underset{(-0.05)}{0.001}\lg sci_1 + \underset{(1.46)}{0.046}\lg edu_1 + \underset{(3.92)}{0.517}sein_1 + \underset{(1.96)}{0.268}tein_1 - \underset{(-2.52)}{0.049}\lg stu_1 , \quad (7)$$

where the subscript "1" means group one, cities with higher multifactor productivity during the period of 1990 to 2009.

That is to say, for cities with higher productivity, public expenditure of local governments on science & technology does not enhance city multifactor productivity growth significantly, while an increase of 1 percent in that on education enhances productivity growth by 0.046 percent.

For cities with lower productivity, we carry out the same regression. Firstly, we regress with local government public expenditure as independent variable, then with local government public expenditure on science & technology and education as independent variables. Now we have:

$$\lg a_3 = \underset{(19.49)}{6.025} - \underset{(-5.80)}{2.087}\lg g_3 - \underset{(-3.56)}{0.033}\lg stu_3 , \quad (8)$$

$$\lg a_3 = \underset{(22.3)}{3.604} - \underset{(-2.86)}{0.027}\lg stu_3 + \underset{(1.54)}{0.022}\lg sci_3 + \underset{(3.44)}{0.062}\lg edu_3 , \quad (9)$$

where the subscript "3" means group three, that is to say, cities with lower multifactor productivity during the period of 1990 to 2009.

Equation (8) shows that just as situations of all the 223cities and in higher productivity cities, total public expenditure of local government of cities with lower productivity is negatively correlation with productivity growth, the controlled variable education level of labours, denoted by the number of students enrolment in regular institutions of higher education, shows the same negative correlation with multifactor productivity. Other controlled variables do not influence the dependent variable significantly, and are dropped out of the equation.

Equation (9) shows that public expenditure of local governments on science & technology and education and the controlled variable education level of labours influenced productivity significantly, public expenditure positively and education level of labours negatively, while other controlled variables are all dropped out. Coefficients 0.022 and 0.062 mean that an increase of 1 percent in public expenditure of local governments on science & technology enhances city multifactor productivity growth by 0.022 percent, and that of education enhances it by 0.062 percent.

For cities with intermediate productivity, public expenditure of local governments influences productivity significantly, while all controlled variable does not work well so that they are taken out of the equation. Both total public expenditure of local government and expenditure on science & technology and education perform the same. The regression equations for the two situations are:

$$\lg a_2 = \underset{(18.61)}{5.084} - \underset{(-3.44)}{1.158}\lg g_2 , \quad (10)$$

$$\lg a_2 = \underset{(24.67)}{3.331} + \underset{(0.586)}{0.007}\lg sci_2 + \underset{(4.59)}{0.083}\lg edu_2 , \quad (11)$$

where the subscript "2" means the second group, cities with intermediate multifactor productivity.

Just as situations in cities with higher and lower productivity, total public expenditure of local governments with intermediate productivity is negatively correlation with their multifactor productivity growth, while public expenditure of local governments on science & technology and education enhance productivity growth significantly, an increase of 1 percent in government public expenditure enhances productivity growth by 0.007 and 0.083 percent respectively.

5.3 COMPREHENSIVE ANALYSES

Putting the entire three productivity situation together, we find that in each group, just as the situation of 223 cities as a whole, total public expenditure of local government negatively influence the city multifactor productivity, while public expenditure of local government on science & technology and education positively enhance it significantly. That is not inconsistent. Nor the negative coefficients in equations for total public expenditure are inconsistent with economic theory. In fact, the reason is that local government public expenditure is divided into many parts, such as expenditure on science & technology, on education, on social security, on social support, on pension, and so on. Most of the expenditure does not enhance city multifactor productivity significantly, except for that on science & technology and on education. So it is not unusual that the coefficients for total government public expenditure are negative, while at the same time, local government public expenditure on science & technology and on education enhances city multifactor productivity significantly.

For relationship between public expenditure of local government on science & technology and multifactor productivity, the higher the productivity, the lower the regression coefficient is. That means that for cities with higher productivity, effect of public expenditure of local government on science & technology on productivity is less, while for cities with lower productivity, the effect is more obvious. The reason is that, for cities with higher productivity, because of higher economic level, the level of science & technology and degree of marketization is higher, productivity growth depends more on the market, so influence of the same amount of public expenditure on science & technology is less obvious than cities with lower productivity; for cities with lower productivity, the level of science & technology and degree of marketization is lower, and their city productivity growth depends more on government support, so the influence of public expenditure on science & technology is more obvious.

We also notice that in cities with higher and lower productivity level, just as the situation of 223 cities as a whole, educational level of labours has negative correlation with city multifactor productivity. There are different reasons. For higher-productivity-cities, social and economic development level are relatively higher, educational level of labours is also higher, according to the law of diminishing marginal benefit, educational level of labours does not show obvious enhancing effect on city multifactor productivity. As for the cities with lower multifactor productivity, the social economic development level and education development level are all lower, though the State and all levels of government attached more importance to the development of education, because of the lag of the mechanism of education to enhance productivity growth and economic growth, the expenditure of local government on education in these cities does not show obvious effect on city multifactor productivity at the present stage.

6 Conclusions

On the basis of Instrument Variable Model, positive analysis with panel data of 223 cities at prefecture level and above in China shows that, total public expenditure of local government and city multifactor productivity correlation negatively, while public expenditure of local governments on science & technology and on education has positive correlation with productivity. Regression coefficients of total public expenditure for higher, intermediate and lower cities are -0.712, -1.158 and -2.087 respectively. The reason is that, public expenditure of local government are most put into public services, which includes not only science & technology and education that enhance productivity growth significantly, but also social security, medical and health care and other analogous public service that do not boost the economic development remarkably.

For cities with higher productivity, because of higher economic level, demands for social security, medical and health care and other analogous public service demands are less, the local governments can put more of its expenditure on science & technology and education; while for cities with lower productivity, because of lower economic level, demands for social security, medical and health care and analogous public service demands are more, the local governments of those cities must put more for these demands, so expenditure on science & technology and education have to be a less proportion.

Relationship between public expenditure of local government on science & technology and multifactor productivity in cities of different multifactor productivity level shows that, the higher the productivity, the lower the regression coefficient is. The reason is that, for cities with higher productivity, the level of science & technology and degree of marketization is higher, productivity growth depends more on the market, influence of public expenditure on science & technology is less obvious than that with lower productivity; for cities with lower productivity, just the opposite.

As for relationship between public expenditure of local government on education and multifactor productivity, cities with intermediate productivity have the highest coefficient, 0.083, and that of cities with higher and lower productivity are 0.046 and 0.062 respectively. It shows that, for cities with higher productivity, because of higher level of economy and education, marginal effect of education on productivity growth decreases; and for cities with lower productivity, because of weaker economic and education foundation, the effect of public expenditure of local and central government on education of these cities in recent years has not fully manifest itself due to mechanism of action of education on productivity and economic growth.

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