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Original citation & hyperlink:
Leong, KY, Ariff, M, Zarei, A & Bhatti, MI 2022, 'Bank stock valuation theories: do they explain prices based on theories?', International Journal of Managerial Finance, vol. 18.
https://doi.org/10.1108/IJMF-06-2021-0278

DOI 10.1108/IJMF-06-2021-0278
ISSN 1743-9132

Publisher: Emerald

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Manuscript to: International Managerial Finance

Revised: 25 January 2022

Acknowledgment: The authors wish to express their thanks for the constructive comments received from the participants at the Sydney Conference on Interdisciplinary Business & Economics Research and the 21st Malaysia Finance Association Conference (August 2020 in Kuala Lumpur). The authors take full responsibility for any remaining errors.

Bank stock valuation theories: Do they explain prices based on theories?

Abstract

This paper is motivated by lack of empirical evidence on the validity of stock valuation theories and their forecasting ability. Our findings reported are on *applicability* and *forecastability* of valuation theories. Four most-commonly-used theories are tested using banking-firm market data over 19-years in a stock market. Results produced useful findings: the variables in the theories are statistically significant and the coefficient of variation is about 82%. These statistics verify that theory-suggested variables significantly determine banking stock prices. Correspondingly, we find evidence corroborating the concordance of price forecasts over a five-year forward horizon using advanced forecast evaluating techniques. These two key findings add important insights on rational investor behavior, while validating why these valuation theories are popular in the finance industry, and why theories are taught in tertiary institutions.

Keywords: Stock valuation theories, Bank stocks, Bursa Malaysia, Forecasting prices, Concordance test

JEL Classification: G1, G2

Bank stock valuation theories: Do they explain/predict prices based on theories?

1. Introduction to Research Problem

This paper is motivated by a paucity of empirical evidence on bank stock valuation theories as well as on theory-based models' ability to forecast correctly forward-horizon stock prices. A review of the empirical literature on stock valuation reveals that there are scant studies on bank stock valuation. The extent and evidence of academic and policy implications of the theory-based valuation techniques for banking stocks has rarely been determined. More specifically, the existing sprawling body of literature particularly documents major concerns in this regard, pertaining to bank assets' opacity (Morgan, 2002; Flannery et al., 2013; Blau et al., 2017). Tim et al. (2020) likewise emphasize on the fundamental difficulties in valuation of the banking stocks given the specific peculiarities that distinguishes the nature and operation of banking businesses. From the practical standpoint however, unlike the prevailing limitations considering the distinctive regulatory framework of financial services firms, banking and non-banking industries are happily busy using stock valuation models for assessing prices for new issues, loan applications of listed firms, for example, as well as estimating merger gains in M&A cases. More specifically, we believe studying banks is a major area of interest. Considering the recent financial shocks destabilizing the credibility of financial institutions, assessing the safety and soundness of banks in securing individual, institutional and national wealth has received increased attention. Moreover, as the financial systems are becoming increasingly inter-connected and globalised, the stability of banks is crucial to maintaining economic health of all countries, including both emerging and developed markets. If one examines recent research conducted on the valuation models to predict stock prices – a common-place activity among financial analysts – the findings as to whether stock price forecasting is accurate in reality is seldom reported in the existing literature. Furthermore, the financial media taunts interested parties to use this and software-based models to help invest wisely.

Our motivation for undertaking this arduous research over several years is to find evidence if valuation theories are viable and if so, are theory-based fair *ex-ante* forecasts of actual prices that evolve in the matched forward period. These constitute the two research objectives of this study. It seeks to fill these gaps in the banking literature on what should be two major concerns of the banking industry and academia engaged in devising and proving theories. We build atop the existing body of empirical literature while offering additional accuracy tests following most recent developments in the works of Ho et al. (2016), Anesten et al. (2020) and Rizvi et al. (2020). Correspondingly, we offer a fresh perspective first on the application of four fundamental valuation techniques for bank stocks. Empirical evidence of income-based valuation techniques on the experience of financial institutions can be found in studies by Schoon (2015) and Kumar (2020). Likewise, there is evidence of few studies on the relative-type methods of equity valuations for financial firms (Nissim, 2013). Second, we use panel data to apply series of advanced testing to improve the forecasting precision and validation of the models in addressing the existing methodological gaps. More specifically, the adopted panel-data estimators are the Pooled OLS, One-way and Two-way Fixed Effects as well as the Random Effect models. The estimation process follows an identification of the regression parameters to obtain the fitted price values, which will then be compared against the actual prices via forecasting evaluation techniques. Much of our work uses advanced econometrics to reduce type II error in testing.[1] Third, we attempt to investigate the experience of the Malaysian banks given the country's significant financial development scores, dual-banking system, and high transparency and disclosure quality due to its improved regulatory oversights in the aftermath of the Global Financial Crises (Patel et al., 2002).

This study has two research questions on each of four valuation theories to explore evidence on the relevance of popular valuation models that are being used widely in the industry:

1. What is the empirical evidence that four theories to be operationalised as valuation models (in the methodology Section 3) about the validity of four valuation theories, can significantly explain bank stock price variability in a capital market?
2. What is the predictive accuracy of such operationalised model's forecast of forward bank prices using the four models and the actual price formation in the tested capital market?

These research questions are termed *applicability* (implying that the factors in the theories help explain the variability in bank stock price formation)

[1] Theil provides an advanced test if two vectors, one actual and the other forecasts, are close together (See Thiel, (1965). "Econometrics and Management Science: Their Overlap and Interaction". *Management science,* 11(8), B-200-B-212.

and *forecastability* (reflecting that the theory-based forecasts for a forward period are not significantly far off the actual banking stock prices. We uncover strong empirical evidence pointing to the relevance of several theory-embedded factors in driving stock price formation in the *Bursa* Malaysia while the forecast prices utilising the four theories are very close to the actual prices. This suggests price formation is likely to be based on rational investors observing/making forecasts of factors embedded in the four theories. These results cannot be accidental without alluding to rationality based on using information on factors driving bank stock prices.

The rest of this paper is organised as follows. Section 2 briefly describes the four most widely used theories to test their validity and forecasting ability. The literature on valuation theories/studies are reviewed to provide support for the existence of these theories, and the lack of studies relating these theories to banking firms (Section 2.2). The data sources, the variable set-up and the test models are explained along with the hypotheses in Section 3. The findings are described Section 4 leading to the conclusion in Section 5.

2. The Models Selected for Testing

The four models to be tested are stated in the following sub-section and a brief literature review is offered in Section 2.2 on banking studies.

2.1 Valuation Theories Selected

References to a few popular authors (Damodaran, 2007; Koller et al., 2010) in recent times would have us believe that there are upwards of 15 stock valuation-relevant theories. Of these, four are perhaps the most commonly used along with a pricing theory that yields a key cost of capital or $\boldsymbol{r_e}$variable in all four models using the Capital Asset Pricing Model. The $\boldsymbol{r_e}$ can be stated in two versions (k^f) used for valuing the firm or (k^e) for valuing common equities.

These four are subsequently selected because of their widespread usage. The most popular model appealing to investors is the P/E multiples model going back almost a century in use:

$$P/E = \frac{\textit{Market price per share}}{\textit{Earnings per share}} \tag{1a}$$

The P/E ratio can be defined alternatively as trailing P/E and forward P/E, where trailing P/E is computed for current market price to the most recent four quarters' EPS of a firm. The forward P/E or leading P/E is computed as the current share price to the following year's expected earnings (Pinto et al., 2010):

$$\frac{P_0}{E_1} = \frac{\frac{D_1}{E_1}}{r_e - g} = \frac{1 - b}{r_e - g} \tag{1b}$$

where P is price observed at time $t = 0, 1 \ldots, T$ periods (this study will use 19-year data set) with D denoting dividend per share values along with E, the earnings per share values. The other terms are; b is retention ratio while g is growth in dividends while k^e = $\boldsymbol{r_e}$ is required rate of return from Eq. (5). By re-arranging the terms in Eq. (1b), it may be reduced to:

$$P_0 = \frac{1 - \mathrm{b}}{k_e - \mathrm{g}}(E_1) \tag{1c}$$

The second theory is accounting-information-based, and is:

$$B_t = B_{t-1} + E_t - D_t \tag{2a}$$

which is called the clean surplus model where B_t is the ending book value of equity of a bank with B_{t-1} as the beginning book value; E_t is the earning for the period from $t - 1$ to T and D_t is the dividends at time t. The idea of *clean surplus ratio* specifies that one could estimate stock values using weighted average of (i) current earnings and (ii) the current book value.

In comparison with all conventional models of valuation, a present value of expected dividends (PVED) is used to determine the forecast of market value, so this could be applied to bank stocks since all banks pay regular dividends. This is named the residual income model (RIM), which relies on the *clean surplus relationship* as a consistent valuation approach along with the dividend-discounting as in the Eq. (2b). The book value and present value of future expected RI (in replacement of future expected dividends) are used. This assumption allows future dividends to be expressed as future earnings and book values,

$$P_0 = \sum_{t=1}^{\infty} \frac{B_{t-1} + E_t - B_t}{(1 + k_e)^t} \tag{2b}$$

where the terms are all as defined before.

Based on discounting infinite dividend streams (following Williams, 1952, for finite coupons of a bond), the third theory from Gordon and Shapiro (1956) is the most recognised but not-so-much-applied theory:

$$P_0 = \sum_{t=0}^{\infty} \frac{DPS_t(1+g)}{(1+r_e)^t} \tag{3}$$

where g is growth factor in dividend stream to investors; $DPS = D$ in previous equation at $t = 1$ ... infinity.

The fourth theory is perhaps the most popular, i.e. the Damodaran-Kottler Free Cash Flow or FCF theory based on discounting (instead of the hitherto DPS). FCF emerged from the adjustment of short-term items in current accounts and long-term capital accounts at the bottom half of the balance sheet to get free cash flow to equity FCF to Equity or FCF to Firm:

$$P_0 = \sum_{t=1}^{\infty} \frac{FCFE_t}{(1+r_E)^t} \tag{4}$$

There are several steps to set up what appears to be simple FCFE, but are in fact complex, one that is to be explained later.[2] Researchers need to specify market-based k^e or $\boldsymbol{r_e}$ for the cost of equity in the equations. The existing literature in this regard provides evidence in support of the application of

[2] To understand this aspect of the complex "estimation" problem for operationalising theories, we followed carefully constructed procedures published by Damodaran as listed in the reference pages. Please refer to those books for details on how we had to set up the test data in all four cases using 19-year data set for all listed banks.

single-index market model as a common practice for estimation of the cost of equity capital. Studies in this area broadly point to the relative lower superiority of the two-index models against the ordinary ones (Flannery & James, 1984; Unal & Kane, 1986; Anderson et al., 2000). The CAPM used for that purpose is written as follows:

$$E(r_i) = r_E = r_f + \beta_i(r_m - r_f) \tag{5a}$$

where r_f is the risk-free rate from Treasury yield with β_i as the Beta or risk ratio of a firm relative to other firms in the market: the term r_m is the return of the market over a long-enough horizon for investors. β_i (beta) is computed using the Market Model (Sharpe, 1963) as:

$$(r_{it}) = a_i + \beta_i(r_m - r_f) + \varepsilon_{it} \tag{5b}$$

with the dependent variable on the left side of each equation being rate of returns of a banking stock over $t - T$ period: in Eq. (5a) E denotes expected return. The only variable relevant to use in Eq. (5a) is beta estimated in Eq. (5b) while risk premium $(r_m - r_f)$ is estimated from the market data.

Hence, these are the theories embedded in five equations for application to each bank, once to test validity using 19-year data set, and then using the hold-out sample over 5-years forward to estimate forecasts derived from theories. Thomson Reuters database and occasional searches of company websites provide all the data needed for this one market.

2.2 Review of Bank Stock Studies

A quick review of the literature is documented in this sub-section. Carefully reviewing a vast literature under "asset pricing", it spans over a century, perhaps divided into two phases. Theory-building started in the 1920s and continued until the 1940s (see Menger & Knight, 1950; Arrow, 1965; Frederick et al., 2002; Olson & Bailey, 1981) mostly as advanced economic theories. These were, namely, utility maximisation, Isoquants, supply-demand equilibrium, time preference, rational behaviour, etc.[3] According to the two well-cited studies (Damodaran, 2007; Koller et al., 2010) there are some 15 pricing theories. The most popular-in-practice theories are: Price-to-earnings multiple or P/E (see Eq. (1a)); the residual income model RIM (see Eq. (2a)); the dividend valuation model DDM (see Eq. (3)); and the free cash flow model FCFE (see Eq. 4).[4] To apply any of these four

[3] Since the focus of this research paper is on more recent finance theories, the literature review will not explore advances made prior to the 1950s, when Markowitz's (1952) Optimal Portfolio Theory emerged. Our review will further focus on those relevant to banking studies on asset pricing.

[4] Since the goal of this research is on stocks, we do not test the FCFF model.

models, as stated before, the literature on CAPM is a key theoretical equation so we need to add this as the fifth theory.

The P/E model is theoretically equal to DDM as stated in section 2.1. Investors have been using the P/E model as a simple process to assess risk when buying share securities: a P/E = 10 (if a stock invested is priced $20 with an E of $2) that investment is less risky than an investment in a stock with a P/E = 20 (stock priced at $20 with E of $1). Hence, investors use this ratio as a crude classifier of investment risk. Obviously, a riskier stock needs to yield a higher return on investment *ex post* as an investment in a lower P/E stock. Its popularity is recorded in a decades-old book by Graham and Dodd. Eq. (1c) is ideally the test model (see Graham and Dodd (1934); Fairfield (1994).

The RIM is attributed to Ohlson (1983) although this idea of book-value-based theory had existed for some time prior to Ohlson's publication. It is based on techniques developed prior to the work of Edwards and Bell (1965), Ohlson (1990) and Feltham and Ohlson (1995). Ohlson (1990) synthesised a theory to promote empirical studies on RIM. His studies gained significance as a valuation tool (Feltham & Ohlson, 1995; Ohlson, 1995). In essence, the RIM is an earnings-based valuation model, which conceptualises how value relates to three accounting variables, earnings, book value, and dividends associated with *information dynamics* (Ohlson, 1995) as stated in Eq. (2a). This model has not been supported yet in any well-constructed research publications so little is known of its efficacy unlike the P/E model.

The third model is perhaps the most popular one, which extended Williams' (1938) finite coupon discounting to discounting infinite stream of dividends with a new idea concerning a growth rate g in Eq. (3a). Gordon and Shapiro are said to have developed it, although Gordon's (1962) paper is the most cited for DDM.[5]

The fourth idea is attributed to Damodaran (2012) and Koller (2010) for the FCF model, with FCFE applied to stock valuation. Presently, this is the most popular pricing model and it may be also the most expensive to buy, at the top-end of industry. Fortune reports that the top-1000 firms use this model and report results in their annual reports.

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[5] In one version of an investment book by Reilly (also in Brealey and Myers), there are footnotes reporting that discounting infinite streams are traceable to Shapiro, a PhD student of Gordon in 1956.

2.3 Empirical Verification Attempts

In general, past empirical research on valuation models has been focusing on: 1) their ability to explain current prices, 2) their functionality to investigate and identify mispriced securities (if any), and 3) their application by reverse engineering to estimate the so-called implied cost of capital (Graham & Harvey, 2001; Demirakos et al., 2004; Penman, 2015). Recent years has seen some renewed interest in testing the applicability and accuracy of fundamental valuation models. More importantly, a number of researchers have recently sought to determine higher relative validity of valuation techniques by imposing less stringent and complex adjustments while adhering to the parsimonious specification rules (Asquith et al., 2005; Cavezzali & Rigoni, 2013; Anesten et al., 2020; Rizvi et al., 2020). The findings of such studies broadly point to a significant concordance of the valuation and pricing accuracy techniques to the standard-type stock-picking return tests.

The literature to date on bank stock valuation is limited since the four approaches described in the earlier section were adopted primarily in valuation of industrial companies or for use in event-type studies (Damodaran, 2007; Dermine, 2010). We attribute lack of bank stock studies to the complexity of financial statements of banks as sources for data needed to apply theoretical models. There are research studies and valuation manuals but these tend to omit banking firms until recent years (Copeland et al., 1991; Hitchner, 2010; Damodaran, 2012). Penman and Sougiannis (1998) state there are limited statistically robust empirical verification of these theories/models despite their sound development and actual widespread usage in the non-finance industry sectors.

A pioneering study on bank stocks is Durand (1955). Using regression analysis with data on 117 stocks over 1945-52 annual observations, he said it is useful to apply valuation models. Using the clean surplus model discussed in an earlier section, Karathanassis and Spilioti (2003) reported evidence supporting RIM: they reported a coefficient of determination of 50%. They did not use many theories as we do in our paper. Using a large sample of banking firms, their variables, Isidro and Grilo (2012) tested value-creation, an accounting-theory construct, studying 12 EU markets. Allowing goodwill generated via fee-based services, and using borrowing as well as other off-balance sheet items, that study shows his model led to identifying value creation. Using return on equity of a wide set of U.S. bank-holding companies, it is shown that volatility is associated with operating choices of companies.

Foerster and Sapp (2011)findings are directly relevant to the estimation of intrinsic values. That study led to a study model's ability to explain actual equity prices for more than one hundred years in the U.S. That was a test of some sort on mispricing rather than if theory held, but not about predictability. It may therefore be concluded that it is worthwhile to address the two research questions on applicability and forecastability of the four theories which are covered in this paper.

3. Data Sources, Variables and Methodology

The data sources and variable definitions are described in Section 3.1 with Table 1 serving as a summary of the variables identified. In the subsequent next two sections are the specifications of four models with descriptions on how the research design is set up to reveal results on the two research questions.

3.1 Data Sources and Variables Identified

The four models to be tested are: P/E; RIM; DVM; and FCFE. The data sources are the items in financial statements and stock prices of exchange-listed banks as found in the Thompson Reuters' Eikon database. Using a 21-year test period (1999-2019) annual data on eleven listed commercial banks are used. Related data items were selected from web-based sources.[6] The test period is thus 21 years over 1999-2019 with 2020 left out due to the global Covid-19 pandemic. The total observation amounts to 231 data items with n-number of variables from four models. The variables needed are constructed from observations on bank stock prices and model-suggested variables described in Section 2.1. A summary is found in Table 1. The dependent variable in all four models is the market-cleared end of period bank stock prices for each of the j number of banks $j = 1, \ldots, n = 10$ banks. Likewise, the data items from annual financial statements for each year over $t = 2000, \ldots, 2019$ are accessed then transformed to variables. The theory-suggested variables are all independent variables while the stock price (actual and forecast) is the dependent variable.

<Insert Table 1 here>

3.2. Test Models and Methodology

[6]The market chosen for this study had a major consolidation of banks from about 194 fragmented banks consolidated in 2000 into only 11 larger banks to reduce 2-3 decades of banking sector fragility (see Ahmad, Ariff, and Skully, 2007). As a result, data are available from the year 2000 for all the listed banks. In an extension of this study on Japan, for example, we also found just 54 banks listed on the Tokyo Stock Exchange with 2,200 firms. It is normal to have a few listed banks in any of the 137 markets.

For each bank, four tests are conducted after setting up the needed data set over the test period, leading to four test runs done for all four models on research question 1. On research question 2, four tests were executed on concordance using the UI statistics. Prior to that, four equations were fitted with data over the pre-hold-out period to estimate the model parameters for forecasting prices. The results are then summarised for the country and analysed with appropriate statistical/econometric methods. To test the models' applicability to find evidence if they can adequately explain price formation, we use the data set over the first 10 years to run panel regression using $n \times t = \ 10 \times 14$ observations over $t - T$ period and $n - N$ banks. This helps to establish a panel data set-up for implementation of tests. This research process, if done carefully with econometric refinements, means that the two research questions may obtain robust findings. The process involves using model fitness ratios, coefficient of variation statistics as well as CUSUM statistics.

The research design is divided into three steps. In step one, using all the data across test period, each model is tested if the model explains price volatility, and then in the same tests, assess the significance of each variable in each model. In step two, we use price data over five years 2010-14 to fit all four models to estimate model parameters. Those estimated parameters multiplied by actual variable values during 2014-19 five years provided forecast prices for all banks. The final step is the concordance of forecast prices with actual prices (Thiel, 1984, UI). The UI concordance test reveals that the UI values for each model are close to 0 and 0.10. If that is accepted, the forecast prices are accurate 9 out of 10 times to the actual prices forming over the forward years.

$$\textit{Inequality Coefficient (UI)} = \frac{\sqrt{\sum_{t=T+1}^{T+h}\frac{(F_t-A_t)^2}{h}}}{\sqrt{\sum_{t=T+1}^{T+h}\frac{F_t^2}{h}}+\sqrt{\sum_{t=T+1}^{T+h}\frac{A_t^2}{h}}} \qquad (6)$$

With F as the forecast stock price against A as the actual market prices observed: h is a counter for the number of years on the forecast horizon. If this value is equal to zero, then the forecasts and the actual prices are exactly the same. The researchers do not expect this to be the case (to assume there is a perfect forecast is unthinkable), so a decision must be made whether there is a usable degree of forecastibility. By setting that benchmark at 0.10 or 9 in 10 chance of forecasts being close, we will judge the results. Another test is the Mean Absolute Percentage Error:

$$MAPE = 100 \sum_{t=T+1}^{T+h} \frac{\left|\frac{A_t - F_t}{A_t}\right|}{h} \tag{7}$$

and the Symmetric Mean Absolute Percentage Error test:

$$SMAPE = \frac{100}{n} \sum_{t=T+1}^{T+h} \frac{\frac{|F_t - A_t|}{(A_t + F_t)}}{2} \tag{8}$$

where, forecast sample is $h = T + 1,\ T + 2, \ldots, T + h$, and the actual vs forecast values in period t as A_t and F_t, respectively, with $t = 1, \ldots, h$.

3.3 Test Models to Generate Forecasts

The test models are specified next in this sub-section following the order in which the models were explained in Section 2. The P/E model is operationalised as:

$$P_{j,t} = \alpha_0 + \phi_1 \sum \overline{EPS} + \cdots + d_c + \varepsilon_{j,t} \tag{9}$$

with $P_{j,t}$ are the observed bank stock prices j, where t refers to1999-2012 while $\overline{\text{EPS}}$ is the arithmetic mean of earning per share for security j, $\varepsilon_{j,t}$ as residuals and d_c denotes the dummy variable for the crisis effect in the linear relationship fitted between forecast prices of bank j and its arithmetic mean of earning per share.

The RIM is specified as:

$$P_{j,t} = \alpha_0 + \gamma_1 B_{j,t} + \gamma_2 \sum PV_{j,t}^{RI} + \gamma_3 DTV_{j,T+1}^{RI} + d_c + \varepsilon_{j,t} \tag{10}$$

where, $P_{j,F}$ are observed bank stock price of banks' security j, where t refers to1999-2012 while $B_{j,t}$ are book values of equity at valuation time t. The term $\sum PV_{j,t}^{RI}$ is the sum of present values of the five-year stream of forecast dividends over t, whereas $DTV_{j,T+1}^{RI}$ is the terminal values from discounting dividends from beyond the horizon H. We use the market practice to estimate present value over a horizon $H = 5$ years, and then the PV of distant dividends beyond H in this way.

The DDM is specified as:

$$P_{j,t} = \alpha_0 + \beta_1 \sum PV_{j,t}^{DIV} + \beta_2 DTV_{j,T+1}^{DIV} + d_c + \varepsilon_{j,t} \tag{11}$$

where, $P_{j,t}$ are observed j^{th} bank stock price, t refers to 1999-2012 while the next two terms are the present values, respectively, of the Horizon streams from first 5 years and the present value of streams in the period beyond H.

The FCFE is specified as:

$$P_{j,t} = \alpha_0 + \omega_1 NFA_{j,t}^{FCFE} + \omega_2 \sum PV_{j,t}^{FCFE} + \omega_3 DTV_{j,T+1}^{FCFE} + d_c + \varepsilon_{j,t} \tag{12}$$

As described above for DDM, the terms in Eq. (10) may be interpreted in this way. NFA is the net fixed asset of j^{th} bank at time t while the next two terms are, respectively, the horizon present value and the present value of the terminal cash flows.

Following the implementation using specified regression equations as stated from Eq. (9) to Eq. (12), the estimators of the coefficients for all regression equations are used along with observed values for the right-hand side factors. This is done to compute the estimated prices on each forward year, i.e. 1=2005, 2=2006, 3=2007, 4=2008 and 5=2019 that provided the data set for forecastability. The estimated correlation coefficients (Equations 9-12) are used with actual observations of variables for five forward years to forecast theory-suggested values for each year over five years for each of the four models. The actual prices are then matched for this test. Finally, the estimated prices are used in Thiel's test giving UI ratios on each model's fitness between forecasts and actual market prices.

3.4 Research Hypotheses

There are 2 strategic hypotheses with four possible tests in each country:

H_1: *There is no evidence of significant explanatory power in the cases of the four stock valuation models, P/E, RIM, DDM or FCFE in the tested market.*

H_2: *There is no evidence on forecastability by any model with a significant relation between forward forecasts using model-fitted parameters and the actual observed bank stock prices in the same forward period using P/E, RIM, DDM and FCFE in the tested market.*

The four models will therefore be tested using Thiel's UI ratio. We expect to reject the two null hypotheses of explainability and forecastability if there is in fact no evidence to reject the two strategic hypotheses for one or more test models. Only rejections of hypotheses will provide evidence that: firstly, the variables in the theories explain bank stock price volatility or actual prices are significantly correlated; and secondly, the theories do forecast well.

4. Findings: Explainability and Forecastability

The results are summarised and discussed in this section. The summary statistics on variables used are presented first in Section 4.1 followed by test evidence on the explanatory power of four models in Section 4.2 before presenting evidence on forecastability in Section 4.3.

4.1 Descriptive Statistics

The dependent variables in all tests are actual prices fitted to theory-suggested independent variables in the 21-year test period for explainability. Table 1 summarises the variables used in the various models tested. Data collected is over 21 years and for explainability testing, 16 years of data on 10 banks are used (Test Sample).

<Insert Table 2 here>

For each model, the procedure used is as described in a standard investment textbook to first observe end-of-year values in a theory-suggested variable and then specify them as relevant to theory being tested and then run one or more tests. In this study, four tests considered econometrically accurate estimating equations are run. For example, the actual dividends are observed: for predicting prices in each model, the present value (PV) over a test horizon $t = 1, \dots, h = n$ period is estimated followed by estimating terminal value (TV) for the period from $horizon = n + 1$ to infinity, and so forth as in any investment decision by the industry analysts.

ROE is a variable often used to reflect underlying profitability of firms in an economy as productivity of assets or financial leverage. The average

ROE of 9.77 per year is rather small relative to what it was for banks in the years before 1999, when the economy was growing at a long-run rate of 7.5 percent. The years including the test period are the ones where there is low to middling economic growth averaging at about half the growth rate prior to 1997. ROE of 9.77% is consequently low. All other variables are similarly describable in the chosen test period of 19 years and the other values are also low to moderate numbers.

4.2 Findings II: Ability of Theories to Explain Bank Price Variation

The results from the several panel regressions for each theoretical model are from the pooled OLS method without fixed and/or random effect tests after tests revealed no need for a choice to be made (decision based on Hausman tests). By assuming constant intercepts and slopes across all banks over time period, test results suggest there is no difference in the intercepts and slopes across banks and years.

<Insert Table 3 here>

The test statistics in Table 3 are summarised as follows: (i) model fitness statistics are shown in rectangular boxes; and (ii) the findings on significance of variables entering each test run (there are four test runs for each model of which 2FE test runs are perhaps the most accurate although all other tests are superior to cross-sectional tests) are shown in the non-boxed parts of the table.

For each of the four models, four tests are run specifically for each valuation model to ensure any econometric issues are addressed carefully so the estimated parameters are robust. These tests are: LSDV (Test 1); RREM (Test 2); POLS (Test 3); and 2-FE (Test 4) as shown in each panel. The four valuation models' results are shown in four panels from A to D as shown in the table.

As for the fitness of the valuation theories to explain bank price volatility over the full test period of 19 years, note that the explanatory power (R^2) of all four models range between a lowest ratio of 26% (in the case of FCFE in Panel D) and 87%. This is a good level of explainability for variation of bank stock prices being accounted for by named variables from the theories being tested. Second, all F-values are significant and show good model fitness in all four cases. This would have us suggest that the four theories have very good deal of accounting for the variations in this one market. Consequently, there is explainability evidence, so the four theories hold well in our 44 test runs.

With reference to the individual variables - are these significant? There are in total 44 estimated parameters for all the theory-suggested valuation factors. All estimated parameters except those of9 factors are statistically significant at the normal acceptance levels. It is suggested that the individual factors in the four models are mostly driving bank stock prices. Referring to the signs, they are all as per what the theories predict. For example, in the P/E Model, all 12 estimated parameters from four econometric test runs are statistically significant at 0.01 or lower p-values.

There are some cases in the other theories where estimates are not statistically significant, while the signs are correct. That would encourage an observer to suggest that the four theories tested in this study can explain stock price volatility in one stock market. The null hypothesis-one is thus rejected for all four theories in all the test results reported in the table.

It is worth recording some aspects of test statistics that were applied. The standard procedure is performed to test the presence of random effects and fixed effects using Breusch-Pagan (1979) and Lagrange Multiplier (BP-LM) tests for the presence of variances of individual effects. Doing will help determine whether a common set of parameters is applicable across individual banks. That is a major problem in panel regression. The test statistics LM suggest the null hypothesis (H_0) is rejected. Hence, the REM test reported in the table as a second test is preferred because it is more accurate than the pooled test. It is explained by individual banks having significantly different intercepts, where σ^2_λ is not 0 and hence the subjects may have heteroskedasticity.

The Chow test on pooled OLS test run and the competing FEM tests run yielded a p-value of less than 0.05. There is subsequently a significant fixed effect and a significant increase in goodness-of-fit. Thus, the FEM model suggests FEM-model-derived results are preferred over those from pooled OLS. The Hausman test is performed to make a comparison of estimators from the two tests, REM and FEM. The results also suggest the preferred model is the FEM with a p-value of less than 0.05 hence being significant. Therefore, the FEM is again chosen as the appropriate model with results that are highly accurate compared to estimators of the Pooled OLS and REM.

These estimators were taken from the common estimators of LSDV, RFEM (after diagnostic tests), POLS and two-way Fixed Effect (2FE). The estimators are robust to the lack of multicollinearity, heteroskedasticity and serial correlations. Absolute t-statistics are reported in brackets, respectively. All estimators produce statistically significant and sensible parameters. The ROE variable is the only one which recorded a lower coefficient perhaps due to the long-term underperformance of the economy during the test period compared to earlier phases. This can be explained from the use of ROE for the computation of sustainable growth rate, commonly used as the proxy for dividend and earnings growth rate for firms operating in a mature industry (i.e. the banks).

4.3 Findings III: Forecasting Ability of Four Theories

In this final section on results, four forward forecasts by four theories are estimated using the parameters calculated over the hold-out period data, These five forecasts for the years 1, 2, 3, 4 and 5 for each bank are then matched with the actual observed bank stocks in the five forward years.

The data for forecasting are from the in-sample observations from 1999 to 2012 based on the estimation method as discussed in Section 3. The estimated coefficients obtained from the LSDV, RFEM, POLS and 2FE are subsequently used to perform *ex-post* forecast of *h*-steps years ahead over a common 5-year forecasting period. It is based on the realised observations available until the year 2017, i.e. one-year ahead, then two-year ahead, three-year ahead, and so on till five-year ahead. The rolling moving window procedure is applied in using data and values estimated for the in-sample to estimate prices using coefficients estimated from the in-sample models. The moving window approach is supported in the literature to avoid forward bias on later year forecast results, therefore dropping the penultimate data behind by one year and adding one year next is useful. Moving window improves the forecasting accuracy of out-of-sample using the time-series models.

The test of congruence described in Section 3 is run for each model to estimate the UI values (if UI is zero, it is good forecasting ability; if $UI < 0.10$, it is significant forecasting ability at 1:10 chance of being correct forecasting; if $UI > 0.10$ forecastability is suspect). The results of the UI tests for the PE Model are tabulated in Table 3. From a theory perspective, there is no "best" forecast method, so instead this study looks at the *ex post* forecasting ability of a model by examining if the forecast is at least closer by 0.10 or lower values.

By examining the five UI values in the last column, it is evident there is a one-in-ten chance of forecasts being close to the actual prices in the forward 5 years. Note also the 1-year-ahead forecasts have the best odds of 1:20 or

0.05 probability of being correct. As one moves to further and further years forward, the odds go from one-in-twenty to 1-in-10 or thereabouts. That is, a forecast with a nearer-to-forecast-year is more accurate than those at the other end. This is true for the PE test results (and is also for other models).

Table 4 is a summary of results for residual income theory (RIM). This model became prominent in the 1990s but is the least tested model on valuation theories. From the statistics interpreted earlier, it is evident that the RIM holds well as a theory to explain the variation in stock prices with R^2 values representing 72 to 92 percent coefficient of determination, implying an excellent model fitness along with all factors being statistically significant in all four tests in Panel B of Table 4.

<Insert Table 4 here>

On forecasting ability test as shown in Table 5, it appears that the one-nearest year forecast is accurate with $UI = 0.94$. It suggests significant forecasting accuracy at one-in-ten chance for one-year-ahead forecasts. Overall average of $UI = 0.11$ for a five-year period means that odds of being correct are just outside the one-in-ten (in fact one-in-eleven) ratio.

That means the RIM performs as good as PEM for near-term forecasts, but for further than one-year forward, it is not as accurate.

The results are summarised in Tables 5 and 6 for the dividend discount model (DDM) and free cash flow to equity (FCFE) model. The $UI = 010$ (0.096 rounded) for all the five years suggests that the DDM is as good as the PEM in terms of being correct one-in-ten chance of correct forecasting.

<Insert Table 5 here>

The nearest year forecast is the smallest as in the previous two models and the $UI = 0.13$ for year 5 is not acceptable as a one-in-ten chance of being correct. RIM appears to be slightly worse off than the REM forecasts while the RIM forecasts are as good as the forecasts of PEM. It is observed that the average of $UI = 0.06$ for P/E will place PEM as the best forecasting model amongst the four tested in this study.

Table 6 reports the statistics on forecastability. It is about findings on UI values for our interpretation of the statistics. These results are for the FCFE model making forward forecasts for three years. The average and each year's forward forecast accuracy are all about $UI = 011$. It means this model makes consistent forecasts across the near-term as well as longerterm horizon with an accuracy of one-in-eleven chance. Those odds are outside our acceptance level as a useful forecasting model. So among the four models the FCFE model forecasts perform slightly worse, and is the least preferred model for forecastability. Commenting on the overall abilities of the four popular models for forecasting bank stock values, evidence shows their rank-order preference as follows: PEM is the best, followed by DDM, then REM while the FCFE is the last. Obviously, the value of $UI < 0.10$ is arbitrarily chosen for our adopted interpretation for ranking models.

<Insert Table 6 here>

If one examines the other two measures of $MAPE$ or $SMAPE$, which are measures of being correct, it appears that the baseline for those models is whether a model has much predictability beyond a 50:50 chance of being correct. In that sense, the other measures would agree that there is predictability if the measured forecast accuracy is well above 50:50 or random ability. Hence, if a choice is forced, the researchers would prefer Thiel's measure of concordance, which helps observers to align the UI along the same line as statistical testing using statistical accuracy of p-value=0.10 used in decision-making as the permissible test statistics in all scientific testing. If this is a reasonable interpretation, it is possible to conclude that null hypothesis two is broadly accepted for three of the four models (PE, RI and DD), while the FCFE is just slightly outside the acceptance level of 0.10.

5. Conclusions

This research report is about applicability of four widely used stock valuation models across the world using spectacular theoretical advances in Financial Economics to address real-world investment decisions involving in aggregate trillions of dollars. This study provides detailed empirical evidence on four popular stock pricing theories used in tertiary institutions and in the industry board rooms.

The a priori assumptions of these theories are helpful in explaining how stock prices are formed in competitive capital markets organised to provide reliable information, which are assessed by rational people to convert information price signals speedily via trading. Two research questions raised are as follows. Firstly, could the four popular theories among the less-popular other 10 sufficiently explain stock price variation over a recent 19-year period. Whether bank stock price forecasts based on each of these four theories are close to the actual stock prices formed in one stock market studied in this case, is examined here.

The tests show that the four theories have a significant fit with the actual price formation. The explained variation (coefficient of variation) ranges from 72-92% so the explanatory power of the theories accounting for variations in bank prices over 19-year period is substantial. The model fit is also evident with F-ratios in each model tested with refined econometric panel regressions being significant with p-values less than 0.001. The second research question is: Are the forecasts accurate for bank stock prices derived from theory-derived estimated parameters so the actual stock prices formed in a capital market over a forward 5-year forward period accurate enough as good forecast prices?

Statistical evidence is indicative of an overall high forecasting accuracy. The P/E model has superior predictive power (one-in-six chance of being correct) followed by the RIM, DDM and FCFE. These findings shed new lights on the relative performance of valuation models. Published evidence exists the tested market is semi-strong-form efficient and is an investible grade market-place.[7] Overall, the forecast optimism is found to diminish as the length of the horizon expands. This finding is consistent with existing empirical literature on valuation models (Mentzer & Cox Jr, 1984; Makridakis, 1986).

This is a limited but an extensive study because of the complexity of: (i) setting/computing theoretical variables over two decades; and (ii) the adoption of complex econometrics incorporated to obtain robust reliable estimations. Despite these merits, it is a study of what happened in one banking market. The results are thus not generalisable before a few more markets are similarly tested with other markets to obtain generalisable results. Hence, further testing is advocated on applying these tests to data from other markets.[8]

This is a multi-country study using the multi-model testing approach to the forecast accuracy of banking firms. Results obtained from the two sampled

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[7]This market has been shown to be Fama-Efficient (see Anwar, Ariff and Shamsher, 1994). The Investor’s Guide Handbook by Dow-Jones-Irwin includes this market as one of some 30 investible global markets.

[8]As part of this study, there is an ongoing effort to collect data on Japan, the United Kingdom, and the United States banking industries. That effort for a future analysis will shed light on assessing the general-is-ability of findings reported in this paper.

countries are based on the accuracy and reliability of the collected time series data. Hence, the results are sensitive to the degree of precision of these secondary data. The sampled period of FCFE is relatively shorter compared to the other three valuation models due to the availability of the data needed for estimating parameters. Subsequently, the forecast evaluation of the FCFE is only limited to three-years ahead, as opposed to the total of four *h*-step forecast horizons, i.e. one-year, two-year, three-year and five-year-ahead. The study is also limited in terms of the sample period size for 1999-2019. The availability of essential financial data prior to 2000 is very limited. Hence, the sample years could cover the period 1999 to 2019.

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Table 1: Variable Specification, Definition and Expected Signs from Theories

No.	Variables	Definition	Expected Sign
1.	$P_{j,t}$	Share Prices over time	Dependent Variable
2.	$\mathrm{PV}_{\mathrm{j,t}}^{\mathrm{DIV}}$	Present values of the forecasted dividends for bank j at time t	+
3.	$DTV_{j,T+1}^{DIV}$	Discounted terminal value for the Dividend Discount Model specification for bank j at T+1 period	+
4.	$NFA_{j,t}^{FCFE}$	Net financial assets at time t	+
5.	$PV_{j,t}^{FCFE}$	Present values of the forecasted free cash flow to equity for bank j at time t	+
6.	$DTV_{j,T+1}^{FCFE}$	Discounted terminal value for the FCFE Model specification for bank j at T+1 period	+
7.	$\overline{EPS}$	Arithmetic mean of earning per share for bank j	+
8.	$BV_{j,t}$	Book value of bank j's equity at the date of valuation t	+
9.	$PV_{j,t}^{RI}$	Present values of the expected per-share residual income of bank j	+
10.	$DTV_{j,T+1}^{RI}$	Discounted terminal value for the RIM specification for bank j at T+1 period	+

Table 2: Descriptive Statistics of in-sample for Four Valuation Models

This table is a summary of test statistics relating to the sample of 10 listed banks in the market. The results are interpreted in the text relating to this table. The dependent variable is the bank stock price observations. All other variables are those suggested by the theories.

	Mean	Median	Std. Dev.	Observations
The variables except the PRICE are in ratios				
PRICE (local currency)	4.267	3.017	3.076	140
DPS (RM dividends)	0.159	0.090	0.164	140
ROE (Return on equity)	8.925	11.995	32.205	140
EPS (RM Earnings per share)	0.365	0.325	0.294	140
BV (Book Value per share)	2.595	2.414	1.224	140
PV^{RI} (PV for RIM)	0.242	0.185	0.527	140
DTV^{RI} (PV for RIM)	1.321	1.023	2.312	140
PV^{DIV}(PV for DDM)	0.557	0.399	0.498	140
DTV^{DIV}(Terminal value)	2.364	1.981	1.836	140
PV^{FCFE}(PV value)	0.569	0.230	1.325	108
DTV^{FCFE}(Terminal value)	4.721	4.447	13.126	108
NCCFI (Net change, cash flow)	0.344	0.133	1.820	108

Table 3: Summary of Results from Panel-Data Estimators

This table is a summary of pooled data regression results for 10 banks across 14 years in the tested market. The text to this table explains further all the results. There are four variations of tests done. The 2FE (Model 4) is the model with the highest explainability as reported in the last column while the LSDV (Model 1), RREM (Model 2) and POLS (Model 3) yield somewhat slightly different outcomes.

Panel A: PE Model	**(1)**	**(2)**	**(3)**	**(4)**
Constant	1.994***	0.961**	1.490***	3.079***
	(2.69)	(3.45)	(2.46)	(3.64)
DPS	6.236***	8.151***	8.848***	4.886***
	(3.58)	(3.75)	(7.20)	(2.98)
ROE	0.011*	0.011**	0.010	0.0064
	(1.71)	(2.43)	(1.49)	(1.13)
EPS	5.951***	5.533***	5.061***	4.554***
	(6.93)	(6.10)	(5.71)	(4.44)
Crisis Effect	-0.631**	-0.701**	-1.718***	-1.003
	(-2.40)	(-2.51)	(-2.74)	(-1.58)
Order of Integration	I(0)	I(0)	I(0)	I(0)
Dummy variables	Yes	No	Yes	Yes
R^2	0.8589	0.8339	0.8527	0.8850
Observations	140	140	140	140
Panel B: RI Model	**(1)**	**(2)**	**(3)**	**(4)**
Constant	1.427***	-0.442	1.042**	2.843***
	(2.84)	(-0.89)	(2.30)	(4.93)
BV	1.657***	1.623***	1.237***	1.401***
	(12.17)	(8.96)	(8.32)	(9.26)
PV^{RI}	1.162***	1.286**	1.830***	1.050**
	(2.81)	(2.96)	(3.33)	(2.38)
DTV^{RI}	0.204**	0.224	0.308**	0.283***
	(2.07)	(1.59)	(2.13)	(2.63)
Crisis Effect	-0.734**	-0.778***	-2.602***	-2.316***
	(-2.21)	(-3.25)	(-4.34)	(-3.87)
Order of Integration	I(0)/I(1)	I(0)/I(1)	I(0)/I(1)	I(0)/I(1)
Dummy variables	Yes	No	Yes	Yes
R^2	0.8695	0.7262	0.7800	0.9045
Observations	140	140	140	140

Panel C: DD Model	**(1)**	**(2)**	**(3)**	**(4)**
Constant	-1.522	0.954***	1.432***	3.107*
	(-1.32)	(3.04)	(5.22)	(1.92)
PV^{DIV}	0.931	0.405	1.981***	0.926
	(1.24)	(0.71)	(3.72)	(1.04)
DTV^{DIV}	1.480***	1.355***	0.749***	0.435*
	(7.10)	(4.72)	(4.14)	(1.85)
Crisis Effect	-1.041***	-0.831**	-1.811***	-0.731
	(-2.94)	(-2.39)	(-4.35)	(-0.85)
Order of Integration	I(0)/I(1)	I(0)/I(1)	I(0)/I(1)	I(0)/I(1)
Dummy variables	Yes	No	Yes	Yes
R^2	0.7082	0.6697	0.7769	0.8222
Observations	140	140	140	140
Panel D: FCFE Model	**(1)**	**(2)**	**(3)**	**(4)**
Constant	7.791***	3.555***	3.841***	7.347***
	(19.26)	(5.23)	(3.51)	(12.71)
PV^{FCFE}	-0.207**	-0.206*	-0.016	0.064
	(-2.35)	(-1.81)	(-0.12)	(0.74)
DTV^{FCFE}	-0.001	-0.002	-0.021	-0.004
	(-0.19)	(-0.24)	(-1.21)	(-0.49)
NCCFI	0.231**	0.234*	0.308**	0.107
	(2.13)	(1.76)	(2.05)	(1.35)
Crisis Effect	0.313	0.308	0.218	0.828
	(1.11)	(0.89)	(0.16)	(1.49)
Order of Integration	I(0)/I(1)	I(0)/I(1)	I(0)/I(1)	I(0)/I(1)
Dummy variables	Yes	No	Yes	Yes
R^2	0.7123	0.0803	0.2304	0.8788
Observations	108	108	108	108

Notes: Figures in the parentheses are t-statistics, while *, ** and *** indicate the respective 0.10, 0.05, and 0.01 significance levels. Based on the diagnostic results, all estimators' residuals are found to be stationary, $I(0)$. The results obtained with a mean VIF of 1.66 (VIF < less than 10) indicate multicollinearity is absent.

Table 4: Summary of the Averages of Forecast Result of P/E

This table is a summary of forecast evaluation results of P/E valuation. There are three measures used for the testing of the P/E approach. MAPE is the Mean Absolute Percentage Error; SMAPE is Symmetric Mean Absolute Percentage Error while Thiel-U is the Thiel's UI Statistic. All banks are weighted equally for computation of overall average of the three statistical measures for *h*-steps-ahead forecasts. Entries in bold denote Thiel's statistic below 0.10 for each one-year forward forecast.

Forecast measure of *h*-step-ahead	MAPE	SMAPE	Thiel's U
1-year	8.5025	9.5479	**0.0477**
2-year	11.3738	12.1375	**0.0637**
3-year	11.0903	11.8500	**0.0647**
5-year	13.1425	14.2492	**0.0759**
Overall Average	11.0273	11.9462	**0.0630**

Table 5: Summary of the Averages of Forecast Result of RIM

This table is a summary of forecast results for bank stocks over five forward years compared with actual prices. All banks are weighted equally in the computation of overall average of the three statistical measures for *h*-step ahead forecasts. The text following this table explains the results. There are three measures used for testing the RIM. MAPE is the Mean Absolute Percentage Error; SMAPE is Symmetric Mean Absolute Percentage Error while Theil-U is the Theil's UI-Statistic. Entries in bold denote Theil's statistic below 0.10, which is a good forecast so we adopt those values.

Forecast measure of *h*-step-ahead	MAPE	SMAPE	Thiel's U
1-year	22.9160	18.8034	**0.0940**
2-year	25.8898	21.4725	**0.1103**
3-year	27.0623	21.9890	**0.1145**
5-year	24.8756	21.9863	**0.1196**
Overall Average	25.1859	21.0628	**0.1096**

Table 6: Summary of the Averages of Forecast Result of DDM

This table is a summary of forecast evaluation results for the Malaysian banks sample. The text to this table explains the results. There are three measures used for testing the DDM. Note: MAPE is the Mean Absolute Percentage Error; SMAPE is Symmetric Mean Absolute Percentage Error while Thiel-U is UI Statistic. All banks are weighted equally in the computation of overall average of the three statistical measures for *h*-step ahead forecasts. Entries in bold denote Thiel's statistic below 0.10.

Forecast measure of *h*-step-ahead	MAPE	SMAPE	Thiel's U
1-year	14.0249	16.4338	**0.0822**
2-year	14.8683	17.1269	**0.0873**
3-year	14.0683	16.2215	**0.0836**
5-year	19.1942	22.7840	**0.1314**
Overall Average	15.5389	18.1415	**0.0961**

Table 7: Summary of the Averages of Forecast Result of FCFE

This table is a summary of forecast evaluation results for the Malaysian banks sample. The text to this table explains the results. All banks are weighted equally in the computation of overall average of the three statistical measures for *h*-step ahead forecasts. There are three measures used for the testing of the FCFE. MAPE is the Mean Absolute Percentage Error; SMAPE is Symmetric Mean Absolute Percentage Error while Thiel-U is the Thiel's U Statistic. Entries in bold denote Thiel's statistic below 0.10.

Forecast measure of *h*-step-ahead	MAPE	SMAPE	Thiel's U
1-year	21.1215	22.9076	**0.1145**
2-year	20.7561	22.7870	**0.1189**
3-year	18.7895	20.5504	**0.1097**
Overall Average	20.2223	22.0817	**0.1144**