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Analysis of Factors Influencing Total Retail Sales of Consumer Goods in Hainan Province, China

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ABSTRACT: The total retail sales of social consumer goods is a comprehensive reflection of a country's consumption capacity, consumption structure and living standard, which is of great significance for evaluating a country's economic vitality and social development level. In recent years, with the continuous expansion of the consumer market and the improvement of consumers' purchasing power, the total retail sales of social consumer goods has continued to grow, and its role in the national economy has gradually increased. However, there are many factors that affect the total retail sales of social consumer goods, including economic environment, policies and regulations, consumer behavior and so on. Under this background, this paper takes Hainan Province as the empirical research object, and selects per capita disposable income, rural residents' per capita disposable income, gross domestic product, resident population at the end of the year and local government's general budget expenditure as explanatory variables to analyze the factors affecting the total retail sales of social consumer goods. The results show that the average disposable income of rural residents and the general budget expenditure of local governments are significant factors affecting the total retail sales of social consumer goods in Hainan Province. Finally, the model is analyzed economically, and some conclusions are drawn, and some policy suggestions are put forward.

KEYWORDS: Total retail sales; disposable income; budget expenditures; stepwise regression method

1. INTRODUCTION

(i) Purpose of the Study and Significance of the Study

1. Purpose of the study

The total retail sales of social consumer goods is an important indicator reflecting the macro-economic operation, which is mainly used to reflect the consumption of physical goods in the whole society. Starting from the final link of commodity circulation, it observes the transformation of commodity sales to urban and rural residents' living consumption and social public consumption.

The total retail sales of social consumer goods reflects the total scale and geographical distribution of the domestic consumer goods market, providing reference for analyzing and judging the overall situation, regional characteristics, commodity category supply and future market trend of the domestic consumer goods market, and providing basis for national macro-control; It reflects the total amount and trend of consumption demand for physical goods by urban and rural residents and society, and can be used to analyze and judge the influence of consumption demand on economic operation.. Reflects the economic prosperity, as an important reference for judging the economic operation, in order to make a greater contribution to the realization of the stable growth of the economy of Hainan Province. By analyzing the social environment factors and characteristics of the economic development of retail enterprises in Hainan Province, we seek good countermeasures to solve some problems in the process of researching Hainan's retail development model.

2. SIGNIFICANCE OF THE STUDY

The theoretical significance of studying the total retail sales of consumer goods lies in the following:

The total retail sales of social consumer goods is an important economic index to measure the total amount of social consumer goods

purchased by residents of a country or region in a certain period, which is of great significance to understand the consumption pattern, economic health and material and cultural living standards of people in Hainan Province. Consumer goods also reflect the market supply and demand situation, product distribution and the dynamics of commercial operation and market competition. A high level of total retail sales of social consumer goods means strong consumer demand, which has a positive impact on related industries and enterprises and promotes employment growth and economic vitality. The total retail sales of social consumer goods can also provide reference for the government to formulate macroeconomic policies. By monitoring the changes of total retail sales, the government can evaluate the economic development, consumer confidence and the relationship between market supply and demand, and take appropriate regulatory measures.

The practical significance of studying the total retail sales of consumer goods is:

The growth of total retail sales of consumer goods is of great significance to the development and structural adjustment of Hainan Province's economy. On the one hand, the contribution of consumption to the economic growth of Hainan Province is gradually increasing, which helps to realize the transformation and upgrading of the economic structure. On the other hand, the growth of total retail sales of consumer goods also reflects the improvement of the living standard of the people in Hainan Province, which can further promote the upgrading of consumption and the development of the culture and entertainment industry.

(ii) Research content

Then the empirical analysis, selecting "total retail sales of consumer goods" as the explanatory variable, "disposable income per capita of urban residents", "disposable income per capita of rural residents", "regional GDP", "year-end resident population", "general budget expenditure of local finance" as the explanatory variables, and analyzing the "Hainan Province's social and economic development". We choose "gross domestic product", "year-end resident population", "local general budget expenditure" as the explanatory variables to analyze the factors influencing the "total retail sales of consumer goods in Hainan Province". The problem of "the influence factors of total retail sales of consumer goods in Hainan Province" is analyzed empirically, and a multiple linear regression model is established through parameter estimation, multiple covariance, heteroskedasticity and autocorrelation tests and corrections.

Finally, the conclusion and policy recommendations of the whole paper summarize and summarize the empirical findings of the empirical analysis, and put forward the corresponding recommendations and initiatives accordingly.

3. LITERATURE REVIEW

Economic influencing factors

When studying the influencing factors of total retail sales of consumer goods, economic factors are often regarded as the most direct and significant influencing factors. In their study, Yuan Dan, Lu Yang and Zhang Yi (2022) point out that gross regional product (GDP) is an important factor influencing total retail sales. Their study used advanced econometric models to analyse and forecast retail sales in various provinces of China, highlighting the direct role of economic growth in enhancing consumption levels. In addition, Chen et al. (2023) also confirmed the positive correlation between GDP and total retail sales through time series analysis, showing that an increase in economic output can effectively promote the expansion of the retail market.

The role of income level

The level of residents' income is another core factor affecting the total retail sales of consumer goods. Cai Hong (2020) showed that the growth of per capita disposable income of urban and rural residents has a significant positive impact on total retail sales. This finding is supported by Luo Zhida and Lai Mingyu (2013), who point out through multiple regression analysis that higher income levels drive increased consumer demand, which in turn contributes to the prosperity of the retail market.

Demographic factors

The size and structure of the resident population at the end of the year also had a significant impact on total retail sales. A study by Sun Mei and Zhou Ming (2021) focused on Shanghai and found that population growth is positively correlated with total retail sales. They note that population growth not only increases overall consumption potential, but also promotes retail market diversification and the development of the service sector.

Local Government Policies

Local government fiscal spending plays a key role in regulating and stimulating the consumer market.Fang H.L. (2009) examines the positive effect of local fiscal spending on retail sales in his study, suggesting that government policy measures are crucial in promoting economic growth and consumption expansion.

Comprehensive Analysis and Methodological References

In summary, the previous studies provide a valuable theoretical and empirical foundation for this paper. By analysing data from different regions and time periods in China, these studies have revealed a variety of factors affecting the total retail sales of consumer goods. Based on these research results, this paper will conduct an in-depth analysis using a multiple linear regression model, taking into account the specific economic and social conditions of Hainan Province, with a view to identifying the key factors affecting the total retail sales in the region. Through parameter estimation, multiple covariance test, detection and correction of heteroskedasticity and autocorrelation, the aim is to establish a forecasting model that is both accurate and region-specific.

4. METHODOLOGY

Selection of variables：

According to the research purpose and research needs, and with reference to economic theories and practical experience, the explanatory and interpreted variables selected in this paper are shown below:

Y - total retail sales of consumer goods (unit: billion yuan)

X2-Disposable income per capita of urban residents (unit: yuan)

X3-Disposable income per capita of rural residents (unit: yuan)

X4-Gross Regional Product (unit: billion yuan)

X5-Year-end resident population (unit: ten thousand)

X6-Local general budget expenditure (unit: billion yuan)

Source of Data：

Data source of this paper: National Bureau of Data and Statistics (individual missing values are obtained through the Statistical Yearbook on the official website of Hainan Provincial Bureau of Statistics). The data of Hainan Province from 1990 to 2022 are selected.

In order to make the empirical results more comparable, it is necessary to remove the price factor from the sample data to exclude its impact on the data and interference, the specific price adjustment is as follows:

(1) Hainan Province total retail sales of consumer goods (Y) data: first of all, through the Statistical Yearbook to obtain the retail price index of goods in Hainan Province (the previous year = 100), and then the use of fixed-base index is equal to the product of the chain index of the chain index will be converted into the above chain index to the fixed-base index of the base period of 1990, and finally the use of the nominal value of successive years divided by the corresponding fixed-base price index, and ultimately get the real value of the corresponding year. The real value of the corresponding year is finally obtained by dividing the nominal value by the corresponding fixed-base price index.

(2) Disposable income per capita of urban residents (X2) data: firstly, obtain the consumer price index of urban residents (previous year=100) through the statistical yearbook, then use the formula of fixed-base index equals to the product of chain index to transform the above chain index into the fixed-base index of the base period of 1990, and finally, use the nominal value of the calendar year to divide by the corresponding fixed-base price index, and finally, get the real value of the corresponding year. (2) The average value of per capita disposable income of rural residents

(3) Per capita disposable income of rural residents (X3): firstly, the consumer price index of rural residents (previous year = 100) is obtained through the Statistical Yearbook, and then, using the formula of fixed-base index equals to the product of chained indices, the above-mentioned chained indices are transformed into fixed-base indices with 1990 as the base period, and finally, the nominal value of a calendar year is divided by the corresponding fixed-base price index, and finally the actual value of the corresponding year is obtained. (3) Gross Regional Product (GRP)

(4) Gross regional product (X4) data: firstly, the index of Hainan Province's gross regional product (previous year=100) is obtained through the Statistical Yearbook, and then, using the formula of fixed-base index equals to the product of multiplying chain indexes,

the above chain indexes are transformed into fixed-base indexes with 1990 as the base period, and finally, using the nominal value of the base period of 1990 multiplied by the fixed-base speed of development of the respective period, thus obtaining the real value after the price adjustments. The real value after price adjustment is obtained.

(5) Year-end resident population (X5) data: the year-end resident population data of Hainan Province is obtained through the statistical yearbook, which does not require price adjustment because it is not measured in monetary units.

(6) General Budget Expenditure of Local Finance (X6): The data of Consumer Price Index of Hainan Province (previous year=100) is obtained through the Statistical Yearbook, and then it is transformed into the fixed-base index with 1990 as the base period, and finally, the nominal value of all the years is divided by the corresponding fixed-base price index to get the real value of the corresponding year.

This paper uses quantitative research methods and econometric methods to quantify the data, and forms objective conclusions, mainly including:

The stepwise regression method was used in correcting the multicollinearity; the white test was used in testing the heteroscedasticity of the model, and the weighted least squares method was needed in correcting the heteroscedasticity; the D.W. test was used in testing the autocorrelation of the model, and the generalized difference was used in correcting the model.

5. RESULTS AND DISCUSSION

(i) Selection of variables and data sources

1. Selection of variables

According to the research purpose and research needs, and with reference to economic theories and practical experience, the explanatory and interpreted variables selected in this paper are shown below:

Y - total retail sales of consumer goods (unit: billion yuan)

X2-Disposable income per capita of urban residents (unit: yuan)

X3-Disposable income per capita of rural residents (unit: yuan)

X4-Gross Regional Product (unit: billion yuan)

X5-Year-end resident population (unit: ten thousand)

X6-Local general budget expenditure (unit: billion yuan)

2. Source of Data

Data source of this paper: National Bureau of Data and Statistics (individual missing values are obtained through the Statistical Yearbook on the official website of Hainan Provincial Bureau of Statistics). The data of Hainan Province from 1990 to 2022 are selected.

In order to make the empirical results more comparable, it is necessary to remove the price factor from the sample data to exclude its impact on the data and interference, the specific price adjustment is as follows:

(1) Hainan Province total retail sales of consumer goods (Y) data: first of all, through the Statistical Yearbook to obtain the retail price index of goods in Hainan Province (the previous year = 100), and then the use of fixed-base index is equal to the product of the chain index of the chain index will be converted into the above chain index to the fixed-base index of the base period of 1990, and finally the use of the nominal value of successive years divided by the corresponding fixed-base price index, and ultimately get the real value of the corresponding year. The real value of the corresponding year is finally obtained by dividing the nominal value by the corresponding fixed-base price index.

(2) Disposable income per capita of urban residents (X2) data: firstly, obtain the consumer price index of urban residents (previous year=100) through the statistical yearbook, then use the formula of fixed-base index equals to the product of chain index to transform the above chain index into the fixed-base index of the base period of 1990, and finally, use the nominal value of the calendar year to divide by the corresponding fixed-base price index, and finally, get the real value of the corresponding year. (2) The average value of per capita disposable income of rural residents

(3) Per capita disposable income of rural residents (X3): firstly, the consumer price index of rural residents (previous year = 100) is obtained through the Statistical Yearbook, and then, using the formula of fixed-base index equals to the product of chained indices, the above-mentioned chained indices are transformed into fixed-base indices with 1990 as the base period, and finally, the nominal

value of a calendar year is divided by the corresponding fixed-base price index, and finally the actual value of the corresponding year is obtained. (3) Gross Regional Product (GRP)

(4) Gross regional product (X4) data: firstly, the index of Hainan Province's gross regional product (previous year=100) is obtained through the Statistical Yearbook, and then, using the formula of fixed-base index equals to the product of multiplying chain indexes, the above chain indexes are transformed into fixed-base indexes with 1990 as the base period, and finally, using the nominal value of the base period of 1990 multiplied by the fixed-base speed of development of the respective period, thus obtaining the real value after the price adjustments. The real value after price adjustment is obtained.

(5) Year-end resident population (X5) data: the year-end resident population data of Hainan Province is obtained through the statistical yearbook, which does not require price adjustment because it is not measured in monetary units.

(6) General Budget Expenditure of Local Finance (X6): The data of Consumer Price Index of Hainan Province (previous year=100) is obtained through the Statistical Yearbook, and then it is transformed into the fixed-base index with 1990 as the base period, and finally, the nominal value of all the years is divided by the corresponding fixed-base price index to get the real value of the corresponding year.

(ii) Modeling and testing

1. Model building and parameter estimation

According to the research purpose of this topic, an econometric model of the following form is set up (overall regression function):

$$Y_t = \beta_1 + \beta_2 X_{2t} + \beta_3 X_{3t} + \beta_4 X_{4t} + \beta_5 X_{5t} + \beta_6 X_{6t} + \mu_t, t = 1990, \ldots\ldots 2022$$

Based on the resulting data (Figure 1), the estimation of the model is written as:

$$\widehat{Y}_t = 450.9463 + 0.032594 X_{2t} + 0.100225 X_{3t} + 0.220017 X_{4t} - 0.827083 X_{5t} - 0.211674 X_{6t}$$

standard error (136.4054) (0.025991) (0.051850) (0.203638) (0.223536) (0.247972)

t-statistic (3.305927) (1.254071) (1.932975) (1.080434) (-3.699997) (-0.853622)

$R^2 = 0.995471$，$\overline{R}^2 = 0.994632$，$F = 1186.808$，$D.W. = 1.618275$，$n = 33$

2. Tests of the economic significance of the model

The model estimation results show that under the assumption that other variables remain unchanged, for every increase of RMB 1 in disposable income per capita of urban residents (X2), on average, the total retail sales of consumer goods (Y) will increase by RMB 0.032594 billion; for every increase of RMB 1 in disposable income per capita of rural residents (X3), on average, the total retail sales of consumer goods (Y) will increase by RMB 0.100225 billion; for every increase of RMB 1 in regional GDP (X4), on average, the total retail sales of consumer goods (Y) will increase by RMB 0.220017 billion; these regression parameters have positive and negative relationships. billion yuan; every increase of 100 million yuan in GDP (X4), on average, the total retail sales of consumer goods (Y) will increase by 0.220017 billion yuan; the positive and negative relationships of these regression parameters are consistent with the theory of economic significance, and therefore pass the test of economic significance.

For every 10,000 increase in the year-end resident population (X5), the total retail sales of consumer goods (Y) will decrease by 0.827083 billion yuan on average; for every 100 million yuan increase in the general budget expenditure of the local government (X6), the total retail sales of consumer goods (Y) will decrease by 0.211674 billion yuan on average; this is contrary to the meaning of the reality, and does not pass the test of economic significance.

Therefore, the two explanatory variables of year-end resident population (X5) and local general budget expenditure (X6) are excluded.

3. Tests for the significance of model regression parameters

t-test: respectively, for,If the significance level is given, check the t-distribution table to get the critical value of the degrees of freedom for and; If the significance level is given, check the t-distribution table to get the critical value of the degrees of freedom for and.

From the Eviews data, the corresponding t-statistics are 3.305927, 1.932975, whose absolute values are greater than, which indicates that at the level of significance, it should be rejected, that is to say, in the case of other explanatory variables remain unchanged, the explanatory variable "per capita disposable income of rural residents (X3)" has a negative effect on the explanatory variable "retail sales of consumer goods". That is to say, the explanatory variable "disposable income per capita of rural residents (X3)" has a significant effect on the explained variable "total retail sales of consumer goods (Y)", while other explanatory variables remain

unchanged.

In addition, the corresponding t-statistics are 1.254071 and 1.080434, whose absolute values are less than, that is to say, they do not fall into the rejection domain and cannot be rejected under the given significance level, that is to say, under the condition that other explanatory variables remain unchanged, the explanatory variables of "per capita disposable income of urban residents (X2)" and "total retail sales of consumer goods (Y)" have a significant effect on the explanatory variable "total retail sales of consumer goods (Y)". That is to say, if other explanatory variables remain unchanged, the explanatory variables "disposable income per capita of urban residents (X2)" and "gross regional product (X4)" do not have a significant effect on the explanatory variable "total retail sales of consumer goods (Y)". Moreover, the corresponding t-statistics are all less than and do not fall into the rejection domain, which means that they cannot be rejected under the condition. That is to say, under the condition that other explanatory variables remain unchanged, the explanatory variables "disposable income per capita of urban residents (X2)" and "gross regional product (X4)" have no significant effect on the explanatory variable "total retail sales of consumer goods (Y)". Y)" has no significant effect on the explanatory variable "total retail sales of consumer goods (Y)".

Such a conclusion can also be judged from the P-value in the output of Eviews, and the corresponding P-value is 0.0638, which is greater than, but less than, indicating that the effect of "disposable income per capita of rural residents (X3)" on "total retail sales of consumer goods (Y)" is significant at the significance level. The effect of "per capita disposable income of rural residents (X3)" on "total retail sales of consumer goods (Y)" is significant.

4. Model fit goodness-of-fit test

From the Eviews output, it can be obtained that the decidable coefficients, modified decidable coefficients, which indicates that the overall fit validity of the regression equation is very good.

5. Tests for overall significance of the model

F test: for,given the level of significance, in the F distribution table to find out the degree of freedom for and the critical value. From the Eviews output results can be obtained,, due to >, the original hypothesis should be rejected, indicating that the regression equation is significant, i.e., "per capita disposable income of urban residents (X2)" "per capita disposable income of rural residents (X3)" The five variables of "Gross Regional Product (X4)" "Year-end Resident Population (X5)" "General Budget Expenditures of Local Finance (X6)" together do have a significant effect on "total retail sales of consumer goods (Y)" has a significant effect.

The model,, the decidable coefficient is very high,, clearly significant. At that time, the explanatory variables X3, X5 were significant, but the sign of the X5 parameter estimate was the opposite of what was expected in terms of economic significance, suggesting that the higher the number of permanent residents at the end of the year, the lower the total retail sales of consumer goods would be, which is clearly unreasonable. This suggests that there may be serious multicollinearity in the model.

To confirm the existence of multicollinearity, the model will be tested and corrected below.

6. TESTS AND CORRECTIONS FOR MODEL MULTICOLLINEARITY

(1) Test of multicollinearity

Simple correlation coefficient method, intuitive judgement method and variance expansion factor method are chosen to test.

Simple correlation coefficient test (Fig. 2): The correlation coefficient matrix shows that the correlation coefficients of the explanatory variables are high, which confirms that a certain degree of multicollinearity does exist.

Intuitive judgement method: ① The decidable coefficient of the model, the modified decidable coefficient, indicates that the overall fit of the regression equation is very good.

②, the F-statistic is very large, indicating that the model as a whole is very significant, i.e., the five explanatory variables ("disposable income per capita of urban residents (X2)" "disposable income per capita of rural residents (X3)" "gross regional product (X4)," "year-end resident population (X5)," "general budget expenditure of local finance (X6)") combine to have a significant effect on the explanatory variable Y ("total retail sales of social consumer goods ") has a significant effect on the explanatory variable Y ("Total Retail Sales of Consumer Goods").

③For the regression parameters "disposable income per capita of urban residents (X2)" "disposable income per capita of rural residents (X3)" "Gross regional product (X4)" has a significant effect on the explanatory variable Y ("total retail sales of consumer goods"). "Total Retail Sales of Consumer Goods (Y)" shows a positive correlation; while "Year-end Resident Population (X5)"

"General Budget Expenditure of Local Finance (X6)" and "The sign of the regression coefficients of X5 and X6 in the model is contrary to the economic theory, and the t-value of the regression coefficients of X6 is smaller than the critical value, so it can't pass the test of significance.

Variance Expansion Factor Method (Figure 3): experience has shown that if the variance expands by a factor, it usually indicates that there is a serious multicollinearity between that explanatory variable and the rest of the explanatory variables. Here the variance expansion factors for X2, X3, X4, X5, and X6 are much greater than 10, indicating a serious multicollinearity problem.

(2) Logarithmic transformation and re-test of multicollinearity

In order to avoid setting errors caused by deleting important explanatory variables, explanatory variables are not arbitrarily deleted. Consider the variables to be log-transformed and then estimate the following model.

Therefore logarithmic transformation is done for Y, X2, X3, X4, X5 and X6. (Figure 4) After the transformation, it can be seen from the correlation coefficient matrix that each of the explanatory variables have high correlation coefficients with each other, confirming that there is indeed some multicollinearity.

In order to further understand this, variance expansion factor method was carried out and it can be seen from the Eviews output (Figure 5), which indicates that there is a serious multicollinearity between this explanatory variable and the rest of the explanatory variables. Here the variance expansion factor of 、、、、 is much greater than 10, indicating a serious multicollinearity problem. Therefore, the model needs to be corrected for multicollinearity.

(3) Correction for multicollinearity

After determining the existence of multicollinearity in the model, this paper applies the stepwise regression method to correct the multicollinearity existing in the model. Using EViews to estimate the model parameters, respectively, with the explanatory variables to each explanatory variable for simple regression (regression results are shown in the Appendix Figure 6 - Figure 10), the regression results are organised as shown in Table 1.

Table 1. Regression results corresponding to each explanatory variable of the univariate stepwise regression

model	X2: (+)	X2: (+)	X2: (+)	X2: (+)	X2: (+)
Coefficient value	0.080081	0.193277	0.415370	2.534998	1.362875
t-value	41.37209	57.90087	56.17226	15.68385	44.27289
Admissibility factor	0.982211	0.990838	0.990271	0.888080	0.984431
Revision of the decidability factor	0.981637	0.990542	0.989957	0.884469	0.983928

Through the regression results, it can be found that for the five one-way linear regression equations, the economic significance and significance of the parameters in the one-way model with as explanatory variables can pass the test. Next, for the five univariate models as explanatory variables, by comparing the size of the decidable coefficients, it was found that the model with as explanatory variables was the largest, so it was retained in this step. Subsequently, a binary linear regression model was constructed with as the base variable.

The binary linear regression model was constructed with as the benchmark variable and added sequentially. The regression results are shown in Table 2.

Table 2. Regression results corresponding to each explanatory variable in binary stepwise regression

Add variable	X2（+）	X3（+）	X4（+）	X5（+）	X6(+)	Admissibility factor	Revised decidability factor
X_2、X_3	0.013281（1.091990）	0.161570（5.528375）				0.991188	0.990601
X_3、X_4		0.110894（2.123666）	0.177445（1.580744）			0.991542	0.990979
X_3、X_5		0.222830（20.95066）		-0.426751（-2.896177）		0.992840	0.992363
X_3、X_6		0.129450（6.020595）			0.455927（2.997432）	0.992949	0.992479

From the output results of the four binary linear regression equations (Figure 11-Figure 14), it can be seen that the four binary linear regression equation model's compared to the retained univariate linear regression model (), the regression model's decidable coefficient increases, that is, the introduction of all can effectively improve the model's fitting effect.

With the binary model as the explanatory variables, the economic significance of the economic significance can not pass the test, so this binary linear regression model is removed from the step; with the binary model as the explanatory variables, of the, that the explanatory variables on the explained variables is not significant, so it is removed from the step; due to the decision-making coefficients of the other two sets of variables in the other two sets of variables is larger, so it is thought to be the benchmark variable, in order to join, and to construct the ternary linear regression model. (See Figures 15 and 16 in the Appendix.) The regression results are shown in Table 3.

Table 3. Regression results corresponding to each explanatory variable of the ternary stepwise regression

Add variable	X_2（+）	X_3（+）	X_4（-）	X_5（+）	X_6(+)	Admissibility factor	Revised decidability factor
X_2、X_3、X_6	-0.008019（-0.597802）	0.139607（5.060402）			0.520121（2.773284）	0.993035	0.992315
X_3、X_4、X_6		0.133823（2.708410）	-0.012910（-0.098693）		0.467504（2.408169）	0.992952	0.992223

X_3、X_5、X_6		0.165070 （6.678421）		-0.340250 （-2.435543）	0.369799 （2.544583）	0.994147	0.993541

For the output results of the three ternary linear regression equations, it can be seen that the economic significance of the ternary model with as explanatory variables cannot pass the test; and the economic significance of the ternary model with as explanatory variables cannot pass the test, so these two ternary models are eliminated from this step; and the economic significance of the ternary model with as explanatory variables cannot pass the test;.

Since no ternary model can be retained in this step, the stepwise regression method ends here. Return to the previous step as the final result.

After the above 3 stepwise regression corrections, it has been possible to determine the elimination of the multicollinearity present in the model. The final regression equation obtained after eliminating the multicollinearity is:

Standard error (18.35369) (0.021501) (0.152106)

t-statistic (-3.927855) (6.020595) (2.997432)

$R^2 = 0.992949$，$\bar{R}^2 = 0.992479$，$F = 2112.497$，$DW = 2.141959$，$n = 33$

The results illustrate that, keeping other explanatory variables constant, for every increase of RMB 1 in per capita disposable income of rural residents (X3), on average, the total retail sales of consumer goods (Y) will increase by RMB billion correspondingly; for every increase of RMB 100 million in general budget expenditures of local finance (X6), on average, the total retail sales of consumer goods (Y) will increase by RMB billion correspondingly.

7. TEST AND CORRECTION OF MODEL HETEROSKEDASTICITY

According to this case, WHITE test needs to construct the auxiliary regression function as:

1. Conduct a significance test: (Appendix Figure 18)

(1) Formulate the hypothesis (overall parameters):

$H_0: \alpha_1 = \alpha_2 = \alpha_3 = \ldots = \alpha_5 = 0$(homoskedasticity)

$H_1: \alpha_i$Not all 0(Heteroskedasticity)

(2) Find the sample observations for the test statistic:

$$nR^2 = 27.226683$$

(3) Find the critical value to determine the rejection domain

Critical Value: $\chi^2_{\alpha}(p) = \chi^2_{0.05}(5) = 11.0705$

Rejection domain:$[11.0705, +\infty)$

Make a decision

$nR^2 = 27.226683 > \chi^2_{0.05}$that falls into the rejection domain, reject it, and assume that heteroskedasticity exists.

2. correct for heteroskedasticity (weighted least squares):

[RESULTS]: weighted using w1=1/(x3^2-x3*x6) to get the EVIEWS output.

Firstly, the test of model parameter significance and economic significance: the model,, the decidable coefficients are high and clearly significant. The economic significance is consistent with reality and passes the test of economic significance.

Next, White was used again to test for heteroskedasticity: (results are shown in Appendix Figure 19), at which point the P-values are all greater than 0.05, indicating that there is no longer any heteroskedasticity.

It can be seen that after eliminating the heteroskedasticity using the weighted least squares method, the parametric t-tests are significant, as are the F-tests. It is found that there is no more heteroskedasticity by white test. The estimation results are:

Standard error (3.770616) (0.005704) (0.054177)

t-statistic (-8.493289) (15.62993) (12.01390)

$R^2 = 0.990472$，$\bar{R}^2 = 0.989837$，$F = 1559.289$，$DW = 1.271058$，$n = 33$

This indicates that for every 1 yuan increase in the disposable income per capita of rural residents, on average, the total retail sales

of social consumer goods will increase by billion yuan. For every RMB 1 increase in the general budget expenditure of local finances, the total retail sales of consumer goods will, on average, increase by RMB 100 million.

Tests and corrections for model autocorrelation

(1) Autocorrelation test (using the D.W. test) (see Appendix Figure 20)

From the Eviews output it can be obtained that$d_L = 1.321, d_U = 1.577, n = 33, \alpha = 0.05$,

D.W.=1.271058，$0 < D.W. < d_L$, A positive autocorrelation can be seen.

(2) Modified autocorrelation (generalised difference method)

1.From D.W.=1.271058 计算$\hat{\rho}$

initial step：calculate $\hat{\rho} = 1 - \frac{D.W.}{2} = 1 - \frac{1.271058}{2} = 0.364471$

second step：Generating generalised difference variables:

$$Y_t^* = Y_t - 0.364471Y_{t-1}，\ X_{3t}^* = X_{3t} - 0.364471X_{3(t-1)}，\ X_{6t}^* = X_{6t} - 0.364471X_{6(t-1)}$$

generalised difference regression (GDR)：

$$Y_t - 0.364471Y_{t-1} = \beta_1(1 - 0.364471) + \beta_2(X_3 - 0.364471X_{3-1}) + \beta_3(X_6 - 0.364471X_{6-1})$$

The output of the generalised difference regression was obtained using EViews as (see Appendix Figure 21)：

$$Y_t - 0.364471Y_{t-1} = -18.57524(1 - 0.364471) + 0.086505(X_3 - 0.364471X_{3-1}) + 0.659375(X_6 - 0.364471X_{6-1})$$

Standard error (3.662715) (0.008148) (0.073344)

t-statistic (-5.071442) (10.61644) (8.990184)

$R^2 = 0.981457$，$\bar{R}^2 = 0.980178$，$F = 767.4765$，$D.W. = 1.650241$

Due to the use of generalised difference, the sample sample size is reduced by 1 to 32, checking the D.W. statistics table at 5% significant level shows that the model is in the model, indicating that there is no more autocorrelation in this generalised difference model at 5% significant level.

(III) Analysis of the final empirical results

Through the above analysis, the model has been corrected for multicollinearity, heteroskedasticity and autocorrelation problems and the final model established is:

$$\hat{Y}_t = -18.57524 + 0.086505X_{3t} + 0.659375X_{6t}$$

Standard deviation (3.662715) (0.008148) (0.073344)

T-value (-5.071442) (10.61644) (8.990184)

1. Test of economic significance

Under the condition of controlling other explanatory variables unchanged, every increase of RMB 1 in per capita disposable income of rural residents will increase total retail sales of consumer goods by 100 million yuan on average; and an increase of 100 million yuan in the general budget expenditure of local finances will increase total retail sales of consumer goods by 100 million yuan on average, which is in line with the actual economic theory, and the test passes.

2. Goodness-of-fit test

From the results of the model, it can be seen that the coefficient of determination, the modified coefficient of determination, the coefficient of determination is high, which means that the model is well fitted.

Significance test of regression parameters

（1）Formulation of the hypothesis: original hypothesis：$H_0 : \beta_j = 0$ (X has no significant effect on Y);

alternative hypothesis: $H_1 : \beta_j \neq 0$ （j=3,6)

（2）The t-test statistics were: t3=10.61644　t6=8.990184

（3）Determine the denial domain：$(-\infty, -t_{\alpha/2}(n-k)]U[t_{\alpha/2}(n-k), +\infty)$

t0.025(32-3)=t0.025(29)=2.045

Therefore, the determined rejection domain is$(-\infty，2.045]U[2.045, +\infty)$

(4) Making Decision .

Because the absolute value of the t-value corresponding to X3 is greater than t0.025(29)=2.045, which indicates that $\alpha = 0.05$, at the level of significance, falls into the rejection domain, so the original hypothesis is rejected, and it is considered that there is a significant effect of X3 disposable income per capita of rural residents on the total retail sales of consumer goods in Y. Because the absolute value of the t-value corresponding to X6 is greater than t0.025(29)=2.045, which indicates that, $\alpha = 0.05$ at the level of significance, falls into the rejection domain, so the original hypothesis is rejected and it is considered that there is a significant effect of X6 local finance general budget expenditure on Y total retail sales of consumer goods.

4. Test of the significance of the equation

Test objective: whether all the explanatory variables jointly have a significant effect on the explained variable Y.

(1) Proposing hypothesis: original hypothesis

Alternative hypothesis: at least one of βj is not zero,(j=3,6)

(2) Find the test statistic:$F^* = 767.4765$

(3) Determine the rejection domain: $[F_\alpha(k-1,\ n-k),+\infty)$

$F_{0.05}(2,29) = 3.33$

Therefore, determine the rejection domain as$[3.33, +\infty)$

(4) Make a decision: since $F^* = 767.4765 > F_{0.05}(2,29) = 3.33$,falls into the rejection domain, the original hypothesis is rejected and it is considered that all the explanatory variables jointly have a significant effect on Y total retail sales of consumer goods, i.e. the regression equation as a whole is significant.

8. POLICY IMPLICATION AND CONCLUSIONS

1. CONCLUSION

After testing the model for multicollinearity, heteroskedasticity and autocorrelation, this paper finds that the disposable income per capita of rural residents and the general budget expenditure of local finance have a significant impact on the total retail sales of consumer goods in Hainan Province. Although the disposable income per capita of urban residents, GDP, and the number of permanent residents at the end of the year do not have a significant effect on the total retail sales of consumer goods in Hainan Province, it does not mean that there is no effect.

2.Policy Recommendations

①Increase the income level of the residential sector by expanding employment.

② Increase the proportion of residents' income in the distribution of the national economy. China's residents' disposable income as a proportion of gross domestic product (GDP) is low, and in the future, we should increase the transfer of payments from the government sector to the residents' sector.

③ Diversify consumer goods categories: Hainan Province's total retail sales of consumer goods can be raised by increasing the variety of consumer goods. Enterprises can be encouraged to develop innovative products to meet diversified consumer needs and further enrich consumer brands and categories.

(iv) Enhance the quality of consumer goods: Hainan Province can strengthen the supervision of the quality of consumer goods and establish an effective quality inspection system to ensure the quality and safety of consumer goods. At the same time, enterprises are encouraged to strengthen product research and development and production processes to improve the quality level of products and increase consumers' trust and satisfaction with them.

⑤ Promote the integration of online and offline: Hainan Province can promote the integration of online and offline development and build an intelligent and convenient shopping environment. Traditional retail enterprises can be encouraged to co-operate with e-commerce platforms to promote the interoperability between online and offline, and enhance consumers' shopping experience.

(6) Strengthen the protection of consumers' rights and interests: Hainan province can strengthen the protection of consumers' rights and interests and establish and improve the protection mechanism of consumers' rights and interests. We can intensify the crackdown on false advertisements and unreasonable prices, improve consumers' satisfaction and trust, and promote consumers' willingness to buy goods.

(vii) Optimising the consumer environment: Hainan Province can increase its efforts to improve and build commercial districts and shopping centres to provide a more comfortable and convenient shopping environment. Public parking spaces can be increased and transport facilities improved to facilitate consumers to shopping areas.

(8) Enhance market competition: Hainan Province can encourage competitive pricing and quality services to improve market competitiveness. It can promote the reform of the market access system, reduce the threshold of business access, encourage more enterprises to enter the market, and promote the intensification of market competition.

⑨ Support the development of emerging consumer areas: Hainan Province can increase support for emerging consumer areas and promote the development of emerging industries. Entrepreneurs can be encouraged to innovate and start businesses in emerging areas, providing appropriate policy support and financial support to promote the rapid development of emerging consumer areas. To promote the total retail sales of consumer goods in Hainan Province.

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APPENDIX

Table 1 Total retail sales of consumer goods

period	Total retail sales of consumer goods (billion yuan)	Retail merchandise price index (previous year = 100)	1990=100	Total retail sales of consumer goods after price adjustment ($ billion)
1990	40	100.6	100.0	40.000
1991	45	103.1	103.1	43.647
1992	58.3	108.7	112.1	52.021
1993	72.7	123.9	138.9	52.357
1994	89.6	121.6	168.8	53.066

1995	109.2	111.3	187.9	58.108
1996	121.6	102.3	192.2	63.251
1997	133.4	99.4	191.1	69.808
1998	147.8	96.5	184.4	80.149
1999	157.7	96.6	178.1	88.527
2000	172.5	99.9	178.0	96.932
2001	187.5	97.7	173.9	107.842
2002	204.4	98.4	171.1	119.473
2003	191.6	100.4	171.8	111.545
2004	220.2	103.4	177.6	123.980
2005	270.8	100.9	179.2	151.110
2006	313.4	101.3	181.5	172.637
2007	370.9	104.2	189.2	196.076
2008	463.2	106.7	201.8	229.494
2009	537.5	98.5	198.8	270.362
2010	663.8	104.6	208.0	319.207
2011	822.5	105.4	219.2	375.258
2012	950.2	102.7	225.1	422.123
2013	1090.9	101.5	228.5	477.467
2014	1224.5	101.2	231.2	529.586
2015	1409.4	99.8	230.8	610.775
2016	1547.3	101	233.1	663.896
2017	1729.4	102	237.7	727.480
2018	1852.7	102.5	243.7	760.338
2019	1951.1	102.5	249.8	781.191
2020	1974.6	101.6	253.8	778.150
2021	2497.6	101.3	257.1	971.622
2022	2268.4	102.1	262.5	864.308

Table 2. Per capita disposable income of urban residents

period	Disposable income per urban resident X2 (yuan)	Consumer price index for urban residents (previous year = 100)	1990=100	Post-adjustment disposable income per urban resident X2 (yuan)
1990	1650	99.6	100.0	1650.000
1991	1799	104	104.0	1729.808
1992	2318	109	113.4	2044.813
1993	3072	123.7	140.2	2190.744
1994	3920	125.6	176.1	2225.701
1995	4770	110.6	194.8	2448.748

1996	4926	104.8	204.1	2413.008
1997	4850	101.5	207.2	2340.670
1998	4845	97.6	202.2	2395.755
1999	5320	99.1	200.4	2654.523
2000	5332	101.5	203.4	2621.193
2001	5800	98.8	201.0	2885.891
2002	6764	99	199.0	3399.541
2003	7185	99.4	197.8	3632.931
2004	7643	103.2	204.1	3744.678
2005	8013	101.3	206.8	3875.577
2006	9250	101.2	209.2	4420.816
2007	10807	104.6	218.9	4937.807
2008	12367	106.1	232.2	5325.716
2009	13465	99.5	231.1	5827.696
2010	15229	104.5	241.4	6307.331
2011	17954	105.5	254.7	7048.278
2012	20446	103.2	262.9	7777.687
2013	22411	102.8	270.2	8292.972
2014	24487	102.2	276.2	8866.121
2015	26356	101.2	279.5	9429.682
2016	28453	102.9	287.6	9893.051
2017	30817	103.2	296.8	10382.761
2018	33349	102.4	303.9	10972.494
2019	36017	103.2	313.7	11482.868
2020	37097	101.8	319.3	11618.066
2021	40213	100.5	320.9	12531.281
2022	40118	101.5	325.7	12316.923

Table 3. Per capita disposable income of rural residents

period	Per capita disposable income of rural residents X 3 (yuan)	Rural consumer price index (previous year = 100)	1990=100	Post-adjustment disposable income per rural resident X 3 (yuan)
1990	696	108.1	100.0	696.000
1991	730	104.4	104.4	699.234
1992	843	103.4	107.9	780.920
1993	992	116.5	125.8	788.796
1994	1305	128.2	161.2	809.423
1995	1520	118.4	190.9	796.264
1996	1746	103.7	198.0	882.021
1997	1917	100.3	198.5	965.508

1998	2026	96.6	191.8	1056.321
1999	2104	97.3	186.6	1127.429
2000	2208	100.2	187.0	1180.796
2001	2262	98.3	183.8	1230.595
2002	2472	100.2	184.2	1342.157
2003	2651	100.9	185.8	1426.505
2004	2898	106.4	197.7	1465.616
2005	3102	101.7	201.1	1542.562
2006	3376	102.3	205.7	1641.072
2007	3949	106.3	218.7	1805.840
2008	4593	108.8	237.9	1930.455
2009	4984	99	235.5	2115.953
2010	5566	105.8	249.2	2233.498
2011	6801	107.8	268.6	2531.607
2012	7816	103.2	277.2	2819.216
2013	8802	102.7	284.7	3091.397
2014	9913	102.8	292.7	3386.767
2015	10858	100.5	294.2	3691.170
2016	11843	102.5	301.5	3927.825
2017	12902	101.9	307.2	4199.264
2018	13989	102.5	314.9	4442.004
2019	15113	104	327.5	4614.341
2020	16279	103.8	340.0	4788.388
2021	18076	99.7	338.9	5332.966
2022	19117	102	345.7	5529.502

Table 4. gross regional product (GDP)

period	Gross regional product X 4 (billion yuan)	Gross regional product index (previous year = 100)	1990=100	Post-adjustment GDP X 4 ($ billion)
1990	102.49	110.6	100.0	102.490
1991	120.5	114.9	114.9	117.761
1992	184.9	141.5	162.6	166.632
1993	260.4	120.6	196.1	200.958
1994	332	111.2	218.0	223.465
1995	363.3	103.8	226.3	231.957
1996	389.7	104.7	237.0	242.859
1997	411.2	106.8	253.1	259.373
1998	442.1	108.4	274.3	281.161
1999	476.7	108.5	297.6	305.059
2000	526.8	109	324.4	332.515

2001	579.2	109.1	354.0	362.774
2002	642.7	109.6	387.9	397.600
2003	714	110.6	429.1	439.745
2004	802.7	109.7	470.7	482.401
2005	884.9	110.5	520.1	533.053
2006	1027.5	110.6	575.2	589.556
2007	1234	115.8	666.1	682.706
2008	1474.7	110.3	734.7	753.025
2009	1620.3	111.7	820.7	841.129
2010	2020.5	116	952.0	975.710
2011	2463.8	112.2	1068.1	1094.746
2012	2789.4	109.4	1168.6	1197.652
2013	3115.9	109.6	1280.7	1312.627
2014	3449	108.6	1390.9	1425.513
2015	3734.2	107.8	1499.4	1536.703
2016	4090.2	107.5	1611.8	1651.956
2017	4497.5	107	1724.6	1767.592
2018	4910.7	105.8	1824.7	1870.113
2019	5330.8	105.8	1930.5	1978.579
2020	5566.2	103.5	1998.1	2047.830
2021	6504.1	111.3	2223.9	2279.234
2022	6818.2	100.2	2228.3	2283.793

Table 5. Year-end resident population

period	Resident population at the end of the year X5 (million)
1990	663
1991	674
1992	686
1993	701
1994	711
1995	724
1996	734
1997	743
1998	753
1999	762
2000	789
2001	796
2002	803
2003	811
2004	818
2005	828

2006	836
2007	845
2008	854
2009	864
2010	869
2011	890
2012	910
2013	920
2014	936
2015	945
2016	957
2017	972
2018	982
2019	995
2020	1012
2021	1020
2022	1027

Table 6. General budget expenditures of local finances

period	General budget expenditure of local finance X6 (billion yuan)	Consumer price index (previous year = 100)	1990=100	Post-adjustment local finance general budget expenditure X6 (billion yuan)
1990	17.42	102.1	100.0	17.420
1991	19.39	103.9	103.9	18.662
1992	25.36	108.7	112.9	22.455
1993	38.52	123.3	139.3	27.662
1994	40.01	126.7	176.4	22.677
1995	42.39	113.5	200.3	21.168
1996	45.16	104.3	208.9	21.622
1997	48.48	100.8	210.5	23.027
1998	54.91	97.3	204.9	26.805
1999	56.78	98.3	201.4	28.197
2000	64.12	101.1	203.6	31.496
2001	78.94	98.5	200.5	39.366
2002	92.26	99.5	199.5	46.239
2003	105.4	100.1	199.7	52.772
2004	127.2	104.4	208.5	61.003
2005	151.24	101.5	211.6	71.460
2006	174.54	101.5	214.8	81.250
2007	245.2	105.1	225.8	108.605

2008	357.97	106.9	241.4	148.319
2009	486.06	99.3	239.7	202.811
2010	581.34	104.8	251.2	231.457
2011	778.8	106.1	266.5	292.247
2012	911.67	103.2	275.0	331.499
2013	1011.17	102.8	282.7	357.665
2014	1099.74	102.4	289.5	379.876
2015	1239.43	101	292.4	423.889
2016	1376.48	102.8	300.6	457.939
2017	1443.97	102.8	309.0	467.307
2018	1691.3	102.5	316.7	534.000
2019	1858.6	103.4	327.5	567.526
2020	1972.46	102.3	335.0	588.752
2021	1971.37	100.3	336.0	586.667
2022	2097.37	101.6	341.4	614.334

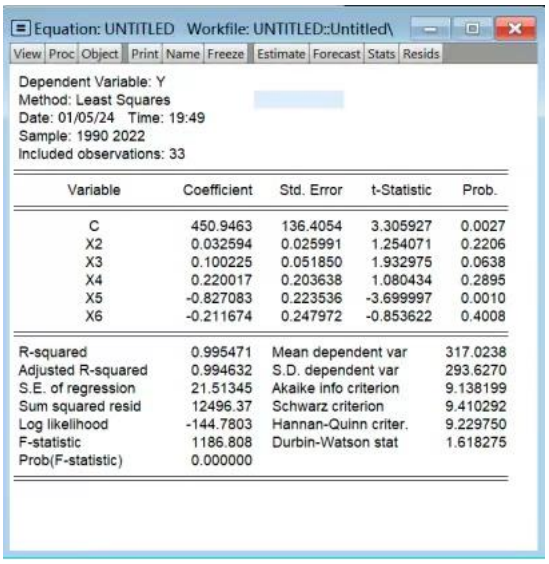


Fig. 1 Output of model building (using OLS method)

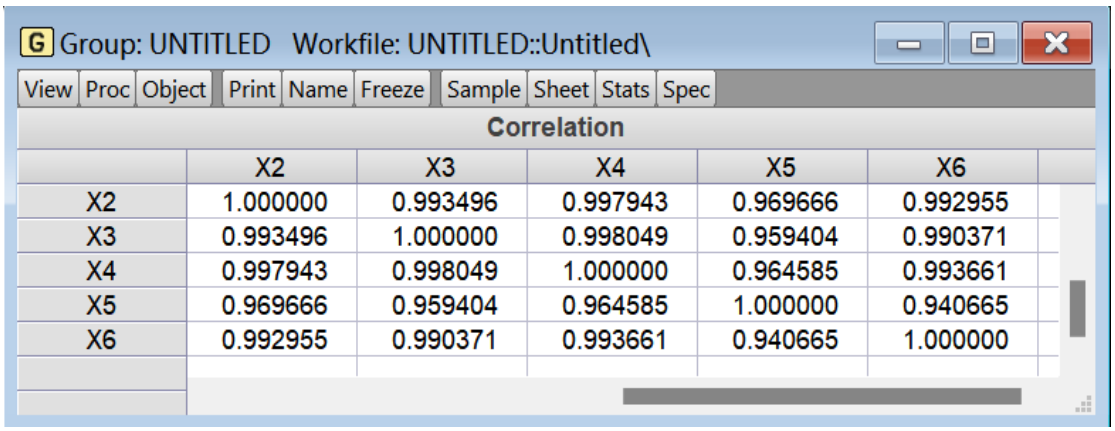
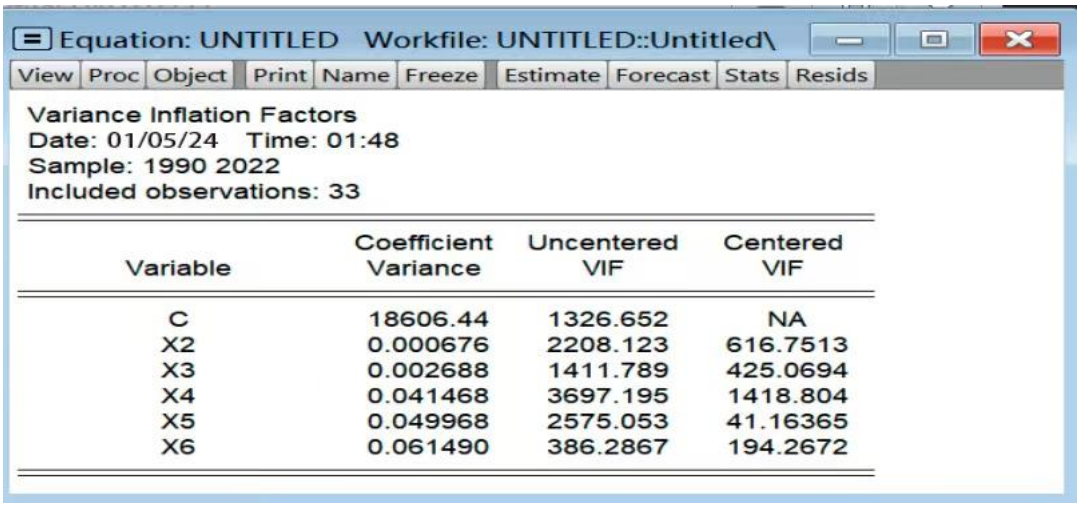
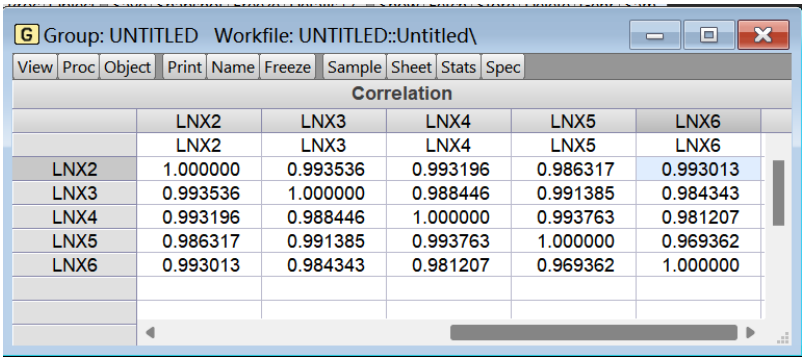


Fig. 2 Output of multiple covariance test (correlation coefficient method)



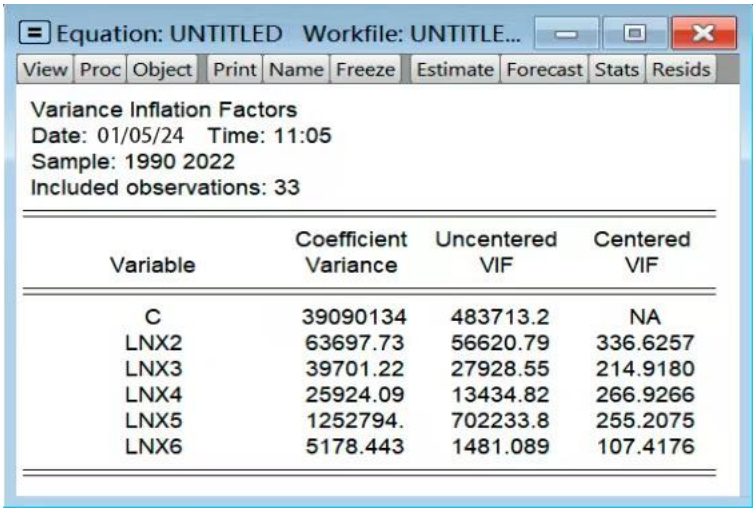
Variable	Coefficient Variance	Uncentered VIF	Centered VIF
C	18606.44	1326.652	NA
X2	0.000676	2208.123	616.7513
X3	0.002688	1411.789	425.0694
X4	0.041468	3697.195	1418.804
X5	0.049968	2575.053	41.16365
X6	0.061490	386.2867	194.2672

Fig. 3 Output of multiple covariance test (variance expansion factor method)



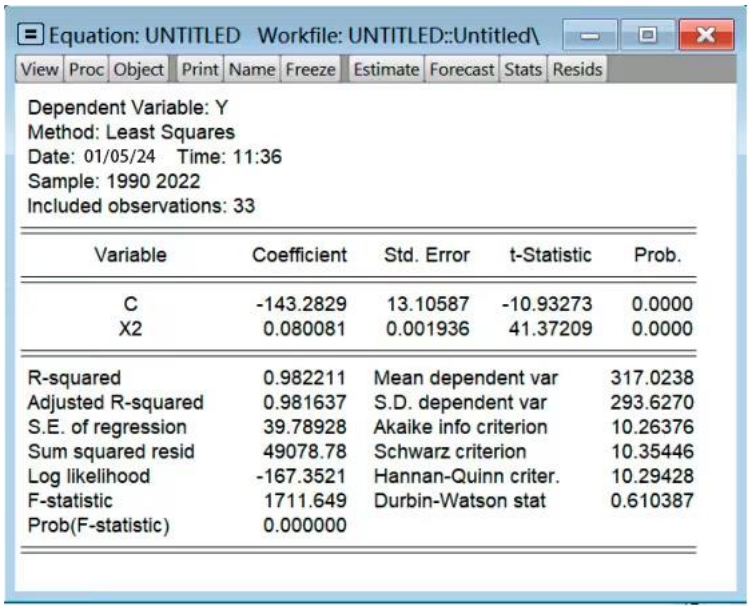
	LNX2	LNX3	LNX4	LNX5	LNX6
	LNX2	LNX3	LNX4	LNX5	LNX6
LNX2	1.000000	0.993536	0.993196	0.986317	0.993013
LNX3	0.993536	1.000000	0.988446	0.991385	0.984343
LNX4	0.993196	0.988446	1.000000	0.993763	0.981207
LNX5	0.986317	0.991385	0.993763	1.000000	0.969362
LNX6	0.993013	0.984343	0.981207	0.969362	1.000000

Fig. 4 Calculation of correlation coefficients of transformed explanatory variables (output results)



Variable	Coefficient Variance	Uncentered VIF	Centered VIF
C	39090134	483713.2	NA
LNX2	63697.73	56620.79	336.6257
LNX3	39701.22	27928.55	214.9180
LNX4	25924.09	13434.82	266.9266
LNX5	1252794.	702233.8	255.2075
LNX6	5178.443	1481.089	107.4176

Fig. 5 Calculation of variance expansion factors for transformed explanatory variables



Equation: UNTITLED Workfile: UNTITLED::Untitled\

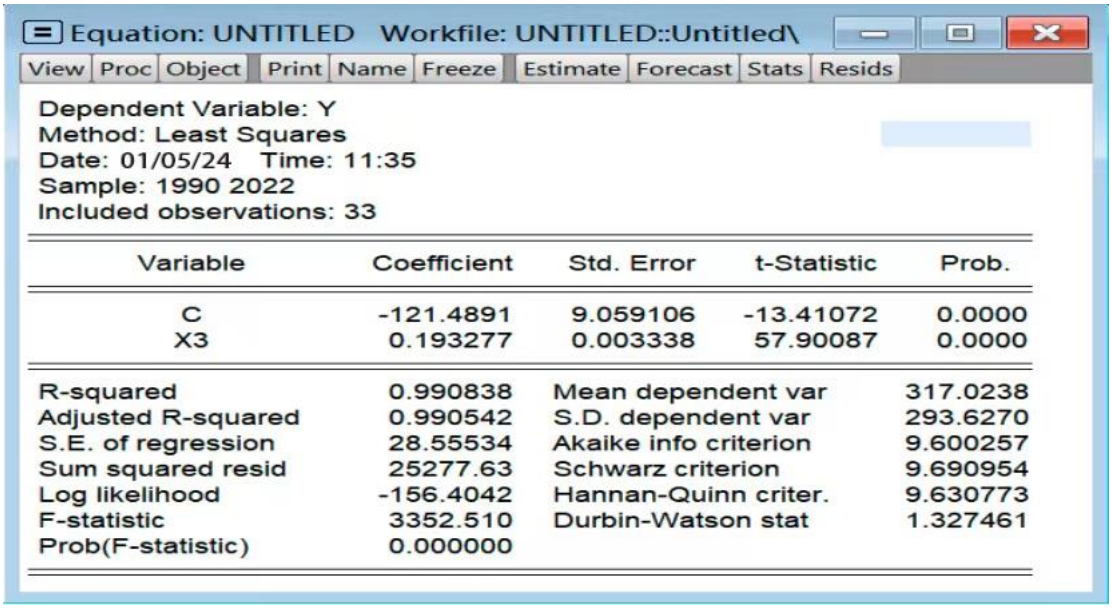
View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: Y
Method: Least Squares
Date: 01/05/24 Time: 11:36
Sample: 1990 2022
Included observations: 33

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-143.2829	13.10587	-10.93273	0.0000
X2	0.080081	0.001936	41.37209	0.0000

R-squared	0.982211	Mean dependent var	317.0238
Adjusted R-squared	0.981637	S.D. dependent var	293.6270
S.E. of regression	39.78928	Akaike info criterion	10.26376
Sum squared resid	49078.78	Schwarz criterion	10.35446
Log likelihood	-167.3521	Hannan-Quinn criter.	10.29428
F-statistic	1711.649	Durbin-Watson stat	0.610387
Prob(F-statistic)	0.000000		

Fig. 6 X2 simple regression output



Equation: UNTITLED Workfile: UNTITLED::Untitled\

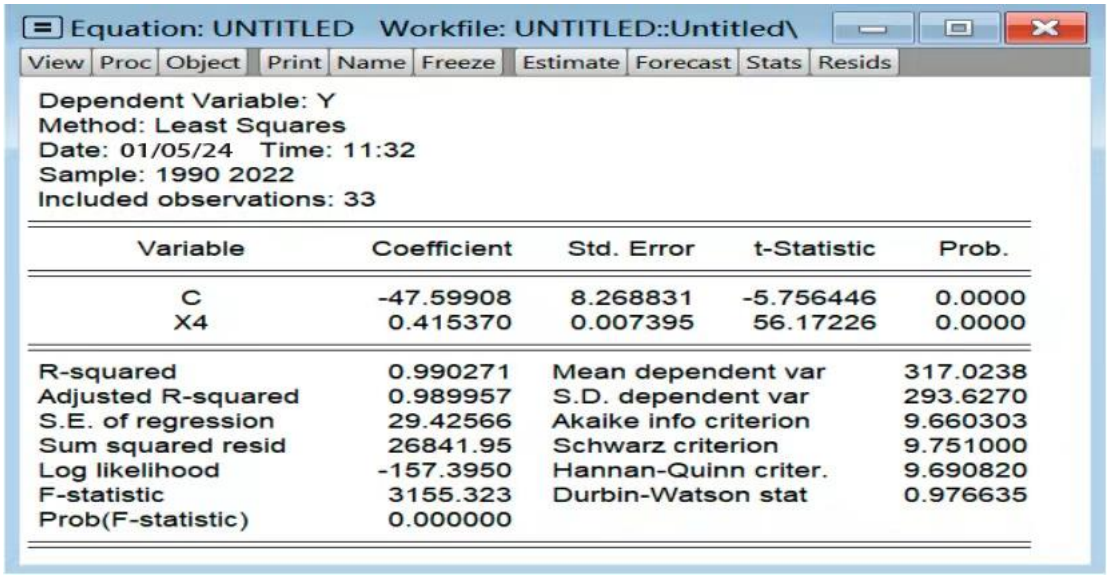
View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: Y
Method: Least Squares
Date: 01/05/24 Time: 11:35
Sample: 1990 2022
Included observations: 33

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-121.4891	9.059106	-13.41072	0.0000
X3	0.193277	0.003338	57.90087	0.0000

R-squared	0.990838	Mean dependent var	317.0238
Adjusted R-squared	0.990542	S.D. dependent var	293.6270
S.E. of regression	28.55534	Akaike info criterion	9.600257
Sum squared resid	25277.63	Schwarz criterion	9.690954
Log likelihood	-156.4042	Hannan-Quinn criter.	9.630773
F-statistic	3352.510	Durbin-Watson stat	1.327461
Prob(F-statistic)	0.000000		

Fig. 7 X3 simple regression output



Equation: UNTITLED Workfile: UNTITLED::Untitled\

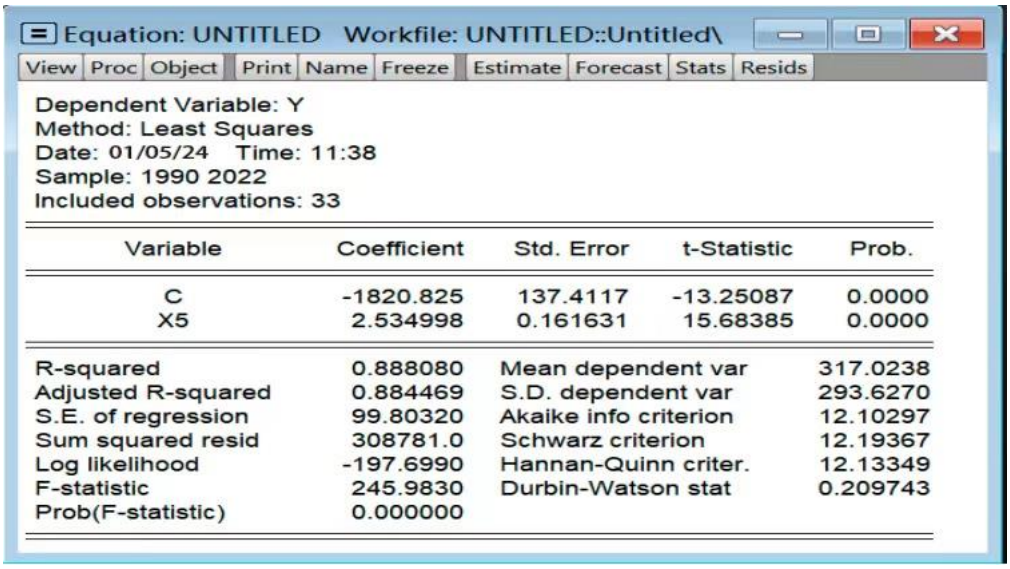
View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: Y
Method: Least Squares
Date: 01/05/24 Time: 11:32
Sample: 1990 2022
Included observations: 33

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-47.59908	8.268831	-5.756446	0.0000
X4	0.415370	0.007395	56.17226	0.0000

R-squared	0.990271	Mean dependent var	317.0238
Adjusted R-squared	0.989957	S.D. dependent var	293.6270
S.E. of regression	29.42566	Akaike info criterion	9.660303
Sum squared resid	26841.95	Schwarz criterion	9.751000
Log likelihood	-157.3950	Hannan-Quinn criter.	9.690820
F-statistic	3155.323	Durbin-Watson stat	0.976635
Prob(F-statistic)	0.000000		

Fig. 8 X4 simple regression output



Equation: UNTITLED Workfile: UNTITLED::Untitled\

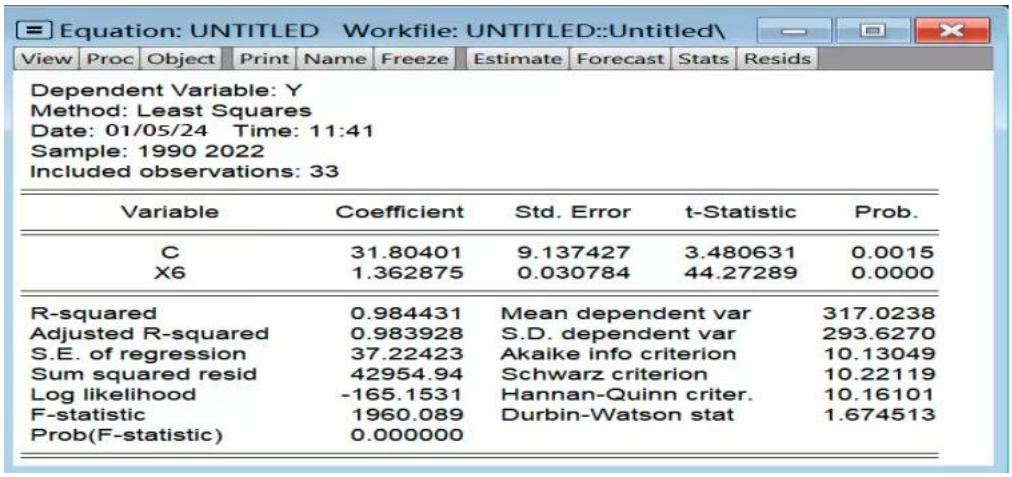
View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: Y
Method: Least Squares
Date: 01/05/24 Time: 11:38
Sample: 1990 2022
Included observations: 33

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1820.825	137.4117	-13.25087	0.0000
X5	2.534998	0.161631	15.68385	0.0000

R-squared	0.888080	Mean dependent var	317.0238
Adjusted R-squared	0.884469	S.D. dependent var	293.6270
S.E. of regression	99.80320	Akaike info criterion	12.10297
Sum squared resid	308781.0	Schwarz criterion	12.19367
Log likelihood	-197.6990	Hannan-Quinn criter.	12.13349
F-statistic	245.9830	Durbin-Watson stat	0.209743
Prob(F-statistic)	0.000000		

Fig. 9 X5 simple regression output



Equation: UNTITLED Workfile: UNTITLED::Untitled\

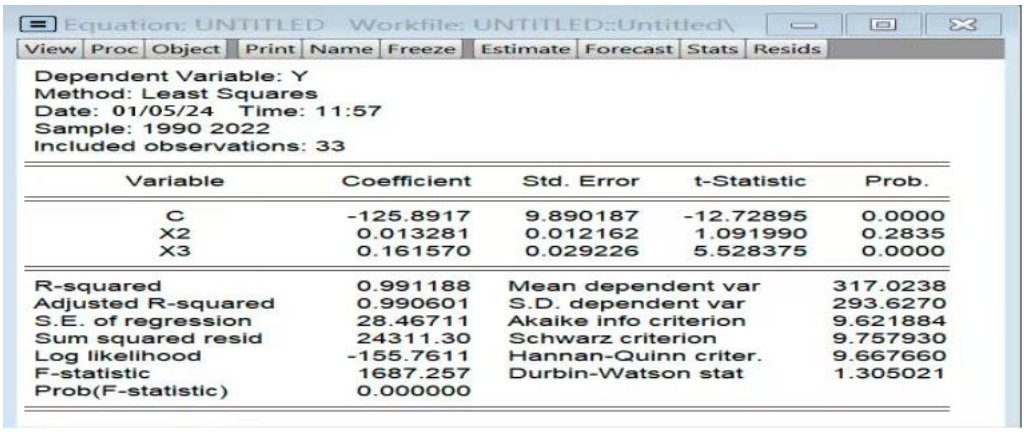
View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: Y
Method: Least Squares
Date: 01/05/24 Time: 11:41
Sample: 1990 2022
Included observations: 33

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	31.80401	9.137427	3.480631	0.0015
X6	1.362875	0.030784	44.27289	0.0000

R-squared	0.984431	Mean dependent var	317.0238
Adjusted R-squared	0.983928	S.D. dependent var	293.6270
S.E. of regression	37.22423	Akaike info criterion	10.13049
Sum squared resid	42954.94	Schwarz criterion	10.22119
Log likelihood	-165.1531	Hannan-Quinn criter.	10.16101
F-statistic	1960.089	Durbin-Watson stat	1.674513
Prob(F-statistic)	0.000000		

Fig. 10 X6 simple regression output



Equation: UNTITLED Workfile: UNTITLED::Untitled\

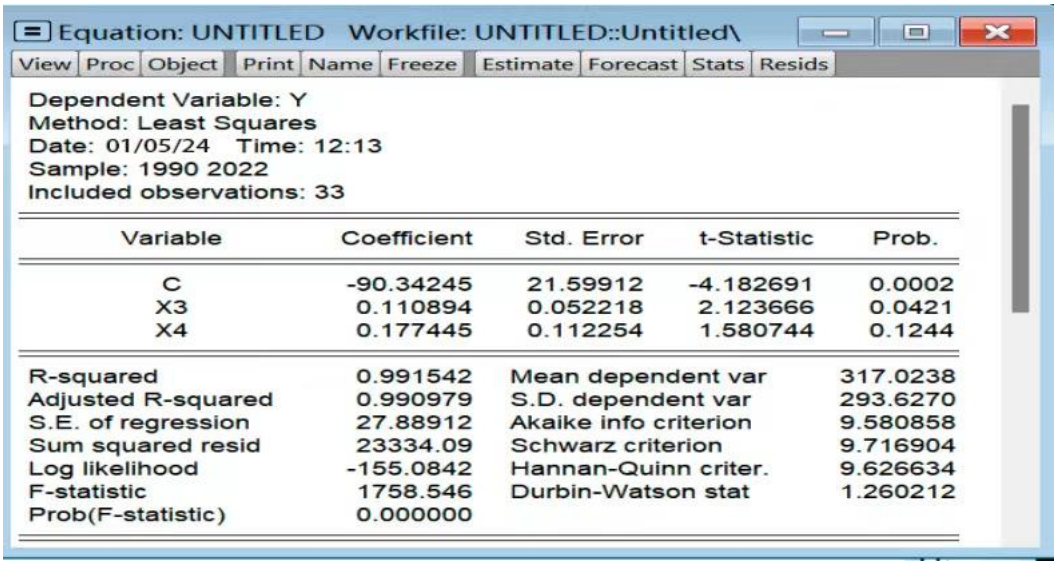
View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: Y
Method: Least Squares
Date: 01/05/24 Time: 11:57
Sample: 1990 2022
Included observations: 33

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-125.8917	9.890187	-12.72895	0.0000
X2	0.013281	0.012162	1.091990	0.2835
X3	0.161570	0.029226	5.528375	0.0000

R-squared	0.991188	Mean dependent var	317.0238
Adjusted R-squared	0.990601	S.D. dependent var	293.6270
S.E. of regression	28.46711	Akaike info criterion	9.621884
Sum squared resid	24311.30	Schwarz criterion	9.757930
Log likelihood	-155.7611	Hannan-Quinn criter.	9.667660
F-statistic	1687.257	Durbin-Watson stat	1.305021
Prob(F-statistic)	0.000000		

Fig. 11 X2, X3 simple regression output results



Equation: UNTITLED Workfile: UNTITLED::Untitled\

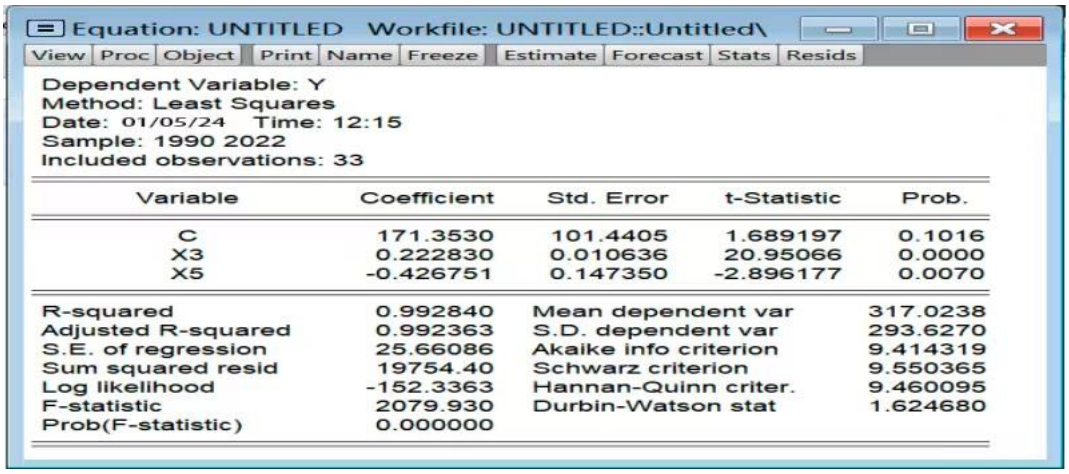
View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: Y
Method: Least Squares
Date: 01/05/24 Time: 12:13
Sample: 1990 2022
Included observations: 33

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-90.34245	21.59912	-4.182691	0.0002
X3	0.110894	0.052218	2.123666	0.0421
X4	0.177445	0.112254	1.580744	0.1244

R-squared	0.991542	Mean dependent var	317.0238
Adjusted R-squared	0.990979	S.D. dependent var	293.6270
S.E. of regression	27.88912	Akaike info criterion	9.580858
Sum squared resid	23334.09	Schwarz criterion	9.716904
Log likelihood	-155.0842	Hannan-Quinn criter.	9.626634
F-statistic	1758.546	Durbin-Watson stat	1.260212
Prob(F-statistic)	0.000000		

Fig. 12 Simple regression output results for X3 and X4



Equation: UNTITLED Workfile: UNTITLED::Untitled\

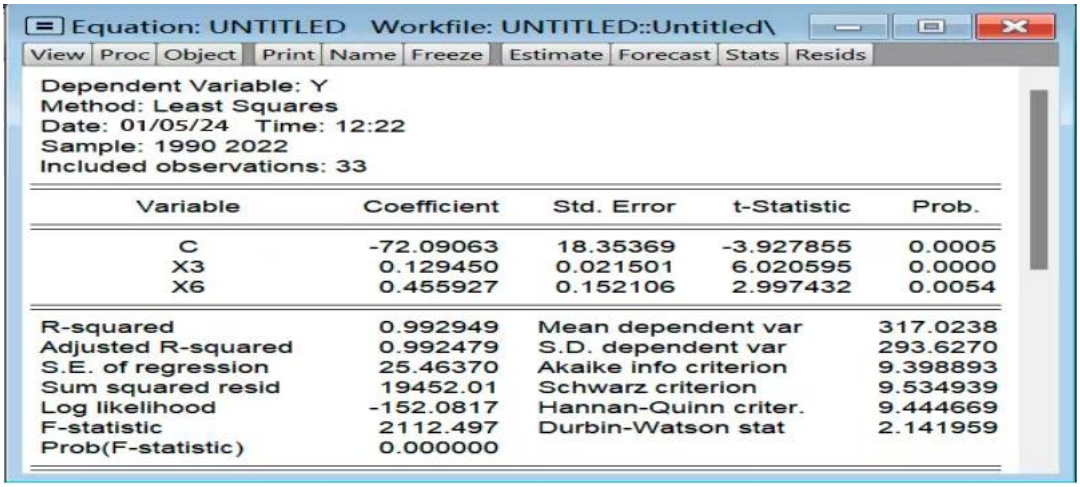
View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: Y
Method: Least Squares
Date: 01/05/24 Time: 12:15
Sample: 1990 2022
Included observations: 33

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	171.3530	101.4405	1.689197	0.1016
X3	0.222830	0.010636	20.95066	0.0000
X5	-0.426751	0.147350	-2.896177	0.0070

R-squared	0.992840	Mean dependent var	317.0238
Adjusted R-squared	0.992363	S.D. dependent var	293.6270
S.E. of regression	25.66086	Akaike info criterion	9.414319
Sum squared resid	19754.40	Schwarz criterion	9.550365
Log likelihood	-152.3363	Hannan-Quinn criter.	9.460095
F-statistic	2079.930	Durbin-Watson stat	1.624680
Prob(F-statistic)	0.000000		

Fig. 13 Simple regression output results for X3 and X5



Equation: UNTITLED Workfile: UNTITLED::Untitled\

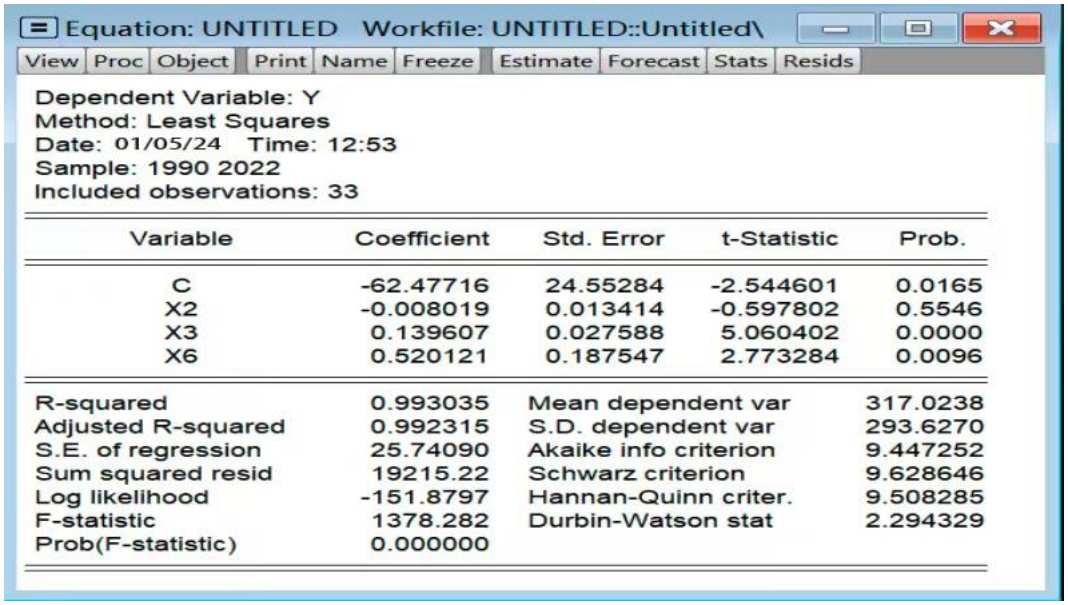
View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: Y
Method: Least Squares
Date: 01/05/24 Time: 12:22
Sample: 1990 2022
Included observations: 33

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-72.09063	18.35369	-3.927855	0.0005
X3	0.129450	0.021501	6.020595	0.0000
X6	0.455927	0.152106	2.997432	0.0054

R-squared	0.992949	Mean dependent var	317.0238
Adjusted R-squared	0.992479	S.D. dependent var	293.6270
S.E. of regression	25.46370	Akaike info criterion	9.398893
Sum squared resid	19452.01	Schwarz criterion	9.534939
Log likelihood	-152.0817	Hannan-Quinn criter.	9.444669
F-statistic	2112.497	Durbin-Watson stat	2.141959
Prob(F-statistic)	0.000000		

Fig. 14 Simple regression output results for X3 and X6



Equation: UNTITLED Workfile: UNTITLED::Untitled\

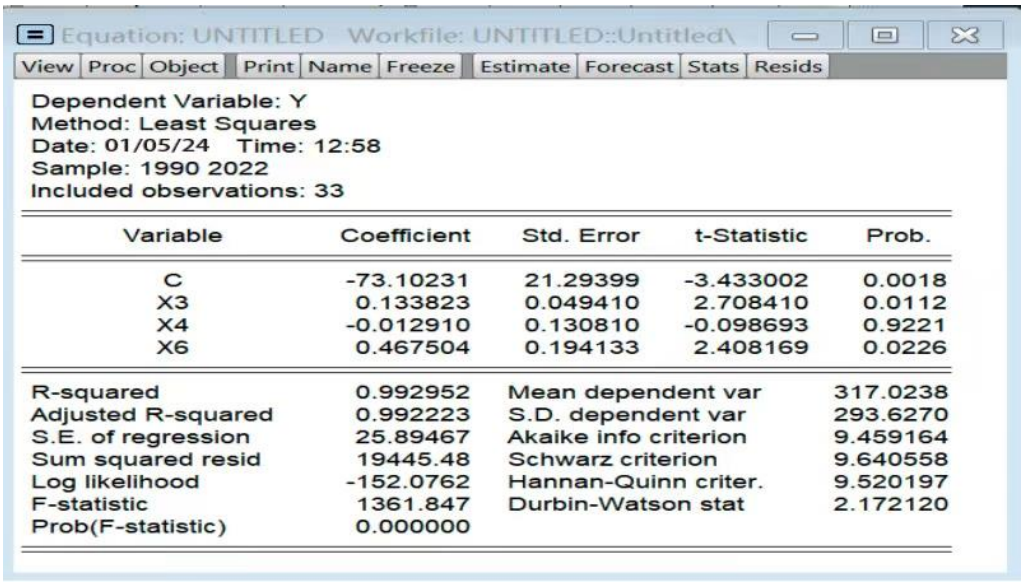
View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: Y
Method: Least Squares
Date: 01/05/24 Time: 12:53
Sample: 1990 2022
Included observations: 33

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-62.47716	24.55284	-2.544601	0.0165
X2	-0.008019	0.013414	-0.597802	0.5546
X3	0.139607	0.027588	5.060402	0.0000
X6	0.520121	0.187547	2.773284	0.0096

R-squared	0.993035	Mean dependent var	317.0238
Adjusted R-squared	0.992315	S.D. dependent var	293.6270
S.E. of regression	25.74090	Akaike info criterion	9.447252
Sum squared resid	19215.22	Schwarz criterion	9.628646
Log likelihood	-151.8797	Hannan-Quinn criter.	9.508285
F-statistic	1378.282	Durbin-Watson stat	2.294329
Prob(F-statistic)	0.000000		

Fig. 15 Simple regression outputs for X2, X3 and X6



Equation: UNTITLED Workfile: UNTITLED::Untitled\

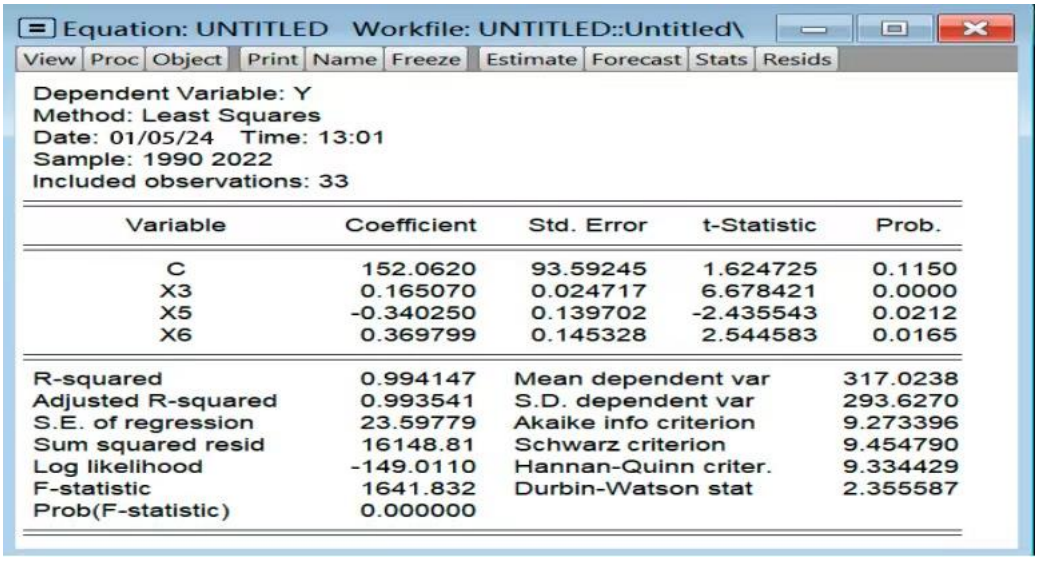
View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: Y
Method: Least Squares
Date: 01/05/24 Time: 12:58
Sample: 1990 2022
Included observations: 33

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-73.10231	21.29399	-3.433002	0.0018
X3	0.133823	0.049410	2.708410	0.0112
X4	-0.012910	0.130810	-0.098693	0.9221
X6	0.467504	0.194133	2.408169	0.0226

R-squared	0.992952	Mean dependent var	317.0238
Adjusted R-squared	0.992223	S.D. dependent var	293.6270
S.E. of regression	25.89467	Akaike info criterion	9.459164
Sum squared resid	19445.48	Schwarz criterion	9.640558
Log likelihood	-152.0762	Hannan-Quinn criter.	9.520197
F-statistic	1361.847	Durbin-Watson stat	2.172120
Prob(F-statistic)	0.000000		

Figure 16 Simple regression outputs for X3, X4 and X6



Equation: UNTITLED Workfile: UNTITLED::Untitled\

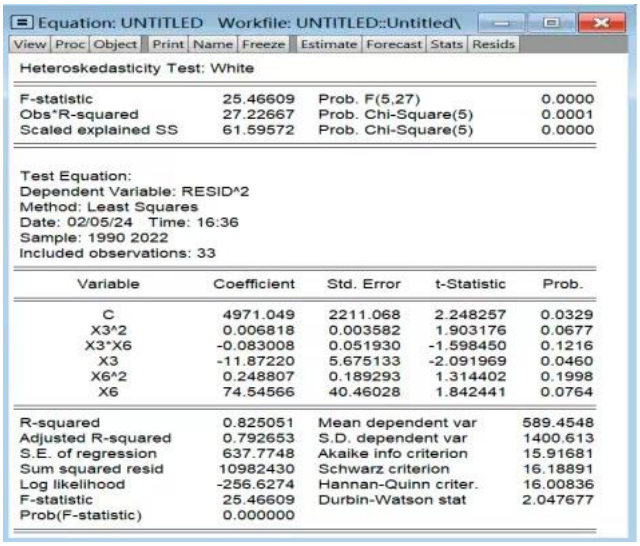
View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: Y
Method: Least Squares
Date: 01/05/24 Time: 13:01
Sample: 1990 2022
Included observations: 33

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	152.0620	93.59245	1.624725	0.1150
X3	0.165070	0.024717	6.678421	0.0000
X5	-0.340250	0.139702	-2.435543	0.0212
X6	0.369799	0.145328	2.544583	0.0165

R-squared	0.994147	Mean dependent var	317.0238
Adjusted R-squared	0.993541	S.D. dependent var	293.6270
S.E. of regression	23.59779	Akaike info criterion	9.273396
Sum squared resid	16148.81	Schwarz criterion	9.454790
Log likelihood	-149.0110	Hannan-Quinn criter.	9.334429
F-statistic	1641.832	Durbin-Watson stat	2.355587
Prob(F-statistic)	0.000000		

Figure 17. Simple regression outputs for X3, X5 and X6



Equation: UNTITLED Workfile: UNTITLED::Untitled\

View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Heteroskedasticity Test: White

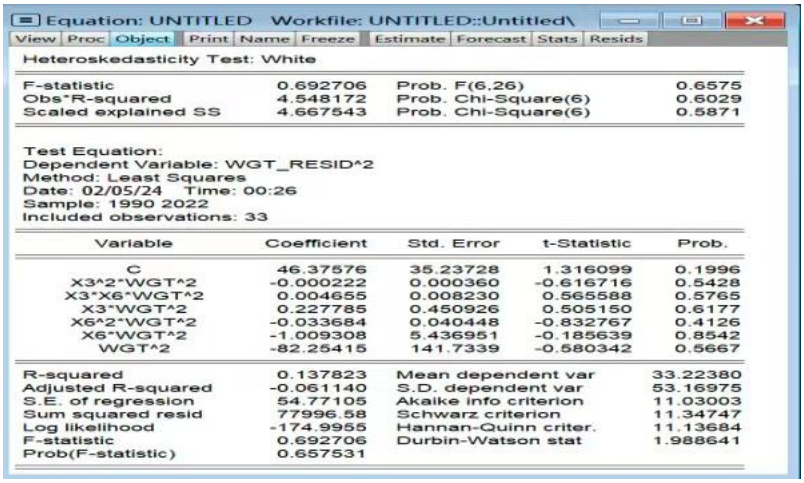
F-statistic	25.46609	Prob. F(5,27)	0.0000
Obs*R-squared	27.22667	Prob. Chi-Square(5)	0.0001
Scaled explained SS	61.59572	Prob. Chi-Square(5)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 02/05/24 Time: 16:36
Sample: 1990 2022
Included observations: 33

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4971.049	2211.068	2.248257	0.0329
X3^2	0.006818	0.003582	1.903176	0.0677
X3*X6	-0.083008	0.051930	-1.598450	0.1216
X3	-11.87220	5.675133	-2.091969	0.0460
X6^2	0.248807	0.189293	1.314402	0.1998
X6	74.54566	40.46028	1.842441	0.0764

R-squared	0.825051	Mean dependent var	589.4548
Adjusted R-squared	0.792653	S.D. dependent var	1400.613
S.E. of regression	637.7748	Akaike info criterion	15.91681
Sum squared resid	10982430	Schwarz criterion	16.18891
Log likelihood	-256.6274	Hannan-Quinn criter.	16.00836
F-statistic	25.46609	Durbin-Watson stat	2.047677
Prob(F-statistic)	0.000000		

Figure 18. Test for heteroscedasticity



Equation: UNTITLED Workfile: UNTITLED::Untitled\

View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Heteroskedasticity Test: White

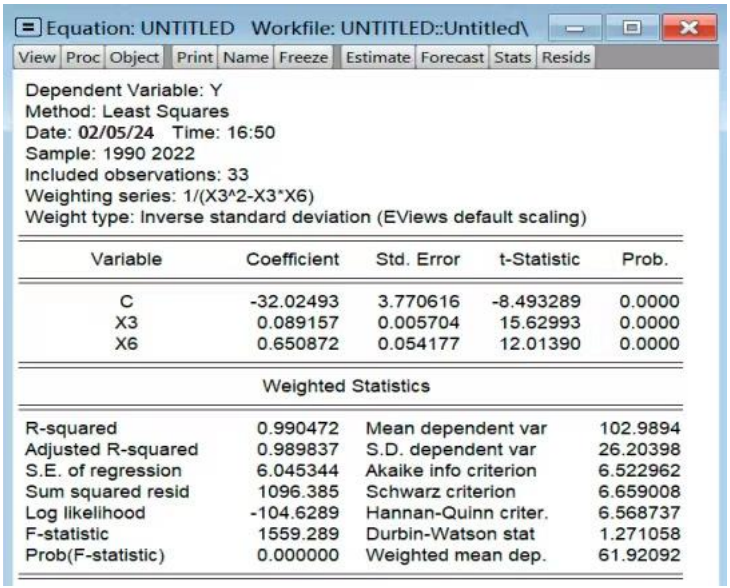
F-statistic	0.692706	Prob. F(6,26)	0.6575
Obs*R-squared	4.548172	Prob. Chi-Square(6)	0.6029
Scaled explained SS	4.667543	Prob. Chi-Square(6)	0.5871

Test Equation:
Dependent Variable: WGT_RESID^2
Method: Least Squares
Date: 02/05/24 Time: 00:26
Sample: 1990 2022
Included observations: 33

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	46.37576	35.23728	1.316099	0.1996
X3^2*WGT^2	-0.000222	0.000360	-0.616716	0.5428
X3*X6*WGT^2	0.004655	0.008230	0.565588	0.5765
X3*WGT^2	0.227785	0.450926	0.505150	0.6177
X6^2*WGT^2	-0.033684	0.040448	-0.832767	0.4126
X6*WGT^2	-1.009308	5.436951	-0.185639	0.8542
WGT^2	-82.25415	141.7339	-0.580342	0.5667

R-squared	0.137823	Mean dependent var	33.22380
Adjusted R-squared	-0.061140	S.D. dependent var	53.16975
S.E. of regression	54.77105	Akaike info criterion	11.03003
Sum squared resid	77996.58	Schwarz criterion	11.34747
Log likelihood	-174.9955	Hannan-Quinn criter.	11.13684
F-statistic	0.692706	Durbin-Watson stat	1.988641
Prob(F-statistic)	0.657531		

Figure 19. Heteroskedasticity corrected white test



Equation: UNTITLED Workfile: UNTITLED::Untitled\

View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

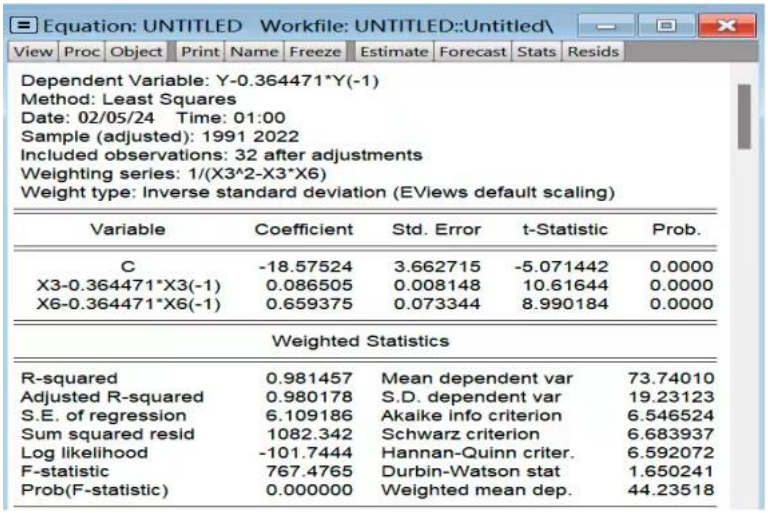
Dependent Variable: Y
Method: Least Squares
Date: 02/05/24 Time: 16:50
Sample: 1990 2022
Included observations: 33
Weighting series: 1/(X3^2-X3*X6)
Weight type: Inverse standard deviation (EViews default scaling)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-32.02493	3.770616	-8.493289	0.0000
X3	0.089157	0.005704	15.62993	0.0000
X6	0.650872	0.054177	12.01390	0.0000

Weighted Statistics

R-squared	0.990472	Mean dependent var	102.9894
Adjusted R-squared	0.989837	S.D. dependent var	26.20398
S.E. of regression	6.045344	Akaike info criterion	6.522962
Sum squared resid	1096.385	Schwarz criterion	6.659008
Log likelihood	-104.6289	Hannan-Quinn criter.	6.568737
F-statistic	1559.289	Durbin-Watson stat	1.271058
Prob(F-statistic)	0.000000	Weighted mean dep.	61.92092

Fig. 20 Test of autocorrelation (D.W. method)



Equation: UNTITLED Workfile: UNTITLED::Untitled\

View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: Y-0.364471*Y(-1)
Method: Least Squares
Date: 02/05/24 Time: 01:00
Sample (adjusted): 1991 2022
Included observations: 32 after adjustments
Weighting series: 1/(X3^2-X3*X6)
Weight type: Inverse standard deviation (EViews default scaling)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-18.57524	3.662715	-5.071442	0.0000
X3-0.364471*X3(-1)	0.086505	0.008148	10.61644	0.0000
X6-0.364471*X6(-1)	0.659375	0.073344	8.990184	0.0000

Weighted Statistics

R-squared	0.981457	Mean dependent var	73.74010
Adjusted R-squared	0.980178	S.D. dependent var	19.23123
S.E. of regression	6.109186	Akaike info criterion	6.546524
Sum squared resid	1082.342	Schwarz criterion	6.683937
Log likelihood	-101.7444	Hannan-Quinn criter.	6.592072
F-statistic	767.4765	Durbin-Watson stat	1.650241
Prob(F-statistic)	0.000000	Weighted mean dep.	44.23518

Fig. 21 Corrected autocorrelation results