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Can Residual Income Model Explain Taiwan's Stock Price Movement? Evidence from VAR-based Cross Equation Restriction Test

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Abstract: This study tests the validity of the Residual Income Model (RIM) by employing VAR-based cross equation restrictions test proposed by Campbell and Shiller (1987). We estimate a bivariate stationary VAR using data of Taiwan's stock market index of the past ten years. The test results indicate that RIM is consistent with the data and is hence valid for Taiwan's stock valuation. The results also imply the main variables of RIM, residual income and book value, are intrinsic-value relevant indicators capable of explaining Taiwan's stock price movements. Therefore, investors can take advantage of the residual income valuation technique to predict future stock prices and assess investment risks in the markets.

Keywords: Residual Income Model (RIM), Cross Equation Restriction Test, Stock Valuation Model, Vector Autoregression (VAR)

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1. Introduction

Whether stock price movements can be explained by traditional dividend discount model (DDM) has been a well debated issue over the past two decades. Most evidence presented seems at odds with DDM (e.g., West, 1988; Campbell and Shiller, 1987; Fama and French, 1993; Gilles and LeRoy, 1991; LeRoy and Porter, 1981; Shiller, 1981). In response to these unsatisfactory findings, an alternative stock valuation model-the residual income model (RIM) was proposed in recent researches and it is often found to perform better than DDM in terms of its ability to evaluate, explain and forecast stock prices.[1] Theses results inspire

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[1] Bernard (1995), Penman and Sougiannis (1998), Dechow, Hutton, and Sloan (1999), Lee, Myers and Swaminathan (1999), Francis, Olsson and Oswald (2000), Jiang and Lee (2005), Lee (2006), Abarbanell and Bernard (1995), Frankel and Lee (1998), Lee (2007).

the current study to test the validity of RIM in explaining stock price movements in Taiwan.[2]

Previous studies testing valuation models mostly use the Ordinary Least Squares (OLS) regressions which were apt to result in the problem of spurious regression (Granger and Newbold, 1974; Phillips, 1986) and problematic variable relations that are identified by authors rather dictated by the theory. The VAR-based cross equation restriction test proposed by Campbell and Shiller (1987) which applies Sim's (1980) VAR model can solve the problems of spurious regression and test the variable relationship across multiple periods.[3] [4] With this approach, Campbell and Shiller (1987) show that DDM can imply testable restrictions for the entire coefficient system of the bivariate vector autoregression (BAVR) on stock prices and dividends. They use U.S. stock market data and reject the cross equation restrictions, similar to Shiller's (1981) findings in opposition to DDM. Jiang and Lee (2005) use similar cross equation restriction tests with U.S. stock market data and confirm the above mentioned finding that RIM outperforms DDM. Lee (2007) uses panel cointegration method to test the RIM-based Ohlson model and DDM by Taiwan data. He finds that the Ohlson model can forecast future stock price movements much more accurately than DDM. Building on these findings favorable to RIM as a valuation model, this paper attempts to examine the validity of RIM from the perspective of Taiwan's stock market. With reference to the existing RIM study with Taiwan's data which involves cross-section firm samples (Lee, 2007) and focuses on forecasting performances, we choose a different route by using the whole listed broad stock index and five listed industry indices in Taiwan as our sample objects. In addition, we employ the Campbell-Shiller (1987) VAR-based cross equation restriction testing approach to examine the validity of RIM. In all, our study is the first in Taiwan that combines the Campbell-Shiller (1987) testing approach with the residual income valuation model.

The bivariate VAR model we constructed involves the first difference of residual income and a spread which is based on a cointegration between price, book value and residual

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[2] Some value-relevant indicators, such as book to market value (B/P) and earnings-to-price ratio (E/P), have been shown to have predictive ability for stock price. (e.g., Fama and French 1992,1995;Campbell and Shiller 1988a ; Lakonishok, Shleifer, and Vishny 1994; Lee 1996,1998; Pontiff and Schall 1998; Lamont 1998)

[3] VAR framework proposed by Sim (1980) need to identify whether variable data is stationary by unit root test. After difference process and identifying that variable data are stationary, the variables can be used to construct VAR model. Therefore, spurious regression problem due to nonstationary variables series can be solved.

[4] An advantage of the VAR framework is that it can be used to generate alternative measures of the economic importance, not merely the statistical significance, of deviations from the present value relation. (Jiang and Lee , 2005)

income implied by RIM. We then derive the cross equation restrictions on the VAR coefficients imposed by RIM and implement the Wald test to obtain statistical evidence regarding the validity of RIM in explaining the stock price behavior. The evidence is positive across the six stock index markets considered, in support of the claim that stock price movement is consistent with or justifiable by the valuation model. The contribution of this study is to provide extra evidence from Taiwan on the validity of the RIM in stock valuation.

The remainder of this paper is organized as follows. Section 2 introduces theory of the residual income model. Section 3 describes the econometric model and data. Section 4 presents empirical results and Section 5 provides conclusions.

2. Theoretical Model-the Residual Income Model

Since previous studies indicated the failure of DDM in explaining stock price movements, researchers have shifted attention to work on the alternative valuation model-the residual income model (RIM). The history of RIM dates back to the work of Preinreich (1938), Edwards and Bell (1961), and Peasnell (1981,1982), and its increasing popularity among finance and accounting scholars has been attributed to the formalization of RIM by Ohlson (1991,1995) and Feltham and Ohlson (1995).

RIM assumes an accounting identity, the clean surplus relation (CSR), which posits that the change in book value is equal to earnings minus dividends.

$$B_t = B_{t-1} + X_t - D_t \tag{1}$$

where B_t is the book value of equity at time t, and X_t is the earnings for the period from t-1 to t. An important implication of the CSR is that dividends are defined broadly as the difference between earnings and change in book value, including not only cash dividends but also other forms such as share repurchases and acquisitions. Recently share repurchases tend to be more widely used by managers as an alternative way of distributing cash to shareholders and so RIM provides a broader dividends definition for valuation purposes. On the other hand, most studies of DDM tend to use narrowly defined cash dividends and ignore the important role of share repurchases (Jiang and Lee, 2005).[5]

The residual income (RI) is defined as earnings minus a charge for the beginning book value B_{t-1} as in:

$$RI_t = X_t - r \cdot B_{t-1} \tag{2}$$

[5] Dechow, Hutton and Sloan 1999; Francis, Olsson, and Oswald 2000; Lee, Myers and Swaminathan 1999; Frankel and Lee 1998.

where the charge being the product of the book value and the cost of equity capital r which is constant over time. Following Jiang and Lee (2005), this study incorporates CSR and RI in DDM and obtains RIM:

$$P_t = B_t + \sum_{i=1}^{\infty} \beta^i E_t[RI_{t+i}] \tag{3}$$

The RIM equation (3) means that current stock price equals current book value plus present value of expected future residual incomes, which explicitly becomes an important factor in influencing a firm's values.

3. Econometric Model and Data

3.1. Bivariate Vector Autoregression Model

We employ the Campbell-Shiller (1987) VAR-based cross equation restriction test to verify the validity of RIM. Our testing procedure begins with constructing the VAR model and then searches for the VAR restrictions implied by RIM. Following Jiang and Lee (2005), we assume that there exists a cointegration relationship between p_t (defined as $P_t - B_t$) and RI_t, and then define S_t as the spread between p_t and RI_t:[6]

$$S_t = p_t - \theta\, RI_t = (P_t - B_t) - \theta\, RI_t \tag{4}$$

Then, it can be shown that equation (3) can take the form of

$$S_t = (1+\theta)\sum_{i=1}^{\infty} \beta^i E_t \Delta RI_{t+i} \tag{5}$$

Consider a bivariate vector autoregression (BVAR) representation for ΔRI_t and S_t:

$$\begin{bmatrix} \Delta RI_t \\ S_t \end{bmatrix} = \begin{bmatrix} a(L), b(L) \\ c(L), d(L) \end{bmatrix} \begin{bmatrix} \Delta RI_{t-1} \\ S_{t-1} \end{bmatrix} + \begin{bmatrix} u_{1t} \\ u_{2t} \end{bmatrix} \tag{6}$$

where variables in the vector are stationary, and the polynomials in the lag operator L, i.e., a(L), b(L), c(L) and d(L), are all of order k. The BVAR can be stacked into a first-order VAR system as:

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[6] This is our preliminary assumption when constructing variables, which is verified in section 4.1 unit root tests.

$$\begin{bmatrix} \Delta RI_t \\ . \\ . \\ . \\ \Delta RI_{t-k+1} \\ S_t \\ . \\ . \\ . \\ S_{t-k+1} \end{bmatrix} = \begin{bmatrix} a_1, \cdots\cdots, a_k & b_1, \cdots\cdots, b_k \\ 1 & 0 \\ . & . \\ 1 & 0 \\ c_1 \cdots\cdots c_k & d_1 \cdots\cdots d_k \\ 0 & 1 \\ . & . \\ 0 & 1 \end{bmatrix} \begin{bmatrix} \Delta RI_{t-1} \\ . \\ . \\ . \\ \Delta RI_{t-k} \\ S_{t-1} \\ . \\ . \\ . \\ S_{t-k} \end{bmatrix} + \begin{bmatrix} u_{1t} \\ 0 \\ . \\ . \\ 0 \\ u_{2t} \\ 0 \\ . \\ . \\ 0 \end{bmatrix} \tag{7}$$

or compactly as:

$$z_t = Az_{t-i} + v_t$$

where matrix A is called the companion matrix of the VAR. The first-order VAR representation is useful because forecasts of the future values of z_t are obtained as

$$E\left[z_{t+k} \middle| H_t\right] = A^k z_t \tag{8}$$

where H_t includes current and past values of z_t (i.e. ΔRI_{t-j} and S_{t-j} for all $j \geq 0$).

We define g1′ and g2′ as row vectors with 2k elements, with all elements being zero except for the (k+1)th element of g2′ and the first element of g1′ being unity. Then, it follows that

$$\Delta RI_t = g1' z_t \text{ and } S_t = g2' z_t \tag{9}$$

We then rewrite restrictions in equation (5) by projecting RIM onto information set H_t:

$$g2' z_t = (1+\theta) \sum_{i=1}^{\infty} \beta^i \, g1' A^i z_t \text{ (1)} \tag{10}$$

Assuming a nonsingular variance-covariance matrix for u_{1t} and u_{2t}, equation (10) can be written as

$$g2' = (1+\theta) g1' \beta A (I - \beta A)^{-1} \text{ (2)} \tag{11}$$

Multiply both sides of equation (11) by (I - β A) to obtain

$$g2' (I - \beta A) = (1+\theta) g1' \beta A \text{ (3)} \tag{12}$$

Then, the restrictions are (4)

$$(1+\theta) a_i + c_i = 0, \text{ for all I} \tag{12.1}$$

$$(1+\theta) b_i + d_i = \frac{1}{\beta}, \text{ for i=1} \tag{12.2}$$

$$(1+\theta) b_i + d_i = 0, \text{ for i=2, 3,…,k} \tag{12.3}$$

Now the RIM in (5) is characterized by the cross-equation restrictions on the VAR coefficients in (7). If the null hypothesis that the data is consistent with the RIM restrictions in (12.1) to (12.3) is not rejected, this means that RIM is consistent with stock market valuations in Taiwan.

3.2. Data

This study employs two types of data from Taiwan Stock Exchange (TWSE): broad market index data and five industry index data. The data sample of direct variables, including earnings, book value, residual income, spans from 1998Q3 to 2008Q1. The data of indirect variables, including TAIEX (aggregate and industrial stock price indices), PB ratio, PE ratio are taken from the period of 1999Q1 to 2008Q2.[7] The five industry sectors selected for examination, including electronic, finance, plastic and chemical, electric machinery and cement, are chosen because these value-weighted indices have shown the highest growth in market capitalization in the past and hence are important industries.

4. Empirical Results

4.1. Unit Root Tests

Assuming the three variables appearing in the present value model in (3) are nonstationary, their representation in (5) then suggests a cointegration relation between $p_t = (P_t - B_t)$ and RI_t with the cointegrating vector (1, -1). That is, since the right-hand-side of (5) should be either zero, constant, or a mean-reverting process in a long-run equilibrium, the spread on the left-hand-side of (5) is necessarily stationary. By Augmented Dickey-Fuller (ADF) test and the Phillips-Perron test, we find P_t, B_t and RI_t series to be non-stationary and their first-differences I(0) stationary. Also, we obtain stationary S_t, confirming that p_t and RI_t are indeed cointegrated with a one-to-one relation, suggesting the RIM relation in (4) holds at least in the long run.

4.2. VAR-based Cross Equation Restriction Test

Upon imposing the cross-equation restrictions of RIM on VAR coefficients, we conduct the Wald test to learn whether data of the six stock market index is consistent with the pricing principle embodied in RIM. Table 1 shows the results of the Wald test for the VAR models estimated with lag lengths from one to four. For Taiwan's whole listed-stock data, except for the lag one model, χ^2 statistics for lags from two to four indicates the joint RIM restrictions are not rejected at all reasonable significance levels. For the industries, χ^2 statistics from a minimum of 0.02 to a maximum of 11.23 again show no rejection of the RIM restrictions at all significance level, except for the lag one and lag two models in

[7] Because no aggregate data of direct variables is available from the data source, they are calculated by multiplying PB ratio (stock price/book value per share) and PE ratio (stock price/earning per share) by the stock price index.

electronic and electric machinery industries which seem not consistent with RIM. These results indicate the null hypothesis that the Taiwan data is consistent with the restrictions based on RIM is not rejected as a rule. Stock price movements can be explained by the theoretical variables of RIM, i.e., book value, earnings and residual income, and this conclusion is empirically born out by Taiwan's stock market data.

Table 1: Results of RIM-based Cross Equation Restriction Test

Data / lag(q)	Whole Listed Stocks		Electronic Industry		Finance Industry	
	χ^2	*p*-value	χ^2	*p*-value	χ^2	*p*-value
1	5.86	0.0534*	15.98	0.0003***	1.50	0.4720
2	6.31	0.1772	14.14	0.0069***	1.71	0.7889
3	8.45	0.2073	10.03	0.1232	2.26	0.8940
4	10.90	0.2072	11.23	0.1892	2.41	0.9659
Data / lag(q)	Electric Machinery Industry		Cement Industry		Plastic And Chemical	
	χ^2	*p*-value	χ^2	*p*-value	χ^2	*p*-value
1	4.98	0.0828*	0.02	0.9883	4.68	0.7132
2	5.41	0.2481	1.25	0.8691	4.02	0.4034
3	5.90	0.4343	1.76	0.9402	6.39	0.3803
4	8.50	0.3865	1.71	0.9888	6.03	0.6441

Note: This table shows the results of VAR-based cross-equation restriction test with *, ** and *** indicating significance at 10%, 5%, 1% level, respectively. The null hypothesis is the RIM restrictions binding on VAR using the Taiwan data. The lag lengths (q) from one to four are all considered for each stock index market.

5. Conclusions

Since previous studies indicate the failure of DDM in explaining stock price movements, this study introduces the RIM as an alternative. We employ Campbell and Shiller's (1987) VAR-based cross equation tests to examine the validity of RIM in Taiwan's stock market valuation over the period 1998Q3 to 2008Q1. Our test results indicate that restrictions on the BVAR model based on RIM are typically not rejected by the Taiwan data. As for financial economics implications, our findings suggest that the variables of RIM, namely, residual income, book value and earnings, could provide useful information for stock market valuation. The residual income model appears capable of explaining Taiwan's stock price movements and hence can be useful for stock valuation and risk assessment purposes. Our findings are in agreement with those of Jiang and Lee (2005) and others. Moreover, RIM may provide Taiwan investors an adequate valuation tool to predict future stock prices and to control investment risks in financial markets. As for the debate in theoretical and empirical literature on whether price movements can be justified or explained by valuation

models, we provide some evidence favorable to RIM as a stock valuation theory and applied technique. Looking onward, similar VAR-based cross equation restriction tests as used in this article can potentially be applied to test other valuation models empirically, e.g., DDM, FCFM (free cash flow model), etc. Future studies can extend this common approach to assess the validity of alternative valuation models.

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