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An Empirical Study of the Impacts of Industry Agglomeration, Population Aggregation and Economic Growth on Japanese Prime Metropolitan Area

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Abstract: Based on the data of Japanese Prime metropolitan area from 1955 to 2013, this paper studies the effect of industry agglomeration and population aggregation on economic growth in Tokyo metropolitan area. Through the processing of the panel data, we find that the industry agglomeration in Japanese Prime metropolitan region has apparently positive impacts on its economic growth, and also, population aggregation can positively effects its economic growth. Following this paper is try to carry out research on Tokyo —the core city of Japanese Prime metropolitan area, to study the influence of industry agglomeration on its economic growth. This paper thinks that in the process of the development of the city group, due to resource constraints, the manufacturing output unit of land demand big industry will gradually from the degree of economic development is relatively high in the whole city and the city to evacuate, inside, labor resources are gradually to the regional flow of high GDP per capita output.

Keywords: Industry Agglomeration; Population Aggregation; Economic Growth

I. Introduction

As a field based on the theory of space economics and the theory of new growth, the relationship between industrial agglomeration and economic growth has received much attention in the academic community. After the Second World War, Japan began to rectify the development of the economy and actively promote the rise of manufacturing. Relying on the rapid development of the manufacturing industry, Japan gradually eliminated the backward industrial and agricultural industries, and realized the replacement of low-efficiency industries by high-efficiency industries in the process of industrial upgrading. In order to further promote economic development, the Japanese government introduced the “Capital Circle Rectification Program” in 1956 with the aim of constructing a “Capital Circle” with a radius of 100 kilometers or less centered on Tokyo. After five times of rectification planning in the capital circle, Japan’s Japanese Prime Minister’s Circle has gradually matured and its development experience has become more and more useful.

II. literature review

For a long time, mainstream economists studying economic growth have not included spatial factors in general equilibrium analysis. However, with the endogenous growth theory, knowledge spillovers have a positive effect on economic growth, and Western economists represented by Krugman pointed out in their new economic geography that industrial agglomeration can promote knowledge and technology spillovers, economists A series of theoretical and empirical studies on the relationship between industrial agglomeration and economic growth began. In 1996, Ciccone and Hall pointed out that the relationship between the productivity and density of economic activities pointed out that the increase in the employment density of non-agricultural industries in the United States would increase the labor productivity of non-agricultural industries by 6 percentage points, which means that industrial agglomeration is conducive to economic growth. In 2006, Brulhart and Mathys made similar experimental results based on European data, and pointed out that the effects of industrial agglomeration will increase over time. However, there are other views on the relationship between industrial agglomeration and economic growth. In 2008, Martinez-Galarraga et al. used the data from 1860 to 1990 to study the situation in Spain, and proposed an "inverted U-shaped" curve between industrial agglomeration and economic growth. Relationships, that is to say, industrial agglomeration can positively promote economic growth and then counter-productive. Domestically, in 2010, Liu Jun and Xu Kangning used China's provincial panel data to study the relationship between industrial clustering and economic growth and regional disparity. Research shows that industrial agglomeration can significantly promote economic growth and is the cause of regional disparities, and indicates China's industrial agglomeration effect is in the middle stage of the "inverted N-type" curve. In 2015, Zhou Xiaoke, Xi Yanling and Ji Shengbao based on the panel data of 30 provinces and regions in China from 2001 to 2011. Using the systematic GMM estimation method, it was found that the manufacturing aggregation and economic growth showed an "inverted U" relationship at the national level.

Regarding the relationship between population concentration and economic growth, most scholars at home and abroad use population as a proxy variable or study the relationship between economic agglomeration and economic growth from the perspectives of population size, population structure, and population density, such as Bautisa and Hu. Qi et al. In 2012, Zhou Qiren studied the intrinsic relationship between economic density and population density. The results show that economic density is higher than population density and can attract a higher degree of population concentration. However, some scholars have conducted direct research on the role of population agglomeration in economic growth. For example, Xie Li and Zhu Guofan selected data from 36 countries in 1994 and 2004 to empirically study the impact of population aggregation on economic growth. The existence of population density. In 2016, Gao Jian and Wu Pei-lin empirically confirmed that the urban population size has an impact on economic growth through the economic effects of aggregation based on the measurement model of urban economic growth. There is a clear "inverted U-shaped" relationship between the two, and based on the calculated threshold value and The optimal urban population size, the impact of urban population size on economic growth can be divided into four stages.

However, in all the current discussions on how industrial agglomeration and population concentration affect economic growth, no scholars specifically target the Japanese Prime Minister Circle and its core city of Tokyo, so this paper decided to collect relevant data empirical research in the formation of the Japanese Prime Minister Circle. And the process of development, the role of manufacturing aggregation and population gathering in economic development.

III. Index selection and research hypothesis

Japan's economic growth in the 1980s was called the Asian miracle, and at the same time the gap in economic development between cities in Japan began to widen. In 1955, the GDP per capita between the cities of the Japanese Prime Minister's Circle was not very different. The highest one was Tokyo's GDP per capita of 1.1 million yen, while the second highest was 630,000 yen in Kanagawa. The lowest was only 370,000 in Yamanashi. JPY. Japan's Prime Minister's Circle, one of the seven counties, is relatively high except for Tokyo, and the gap between the other seven counties is not obvious. In 2013, Tokyo's per capita GDP exceeded 8 million yen, and the gap with other counties in Tokyo is expanding. In order to intuitively understand the economic development of the cities in the Japanese Prime Minister's Circle, based on the constant price in 2000, this paper calculates the per capita GDP of the cities in the Japanese Prime Minister's Circle from 1955 to 2013. And draw a trend chart of the per capita GDP of a county in the county (Figure 1).

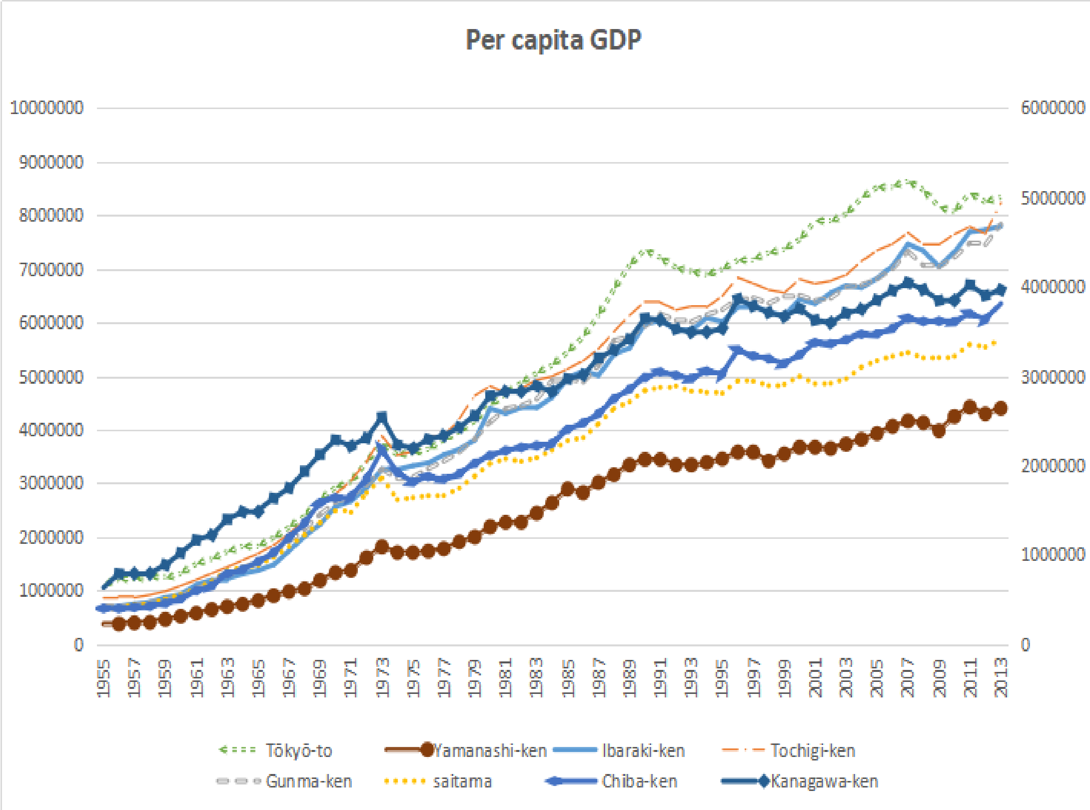

Figure 1 Changes in per capita GDP of the Japanese Prime Minister's Circle

Differences in regional economic growth are also accompanied by differences in population aggregation and industrial agglomeration. Therefore, there is a significant difference in the degree of population aggregation and manufacturing aggregation between the Japanese Prime Minister's Circle cities. In order to accurately reflect the differences in population aggregation, we use population density as a measure of the population concentration of each region.

Economic growth (PGDP): The level of economic development can generally be measured by the gross domestic product or per capita GDP of a region. Due to the large differences in the regional area and population size of each city in the Japanese Prime Minister's Circle, in order to make the results more meaningful, this paper uses per capita GDP (PGDP) as a measure of economic growth.

Population Concentration (POPJ): To exclude the impact of regional area and better reflect the degree of population aggregation, we use the population density indicator to measure the population concentration of each region (Jiang Manqi, Xi Qiangmin, 2015; Li Futian, Tang song2005; Lei Dingan, Jin Ping, 2003). The expression of POPJ for population aggregation in each region is:

$$POPJ_{ij} = POP_{ij} / Area_i$$

Among them, POPij is the population representing the i-year (time) in the i-zone, and Areai represents the area of the i-area (the change in area is small, and the area in the text is uniformly used in the area announced by each city in 2000). It can be known from the definition of calculation that the larger the value, the more the population per unit area, indicating that the population is more concentrated. The calculation of the population concentration of the Japanese Prime Minister's Circle from 1955 to 2013 (see Figure 2) shows that the population of Tokyo is highly concentrated, followed by Kanagawa, Chiba and Saitama, but the difference is large; The degree of aggregation is not high, and the change is relatively stable.

Manufacturing Aggregation (AGGLO): The degree of manufacturing agglomeration in this paper is measured by the location quotient of the manufacturing sector. The location quotient calculation was first proposed by P. Haggett and applied to the location analysis (Wang Yaode, Yi Kui, 2015), originally used to reflect the specific industry sector in a certain region relative to the professional sector of the country. The level of technology can be found in the industrial sectors with advantages in this region (Xiao Zelei, Li Bangyi and Hu Canwei, 2010). The location quotient can also be used to measure the degree of regional industrial agglomeration. If an industrial location quotient is less than 1, the degree of industrial agglomeration is equivalent to the average of a larger area, and there is a possibility of a lower industrial cluster; if the location quotient is greater than 1, The industry is concentrated in a specific area (Liu Wenhua, Huang Xin, 2015), and the competitive advantage is more obvious (Mei Lei, Wang Bao and Cui Linying, 2016); if the location quotient is greater than 2, the industry is highly concentrated in the area. There is a large possibility of industrial clusters (Wang Shixuan, Sun Hui and Zhu Qiaoqiao, 2016).

In the same way, in order to accurately reflect the difference in manufacturing aggregation, we use manufacturing location quotients as a measure. In this paper, the expression of the manufacturing aggregate AGGLOij of the j period (year) in the i region is:

$$AGGLO_{ij} = (p_{ij} / t_{ij}) / (P_j / T_j)$$

Among them, pij represents the output value of the manufacturing industry in the i-year, tij represents the total output value of the industry in the i-year, and Pj represents the manufacturing value of the whole year in Japan, and Tj represents the total output value of the industry in Japan. From the point of view of calculation, the essence of the manufacturing aggregation index is that the output value of the manufacturing industry in each region accounts for the ratio of the output value of the whole industry and the output value of the national manufacturing industry to the national industrial output value. By definition, the larger the aggregate index indicator value, the higher the manufacturing concentration. The paper calculates the Japanese Prime Minister's Circle Manufacturing Concentration Index from 1955 to 2013 (see Figure 3). As can be seen from the figure, the manufacturing location of Tokyo and Kanagawa is generally declining, but Kanagawa was relatively stable in the 1950s and 1980s, and began to decline after the 1980s, while Tokyo The 1950s have been a trend of declining volatility. The manufacturing location of Saitama and Chiba is relatively volatile, with no obvious downward trend. Other manufacturing locations in Ibaraki, Gunma and Tochigi and Yamanashi are on the rise, and the relatively stable state in the end indicates that the concentration of manufacturing is increasing.

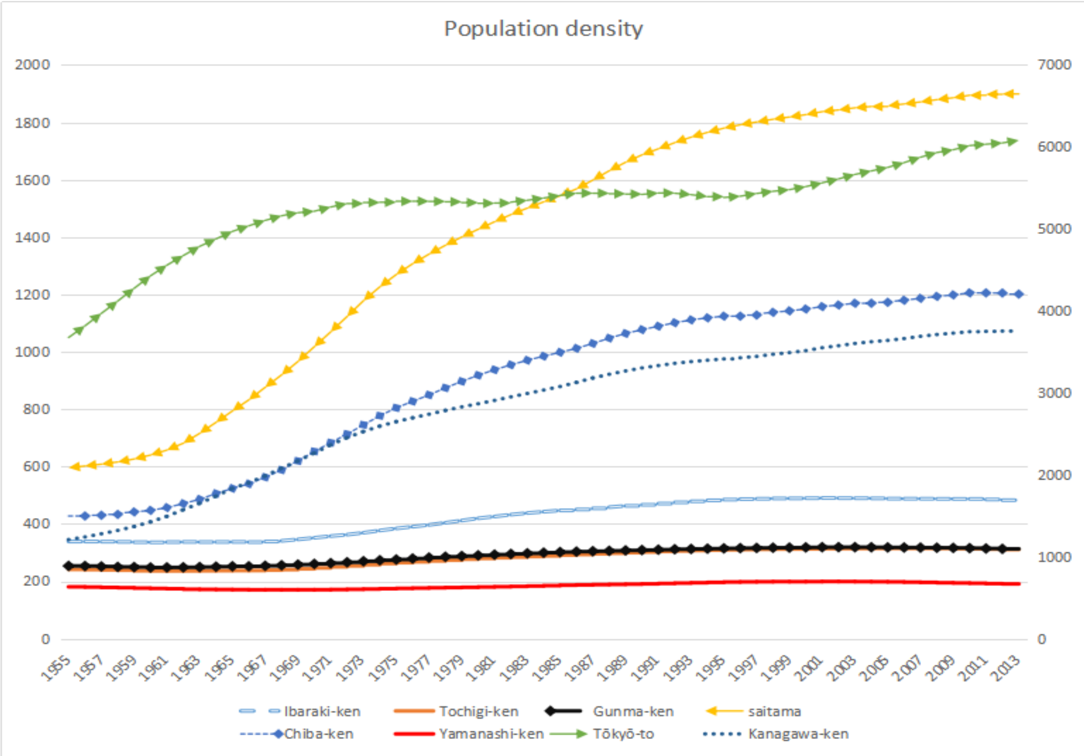

Figure 2 Changes in population density in the Japanese Prime Minister's Circle

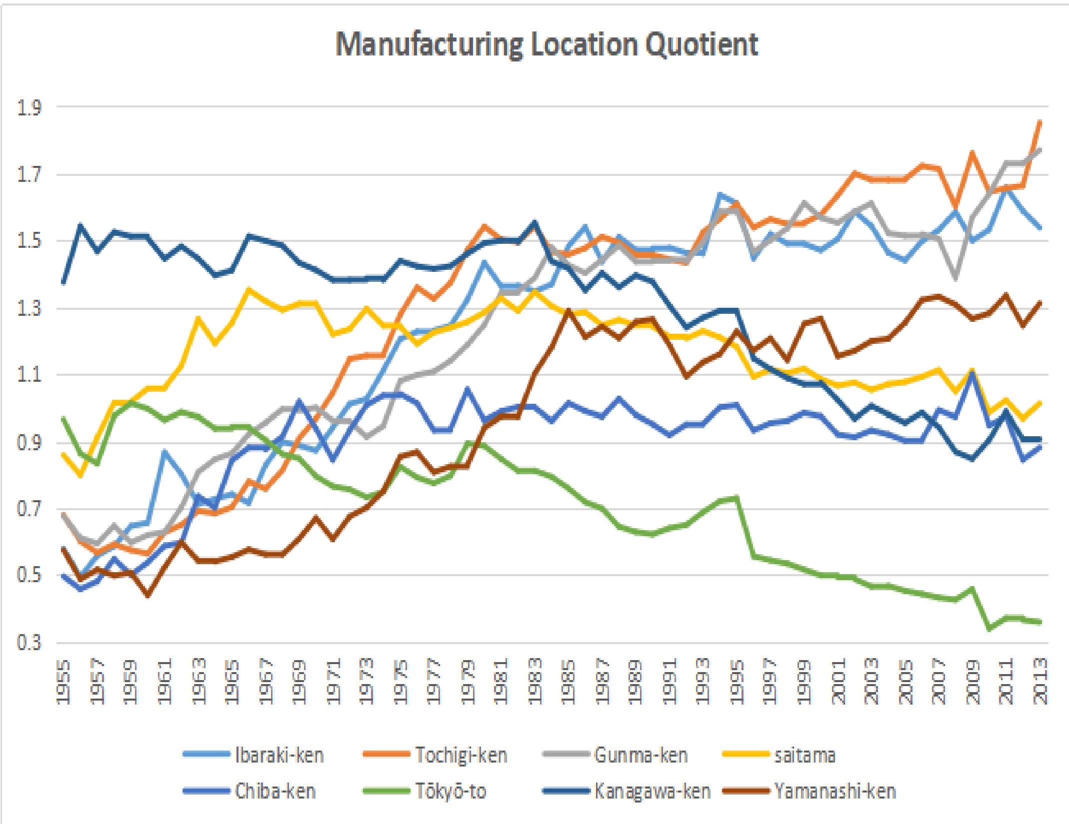

Figure 3 Japan's Prime Minister's Circle Manufacturing Industry Changes

Based on the observation and preliminary judgment of the above three figures, the following three research hypotheses are proposed.

Hypothesis 1: For the Japanese Prime Minister's Circle, manufacturing aggregation has a positive correlation with the economic growth of the Japanese Prime Minister's Circle.

Hypothesis 2: For the Japanese Prime Minister's Circle, population concentration has a positive correlation with the economic growth of the Japanese Prime Minister's Circle.

Hypothesis 3: For the core city of Tokyo, the increase in manufacturing concentration may bring "inverted U" growth to Tokyo's economic growth.

In order to explore whether the relevant hypothesis is true, this paper will establish an econometric model for empirical testing.

The definitions of the relevant indicator variables in this paper are summarized in Table 1.

Table 1 Describes of indicator variable definition

Variable Name	Symbol	Variable Description	Data Source
Per capita GDP	PGDP	Calculated in 2000 as a constant price,	Japan
Population density	POPJ	Population/area	Statistics
Industrial agglomeration	AGGLO	Location entropy	Bureau

IV. Model construction and inspection

(1)Model construction

In order to study the effects of industrial agglomeration and population aggregation on its economic growth, this paper constructs the following expression of the measurement function:

$$Y_i = A * AGGLO_i^{\alpha} * POPJ_i^{\beta} \qquad (1)$$

Where Y represents the economic output of each region, AGGLOi represents the industrial clusters in each region, POPJi represents the population concentration in each region, and α and β represent their associated output elasticity.

Since the index of industrial aggregation is calculated as a relative value, the range of values is small. To exclude the influence of heteroscedasticity, this paper adjusts the original measurement expression to PGDPi and POPJi and logarithm. Get the new model as follows:

$$LnPGDP_i = C + \alpha AGGLO_i + \beta LnPOPJ_i + \varepsilon \qquad (2)$$

(2)An Empirical Study of the Japanese Prime Minister's Circle

① Variable correlation analysis

Descriptive statistical analysis of variable data is the basic premise of quantitative analysis. The specific results of the statistical analysis of the variables in this paper are shown in Table 2.

Table 2 Describes the basic situation variables

Variable	observation sample	Mean	Variance	Minimum	Maximum
LnPGDP	472	14.649	0.722	12.842	15.971
LnPOPJ	472	6.615	1.140	5.138	8.713
AGGLO	472	1.097	0.344	0.340	1.851

Correlation coefficients were analyzed for the relevant variables. The results are shown in Table 3. The correlation coefficients of the variables were all below 0.5, indicating that the variables had no obvious collinearity. The mean variance expansion factor (VIF) values of the model are all less than 3, which is within a reasonable range, so there is no serious multi-collinearity problem between the explanatory variables, and the conclusion will not be seriously deviated.

Table 3 Correlation Analysis of variables

	LnPGDP	LnPOPJ	AGGLO
LnPGDP	1		
LnPOPJ	0.3719	1	
AGGLO	0.3531	-0.1885	1

②Panel data correlation test

The panel unit root test is performed on the variables, and the regression analysis is performed using the unstable data. It is easy to have a "pseudo-regression" problem, resulting in serious deviations in the results. Therefore, the stability test of the variables is performed before the panel data regression.Commonly used inspection standards are LLC(Levin-Lin-Chu)and IPS(Im-pesaran -Shin).The two methods are different. The combination of the two methods can effectively eliminate the error in the single test. The test results of the unit root are shown in Table 4.

Table 4 Variables panel unit root test

Parameter	LLC (P value)		IPS (P value)	
LnPGDP	0.0021	stable	0.9347	unstable
LnPOPJ	0.0000	stable	1.0000	unstable
AGGLO	0.0309	stable	0.6112	unstable

After the LLC and IPS unit root test, there is a unit root. Therefore, the first-order difference is made to the variable and the first-order unit root test is performed. The results are shown in Table 5.

Table 5 Unit root test of variable first-order difference

Parameter	LLC(P value)		IPM(P value)	
DLnPGDP	0.0000	stable	0.0000	unstable
DLnPOPJ	0.0000	stable	0.0000	unstable
DAGGLO	0.0000	stable	0.0000	unstable

As can be seen from Table 5, the conclusion of the LLC test and the IPS test is that the first-order difference of all variables is a stationary sequence. Since the original data of the variable has a unit root but the same order is stable, there may be a cointegration relationship, and panel cointegration analysis can be performed.

In order to test whether the economic growth of Japan's Prime Minister's Circle and the industrial agglomeration and population concentration have a long-term equilibrium and stability relationship, the Johansen panel cointegration test is carried out on the data. This paper conducts cointegration test on the Japanese Prime Minister's circle panel data through

Eviews8.0. The results are shown in Table 6.

Table 6 Johansen panel cointegration test

Null hypothesis	Trace test	Max-eigen test
None	126.9***	64.44***
At most 1	46.53***	51.84***
At most 2	42.49***	42.49***

(* means 10% level is significant, ** means 5% level is significant, *** means 1% level is significant)

It can be seen from Table 6 that in the Johansen panel cointegration test of each variable, the null hypothesis that there is no cointegration relationship is rejected under the condition of "At most 2". Therefore, it can be concluded that there is a cointegration relationship between economic growth and industrial agglomeration and population aggregation.

In addition, the cointegration test shows that in the long run, there is a stable relationship between economic growth and industrial agglomeration and population aggregation, but it does not mean that there is a causal relationship, and the direction is uncertain, so further Granger test is needed. In this paper, Panel Granger causality test was performed using Dumitrescu Hurlin of the software Eviews 8.0. The results are shown in Table 7.

Table 7 Dumitrescu Hurlin Granger causality between variables

Null hypothesis	W	Zbar	P	Result
LnPOPJ is not the Granger reason for LnPGDP	4.4938	3.1536	0.0016	LnPOPJ is the Granger reason for LnPGDP
LnPGDP is not the Granger reason for LnPOPJ	13.7431	15.2375	0.0000	LnPGDP is the Granger reason for LnPOPJ
LnPGDP is not the Granger reason for AGGLO	9.9544	10.2876	0.0000	LnPGDP is the Granger reason for AGGLO
AGGLO is not the Granger reason for LnPGDP	2.7740	0.9066	0.3646	AGGLO is the Granger reason for LnPGDP
AGGLO is not the Granger reason for LnPOPJ	3.9193	2.4030	0.0163	AGGLO is the Granger reason for LnPOPJ
LnPOPJ is not the Granger reason for AGGLO	8.3210	8.1538	0.0000	LnPOPJ is the Granger reason for AGGLO

Table 7 lists Granger causality tests for economic growth and industrial agglomeration, economic growth and population aggregation, and population aggregation and industrial agglomeration. The results show that LnPOPJ and LnPGDP are Granger causes; LnPGDP is the Granger cause of AGGLO, and AGGLO is not the Granger cause of LnPGDP. It shows that economic growth will lead to industrial concentration and population concentration, and population concentration is also conducive to promoting economic growth. This test result is in line with the actual economic significance.

③Model estimation

In the panel data measurement model, it is necessary to test the validity of the model. Firstly, the F test is used to judge whether the hybrid model or the fixed model should be used. Then, the LM test is used to judge whether the hybrid model or the random effect model is selected, and finally the Hausman test is used to judge Use a fixed effect model or a random effects model. After the processing of STATA 14.0 metrology software, the relevant estimation results are shown in Table 8.

Table 8 Panel data regression results

	OLS	FE	RE
C	11.735***	1.125***	5.563***
	（58.45）	(2.70)	(13.38)
AGGLO	0.920***	1.090***	1.242***
	（11.35）	(19.69)	(18.19)
LnPOPJ	0.288***	1.864***	1.167***
	（11.76）	(28.92)	(19.01)
F value	112.39（P=0.0000）	788.68(P=0.0000)	
Wald value			809.47 (0.0000)
R-sq	0.324	0.774	0.733
LM test		952.6 (P=0.0000)	
Hausman test	1229.33（P=0.0000）（V_b-V_B is non-positive）		

(* means 10% level is significant, ** means 5% level is significant, *** means 1% level is significant，T or z values in parentheses)

In the models of economic growth, industrial agglomeration and population aggregation, the F-test from mixed regression and fixed-effect regression shows that the F value is 112.39, the corresponding P value is 0.0000, and the P value is less than 0.01, so the null hypothesis is strongly rejected (panel hybrid regression) Model), the fixed individual effect is considered to be significantly better than the mixed regression. From the LM test of mixed regression and random effect regression, the LM value is 952.6, the corresponding P value is 0.0000, and the P value is less than 0.01. Therefore, the null hypothesis (panel hybrid regression model) is strongly accepted, and the random effect is considered to be significantly better than the mixed regression. The hausman test statistic is 1229.33, the P value is 0.0000, and the P value is less than 0.01. The null hypothesis is rejected (the random effect is better than the fixed effect), and the fixed effect model (FE) should be used. Among the results of the hausman test, there is a case where "V_b-V_B is not positive". The research by scholars Schreiber and Magazzini, L&G. Calzolari pointed out that when "V_b-V_B is not positive", a fixed effect model should be used.

As can be seen from Table 8, the hybrid model, the fixed effect model, and the random effects model are all significant in general, and the regression has economic significance. The main research variables of this paper, AGGLO and POPJ, are in line with the expected economic significance in all three models, and the coefficients of AGGLO and POPJ are both significantly positive. It shows that the accumulation of manufacturing and population concentration are beneficial to the economic growth of the Japanese Prime Minister's Circle.

(3)An empirical study of the core city of Tokyo

As the core city of the Japanese Prime Minister's Circle and the financial centers of Asia and the world, with the continuous upgrading of the industrial structure, Tokyo has entered the service economy stage as early as the 1980s, and how the research industry is concentrated in this process. Affecting the economic development of Tokyo is of great significance for a more comprehensive analysis of the impact of industrial agglomeration on regional economic growth. Therefore, this paper will conduct a separate regression analysis on the data of Tokyo.

In order to more clearly understand the impact of manufacturing aggregation, this paper builds the following two models for verification, model expression:

$$LnPGDP_{Tokyo} = C + \alpha AGGLO_{Tokyo} + \beta LnPOPJ_{Tokyo} + \varepsilon \quad (3)$$

$$LnPGDP_{Tokyo} = C + \alpha AGGLO_{Tokyo} + \alpha_1 AGGLO^2_{Tokyo} + \beta LnPOPJ_{Tokyo} + \varepsilon \quad (4)$$

Among them, PGDPTokyo, AGGLOTokyo, and POPJTokyo represent the per capita GDP and manufacturing concentration and population concentration of Tokyo. Expression (3) is mainly to verify the relationship between manufacturing aggregation and economic growth. The expression (4) is mainly to verify whether the relationship between manufacturing aggregation and economic growth conforms to the hypothesis of "reversing U". According to the estimation result of the expression (4), if $\alpha 1 > 0$, it conforms to the "U" type hypothesis; if $\alpha 1 < 0$, it conforms to the "inverted U" type.

Since the relevant data in Tokyo is no longer panel data, the data is subjected to ordinary OLS regression. The relevant results are shown in Table 9.

Table 9 OLS Estimation results of Tokyo

	Equation expression（3）	Equation expression（4）
C	-12.641***	-9.287***
	(-3.33)	(-3.04)
AGGLO	-1.507***	4.046***
	(-6.38)	(4.21)
$AGGLO^2$	–	-4.255***
	–	(-5.9)
LnPOPJ	3.383***	2.8***
	(7.9)	(7.94)
F value	213.68	239.96
R-sq	0.884	0.929

As can be seen from Table 9, it is found in the results of Expression (3) that the manufacturing clusters in Tokyo have a reverse effect on their economic growth. As can be seen from the results in Expression (4), manufacturing aggregation and economic growth are in line with the "inverted U" type. It shows that the accumulation of manufacturing in the initial stage is conducive to the economic growth of Tokyo, but with the development of the economy, the accumulation of manufacturing industry will have a negative effect on economic growth in a certain period of time.

V. Conclusion and enlightenment

This paper uses the location aggregation and population density to measure the degree of manufacturing aggregation and population aggregation. Using the Japanese Prime Minister's panel data from 1955 to 2013 to study the role of manufacturing aggregation and population aggregation in its economic growth, and focus on the core of the Japanese Prime Minister Circle. The impact of manufacturing clusters in the city of Tokyo on economic growth. The following conclusions are drawn from the empirical results:

First, manufacturing aggregation and population concentration have a significant positive effect on the economic growth of the Japanese Prime Minister's Circle. However, through a separate study of Tokyo, the impact of manufacturing clusters on the economic growth of the core city of Tokyo is “inverted U” and Tokyo is currently in the second half of the “inverted U” type. It has a negative effect on the economic growth of Tokyo. Combining with the reality, this paper analyzes that the main reason is that the manufacturing industry belongs to the industry with relatively large demand for land output, and with the economic development and the successful upgrading of the industrial structure, it enters the service economy stage. The current unit land cost of Tokyo is high, and it has a strong crowding out effect on industries with large demand for land output in such manufacturing units. It can be seen that in the process of urban agglomeration development, due to the constraints of resources, industries with large demand for land output in such industries will continue to withdraw from core cities with relatively high economic development.

In addition, population aggregation often means the existence of a large demand for labor resources. The results of this study indicate that there is a positive relationship between population concentration and economic growth in the Japanese Prime Minister's Circle. That is to say, on the one hand, population aggregation can promote the region. Economic growth; on the other hand, economic growth will also cause population aggregation, and labor resources will flow to regions with high per capita GDP output.

Prospects for future research: Each city in the Japanese Prime Minister's Circle can be studied separately to observe the direction of industry and population flow between different cities in the process of formation and development of the metropolitan area. In addition, you can try to verify whether there is an “inverted U” relationship between population aggregation and industrial growth.

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