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RESEARCH ARTICLE

Aggregate-Level Accounting Information Contains GDP Incremental Information: The Case of China

Mu Sun[1*], Cristina del Campo[2], Julián Chamizo-González[3], Elena Urquía-Grande[4]

[1,2,4] Faculty of Economics & Business, Department of Financial Administration and Accounting, Complutense University of Madrid, 28040 Madrid, Spain

[3] Faculty of Economics & Business, Department of Accounting, Autonomous University of Madrid, 28049 Madrid, Spain

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***Corresponding Author:**

musun@ucm.es

ABSTRACT

Existing research wants to find the relationship between accounting earnings and country-level GDP usually using the aggregate earnings indicator based on accounting earnings data. However, the research on the relationship between GDP and accounting information often lacks a theoretical basis. The gaps in accounting standards in different countries leads to differences in the accounting of items in the financial statements, making in-depth discussions on this topic necessary. Therefore, the present study takes China's current accounting standards and conducts in-depth research and verification of its data availability, international comparability, and adaptability of existing research models. First, we checked the most critical existing research model on aggregate earnings and did not find strong evidence to support that existing research. Secondly, from the empirical point of view it uses the four elements of the earnings-based GDP model as independent variables to find the relationship between company-level earnings and country-level GDP. The results found that income contains the most incremental information on GDP, that depreciation of fixed assets has a strong positive effect, and that changes in tax policy leads to unexpected effects on GDP. Furthermore, this study found no evidence to support incremental GDP information contained in employee salaries item. The present research complements the theoretical basis for forecasting GDP from aggregate-level accounting information data and contributes to future research in the proposed new model.

INTRODUCTION

Macroeconomics serves as the external environment for economic operations, exerting significant influence on businesses, investors, and even governments. Predicting the macroeconomic development of a country has consistently been a hot topic in academic research. However, since the outbreak of the global financial crisis, global stock markets have witnessed substantial volatility. Furthermore, amid the lingering uncertainties of the global economy, the COVID-19 global pandemic has introduced a new wave of turbulence. Currently, with the global economy yet to fully recover, events such as the Russia-Ukraine conflict and conflicts in Israel have once again disrupted global economic stability. Therefore, in the current environment of economic uncertainty, studying the macroeconomic GDP information embedded in micro-level corporate accounting data will contribute

to observing the macroeconomy from a micro perspective, providing new evidence for research on the utility of accounting.

Existing research takes total income as the object, analyzes the information it contains, and further studies the impact of microenterprise information on the macroeconomy. Early studies used aggregate earnings to explore its role in macroeconomic research. Some studies (Cready & Gurun, 2010; Kothari et al., 2006; Patatoukas, 2014; Shivakumar, 2007; Shivakumar & Urcan, 2014) have focused on the impact of aggregate income information on inflation. While some studies (e.g. Ball et al., 2009; Choi et al., 2016; Gallo et al., 2016; Gkougkousi, 2014; Patatoukas, 2014; Son & Jeong, 2022) considered the relationship between total earnings information and the market relationship between returns.

Furthermore, some studies also focused on the relationship between aggregate earnings and macroeconomic growth. For example, (Abdalla & Carabias, 2022; Konchitchki & Patatoukas, 2014; Lalwani & Chakraborty, 2020; Son & Jeong, 2022) provide evidence that aggregate earnings information contains information about changes in GDP in future quarters.

As the economy main engine, examining the incremental GDP information contained in accounting information is of great significance for predicting future economic growth. Also, when investigating the internal relationship between microeconomics and macroeconomics, most studies focus on how macroeconomics affects microeconomic decision-making (Sun et al., 2022, 2023). Examining the correlation between firm-level accounting information and national-level economic growth can contribute to theoretical research on the usefulness of accounting information. Nevertheless, so far, relevant research is still scarce. The macroeconomic information contained in micro-enterprise accounting information cannot be quantified and widely used. Moreover, the existing international evidence research on the relationship between GDP and accounting information often lacks a theoretical basis.

In view of the differences in the accounting standards of different countries, it is necessary to conduct an in-depth discussion on each single sample. As the world's second largest economy, China's economy is developing rapidly. However, due to the rapid update of accounting standards, it is difficult for existing research to capture effective financial data. Therefore, an in-depth discussion on the international comparability and adaptability of its data is also of practical significance for the study of this topic.

The research questions in this study are defined as follows:

RQ. 1: Is company-level earnings information reliable to test the income-based GDP model?

RQ 2: Can traditional aggregate earnings model explain China's economic growth?

To achieve this objective, first, this research briefly reviews the existing literature to improve the theoretical basis of this topic. Next, it uses China data to verify the existing research model on aggregate earnings. Then, it tests the sample data's performance in the income-based method's GDP component factors, and finally, it reaches interesting conclusions.

LITERATURE REVIEW

In this section, a literature review on the existing research on aggregate earnings, the development of national economic accounting theory and the international comparability of China's economic data is conducted. It constitutes the theoretical basis of this study.

Aggregate earnings

In the early stages of aggregate earnings research, literature extensively employed it to establish a connection between a company's earnings information and macroeconomics. Pioneering this

exploration, Kothari et al. (2006) extended the study of income information to the aggregate level, discovering that aggregate earnings contain information about future inflation in the United States. Subsequent studies, such as (Cready & Gurun, 2010; Patatoukas, 2014; Shivakumar, 2007; Shivakumar & Urcan, 2014), affirmed the inclusion of inflation information or information related to future discount rates in aggregate earnings.

The company's earnings information represents the level of profitability of the company. Listed companies with higher earnings can often bring higher returns to the stock market, a point of view scholars has widely accepted. However, in some studies, researchers have discovered different phenomena. For example, in an analysis of the aggregate earnings from the US market data, Kothari et al. (2006) found that aggregate earnings are negatively correlated with stock market returns, while Gkougkousi (2014) reached a similar conclusion in his research based on the bond market. These results lead to believe that the aggregate-level of accounting information has unique information, generating scholars' enthusiasm for aggregate earnings. The aggregate earnings is an indicator based on the company's earnings information. It is the integration of company-level accounting earnings information and can reflect the overall level of accounting earnings.

Kothari et al. (2006) pointed out that the negative correlation is due to the discount rate. They believe that the increase in aggregate earnings can increase investors' expectations of interest rates. Ball et al. (2009)found that the aggregate earnings negatively correlate with the previously expected US market returns, suggesting that aggregate earnings do not reflect more new information content.

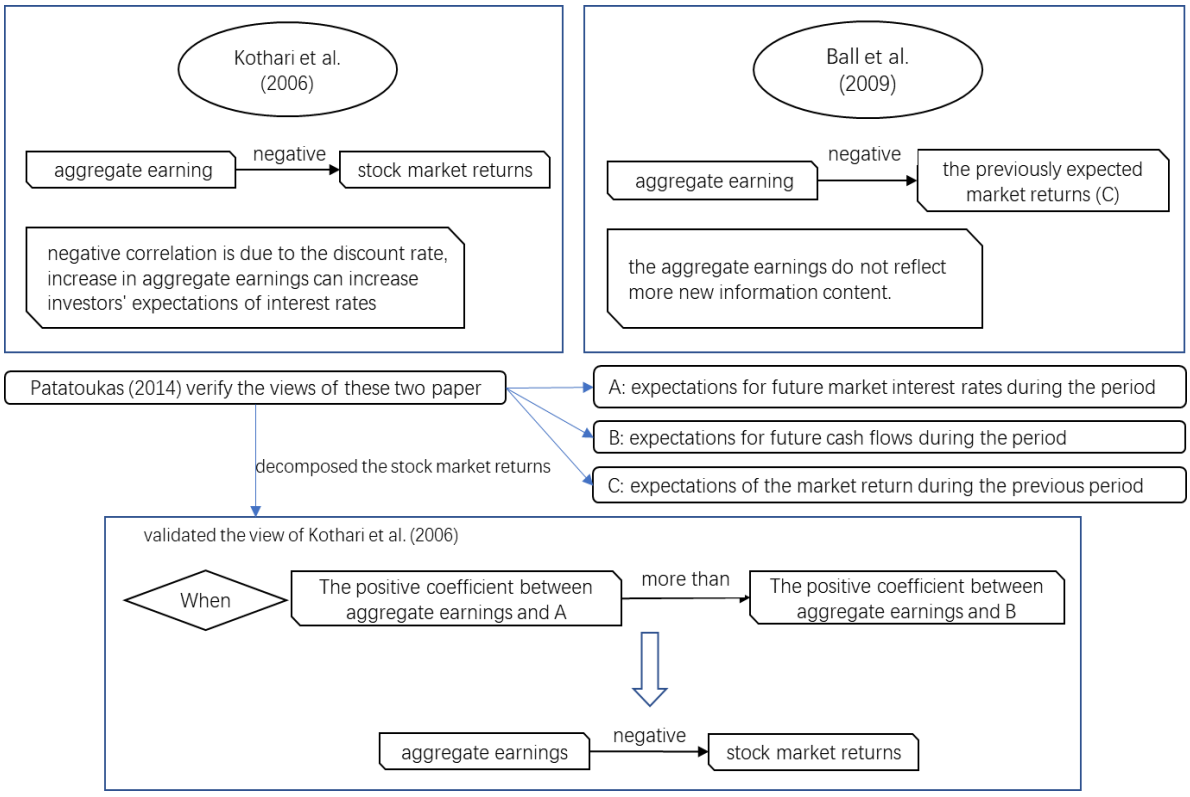


Figure 1: Mainstream views of aggregate earnings

In order to verify the views of these two papers, Patatoukas (2014)decomposed the stock market returns according to Campbell (1991) method: expectations for future market interest rates during the period, expectations for future cash flows during the period, and the expectations of the market return during the previous period. He validated the view of Kothari et al. (2006) that the aggregate earnings are positively correlated with the expected interest rates and the expected future cash

flows. Specifically, when aggregate earnings are negatively correlated with stock market returns, the positive correlation between aggregate earnings and expected interest rates is greater than the positive correlation between aggregate earnings and future cash flows. To facilitate the understanding of the relationship between these studies, see Figure 1.

Later, Choi et al. (2016) found that the aggregate earnings relates positively to the US market returns. Moreover, they confirmed the results of Kothari et al. (2006), that the discount rate does cause their negative relationship. Bailey and Lai (2020) modeled the aggregate earnings time series using principal components analysis, finding that the key to the relation between the aggregate earnings and the US market returns lies primarily in the expected component.

Also, several studies have focused on the relationship between aggregate earnings and macroeconomic growth. Early Kothari et al. (2006) showed that aggregate earnings positively correlate with macroeconomic growth indicators such as industrial output, GDP, and personal consumption to better explain the relationship between enterprises and capital markets. Konchitchki and Patatoukas (2014) confirmed that aggregate earnings growth is positively correlated with the US future nominal GDP growth and can predict future economic growth. They also found that aggregate earnings contained more quantitative forecast information than professional predictions.

Abdalla and Carabias (2022) decomposed firm-level earnings into special items and earnings before special items. They found that aggregate special items in the Income Statement can better predict the US future GDP growth. Ball et al. (2019) investigated whether considering the stability of company-level earnings will increase the information of aggregate earnings to future real GDP of the US, discovering that the aggregate is tilted towards firms with smoother earnings. Lalwani and Chakraborty (2020) have studied the correlation between aggregate earnings and the real GDP growth in eight countries. They found that aggregate earnings can improve the real GDP growth forecasts by merging aggregate earnings information. Son and Jeong (2022) also validated the predictive ability of aggregate earnings on GDP through South Korea's data.

According to the review of the existing literature, the aggregate earnings index is a comprehensive reflection of the company's horizontal return, with unique information content (e.g. Gallo et al., 2016; Gkougkousi, 2014; Patatoukas, 2014). It can have a specific explanatory power for stock market returns and future macroeconomic activity results. However, in the sector of the usefulness of accounting information, the research on applying various indicators based on accounting information in the macroeconomic field is incomplete.

Theories of national accounts

The GDP represents the market value of all the economic society's final products using production factors in a certain period. It is an essential indicator of economic activity and reflects the total output value of a country or region in a certain period. As a core indicator of national accounts, GDP is vital in reflecting economic development and macro service decision-making.

According to the website of the Statistical Commission of the United Nations Department of Economic and Social Affairs (UNDESA, 2022), the national accounts are based on the economic theory, comprehensively using statistics, accounting, mathematics, and other means to describe and measure the economic operation process and results of a country (or region) in a certain period. Also, according to (UNDESA, 1993) the economic growth rate can be measured by GDP growth. There are three methods for calculating GDP, namely, the production approach, the income approach, and the expenditure approach that are briefly explained below.

a) Production approach. GDP is the total value of the final production. It calculates how much value is contributed at each stage of production. GDP is equal to the total output of each industrial sector minus the intermediate sales of various industrial sectors, that is, the value created by the production

factors owned by each industrial sector, indicating the concept of an added value. The formula for calculating GDP by the production approach is:

$$\mathrm{GDP} = \mathrm{grossvalueofoutput} - \mathrm{valueofintermediateconsumption} \quad (1)$$

b) Income approach. Since GDP is the added value of production factors, these added values are also equivalent to their income. Therefore, GDP is also equal to the cost of each department's expenditure on obtaining these factors. Specifically:

$$\mathrm{GDP} = \mathrm{wage} + \mathrm{interest} + \mathrm{profit} + \mathrm{rent} + \mathrm{indirecttax} + \mathrm{enterprisetransferpayment} + \mathrm{depreciation} \quad (2)$$

c) Expenditure approach. It accounts for the fact that GDP is separated from the production process, and it accounts for GDP from another perspective. According to the final product destination, the whole society purchases its total output, GDP. The final product's purchase in the social system is divided into four categories: consumers, enterprises, governments, and foreign units. Therefore:

$$\mathrm{GDP} = \mathrm{consumption} + \mathrm{investment} + \mathrm{governmentspending} + \mathrm{netexport} \quad (3)$$

The GDP accounting theory shows that although the meanings of the production-based and income-based methods are different, the explanations are the same. Therefore, the values of GDP production method and each country's income method are almost identical after adjustment. Earnings information at the company level is an essential component of GDP. Moreover, the company-level as the economy's main body is the core of the economic system for the expenditure method. It affects the accounting of GDP, but it also affects consumers, governments, and foreign units in the whole system. It shows the company's important position in the entire economic system. As the company's most fundamental value indicator, accounting earnings should have a meaningful impact on GDP calculation from a theoretical perspective. This paper hopes to quantify this impact through an empirical perspective.

International comparability of China's economic data

From the early days of the founding of the People's Republic of China to the early days of China's policy "Reform and Opening", China's national accounts' core indicator was the National Income of the Material Product System (MPS) arising from the Soviet Union. After China implemented the policy "Reform and Opening" to meet macroeconomic management needs, China National Bureau of Statistics (NBS) began to study the GDP index of the System of National Accounts (SNA) formulated by the United Nations. In 1985, it carried out GDP accounting and gradually transitioned from National Income accounting to GDP accounting. In 1993, GDP completely replaced National Income as the core indicator of China's national economic accounts.

Nowadays, China's SNA (NBS, 2022) has adopted the basic accounting principles, contents, and methods of the United Nations 1993 SNA, UNDESA (1993), so the GDP data is internationally comparable. After the new accounting system's change, the China NBS has revised the quarterly GDP's historical data, making the quarterly GDP time series since 1992 internationally comparable.

METHODOLOGY, INSTRUMENTS, AND SAMPLE

Sample

This paper aims to investigate the relationship between microdata at the company level and macro data at the country level. To reach that objective, we selected the quarterly macroeconomic data released by the China government, together with Chinese listed companies' quarterly financial data (Song et al., 2017). We only focused on listed companies because the listed company's financial reports' data is uniform, while Chinese SMEs' financial data are challenging to obtain and are not uniform.

For the macro level, we use China's national quarterly GDP data. We downloaded the GDP data corresponding to the micro-enterprise financial statement interval from the China NBS.

We use the quarterly report of all issued A-share listed companies in China as micro-level data. It must be pointed out that China's accounting system adopted new accounting standards in 2007, and the accounting system has undergone tremendous changes. Hence, we chose to use the reports from the first quarter of 2009 to the third quarter of 2019 due to conservative accounting considerations. We obtained the quarterly reports of these listed companies from the China Stock Market & Accounting Research Database (CSMAR) Database1. CSMAR is one of China's most commonly used financial-economic databases, as it has a high degree of integrity for Chinese data. From CSMAR, we collected the completed balance, profit, and cash flow statements of all A-share listed companies for all 43 quarters from the first quarter of 2009 to the third quarter of 2019. A-shares are denominated in Chinese yuan and traded on the Shanghai and Shenzhen stock exchanges.

Simultaneously, we needed to screen out ST-type listed companies. According to the China Securities Regulatory Commission (CSRC) definition, the ST (Special Treatment) mark means that these companies have abnormal financial or other conditions and are warned of delisting risk. Therefore, these companies were not used for our analysis.

We also deleted the original data subsidiary reports from the original data and only retained the parent company's consolidated statements to prevent earnings from being repeatedly included in the data. Then, we merged the balance sheet and the income statement to facilitate unified access to data. Furthermore, cumulative data in all financial reports and the cumulative quarterly GDP need to be adjusted to the current value-added.

Finally, as we want to use the Konchitchki and Patatoukas (2014) method to calculate aggregate earnings, the company's market value is also needed on the date of the financial report announcement to be used as weight. Hence, we collected the corresponding market value data, also from CSMAR. Because some of the data is missing, we completed the missing data with the aid of the RESSET database. RESSET database2 is another of the most commonly used financial and economic databases in China, as it has high credibility of integrity for Chinese data. Nevertheless, in the end, to provide a sound basis, some (over a thousand, less than one percent of the total sample) incomplete records had to be discarded.

Variables and methodology

We use our sample for the first research question to confirm previous studies' reliability on aggregate earnings and GDP.

We refer to Konchitchki and Patatoukas (2014) practice for measuring aggregate earnings. First, the company's net profit P for the current quarter is divided by the company's total revenue R for the current quarter to obtain the profit margin E, which is multiplied by the company's market value at the end of each quarter divided by total market value weight W:

$$AE_{i,t} = \frac{P_{i,t}}{R_{i,t}} \times W_{i,t} \quad (4)$$

Konchitchki and Patatoukas (2014) model is shown in formula (5):

$$g_{q+k} = \alpha_k + \beta_k \Delta X_q + \varepsilon_{q+k} \quad (5)$$

[1] CSMAR, http://us.gtadata.com/

[2] RESSET, http://www.resset.cn/enindex

where g_{q+k} is the GDP growth for quarter q + k, forecasted by professional analysts, k= 1, 2, 3, 4, and ΔX_q is aggregate accounting earnings growth for quarter q.

We must point out that this model cannot directly use data from other regions as it is not possible to get the analyst's historical forecast data as they did. Some studies (e.g. Lalwani & Chakraborty, 2020; Sumiyana et al., 2019) have changed the definition of g_{q+k} in the model to directly use the model for testing. However, it changes the content of the original model. The g_{q+k} in their study is not the professional analysts forecast value, but the direct GDP change.

Therefore, we only test the linear regression of aggregate earnings growth (ΔX_q) to GDP growth (ΔGDP_q) for quarter q. The model is as follows:

$$\Delta GDP_q = c + \beta_k \Delta X_q + \varepsilon_{q+k} \quad (6)$$

Model (6) tests whether aggregate earnings added value will affect the GDP added value. Our difference from previous studies is that researchers (e.g. Abdalla & Carabias, 2022; Lalwani & Chakraborty, 2020; Sumiyana et al., 2019) typically use quarter-to-quarter GDP growth rates, but their models do not discuss the impact of seasonal or other factors on quarter-on-quarter GDP. Therefore, for robustness, we use the year-on-year growth rate of GDP used in most existing studies (e.g. Choi et al., 2016; Gallo et al., 2016; Son & Jeong, 2022).

For our second research question, we use company-level data to test the reliability of China's income-based GDP method. According to the "China 2022 Statistical Yearbook" (NBS, 2022), when using the income-based method to calculate GDP, it is:

$$GDP = CompensationofEmployees + Nettaxesonproduction + Depreciationofassets + Operatingsurplus \quad (7)$$

According to the Chinese NBS definition of the income method to measure GDP, its four components can be interpreted as the four financial accounts in the financial statements. The "compensation of employees" could be approximately equal to the "employee salaries payable" account disclosed in the balance statements. "Net taxes on production" could roughly be equivalent to the "operating tax surcharge" account in the income statements. "Fixed asset depreciation" directly finds the same account in the cash flow statement, and "operating surplus" would be approximately equal to the "income from operations" account in the income statements. Because we want to study whether this microdata will have an impact on the country's macro-level to verify the reliability of China's income-based GDP model, we build the following model:

$$GDP_q = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \varepsilon \quad (8)$$

where: X_1= employee salaries payable, X_2= operating tax surcharge, X_3= fixed asset depreciation, X_4= income from operations.

Based on the above literature, we sort out the collected financial reports. First, we find the corresponding accounting subjects in the collected samples according to the four items in the income-based GDP model and sort them in time series. However, the sample initially includes quarterly reports from all companies. So, we need to adjust all the variables to turn the cumulative value into a quarterly added value. That allows the data to contain more information about changes in the corresponding quarter, while the GDP data is also the adjusted quarterly added value. Next, we sort these companies into quarters.

According to the Chinese NBS definition of GDP calculation by the income-based method, when the value-added of any one of the four variables of an enterprise in a period is negative, it will be recorded as 0 when calculating GDP. Currently, the variable whose value is negative for this firm no longer

contributes to GDP. Therefore, we removed all negative values in the variables and replaced them with 0.

Furthermore, the fixed asset depreciation is only disclosed three times a year according to Chinese law, namely the initial report on January 1, the semi-annual report on June 30, and the annual report on December 31. Therefore, we use the quarterly reports of other variables, namely, the company's semi-annual and annual reports. After adjusting the cumulative value to the added value every half year, the quarterly fixed assets are used as the weighted average to calculate fixed assets depreciation for each quarter.

Finally, we obtain the aggregated added value of each variable for each quarter. Simultaneously, we also use the existing research to calculate the weighting method of aggregate earnings, the company's market value for weighting, and all variables' aggregate value. We will test the unweighted and weighted variables separately to verify whether weighting can optimize the model.

Unless otherwise indicated, all calculations were carried out using Eviews X12.

4. RESULTS AND DISCUSSION

4.1 Aggregate earnings impact test on GDP.

First, we test the model (6) formula. Since the model independent variable and dependent variable data are time series data, they need to pass the unit root test to ensure their stability. The Augmented Dickey-Fuller test (ADF) evaluates the null hypothesis that a unit root is present in a time series sample. The results are shown in Table 1.

Table 1: GDP, ΔGDP_q and aggregate earnings ADF test results.

Augmented Dickey-Fuller test statistic				
Variable	Abbreviation	Exogenous	t-Statistic	Prob.
GDP Growth	GDP_G	Constant	-3.135641	0.0330
Aggregate Earnings Growth	X_G	Constant	-6.968622	0.0000

Table 2: Model (6) test results.

Dependent Variable: GDP_Q. Sample: 2009Q1 2019Q3; Included observations: 39 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.091254	0.016673	5.473287	0.0000
X_G	-0.001327	0.003948	-0.336141	0.7387
R-squared	0.003045			
Adjusted R-squared	-0.0239			

The GDP growth (GDP_G) and the aggregate earnings growth (X_G) can directly pass the ADF test with intercept as both are significative (Prob < 0.05), which means both variables are stationary.

Table 2 shows the linear regression test results using model (6). We can see that the p-value of X_G (aggregate earnings growth) is not significative (Prob > 0.05), accepting the null hypothesis, which means that growth in aggregate earnings and GDP growth are not statistically correlated in our tests. Hence, we find no evidence to support the inclusion of GDP growth information in aggregate earnings.

In the first test, the data did not yield results similar to the research such as Konchitchki and Patatoukas (2014). However, we noticed that some research did not consider the stationarity of time

series data, and we do not rule out the possibility of spurious regression existence that often produces extraordinary model-fitting results.

4.2 Reliability of the income-based GDP model

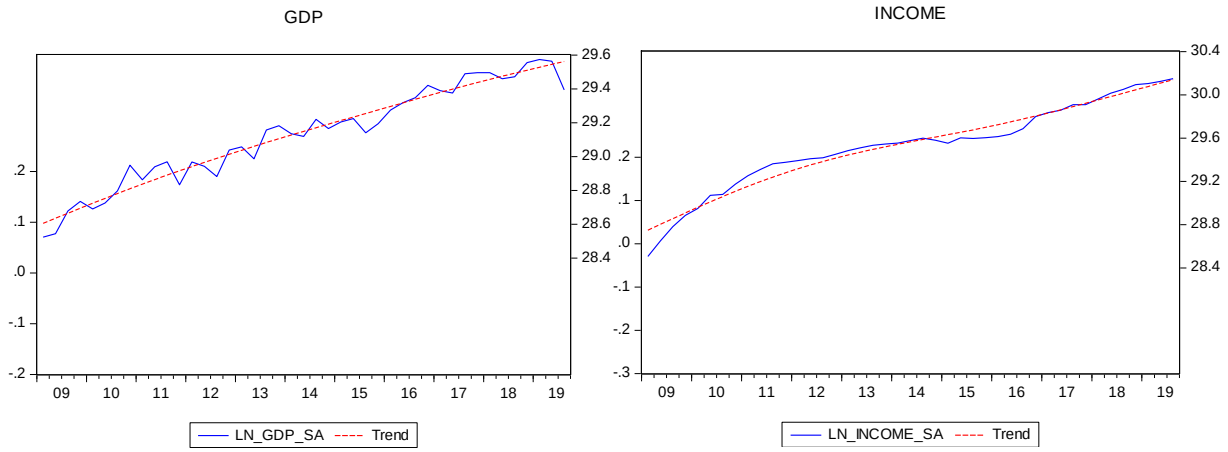
This part will use model (8) to test the weighted and unweighted four variables. We first adjusted all four variables for robustness using the EViews X12 seasonal adjustment module. Seasonal adjustment is a process of estimating and removing seasonal influence from the time series to reveal the seasonal series characteristics or fundamental trends. Also, to reduce the scale, we took the natural logarithm of all variables. The ADF unit root test results for all variables are shown in Table 3.

Table 3: Model (8) weighted variables ADF test results.

Augmented Dickey-Fuller test statistic					
Variable	**Abbreviation**	**Operation**	**Exogenous**	**t-Statistic**	**Prob.**
GDP	LN_GDP_SA	None	Constant, Linear Trend	-4.163829	0.0108
X1	LN_SALARIES_SA	First-order difference	None	-7.100841	0.0000
X2	LN_TAX_SA	First-order difference	None	-6.863319	0.0000
X3	LN_DEPRECIATION_SA	None	Constant	-3.802469	0.0058
X4	LN_INCOME_SA	First-order difference	None	-8.141344	0.0000

Table 3 shows that GDP can pass the ADF test after seasonal adjustment. Except for the X_3 variable (fixed asset depreciation), the other three variables, X_1 the employee salaries payable, X_2 the operating tax surcharge, and X_4 the income from operations can pass the ADF test only after they undergo a first-order difference (Prob < 0.05).

Figure 2 shows graphs of all five variables. All variables were analyzed using the Hodrick-Prescott filter method. Since this study uses quarterly data, the lambda value is set to 1600. On the overall trend, we can see that all variables have almost the same increasing trend. The depreciation and income curves are stable, the seasonally adjusted GDP shows only quarterly volatility, and the salaries show irregular fluctuations in the graph. In addition, the tax curve fluctuated wildly between 2015-2017.



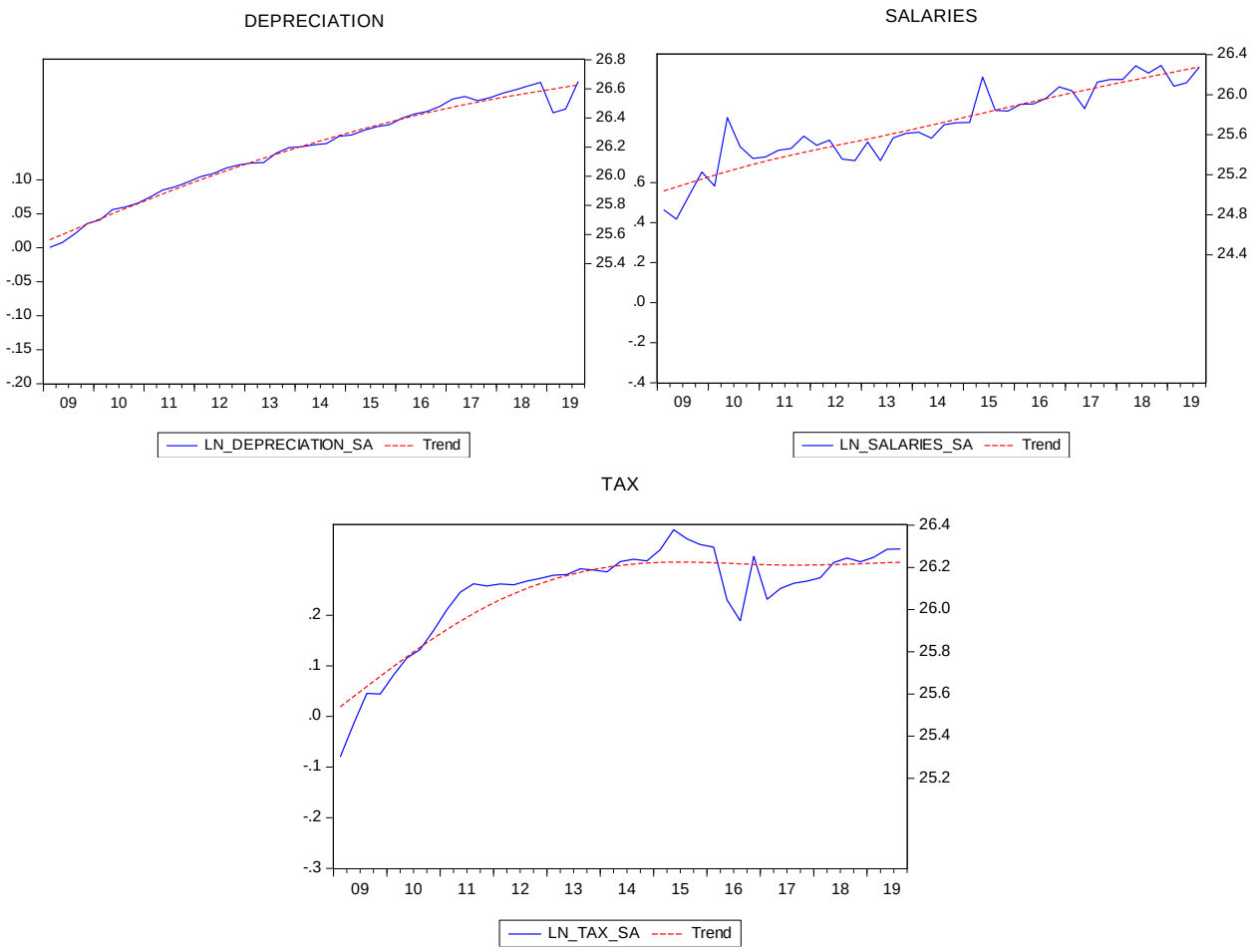


Figure 2: Graphs of all variables.

The linear regression test results using model (8) with weighted variables are shown in Table 4. We can see that the p-value of all four independent variables is bigger than 0.05, accepting the null hypothesis, which means that all four independent variables in the test have no statistical effect on the dependent variable GDP. However, similar to our aggregate earnings test results, this test's R-squared is also very small, and the model does not fit well. These dependent variables, including aggregate earnings, are weighted by market value, and we cannot say that using market value weighting can optimize this model.

Table 4: Model (8) linear regression test results using weighted variables.

Dependent Variable: GDP_ SA; Sample: 2009Q1 2019Q3; Included observations: 42 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.61E+12	3.39E+11	13.59691	0.0000
D_SALARIES_SA	240.5305	1496.585	0.16072	0.8732
D_TAX_SA	96.78095	497.7051	0.194454	0.8469
DEPRECIATION_SA	156.3618	515.6109	0.303255	0.7634
D_INCOME_SA	-2.468759	20.01768	-0.123329	0.9025
R-squared	0.009122			
Adjusted R-squared	-0.097999			

In the third test, we examined unweighted data. Again, we performed the seasonal adjustment and natural log processing for time series data. The ADF test results of the four unweighted independent variables and the dependent variable GDP are presented in Table 5. All five variables, GDP, the employee salaries payable X_1, the operating tax surcharge X_2, the fixed asset depreciation X_3 and the income from operations X_4 can pass the ADF test after both logarithmic and seasonal adjustments.

Table 5: Model (8) unweighted variables ADF test results.

Augmented Dickey-Fuller test statistic					
Variable	Abbreviation	Operation	Exogenous	t-Statistic	Prob.
GDP	LN_GDP_SA	None	Constant, Linear Trend	-4.1638	0.0108
X1	LN_SALARIES_SA	None	Constant, Linear Trend	-4.8161	0.0019
X2	LN_TAX_SA	None	Constant	-3.7845	0.0061
X3	LN_DEPRECIATION_SA	None	Constant	-3.2898	0.0221
X4	LN_INCOME_SA	None	Constant, Linear Trend	-5.131	0.0008

Table 6 shows the linear regression test results using unweighted variables to import model (8). Surprisingly, the p-values of the operating tax surcharge, the fixed asset depreciation, and the income from operations are all less than 0.05, rejecting the null hypothesis within the 0.05 significance level. Hence all three variables have an impact on the dependent variable GDP. Furthermore, the adjusted R-square value is 0.95, indicating that our model has a high degree of fit. The positive coefficients of the income from operations and the fixed asset depreciation prove the importance of earnings and depreciation in GDP accounting. Unexpectedly, the operating tax surcharge's coefficient is negative, and the variable employee salaries payable has no significant impact.

Table 6: Model (8) linear regression and robustness test results using unweighted variables.

Dependent Variable: LN_GDP_SA; Sample: 2009Q1 2019Q3; Included observations: 43				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	8.909038	1.190115	7.485861	0.0000
LN_SALARIES_SA	0.038603	0.06989	0.552339	0.5840
LN_TAX_SA	-0.154891	0.073546	-2.106052	0.0419
LN_DEPRECIATION_SA	0.41337	0.124606	3.317422	0.0020
LN_INCOME_SA	0.421467	0.109871	3.836024	0.0005
R-squared	0.955046			
Adjusted R-squared	0.950314			
Heteroskedasticity Test: White				
F-statistic	1.199451	Prob. F(8,34)	0.3285	
Breusch-Godfrey Serial Correlation LM Test:				
F-statistic	2.470483	Prob. F(2,36)	0.0988	

To verify the robustness of the test, we also performed a residual autocorrelation test (Breusch-Godfrey Serial Correlation LM Test) and heteroskedasticity test (Heteroskedasticity Test: White) on the regression results. The results of both tests (see Table 6) show that the null hypothesis cannot be rejected (Prob. > 0.05), demonstrating that neither residual autocorrelation nor heteroscedasticity is present in our model, indicating that the regression results of the model in this study are reliable and meaningful.

For the third test, we found (see Table 6) that the coefficient of the operating tax surcharge (LN_TAX_SA) is negative. To explore the reasons for this result, we draw a scatterplot of the operating tax surcharge and the GDP, as shown in Figure 3. According to Table 6, the operating tax surcharge has been inversely proportional to GDP in recent years, ultimately forming the results we saw. We believe this phenomenon is due to the Chinese government's reduction of taxes in recent years. In theory, tax cuts will negatively impact GDP, but they will also positively impact GDP indirectly, such as stimulating enterprises and employees' production enthusiasm.

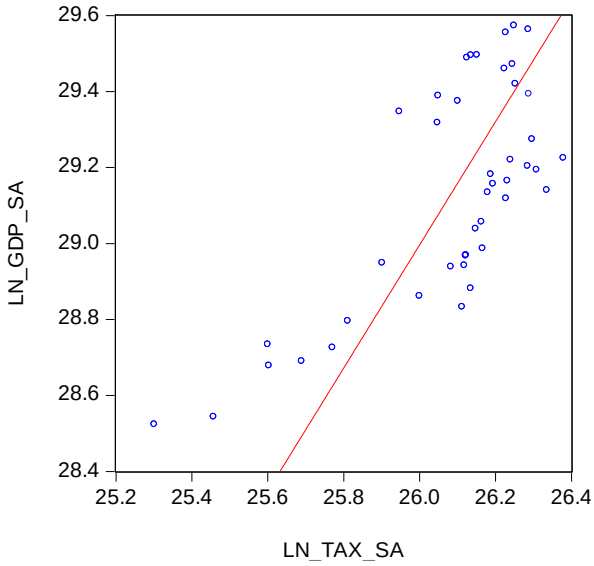


Figure 3: Scatter plot of operating tax surcharge and the GDP.

The absolute value of the additional coefficient of the operating tax surcharge (LN_TAX_SA) is almost one-third of income (LN_INCOME_SA) and depreciation (LN_DEPRECIATION_SA), which shows that it has little impact on our experiments, and our results have scientific significance.

As for the variable employee salaries payable (LN_SALARIES_SA) that have no significant impact. One of the reasons we consider is its complexity and rapid change. Although aggregate-level information has downplayed the impact of its micro-level changes. But this result confirms that it does not contain sufficient GDP information.

In addition, we considered whether using market capitalization to weigh the independent variables could better the model. The advantage of market value weighting is that the impact of company size on earnings can be ignored. Nevertheless, the variables weighted by market capitalization did not show a better fit (the results are shown in Table 4). In addition to the "fixed asset depreciation" of the weighted variables, other variables must pass the first-order difference before passing the ADF stationarity test. The consequences of difference can make the results more challenging to interpret. Therefore, we do not recommend weighing the variables in this study.

5. CONCLUSIONS

Current research on the relationship between microeconomics and macroeconomics is rapidly developing. However, the overall slowdown in global economic growth since the COVID-19 en the Ukraine conflict pandemic has become a reality. Against this backdrop, this study provides new ways of thinking about current uncertain macroeconomic forecasts. The present study not only contributes to the rationality of using aggregate-level data in China on a theoretical basis. At the same time, a four-factor test model based on the income method GDP accounting model is established according to the theory. This not only benefits future related research, but it also provides more information

for professional macro forecasters. In addition, this study can also provide theoretical and empirical support for the usefulness theory of accounting information.

A review of existing literature found that research on the relationship between microeconomics and macroeconomics is mainly based on examining the relationship between aggregate earnings and economic development indicators such as GDP. However, some studies lack a theoretical basis, and a few do not even discuss the international comparability of accounting standards of target economies. The present research believes that micro-accounting information needs to be established based on local accounting standards and needs to be adapted to local conditions.

We found no evidence to support the existing research, that the aggregate earnings contain information on GDP growth. That is, we found no statistical correlation between aggregate earnings growth and GDP growth in the Chinese sample.

Furthermore, we were able to confirm that using market capitalization to weight variables concerning existing research did not optimize the regression results of the model. Also, the present research found that the most critical is the impact of companies' earnings on GDP. Earning is the core goal of an enterprise, and there is no doubt that more earnings will bring more GDP. The development of GDP needs the support of the development of more companies' earnings.

One of the limitations of this research is that there is no in-depth horizontal research on the impact of taxation on GDP, which can become an exciting research direction to be discussed in-depth and quantified in the future. Also, exploring the impact of taxation on GDP is a compelling issue that should be discussed in-depth. In general, the overall research on the amount of macro information contained in other accounting information is incomplete and needs further development.

Finally, it must be pointed out that each country has different specific implementation methods in the data collection process. Therefore, this also brings some limitations to the research on this topic. How to quantify these differences is also an interesting future research line.

FINDINGS AND RECOMMENDATIONS

Conflicts of interest

The authors declare no conflicts of interest with respect to the research, authorship, and/or publication of this article.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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