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Stock price analysis based on the research of multiple linear regression macroeconomic variables

Fei Wang^{1†}, Wanling Chen², Bahjat Fakieh³, Basel J.A Ali⁴¹ Guangzhou Xinhua University, Guangzhou, 510520 China² Research Center for International Trade and Economics, Guangdong University of Foreign Studies, Guangzhou, 510006, China³ Department of Information System, Faculty of Computing and Information Technology, King Abdulaziz University, Jeddah, Saudi Arabia⁴ Applied Science University, Al Eker, Kingdom of Bahrain

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Abstract

The article uses SPSS statistical analysis software to establish a multiple linear regression model of short-term stock price changes of domestic agricultural listed companies. The article uses a stable time series based on the ARMA model for stable agricultural value-added, fiscal expenditure and market interest rates. The regression method is used to study its impact on the stock price index. Compared with the existing stock forecasting methods, this method has simple data collection and no specific requirements for data selection, and the prediction results have a high degree of fit. Therefore, this method is suitable for most stocks.

Keywords: multiple linear regression, macroeconomic variables, listed companies, financial performance, stock prices
AMS 2010 codes: 62J05

1 Introduction

After the 19th National Congress of the Communist Party of China, the government has successively introduced 'Pilot Project for Leading Enterprises to Drive Industrial Development' 'Small and Medium-sized Enterprise Technology Innovation Fund Modern Agriculture Project' and other agricultural support policies. Related agricultural products are listed on the market [1]. As a result, the company has also become the focus

[†]Corresponding author.Email address: wf18027565820@163.com

of attention. Therefore, studying the financial performance of agricultural-related listed companies helps public investors understand the development status of agricultural listed companies and can also provide a particular reference for the government to formulate relevant policies.

Some scholars analysed the company's financial performance that completed the share-trading reform, used the entropy method to explore its correlation and concluded that the correlation between financial performance and stock price is very weak. Some scholars have chosen multiple linear regression methods to discuss and analyse the impact of company performance and stock prices [2]. They concluded that the most influential is the profitability and development ability of listed companies in agricultural products processing. Some scholars have used panel data models to analyse the relationship between company stock prices and profit levels to prove a significant correlation between the two. The CCR model verifies the correlation between financial indexes and stocks and evaluates the stock selection in the portfolio based on the correlation. Some scholars use multiple regression analysis models to find that earnings per share (EPS) and return on net assets are essential factors that affect listed companies' stock price fluctuations. Finally, they analysed whether the monetary policy issued by the country has a particular impact on the company's stock price. They obtained the conclusion that the impact of monetary policy on the stock price varies according to regional differences [3]. They used a variety of methods to examine the impact of financial performance on stock prices. They found that EPS, book value, dividend coverage, growth rates, and dividend yields positively correlate with stock prices. In contrast, dividends per share and price-earnings ratios are negatively correlated with stock prices.

There are relatively few studies on the impact of financial indicators on stock prices of agricultural listed companies. Our selection of financial indicators is not comprehensive enough, and the analysis method is mainly based on multiple statistical regression. Because of this, this article analyses from the four perspectives of profitability, growth ability, operating ability and solvency [4]. We select appropriate financial information indicators and apply the econometric panel data model to analyse the relevance of stock prices of listed agricultural companies in China to financial performance. We use the above methods to study the impact of the financial performance of Chinese agricultural listed companies on stock prices.

2 Data, variable selection and model design

2.1 Data selection

The data in this article comes from the Sina Finance Market Center. After excluding companies with insufficient financial data, we selected 8 financial indicators of 14 listed agricultural companies from 2013 to 2019 as sample data.

2.2 Variable selection

This article selects a total of 8 financial indicators from 4 aspects of profitability, growth ability, operating ability and solvency: EPS (X_1), central business profit margin (X_2), primary business income growth rate (X_3), net asset growth rate (X_4), Total asset turnover rate (X_5), current asset turnover rate (X_6), quick ratio (X_7) and interest payment multiple (X_8).

2.2.1 Profitability and its index selection

Profitability refers to the company's ability to make profits under normal operating conditions. In today's market, the competition between industries and products is becoming increasingly fierce, and the stock market is volatile [5]. Therefore, analysing the company's profitability is of great significance to the company's sustainable development and operation. In addition, this can provide a reference for stakeholders to make financial decisions and play a key role in predicting future cash flows. Among the various indicators for analysing profitability, EPS and paramount business profitability have been widely used as core indicators.

EPS (X_1). EPS is the company's net profit per share for 1 year. EPS equal the company's total profit after tax

divided by the company's total equity. EPS is one of the indicators reflecting the company's operating results. It is the critical basis for stakeholders to evaluate profitability, and it is also the most critical indicator of the company's profitability. The calculation formula is:

$$\text{Earnings per share} = \frac{\text{Gross profit for the period} - \text{preferred stock dividends}}{\text{Total equity at the end of the period}} \quad (1)$$

Prominent business profit margin (X_2). The profit margin of the leading business indicates the ratio of the profit earned by the company's main activities to its net income over some time. This indicator plays a significant role in evaluating the company's profitability. Calculated as follows:

$$\text{Profit margin of main business} = \frac{\text{Main business profit}}{\text{Main business income}} \times 100\% \quad (2)$$

2.2.2 Growth ability and its index selection

Growth ability refers to the development trend of the company at this stage and in the future. Whether it can expand its scale and increase profits can reflect the company's development prospects. The company's growth capability analysis can judge the company's future cash flow changes in operating activities and better analyse the company's future financial fluctuations [6].

Primary business income growth rate (X_3). The main business income growth rate is the income earned by the company's main activities during this period minus the income earned by the company's main activities during the previous period and then divided by the company's main activities during the above period arrive at the ratio of income. The calculation formula is:

$$\text{Growth rate of main business income} = \frac{\text{Main business income in the current period} - \text{Main business income in the previous period}}{\text{Main business income in the previous period}} \times 100\% \quad (3)$$

The growth rate of net assets (X_4). The growth rate of net assets represents the ratio of the company's high net assets during the current period to the total net assets in the previous period. This indicator is used to indicate the growth progress of the company's capital scale and measure the company's ability to grow [7]. The calculation formula is:

$$\text{Growth rate of net assets} = \frac{\text{Net assets at the end of the period} - \text{net assets at the beginning of the period}}{\text{net assets at the beginning of the period}} \quad (4)$$

2.2.3 Operational capability and its index selection

Operational capacity refers to the company's ability to use its assets to obtain benefits. Functional ability plays a decisive role in the company's solvency and profitability, and it is the core content of financial analysis. Operating ability is mainly manifested in the turnover rate of various assets. Among various asset turnover rates, total asset turnover and current asset turnover are the leading indicators. As a result, they can better reflect the company's operational capabilities.

The turnover rate of total assets (X_5) [8]. This indicator is very critical for evaluating the company's operational capabilities. The calculation formula is:

$$\text{Turnover of total assets} = \frac{\text{Net operating income}}{\text{Average total assets}} \times 100\% \quad (5)$$

The turnover rate of current assets (X_6). The turnover rate of current assets refers to the net income ratio of the company's production and operation to the total average current assets during the period [9]. This indicator plays a significant role in evaluating the company's operational capabilities. The calculation formula is:

$$\text{Turnover of current assets} = \frac{\text{Net income from main business}}{\text{Average total current assets}} \times 100\% \quad (6)$$

2.2.4 Debt solvency and its index selection

Solvency refers to the ability of the company to repay the debts it borrows from the outside world when it reaches the time of return. Is it possible to repay the due debts promptly [10]? The former is the primary indicator to measure short-term debt solvency, and the latter is the primary indicator to measure long-term debt solvency.

Quick ratio (X_7). When explaining the solvency of a company or enterprise in a short period, it can be analyzed by comparing the quick ratio. The calculation formula is:

$$\text{Quick ratio} = \frac{\text{Current assets} - \text{inventory} - \text{prepaid accounts} - \text{prepaid expenses}}{\text{Current liabilities}} \times 100\% \quad (7)$$

Interest payment multiple (X_8). The interest payment multiple is also called the interest earned multiple. It is the primary basis for measuring the company's long-term debt repayment ability. It also refers to the company's ability to use operating profits to repay debt and interest. The calculation formula is:

$$\text{Interest payment multiple} = \frac{\text{Profit before interest}}{\text{Interest expense}} \quad (8)$$

2.3 Model design

The panel data is an $X \times Y$ data matrix. What is recorded in the matrix is a particular data index of X objects at Y time nodes. In recent decades, a variety of statistical methods have emerged, including panel data analysis methods. Panel data is generally analysed by Eviews software, so this paper selects Eviews6.0 software for research and analysis. The models used in this article are as follows:

$$Y_{it} = a_i + \beta X_{it} + \varepsilon_{it} \quad (9)$$

$i = 1, 2, \dots, 14$ indicates the cross-section mark. $t = 1, 2, 3, 4, 5$ represents the time stamp. Y_{it} is the dependent variable, which represents the stock price of a company i in year t . a_i is a constant term, and the intercept terms between i individual member equations are not the same. We use it to explain personal effects. That is to say. It is used to explain the effects of variables that are neglected to explain individual differences in the model. X_{it} is the independent variable, where i represents the company and t represents the time. β is the coefficient of the independent variable and ε_{it} is the bias term, which explains the negligence in the model caused by the changes of individual members and time. Combining the eight independent variables and 1 dependent variable of this study, the model is:

$$Y = a_i + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \varepsilon \quad (10)$$

$$\partial_t F + \partial_x G = -2aF - \langle z_x, \nabla S_1(z) \chi_1 + \nabla S_2(z) \chi_2 \rangle \quad (11)$$

Among them $F = \frac{1}{2} \langle z, Mz_x \rangle$ and $G = S_0(z) + \frac{1}{2} \langle z_t, Mz \rangle$. We use Eq. (11) and z_x as the inner product

$$\langle z_x, Mz_t \rangle + \langle z_x, Kz_x \rangle = \langle z_x, -aMz \rangle + \langle z_x, \nabla S_0(z) \rangle + \langle z_x, \nabla S_1(z) \chi_1 \rangle + \langle z_x, \nabla S_2(z) \chi_2 \rangle \quad (12)$$

Among them

$$\begin{aligned} \langle z_x, Kz_x \rangle &= \left\langle \begin{pmatrix} p_x \\ q_x \\ v_x \\ w_x \end{pmatrix}, \begin{pmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ -1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \end{pmatrix} \begin{pmatrix} p_x \\ q_x \\ v_x \\ w_x \end{pmatrix} \right\rangle = \left\langle \begin{pmatrix} p_x \\ q_x \\ v_x \\ w_x \end{pmatrix}, \begin{pmatrix} v_x \\ w_x \\ -p_x \\ -q_x \end{pmatrix} \right\rangle \\ &= \langle p_x, v_x \rangle + \langle q_x, w_x \rangle + \langle v_x, -p_x \rangle + \langle w_x, -q_x \rangle \\ &= \langle p_x, v_x \rangle + \langle q_x, w_x \rangle - \langle p_x, v_x \rangle - \langle q_x, w_x \rangle \\ &= 0 \end{aligned} \quad (13)$$

$$\begin{aligned}
\langle z_x, -aMz \rangle &= -a \langle z_x, Mz \rangle = -a = \left\langle \begin{pmatrix} p_x \\ q_x \\ v_x \\ w_x \end{pmatrix}, \begin{pmatrix} 0 & -1 & 0 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} p \\ q \\ v \\ w \end{pmatrix} \right\rangle = -a \left\langle \begin{pmatrix} p_x \\ q_x \\ v_x \\ w_x \end{pmatrix}, \begin{pmatrix} -q \\ p \\ 0 \\ 0 \end{pmatrix} \right\rangle \\
&= -a (\langle p_x, -q \rangle + \langle q_x, p \rangle) \\
&= a (\langle p_x, q \rangle + \langle -q_x, p \rangle) \\
&= a (\langle z, Mz_x \rangle)
\end{aligned} \tag{14}$$

Get

$$\begin{aligned}
\langle z_x, \nabla S_0(z) \rangle - \langle z_x, Mz_t \rangle &= -\langle z_x, -aMz \rangle - \langle z_x, \nabla S_1(z) \chi_1 \rangle - \langle z_x, \nabla S_2(z) \chi_2 \rangle \\
&= -a \langle z_x, Mz_x \rangle - \langle z_x, \nabla S_1(z) \chi_1 \rangle - \langle z_x, \nabla S_2(z) \chi_2 \rangle \\
&= -2aF - \langle z_x, \nabla S_1(z) \chi_1 + \nabla S_2(z) \chi_2 \rangle
\end{aligned} \tag{15}$$

As well as

$$\begin{aligned}
\partial_t F + \partial_x G &= \frac{1}{2} \partial_t \langle z, Mz_x \rangle + \partial_x \left[S_0(z) + \frac{1}{2} \langle z_t, Mz \rangle \right] \\
&= \frac{1}{2} \langle z_t, Mz_x \rangle + \frac{1}{2} \langle z, Mz_{xt} \rangle + \partial_x S_0(z) + \frac{1}{2} \langle z_{xt}, Mz \rangle + \frac{1}{2} \langle z_t, Mz_x \rangle \\
&= \partial_x S_0(z) + \langle z_t, Mz_x \rangle + \frac{1}{2} \langle z, Mz_{xt} \rangle + \frac{1}{2} \langle z_{xt}, Mz \rangle
\end{aligned} \tag{16}$$

Because of $\langle z_t, Mz_x \rangle = -\langle z_x, Mz_t \rangle$, $\langle z, -Mz_{xt} \rangle = -\langle z_{xt}, Mz \rangle$, so $\partial_t F + \partial_x G = \partial_x S_0(z) - \langle z_x, Mz_t \rangle$. We only need to prove $\partial_x S_0(z) = \langle z_x, \nabla S_0(z) \rangle$, because:

$$\begin{aligned}
\partial_x S_0(z) &= \partial_x \left[-\frac{\lambda}{4} (p^2 + q^2)^2 - \frac{1}{2} (v^2 + w^2) \right] = -\lambda (p^2 + q^2) (pp_x + qq_x) - (vv_x + ww_x) \\
\langle z_x, \nabla S_0(z) \rangle &= -\lambda (p^2 + q^2) pp_x - \lambda (p^2 + q^2) qq_x - vv_x - ww_x
\end{aligned} \tag{17}$$

Based on the above formula

$$\partial_t F + \partial_x G = -2aF - \langle z_x, \nabla S_1(z) \chi_1 + \nabla S_2(z) \chi_2 \rangle \tag{18}$$

3 Empirical test analysis

3.1 Unit root test

We must analyse whether there are unit roots in a sequence we choose. Once we find that there is a unit root, we call this series a non-stationary time series. Such a sequence will lead to spurious regression when performing regression analysis [11]. Therefore, to ensure the data's stability, we must first perform a unit root test on the selected sequence.

First, we use the obtained P-value to indicate whether the data contain unit roots. When the obtained P-value is < 0.05 , we think that the data does not have a unit root, proving that the data is stable. Otherwise, it is considered that the data has a unit root, and the data is not stable.

As can be seen from Table 1, the P-value obtained by LLC inspection of the stock prices of 14 agricultural listed companies and eight financial index data from 2013 to 2019 is 0.0045, and that of IPS inspection, Fisher-ADF inspection, and Fisher-PP inspection. The P values are all 0.0000, and the P values of the 4 test methods are all < 0.05 . The research results show that the data in this paper do not contain unit roots. Therefore, the data in this article are all stable, and we can conduct an empirical analysis on them.

Table 1 Unit root test results of 14 listed agricultural companies' stock prices and eight financial indicators from 2013 to 2019

Method	Statistics	P-value	Section	Number of samples
LLC inspection	−1.60228	0.0045	117	2039
IPS inspection	−6.18041	0.0000	117	2039
Fisher ADF test	541.92500	0.0000	117	2039
Fisher PP inspection	974.79500	0.0000	117	2223

3.2 Model selection

According to the characteristics of this article, we select the variable intercept model as the evaluation method. The Hausman test method is usually used to select a specific model [12]. Assume no correlation between the individual influence and the independent variable in the random influence model. The first step is to do a regression analysis of the original data. Then, we selected and used the random influence variable intercept model on the model, and the estimated results are shown in Table 2.

Table 2 Random influence variable intercept model estimation results

Variable	Regression coefficient value	Standard error	t statistic	P value
C	8.561713	1.408724	6.077637	0.0000
X1	5.595259	1.723203	3.247011	0.0013
X2	0.141354	0.029785	4.745799	0.0000
X3	−0.005861	0.005546	−1.056962	0.2915
X4	0.011152	0.005377	2.074074	0.0390
X5	−0.419311	3.996603	−0.104917	0.9165
X6	0.792386	1.721791	0.460210	0.6457
X7	0.124284	0.126187	0.984921	0.3255
X8	0.000119	2.84E−05	4.172194	0.0000

In the second step, Hausman's test method is used to determine whether the conclusion obtained by the random influence model analysis is appropriate. The results obtained by this method are shown in Table 3.

It can be seen from Table 3 that the model statistic is 17.111761, and the P-value is 0.0290 and <0.05. Therefore, a fixed-effect variable-intercept model should be established. The calculated results of the model are shown in Table 4.

Table 3 Hausman test results

Test items	Chi-squared statistics	Chi-squared distribution	P value
Random section	17.111761	8	0.029000
Coefficient of determination R2	0.669120	Mean of the dependent variable	13.523210
Modified coefficient of determination R2	0.642187	The standard deviation of the dependent variable	7.541425
Regression standard error	4.511087	AIC guidelines	5.926266
Residual sum of squares	5250.276	Schwartz Guidelines	6.211857
Log-likelihood estimate	−807.6773	Hannan-Queen Criterion	6.040817
F statistics	24.844660	DW statistics	0.945865

Table 4 Fixed influence variable intercept model estimation results

Variable	Regression coefficient value	Standard error	t statistic	P value
C	8.871968	1.132411	7.834585	0.0000
X1	4.867471	1.757197	2.770021	0.0060
X2	0.140536	0.033170	4.236831	0.0000
X3	−0.007156	0.005579	−1.282692	0.2008
X4	0.009793	0.005454	1.795464	0.0738
X5	2.303726	4.240355	0.543286	0.5874
X6	−0.333951	1.840312	−0.181464	0.8561
X7	0.013605	0.136984	0.099314	0.9210
X8	0.000127	2.86E−05	4.426097	0.0000

3.3 Analysis of empirical results

From Table 4, the model equation can be obtained as:

$$V = 8.871968 + 4.86747080281X_1 + 0.140535518671X_2 - 0.00715553983237X_3 + 0.0097928613261X_4 + 2.30372560619X_5 - 0.333951126952X_6 + 0.0136045182504X_7 + 0.000126695946192X_8 + \varepsilon$$

The F statistic of this model is 24.84466. The results show that the accuracy of this model is high, and the explanation is robust. The corresponding P-value is 0.000000, indicating that all explanatory variables of the model are significant overall. The explanatory variables (selected eight indicators) explain the stock price is feasible. Therefore, the data of the eight indicators we selected from the four aspects of profitability, growth ability, operating ability and solvency are reliable.

The coefficient of determination R^2 in the process of the fitness test is 0.669120. This result is still relatively ideal in the time series model. The reason may be that the company's finances are sometimes affected by some uncertain factors, causing the current stock price to fluctuate. However, from the perspective of the degree of fit, these fluctuations have little effect on the test index data, and they can be effectively analysed and studied.

The DW statistic is 0.945865, indicating that the residuals of the model follow a normal distribution. Thus, the data has a solid ability to explain the model.

Among the selected eight financial indicators, the P-value of EPS () is 0.0060, and the P-value of the profit margin of the leading business () is 0.0060. They have passed the significance test, and the regression coefficient is positive, showing a positive correlation with the stock price (V). The test results show that EPS are the most important indicator to measure profitability. When it changes, the stock price will also be affected. EPS have extremely high research significance for analyzing stock prices. The primary business profit rate has a considerable impact on stock prices. EPS and paramount business profitability are the most critical indicators for analysing profitability, which can significantly reflect the company's financial performance fluctuations. Investors' attention to the company can be more inclined to the strength of profitability, but it must also be combined with other indicators for a comprehensive analysis.

The P-value of the interest payment multiple (X_8) in other indicators is 0.0000, which has passed the significance test. The regression coefficient is positive, showing a positive correlation with the stock price (V). Judging from the test results, the data on interest payment multiples is reliable. This indicator can reflect the size of profitability and reflect the degree of guarantee of profitability to repay the debts due. Therefore, it is an essential indicator of a company's solvency.

In the remaining indicators, the net asset growth rate (X_4), total asset turnover rate (X_5), and quick ratio (X_7) have not passed the significance test, but the correlation coefficient is positive. This shows that it is positively correlated with stock prices. The primary business income growth rate (X_3) and current assets turnover rate (X_6) have not passed the significance test, and the correlation coefficient is negative. Failure to pass the significance test does not mean that it has nothing to do with its stock price, but the impact on the stock price is not as high as

other factors. However, these indicators cannot be ignored when analysing the impact of financial performance on the company's stock price. We have to analyse more comprehensively and systematically to bring the best benefits.

4 Conclusion

This article takes the financial data released by domestic agricultural listed companies in the 20 quarters from 2013 to 2019 as a sample, selects a panel data model and explores the impact of financial performance on stock prices from four aspects: profitability, growth ability, operating ability, and solvency. EPS are the most critical indicator of the profitability of agricultural listed companies, and investors are very concerned about EPS. Therefore, the quality of these three indicators will directly affect the level of profitability. However, only from a systematic perspective can we scientifically evaluate the factors affecting stock prices. Therefore, to prevent blind investment, investors should conduct a comprehensive inspection of the capabilities of agricultural listed companies in all aspects.

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