Application of panel data-generalized method of moments on the impact of urban output

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Abstract. This article summarized the mechanism of the impact of real estate tax on city output path, on the basis of selecting the Chinese provincial panel data from 2005 to 2019, by using the PD - GMM method. The real estate tax was taken as the core explanation variable, and was added a lot of control variables to establish the impact of real estate tax on city output 7 panel data models. We estimated and analyzed the robustness through Eviews software. Research results showed that: (1) from the national level, the real estate industry tax would have a significant effect on urban output, and there is a "U" shaped relationship between the output and the real estate tax and cities. At the beginning of the urban development, the city real estate tax inhibited output, when the urban economy was in the period of high quality development. The real estate tax on urban output result, had obvious function. (2) At the regional level, the real estate tax in the eastern region had a negative inhibitory effect on the urban revenue, while the real estate tax in the western region had a significant promoting effect on the urban revenue, and the influence degree was shown as the eastern>western>middle. (3) The more real estate investment and human capital are tilted to the west, the more favorable the development of the western region, while the impact on the eastern and central regions was not significant.

1. Introduction

For a long time, the tax revenue and economic growth as close as lips and teeth, inseparable, among numerous tax categories, the real estate industry occupies the important position of tax, tax is directly related to the real estate industry in 2019 including cultivated land usage tax, land value-added tax, deed tax, urban land use tax and property tax amount is 1.9251 trillion yuan, up 7.15% year on year, account for national finance income and local finance main income proportion were 10.11% and 25.01% respectively. On May 18, 2020, the central committee of the communist party of China, promulgated by the State Council "about to speed up the new era's opinions on perfecting the system of socialist market economy, to accelerate the establishment of modern tax system, and steady real estate tax legislation, in October the same year in the central committee of the communist party of China to develop the national economy and social development of 14 five-year plan and 2035 vision of again, to establish a modern financial system of revenue, perfect modern tax system, perfect the system of local taxes. Therefore, in the "our economy has been developed from high quality development stage of high-speed growth stage" of the phase shift, explore the real estate industry tax contact city economic growth and the mechanism of action, to deepen the reform of the real estate tax system,
strengthen the benign interaction, the real estate industry and economic development to promote the real estate market and economic sustainable development of the high quality is of great significance.

2. Literature review
At present, the research on real estate tax and economic growth is mainly carried out from the following three aspects: First, from the perspective of real estate tax itself, domestic and foreign scholars mainly study the nature, function and reform of real estate tax. Cui Zhikun et al. (2020) also regard the acceptability of residents as the key to the real estate tax reform and emphasize the operability of the collection management. Fan Huixia (2020) believes that in the new era of high-quality economic development, real estate tax should give full play to the function of premium recovery, adjust income distribution and further narrow the income gap of residents, which is the key to the smooth progress of tax reform. Secondly, from the perspective of the effect of real estate tax, relevant studies mainly focus on the effect of real estate tax on local fiscal revenue, real estate prices and residents' consumption. Zhu Weiqun (2019) believes that real estate tax is one of the important sources of local fiscal revenue, and it is necessary for local governments to share the decision-making power of real estate tax. Third, Schmalz et al. (2017) believe that real estate investment has a significant positive correlation with economic growth, that is to say, real estate investment can effectively drive economic growth. Luo (2015) believe that the rapid development of real estate leads to the imbalance of resource allocation, which has a significant negative impact on economic growth, may also inhibit the development of emerging technology industries and reduce the innovation motivation of the whole society.

In general, the existing literature mostly studies the real estate tax from the theoretical level, but the empirical research is less involved, so it is necessary to further improve the real estate tax research system and enrich the relevant theoretical content. Therefore, this paper will use the data of 31 provinces (cities) in China from 2005 to 2019 to conduct model estimation from the national and regional levels, to explore whether real estate tax has an impact on economic growth, what kind of relationship exists at different time points, what is the mechanism of such relationship, and how the relationship changes under regional heterogeneity.

3. Theoretical analysis, model construction and variable description
3.1. Theoretical mechanism analysis
As for the theoretical research on the relationship between real estate tax and economic growth, this paper discusses the relationship from the three aspects of public service, real estate development investment and residents' consumption in combination with the "three carriages" that drive economic growth, namely fiscal revenue, investment and consumption. The theoretical framework is shown in Figure 1.

Figure 1. The influence path of real estate tax on urban output.
3.2. Model construction
According to the Ramsey Modle, also known as the neoclassical economic growth model, and with reference to the practice of Zhou Hongbing et al. (2020), assuming constant returns to scale, the Cobb-Douglas production function is constructed as follows:

\[ Y = F(K, L) \cdot B \]  

(1)

Hypothesis B contains a variety of factors affecting Y, and the real estate tax is one of them. Then

\[ B = RET^a \cdot \text{Factor}^\phi \; \]

Then:

\[ B = \frac{\gamma}{F(K, L)} = TFP = EG = RET^a \cdot \text{Factor}^\phi \]  

(2)

Where B represents total Factor productivity TFP, Y represents gross regional product, EG represents urban output, K and L respectively represent capital and labor input, RET represents real estate tax, and Factor represents other factors affecting urban output.

By referring to relevant literature, fiscal expenditure (GOV), real estate development investment (REI), residential consumption (CS), openness level (OPL), infrastructure (IF) and human capital (HC) are taken as the control variables and the following results are obtained:

\[ EG = RET^a \cdot REI^\beta \cdot GOV^\gamma \cdot CS^\eta \cdot OPL^\phi \cdot HC^\delta \cdot IF^\mu \]  

(3)

Take the log of both sides:

\[ \ln EG = a\ln RET + \beta \ln REI + \gamma \ln GOV + \eta \ln CS + \phi \ln OPL + \delta \ln HC + \mu \ln IF \]  

(4)

Considering the difference of time regions, the following econometric model was established:

\[ \ln EG_{i,t} = c + a\ln RET_{i,t} + \beta \ln REI_{i,t} + \gamma \ln GOV_{i,t} + \eta \ln CS_{i,t} + \phi \ln OPL_{i,t} + \delta \ln HC_{i,t} + \mu \ln IF_{i,t} + \ln EG_{i,t-1} + f(\ln RET_{i,t})^2 + \epsilon_{i,t} \]  

(5)

Where, i and t respectively represent province and time; \( \epsilon_{i,t} \) represents random disturbance term; \( \ln EG_{i,t-1} \) represents economic growth level lagging one period; \( (\ln RET_{i,t})^2 \) represents the quadratic term of real estate tax.

3.3. Variable selection and data description
Urban output (EG): is the explained variable, measured by the real GDP per capita of each province. Real estate tax (RET): as the explanatory variable, the sum of the five taxes in the links of real estate development, transaction and holding, land occupation tax, land value added tax, deed tax, real estate tax and urban land use tax is selected as the index to measure the real estate tax. Government behavior (GOV): Select the local fiscal expenditure as the metric index of government behavior.

Real estate development investment (REI): This paper selects the real estate development investment of each province to represent. Household consumption (CS): the total retail sales of social consumer goods in each province is selected to reflect the consumption level and purchasing vitality of residents. Human capital (HC): The level of human capital is reflected by the number of students in provincial colleges and universities. Openness level (OPL): The total import and export volume of foreign-invested enterprises in each province is selected to reflect the level of regional openness, and then influence the level of regional economic development. Infrastructure (IF): The per capita urban road area is selected to reflect the level of urban infrastructure.

The research data in this paper are all from the National Bureau of Statistics, and the nominal value is converted into the real value by the method of deflating according to the research needs. The US dollar is converted into RMB respectively according to the current exchange rate, and China is divided into three regions according to the official statistics: East, Central and West.

4. Empirical results analysis

4.1. Estimated results and analysis at national level
The results of Model (1) show that from 2005 to 2019, the core explanatory variable of real estate tax at the national level is negatively correlated with urban output, and the coefficient is significant at the level of 5%, indicating that every 1 percentage point increase of real estate tax will reduce the number
of economic growth by 0.016 percentage points. Model (2) to join the human capital (HC) after the innovation factors, the real estate industry tax coefficient is still in the 5% significance level, but the coefficient of absolute value declined slightly, the real estate tax one percent increase, economic growth will fall by 0.013%, while human capital and economic growth of cities exist positive correlation, regression coefficient is 0.19 and a significant at 1% level, namely, every one percent increase of human capital city output will be increased by 0.19%, that shows at the same time to speed up the innovative talent training, improve the level of the overall technology, The important practical significance of gathering high-quality human capital to economic development.

Table 1. Estimation results of the impact of real estate tax on urban output at the national level.

| variable | model(1) | model(2) | model(3) | model(4) |
|----------|----------|----------|----------|----------|
| lnRET    | -0.016** (2.03) | -0.013** (1.98) | -0.022* (1.23) | -0.017* (1.15) |
| lnREI    | 0.029** (1.78) | 0.005* (1.61) | 0.012** (1.49) | 0.011** (1.52) |
| lnGOV    | 0.358*** (12.06) | 0.354*** (12.22) | 0.071*** (3.59) | 0.081*** (3.88) |
| lnCS     | 0.325*** (11.25) | 0.310*** (10.93) | 0.032*** (1.62) | 0.035* (1.77) |
| lnOPL    | 0.023*** (3.98) | 0.022*** (3.83) | 0.010*** (2.97) | 0.009*** (2.84) |
| lnIF     | 0.160*** (5.32) | 0.112*** (3.57) | 0.007 (0.38) | 0.008 (0.44) |
| lnHC     | 0.19*** (4.35) | 0.030 (1.14) | 0.026 (1.00) | 0.026 (1.00) |
| LInGDP   | 0.769*** (27.24) | 0.770*** (27.3) | -0.001* (27.3) | -0.001* (27.3) |
| (lnRET)^2 | -0.001* (-1.16) | -0.001* (-1.16) | -0.001* (-1.16) | -0.001* (-1.16) |
| N        | 421       | 421       | 421       | 421       |
| R2       | 0.989     | 0.990     | 0.996     | 0.996     |
| F        | 967.18    | 985.5     | 2835.51   | 2771.22   |
| Sargan   | 23.60     | 23.60     | 23.60     | 23.60     |
| AR(2)    | 0.5057    | 0.5057    | 0.5057    | 0.5057    |
| Fixed    | yes       | yes       | yes       | yes       |

Note: The t-test values are in parentheses. ***, ** and * indicate significance at the significance level of 1%, 5% and 10%, respectively.

The results of Model (3) show that there is still a significant negative correlation between real estate tax and economic growth, but the significant level is lower than the previous two models, that is, every 1 percentage point increase in real estate tax will reduce the economic growth by 0.022 percentage points. At the same time, the coefficient of the first-order lagging term of economic growth is 0.769, and it is significant at the level of 1%, which means that every 0.769 percentage points increase in the economic growth in the last period will increase by 0.769 percentage points in the next period, indicating that economic growth has continuity. Model (4) to join the quadratic term of real estate tax, according to the results of real estate tax is negatively related to the economic growth significantly, but the second item also with related economic growth in the 10% significance level, combining with the real estate tax measuring results can be seen that real estate tax's influence on the city's economic growth is not a simple linear relationship, but a "U" type curve, there is one main reasons: It is in the primary stage of economic growth, the real estate industry tax part will eventually turn grain or in the form of the cost to consumers, because the cost of "effect" offset "wealth effect" together with the primary rough housing irrational expansion mode caused the real estate market, finally reduce the residents' consumption motivation and consumption level, thus inhibiting the growth,
and high quality development in economic growth, to effectively control prices artificially high momentum, residents' consumption more tend to be more rational, the basic role of consumption to economic growth and into full play, and boosting the economic growth; It can also be seen from Figure 2 that real estate tax is the Granger cause of urban output, while urban output is not the Granger cause of real estate tax. Therefore, real estate tax has a significant impact on urban output at the national level.

Pairwise Granger Causality Tests
Date: 04/02/21   Time: 15:53
Sample: 2005 2019
Lags: 2

| Null Hypothesis                      | Obs | F-Statistic | Prob. |
|--------------------------------------|-----|-------------|-------|
| RET does not Granger Cause GDP       | 450 | 9.15873     | 0.0085|
| GDP does not Granger Cause RET       | 1.77292 | 0.2305 |

Figure 2. Granger result.

From the perspective of the test results of control variables, real estate development investment, the government behavior, residents' consumption level, the open level, infrastructure has a positive influence on city output, and are significant at the 10% level, such as model (2) coefficients were 0.005, 0.354, 0.310, 0.022, 0.112, therefore, to promote investment and consumer spending and increased fiscal spending, to strengthen the construction of infrastructure, increase the intensity of open, speed up the economic development of cultivating innovative talents is to lay the foundation, creating economic environment, the effective ways to improve economic quality, consolidate the economic results.

4.2. Estimation results and analysis at regional level
From the estimation results in the east, the middle and the west, the goodness of fit of the model reached 0.988, 0.985 and 0.992, respectively. Most of the significance of F statistics and T statistics were ideal, which indicated the rationality and reliability of model construction and variable selection to a certain extent. In general, there are significant differences in the influence of real estate tax on the spatial distribution of economic development level in different regions, and the degree of difference is large. The order of the influence degree of real estate tax on economic growth is eastern &gt; The western & gt; In the middle. Specific view, in the eastern region, the real estate industry tax coefficient is 0.041, and a significant at 1% level, that every one percent increase in real estate tax, city level of output will fall 0.041%, are consistent with the national level, also shows that in the eastern region of the real estate tax's influence on city output is still before the inflection point, real estate tax is still a "stumbling block" of economic growth, policy shall be extended appropriately for the real estate tax. On the side of the western region to estimate the core variable coefficient is 0.037, and a significant at 10% level, in the western region, the real estate industry tax may have more than affect the inflection point of economic growth, at the right side of inflection point, the real estate industry tax pull effect on the economic growth has obvious, this may be due to the recent policy tilt to the west, investment and financial support to help the industry won a good development environment, relative to the eastern industrial structure more reasonable, so the government in the developers to develop trade link can squeeze tax policy and appropriate heavier taxation, to promote economic growth, It will help resolve the imbalance in regional development. In the central region, the real estate industry tax are negatively related to economic growth, but the coefficient was not significant, probably due to the relatively
stable development in central China, real estate tax's influence on the central regions economic growth is at a turning point, the real estate industry tax by real estate development investment, fiscal expenditure, the path of the residents' consumption affect the economic growth is not obvious, or cancel each other out, so did not show significant correlation.

Table 2. Estimation results of the impact of housing and real estate tax on urban output at the regional level.

| variable | east mode(5) | middle mode(6) | west mode(7) |
|----------|-------------|----------------|-------------|
| lnRET    | -0.041***   | -0.008         | 0.037*      |
|          | (-3.36)     | (-0.16)        | (1.93)      |
| lnREI    | 0.065       | 0.045          | 0.032*      |
|          | (1.05)      | (1.17)         | (1.88)      |
| lnGOV    | 0.422***    | 0.634***       | 0.239***    |
|          | (6.76)      | (8.11)         | (5.625)     |
| lnCS     | 0.350***    | 0.150***       | 0.342***    |
|          | (6.62)      | (3.11)         | (8.26)      |
| lnOPL    | -0.002      | -0.025         | 0.030***    |
|          | (-0.345)    | (-1.42)        | (5.13)      |
| lnIF     | 0.086**     | -0.223*        | 0.132*      |
|          | (2.10)      | (-2.43)        | (2.57)      |
| lnHC     | 0.084       | 0.087          | 0.207***    |
|          | (0.91)      | (0.72)         | (3.07)      |
| N        | 154         | 112            | 155         |
| R2       | 0.988       | 0.985          | 0.992       |
| F        | 676.91      | 451.65         | 890.46      |
| Fixd     | yes         | yes            | yes         |

Note: The t-test values are in parentheses. ***, ** and * indicate significance at the significance level of 1%, 5% and 10%, respectively.

5. Conclusions
From the national level, the real estate industry tax would have a significant effect on urban output, and there is a "U" shaped relationship between the output and the real estate tax and cities. At the beginning of the urban development, the city real estate tax inhibited output, when the urban economy was in the period of high quality development. The real estate tax on urban output result, had obvious function.

At the regional level, the real estate tax in the eastern region had a negative inhibitory effect on the urban revenue, while the real estate tax in the western region had a significant promoting effect on the urban revenue, and the influence degree was shown as the eastern>western>middle.

Government behavior and consumer consumption was still the "engines" of urban output. Real estate development and investment, opening to the outside world and human capital had a significant promoting effect on economic growth in western China. Improving the construction of transportation facilities was conducive to the development of eastern and western regions, while it had a negative effect on economic growth in central China.
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