

Research on the Regression Analysis of Real Estate Investment and Economic Growth in Chongqing

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Abstract: China's economic expansion during the last 30 years has been mostly driven by the real estate sector. However, since 2020, the Chinese market has experienced a lack of energy, particularly within the real estate industry. Therefore, it's imperative to reanalyze the connection between them at this point in time. A clear understanding of the relationship between real estate investment and economic growth is essential for the maintenance of sustainable economic growth in the future. This essay quantitatively examines the relationship between real estate investment and economic growth in Chongqing Municipality over a 30-year period, utilizing co-integration theory, the Augmented Dickey-Fuller Test, Granger causality test, and regression analysis. The regression analysis demonstrates that real estate investment in Chongqing is a substantial catalyst for GDP growth and is essential for fostering economic development. However, in recent years, the housing market has become saturated, which means that it can no longer be used as a major factor to drive economic growth. At this point, there is an urgent need to explore new ways to maintain sustained economic growth.

Keywords: Real estate investment, Econometrics, Regression analysis, Time series analysis, Augmented Dickey-Fuller test, Granger causality test.

1. Introduction

Over the past decade, China has witnessed a remarkable surge in housing prices, exceeding both the growth of its gross domestic product (GDP) and the expansion of per capita income. The investment demand and supply-and-demand contradiction have driven up house prices. Although the Chinese government attempts to control housing prices via different kinds of financial policy, it has had limited impact over an extended period of time as housing prices continue to rise steadily. At the same time, as the property sector develops rapidly, many potential risks have been revealed, especially the risks of high liabilities and high leverage hitting real estate industry heavily. What's more, the real estate market was greatly shocked due to COVID-19 and the government's policy. In 2023, a massive explosion at China's property giant Evergrande Real Estate Group further darkened the future of the market[1]. Therefore, it is necessary to reconsider the relationship between the real estate investment and GDP.

Regarding the relationship between the development of the real estate industry and macroeconomics over the world, researchers have also carried out related research and discussion on it, and currently, there are three main points of view. The first is that the development of the real estate industry effectively promotes national economic growth, and the second is that it is mainly

macroeconomic growth that drives the development of the real estate industry. The third is that the two are interactive. Most scholars prefer the third view. However most researchers aim to analyze the whole country and very few choose a city as the object of study. So, this paper takes Chongqing, one of the municipalities in China, as the research object to analyze the relationship between real estate investment and economic growth.

The methodology employed in this study draws upon well-established techniques from prior research in the field. In particular, the model used has been widely utilized in various previous studies to investigate the relationships between time series variables. Following the approaches outlined by Yue and Sun, as well as Zheng[2,3], this study adopts the Augmented Dickey-Fuller (ADF) test and the differencing method to conduct a co-integration test. These methods are employed to assess whether the time series data are stationary and to determine whether the correlation between variables persists over the long term. Shen and Liu similarly applied the ADF test and co-integration analysis to examine the stationarity of time series data, further reinforcing the robustness of these methods in such research[4]. Beyond testing for stationarity, this study also seeks to identify causal relationships between the variables under investigation. In this context, Granger causality analysis is used to explore whether one variable can be considered the cause of changes in another. This approach is based on the work of Guo and Ma, who utilized Granger causality tests in financial research to determine directional causality between variables[5,6]. Regression analysis is also employed as a primary tool in this research, consistent with the literature cited. Many previous studies have relied on regression techniques to analyze correlations between variables, and their widespread use supports the decision to employ this method in the present study. Overall, the combination of ADF testing, co-integration analysis, Granger causality testing, and regression analysis forms a comprehensive methodological framework for examining the relationships between the variables in question. This approach ensures the robustness and reliability of the study's findings.

2. Methodology

2.1. Data resource and processing

The data used in this paper is selected from the Chongqing Statistical Yearbook[7], so the authenticity of the data can be guaranteed. Table 1 below presents a summary of the GDP and real investment data of Chongqing from 1990 to 2023 according to the Statistical Yearbook. As illustrated in Table 1, an increase in the real estate investment index is accompanied by a corresponding growth in GDP. In light of the aforementioned evidence, it can be concluded that real estate investment constitutes a significant factor in economic growth.

In addition, as shown in Table 1, Chongqing's GDP grows from 3277.5 million yuan in 2003 to 30145.79 million yuan in 2023, a cumulative increase of more than 1,000 times, and the REI index grows 10,000 times, which suggests that the rapid development of Chongqing's real estate investment may serve as a primary catalyst for economic growth.

In this paper, the Stata software is used to make a simple scatter chart of Chongqing GDP and REI to observe the correlation between them more directly. It is obvious from Figure 1 that the scatter points are evenly distributed in a manner that is consistent with an exponential curve. Consequently, it may be deduced that a positive link exists between Chongqing's GDP and real estate investment under certain conditions.

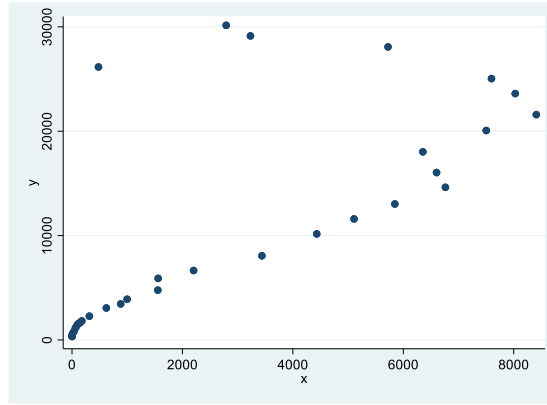


Figure 1: Scatter Diagram(curvilinear regression).

2.2. Model

As illustrated in Figure 1, it can be found that the two index are with a certain correlation nearly suitable to exponential regression. In this way, the following equation can be assumed using the OLS method.

$$\begin{cases} \ln y = \beta_1 \ln x + \beta_0 + \varepsilon \\ \varepsilon \sim N(0, \delta^2) \end{cases} \quad (1)$$

In this equation, x represents REI, y represents GDP, and ε represents random error. And then, we can import the data in Table 1 to do regression analysis.

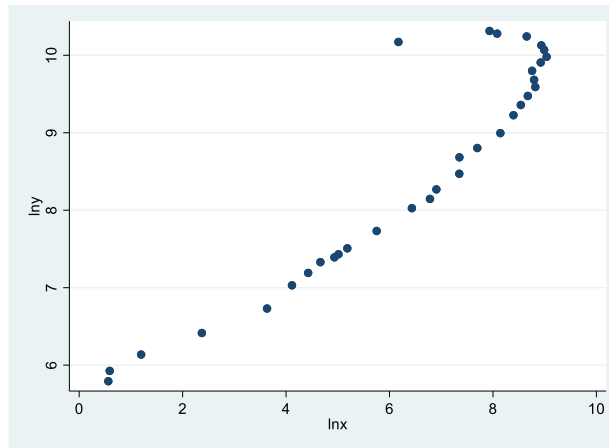


Figure 2: Scatter Figure (Linear Regression).

Subsequently, the natural logarithm of the two variables should be taken and a new scatter plot generated to obtain Figure 2. As can be observed in Figure 2, there is a notable linear correlation between these two indices.

2.3. Co-integration test

2.3.1. Augmented Dickey-Fuller Test (ADF test)

Before the regression analysis of the time series, it is necessary to check whether each factor has stationarity, that is whether their roots of unity are equal. This research Augmented Dickey-Fuller Test(ADF) test to check the first-order difference stationarity of GDP ($\ln y$) and REI ($\ln x$).

ADF test is the expansion of Dickey Fuller Test and mainly deals with the self-correlation that may appear when using the DF test.[8] The null hypothesis is that the series has roots of unity, and the series is not stable. Table 2 is the output below.

Table 1: ADF Test output.

Variable	P-value	ADF value	1% critical value	5% critical value	10% critical value
ln y	0.000	-15.059	-3.736	-2.994	-2.628
ln x	0.000	-34.411	-3.736	-2.994	-2.628

Under the second order difference, the ADF value of variable x is less than the corresponding critical value. At the significance levels of 1%, 5%, and 10%, it shows that it is statistically significant and that there are no roots of unity. It can be concluded that this time series is stationary. Therefore, the variable is suitable for the regression model and the regression coefficients can be estimated and statistically modeled.

2.3.2. Engle-Granger Co-integration Test

After obtaining a stationary time series, a co-integration test is planned. The the Engle-Granger test is used to check the time series. Therefore, the analysis of the series will be performed after the first difference. Firstly, a regression model will be established between GDP(i.e., after the first difference) and REI(i.e., after the first difference). Subsequently, the residual value (Res) of this regression equation will be obtained. Finally, an ADF Test will be conducted to determine if the Res series is stable. The result of this process is as Table 2:

Table 2: ADF Test Output of Res.

Variable	P-value	1% critical value	5% critical value	10% critical value
Res	0.000	-3.723	-2.989	-2.625

The results show that Res passes the ADF test. Therefore, it can be confirmed that there are at least two co-integrating relationships in this sample while rejecting the hypothesis of lower order of co-integration.

2.4. Granger causality test

The co-integration test does not explain whether real estate investment drives economic growth or whether economic growth is driven by real estate investment; it only shows that there is a long-term stable equilibrium relationship between real estate investment and growth. In order to ascertain the causal relationship and direction of effect between two or more variables, this paper employs the Granger causality test. In other words, if X changes as a result of Y, then X is the cause of Y, and vice versa. The data on real estate investment and the GNP of Chongqing (and) are tested using the Granger causality test; the test findings are displayed in Table 3 below.

Table 3: Granger Causality test result.

Equation	Excluded	Lag Phase	F-statistics	P-value
ln x	ln y	2	0.4269	0.514
ln y	ln x	2	29.917	0.000

As for the hypothesis “ $\ln y$ does not Granger cause $\ln x$ ” (row 1 result), the P-value is 0.514, more than 0.05, which means that the null hypothesis cannot be rejected. and there is not enough evidence of Granger causation. However, for the hypothesis that Granger causality does not exist (row 2 result), the P-value is nearly 0.000, significantly less than 0.05. This indicates that the null hypothesis can be rejected and that there is sufficient evidence to support Granger causation.

2.5. Regression analysis

2.5.1. Correlation analysis

Table 4 shows that adjusted $R^2=0.8640$, indicating that the model fits well and the independent variable can account for 86.40% of the variation in the dependent variable according to the chi-square goodness of fit test. It also suggests that the significance of real estate investment as a driver of GDP growth might be clarified using this statistical methodology.

Table 4: Model Summary.

Model	R square	Adjusted R Square	Std. Error of the Estimate
1	0.8683	0.8640	0.0361587
Dependent Variable: GDP1			
b. Dependent Variable: GDP1			

2.5.2. Overall significance test of the model

A hypothesis test can be performed at this point(confidence level $\alpha=0.05$)

$$H_0: \beta_1 = 0; H_1: \beta_1 \neq 0 \quad (2)$$

Establish the test statistics $F = \frac{ESS/k}{RSS/(n-k-1)} \sim F(k, n-k-1)$; and give the rejection region as $\{F > F_{\alpha}(k, n - k - 1)\}$. And for this question, $k=1; n=33$; confidence level $\alpha=0.05$.

Table 5 shows the statistics $F=204.31$, which the corresponding p- value is 0.001 less than 0.05. Therefore, the null hypothesis (H_0) is rejected. Thus, the linear regression is considered to have passed the global significance test, and the regression model is meaningful.

Table 5: ANOVA.

Model	Sum of Square	df	Mean Square	F	Sig.
Regression	56.475	1	56.475	204.31	0.000
Residual	8.569	31	0.276		
Total	65.044	32			

2.5.3. Regression coefficient significance test

This part uses the same assumption as the “3.5.2. Overall significance test of the model”, but with the different test statistics. This part can give the test statistics $T = \frac{\beta_1 - 0}{\sqrt{S^2/L_{xx}}} \sim t(n-2)$; and $S = \sqrt{MS_E}$; then give the rejection region $\{|t| > t_{1-\alpha/2}(n-2)\}$

(In order to facilitate matching with the Stata output data, this part can be converted to the corresponding P-value after calculating the T-value.)

Table 6: Coefficients.

	Coefficients			
Model	B	Std. Error	t	Sig.
(Constant)	5.1744	0.0362	14.29	0.000
REI1	0.5168	0.249	20.74	0.000
Dependent Variable: GDP1				

From Table 6, it is easy to find that $\beta_1 = 0.5168$ and $\beta_0 = 5.1744$, and then the following equation can be established:

$$\ln y = 0.5168 \ln x + 5.1744 + \varepsilon \quad (3)$$

It also can be found that the corresponding P-value of β_1 is nearly 0, and the same, the corresponding P-value of β_0 is also nearly 0. Therefore, the null hypothesis (H_0) is rejected, while the alternative hypothesis is accepted. This explains the fact that the regression coefficient is not 0, so the two variables have a correlation.

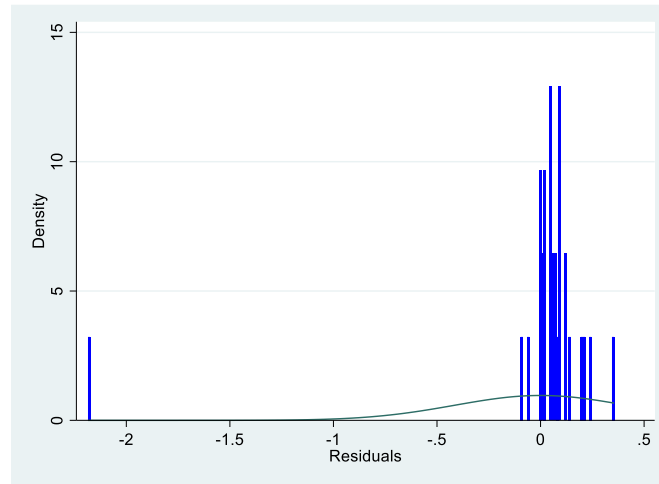


Figure 3: Residual histogram.

It is clear that the Figure 3 depicted exhibits a distribution that closely resembles the normal distribution, providing evidence that the data fits the model effectively.

3. Discussion

This research shows a strong and favorable relationship between real estate investment and Chongqing's economic expansion. This result is consistent with earlier studies that highlight how important the real estate industry is to the growth of regional economies. It also highlights possible drawbacks to depending primarily on real estate investment as a long-term economic driver. Although real estate investment has historically contributed to GDP growth, as confirmed by regression analysis, evidence from recent years indicates that this contribution is diminishing. This fading effect is especially noticeable following market saturation and the implementation of home price stabilization policies.

A notable insight from this study is the reduced explanatory power of real estate investment in 2022 and 2023. The exclusion of these years from the analysis resulted in improved model fit, highlighting the need for the government to reassess the role of real estate in its economic growth strategy. The long-term sustainability of this sector as a primary growth driver is questionable,

especially as new challenges such as high debt levels and market risks, as evidenced by the Evergrande crisis, have emerged.

This study's limitations include its focus on a single municipality, which restricts the generalizability of the findings to other regions in China or globally. Additionally, the research does not fully account for other potential macroeconomic factors that could influence GDP growth. Future studies should explore alternative drivers of economic growth, such as technology and innovation, to provide a more comprehensive understanding of how regional economies like Chongqing's can maintain sustainable growth. Ultimately, policymakers must identify and cultivate new growth engines beyond real estate to ensure long-term economic resilience.

4. Conclusion

Based on the results of this paper, It may be inferred that Chongqing's economic growth and real estate investment are positively correlated over the long run. This research demonstrates that real estate investment substantially contributes to the economic growth of Chongqing. In Chongqing, the relationship between the expansion of the real estate market and economic expansion is a crucial instrumental variable for macroeconomic risk management. Institutional innovation is required to address the issues facing the Chongqing real estate market in order to achieve the overarching goal of economic growth. On the other hand, a scientific understanding of the relationship between real estate market development, real estate risk, and economic growth is required in order to appropriately address the possible hazards associated with the real estate market's development.

Especially in recent years, due to government policies and poor economic performance, real estate investment has ceased to be the main driver of economic growth. Consequently, the government must identify alternative avenues for stimulating the city's economy. In addition, the Chongqing real estate market is currently saturated. In order to maintain high economic growth in the coming decades, it is necessary to identify a new point of focus. The scope of this paper is limited to specific regions and therefore cannot fully characterize the overall economic development. Although this paper identifies a correlation between real estate investment and GDP growth, it also highlights a possible decline in this relationship. Therefore, there is an urgent need to explore new strategies for maintaining sustained economic growth.

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