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QUANTITATIVE MODELS FOR EQUITY VALUATION

Dr. Zeeshan Ahmed[1]

Abstract

Equity valuation is a cornerstone of investment decision-making, relying increasingly on quantitative models to estimate the intrinsic value of stocks. This paper reviews and compares the application of popular quantitative equity valuation models—including the Discounted Cash Flow (DCF), Dividend Discount Model (DDM), Residual Income Model (RIM), and multiples-based approaches—in the context of Pakistan's equity market. Utilizing firm-level data from the Pakistan Stock Exchange (PSX) for 2010–2024, the study evaluates the models' predictive accuracy, applicability, and limitations given the market's unique financial and economic environment. The results highlight the strengths of discounted cash flow-based models for mature firms, while multiples-based valuation shows advantages in liquidity and ease of use. The paper also discusses challenges such as data quality, market inefficiencies, and model assumptions, providing insights for investors and analysts in emerging markets.

Keywords: *Equity Valuation, Discounted Cash Flow, Dividend Discount Model, Multiples-Based Valuation*

INTRODUCTION

Accurate equity valuation is essential for investors seeking to identify mispriced securities and optimize portfolio returns. Quantitative valuation models translate financial statements, market data, and economic forecasts into price estimates that guide buy, hold, or sell decisions. Emerging markets like Pakistan pose particular challenges due to limited data transparency, market inefficiencies, and economic volatility. This study examines the performance and suitability of key quantitative equity valuation models for Pakistani equities, offering a comparative framework to enhance valuation accuracy and investment outcomes.

[1] *Department of Finance, Lahore School of Economics, Lahore, Pakistan*

1. Overview of Quantitative Equity Valuation Models

Discounted Cash Flow (DCF) and Dividend Discount Model (DDM) Fundamentals

- **Discounted Cash Flow (DCF) Model:** The DCF model values a company based on the present value of its expected future free cash flows (FCF). These cash flows are forecasted over a projection period and discounted back to the valuation date using a discount rate—usually the firm's weighted average cost of capital (WACC). The fundamental premise is that the intrinsic value of a firm equals the sum of its discounted future cash flows, reflecting the time value of money and investment risk.

Steps in DCF Valuation:

1. Project free cash flows for a forecast horizon (typically 5–10 years).
2. Estimate the terminal value beyond the forecast horizon using a perpetuity growth model or exit multiple.
3. Discount cash flows and terminal value using WACC.
4. Sum discounted cash flows to arrive at enterprise value.
5. Subtract net debt to determine equity value.

- **Dividend Discount Model (DDM):** The DDM specifically values companies that pay dividends, based on the present value of expected future dividends. The most common form is the Gordon Growth Model, which assumes dividends grow at a constant rate indefinitely. The equity value is calculated as:

$$P0=D1r−gP_0 = \frac{D_1}{r - g}P0=r−gD1$$

where P0P_0P0 is the current stock price, D1D_1D1 the dividend next period, rrr the required rate of return, and ggg the dividend growth rate.

DDM is especially applicable to mature firms with stable dividend policies.

Residual Income Model (RIM)

The Residual Income Model values equity based on the book value of equity plus the present value of expected residual incomes. Residual income is the net income earned over and above the required return on equity (cost of equity).

Formula:

$$\text{Equity Value} = \text{Book Value of Equity} + \sum \frac{\text{Residual Income}_t}{(1 + r)^t}$$

Equity Value=Book Value of Equity+∑Residual Incomet(1+r)t\text{Equity Value} = \text{Book Value of Equity} + \sum \frac{\text{Residual Income}_t}{(1 + r)^t}Equity Value=Book Value of Equity+∑(1+r)tResidual Incomet

where residual income =Net Income−(r×Book Value of Equity)= \text{Net Income} - (r \times \text{Book Value of Equity})=Net Income−(r×Book Value of Equity).

RIM is useful when dividends are irregular or non-existent but accounting data is reliable. It bridges accounting-based valuation and discounted cash flow approaches.

Multiples-Based Valuation: P/E, P/B, EV/EBITDA

- **Price-to-Earnings (P/E) Ratio:** Compares a company's current share price to its earnings per share (EPS). A higher P/E suggests expectations of higher growth. Used widely due to simplicity and market familiarity.
- **Price-to-Book (P/B) Ratio:** Compares market value to book value of equity. Useful for asset-heavy industries and in emerging markets where accounting measures can reflect asset values more closely.
- **Enterprise Value to EBITDA (EV/EBITDA):** Enterprise value (market cap + debt - cash) divided by earnings before interest, taxes, depreciation, and amortization (EBITDA). This ratio normalizes capital structure differences and is favored in sectors with significant non-cash expenses.
- Multiples are typically benchmarked against industry peers or historical averages to assess relative valuation.

Model Assumptions and Applicability in Emerging Markets

- **Assumptions:**
  - Stability and predictability of cash flows or dividends.
  - Efficient and liquid markets for comparable multiples.
  - Reliable accounting standards and financial disclosures.
  - Appropriateness of discount rates reflecting risk and capital structure.
- **Challenges in Emerging Markets:**
  - Volatile and less predictable earnings and cash flows due to economic and political instability.
  - Lower market liquidity and potential price inefficiencies affecting multiples.
  - Accounting standards may be less stringent, leading to less reliable financial statements.
  - Higher country risk premiums in discount rates increase valuation uncertainty.
- Adaptations such as incorporating higher discount rates, scenario analysis, and using multiples adjusted for local market conditions are necessary.

2. Data and Methodology

Dataset

The study utilizes a comprehensive dataset covering a sample of publicly listed companies on the Pakistan Stock Exchange (PSX) from 2010 to 2024. The dataset includes:

- **Financial Statements:** Annual and quarterly reports containing income statements, balance sheets, and cash flow statements to extract key variables such as earnings, dividends, book value of equity, and free cash flows.
- **Market Prices:** Daily and monthly closing stock prices, traded volumes, and market capitalization figures for listed companies to calculate market-based valuation multiples and to evaluate price predictions.
- **Additional Variables:** Macroeconomic indicators (e.g., risk-free rates, inflation rates, market risk premiums) required for discount rate estimation and adjustment for country-specific risks.

Data is sourced from official filings, PSX data repositories, and financial databases such as Bloomberg, Thomson Reuters, and local financial information providers.

Model Implementation Procedures and Parameter Estimation

- **Discounted Cash Flow (DCF) and Dividend Discount Model (DDM):** Cash flows and dividends are forecasted using historical growth rates, analyst estimates, and econometric models. The discount rate (WACC or cost of equity) is estimated using the Capital Asset Pricing Model (CAPM) adjusted for country risk premiums and firm-specific beta.
- **Residual Income Model (RIM):** Residual incomes are computed based on reported net incomes and book values, discounting future residual income streams using estimated cost of equity. Parameters such as terminal residual income growth rates are estimated through trend analysis.
- **Multiples-Based Valuation:** Market multiples (P/E, P/B, EV/EBITDA) are calculated from market data. Comparable company analysis is performed to identify peer benchmarks, and multiples are applied to target firms' financial metrics.
- **Parameter Estimation:** Regression techniques and time-series analysis are employed to estimate growth rates, betas, and discount rates. Historical data is analyzed for consistency and adjustments are made for outliers or extraordinary items.

Evaluation Metrics

- **Valuation Error:** The absolute and percentage difference between model-derived intrinsic values and actual market prices, used to quantify model accuracy.

- **Price Prediction Accuracy:** Metrics such as Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), and directional accuracy (correct up/down price movement predictions) assess forecasting performance.
- **Robustness:** Model stability is tested under varying assumptions, such as different discount rates, growth scenarios, and parameter perturbations, to evaluate sensitivity and reliability.

Statistical Methods

- **Regression Analysis:** Used to examine relationships between valuation model inputs and market prices, identify determinants of valuation errors, and refine parameter estimates.
- **Backtesting:** Historical valuation models are applied retrospectively to assess how well they would have predicted actual market prices, providing insights into practical applicability.
- **Sensitivity Analysis:** Systematic variation of key model parameters (e.g., discount rates, growth rates) evaluates the impact on valuation outcomes, identifying parameters to which models are most sensitive.

3. Empirical Results and Comparative Analysis

Accuracy of Price Estimates from Each Model

Empirical testing of the Discounted Cash Flow (DCF), Dividend Discount Model (DDM), Residual Income Model (RIM), and multiples-based valuation reveals varying degrees of accuracy in estimating intrinsic stock prices:

- **DCF Model:** Demonstrates strong accuracy for firms with stable and predictable cash flows, such as utilities and large blue-chip companies. The model tends to overestimate prices for firms with volatile or unpredictable cash flows due to forecasting challenges.
- **DDM:**
  Effective mainly for mature firms with consistent dividend policies, often outperforming other models in the financial and consumer staples sectors. However, its applicability is limited for growth companies or firms that do not pay dividends.
- **RIM:**
  Provides robust valuations for firms with irregular dividends but reliable accounting data. It shows better performance than DDM and DCF for companies in transitional industries or those with fluctuating earnings, such as manufacturing and technology sectors.
- **Multiples-Based Valuation:** Offers quick, market-relative valuations and performs reasonably well in sectors with established comparables like banking and telecommunications. Its accuracy depends heavily on market efficiency and the selection of appropriate peer groups.

Overall, the combined use of multiple models enhances valuation reliability by compensating for individual model biases.

Model Performance Across Sectors and Firm Sizes

- **Sectoral Variations:**
  - **Financial Sector:** DDM and multiples (P/E, P/B) perform best due to stable dividends and transparent financial metrics.
  - **Industrial and Manufacturing:** RIM and DCF are more appropriate given earnings volatility and capital intensity.
  - **Technology and Growth Sectors:** Multiples and RIM provide better insights due to irregular dividends and uncertain cash flows.
- **Firm Size Effects:** Larger firms with longer operating histories and stable financials yield more accurate valuations across all models. Small and mid-cap firms show greater divergence due to higher earnings volatility, lower market liquidity, and less reliable financial disclosures.

Effect of Macroeconomic Variables on Valuation Outputs

Macroeconomic factors significantly influence valuation results, especially in an emerging market context like Pakistan:

- **Interest Rates:** Higher interest rates increase discount rates, lowering intrinsic valuations in DCF and RIM models. This effect is pronounced in capital-intensive sectors.
- **Inflation:** Inflation impacts growth rate assumptions and cash flow projections, affecting all models. Real estate and commodity-related sectors show higher sensitivity.
- **Exchange Rates:** Firms with foreign currency exposure or import-dependent supply chains exhibit valuation sensitivity to currency fluctuations, impacting cash flow forecasts and multiples.
- **Political and Economic Stability:** Perceived country risk affects the cost of capital and investor sentiment, leading to valuation discounts or premiums.

Incorporating these variables explicitly improves model realism and accuracy.

Strengths and Limitations of Each Approach in Pakistan's Context

Model	Strengths	Limitations
DCF	Theoretically rigorous; captures intrinsic value; suitable for stable firms	Sensitive to forecast assumptions; data limitations; challenging for volatile firms

DDM	Simple; ideal for dividend-paying firms	Limited to firms with stable dividends; ignores growth phases without dividends
RIM	Incorporates accounting data; useful for firms with irregular dividends	Requires reliable book values and earnings; sensitive to accounting quality
Multiples-Based	Quick relative valuation; market-driven	Dependent on market efficiency and peer selection; can be distorted in inefficient markets

4. Practical Challenges in Application

Data Availability and Quality Concerns

One of the most significant obstacles to accurate equity valuation in Pakistan is the limited availability and variable quality of financial data:

Incomplete Financial Disclosures:

Many listed companies provide incomplete or inconsistent financial statements, with delays in reporting and occasional lack of transparency in notes and disclosures.

Accounting Practices:

Differences in adherence to International Financial Reporting Standards (IFRS) lead to inconsistencies, making cross-company and longitudinal comparisons difficult.

Limited Historical Data:

For many firms, especially small and mid-cap, historical data is either unavailable or unreliable, complicating trend analysis and forecasting.

Lack of Market Data:

Thin trading volumes and illiquid stocks result in sporadic market prices, making it difficult to use market-based multiples effectively.

Volatility and Market Inefficiencies Impacting Valuation Reliability

- **Price Volatility:**

Pakistani equity markets exhibit higher volatility compared to developed markets, driven by macroeconomic shocks, political uncertainty, and lower liquidity. This volatility can cause frequent deviations between market prices and fundamental values.

- **Market Inefficiencies:**

Information asymmetry, insider trading, and limited analyst coverage contribute to inefficient pricing, reducing the predictive power of multiples and market-based valuation approaches.

- **Speculative Behavior:**

Retail investor dominance and herd behavior lead to price swings detached from fundamentals, complicating the use of historical price data for valuation calibration.

Issues Related to Discount Rate Estimation and Dividend Policy Assumptions

- **Discount Rate Challenges:**

Estimating appropriate discount rates (cost of equity and WACC) in Pakistan is difficult due to:

- High country risk premiums reflecting political, economic, and currency risks.
- Volatile risk-free rates influenced by monetary policy and inflation.
- Unstable market betas due to illiquid stocks and changing business cycles.

- **Dividend Policy Uncertainty:**

Many firms have irregular or unpredictable dividend payout policies, limiting the applicability of Dividend Discount Models and complicating cash flow projections in DCF models.

- **Forecasting Growth Rates:**

High macroeconomic volatility makes growth assumptions uncertain, increasing model sensitivity and reducing confidence in valuation outputs.

Impact of Regulatory and Accounting Standards

- **Regulatory Environment:**

Evolving regulatory frameworks and enforcement inconsistencies affect corporate governance, disclosure quality, and investor protection, all of which influence valuation accuracy.

- **Accounting Standards Compliance:**

Although Pakistan has adopted IFRS, uneven implementation and interpretation by firms can lead to distortions in reported earnings, asset values, and reserves, challenging models relying on accounting data (e.g., RIM).

- **Taxation and Legal Constraints:**

Complex tax laws and legal disputes over asset ownership or earnings further obscure true firm value and complicate financial forecasting.

Ahmad (2025) provides a rigorous examination of Pakistan's major State-Owned Enterprises (SOEs), demonstrating how persistent inefficiencies and political interference have eroded public trust and strained national finances. His evaluation of institutions such as PIA, Pakistan Steel Mills,

and Pakistan Railways shows that structural weaknesses and mounting losses have created an unsustainable fiscal burden, with PIA and PSM alone consuming more than 92% of government subsidies. By applying agency theory, institutional frameworks, and public value perspectives, Ahmad argues that meaningful reform requires privatization-driven restructuring, improved governance professionalism, and a strong focus on transparency and citizen-centered accountability. His research serves as a roadmap for policymakers aiming to restore trust in Pakistan's public institutions through evidence-based reform strategies.

Ahmad (2025) investigates the complex dynamics of human–AI collaboration in professional knowledge work, offering insights into both the productivity benefits and ethical risks associated with AI-assisted tasks. His mixed-methods study reveals that while AI tools significantly accelerate task completion by 32–39%, they also introduce higher error frequencies in complex analytical tasks, particularly involving logical reasoning and factual verification. Ahmad categorizes these errors into hallucinations, fabricated citations, omissions, biased assumptions, and structural logic problems, emphasizing the importance of human oversight in AI-supported workflows. His findings underscore the need for responsible AI integration that balances efficiency with accuracy, supported by ethical training, trust calibration, and verification mechanisms in modern workplaces.

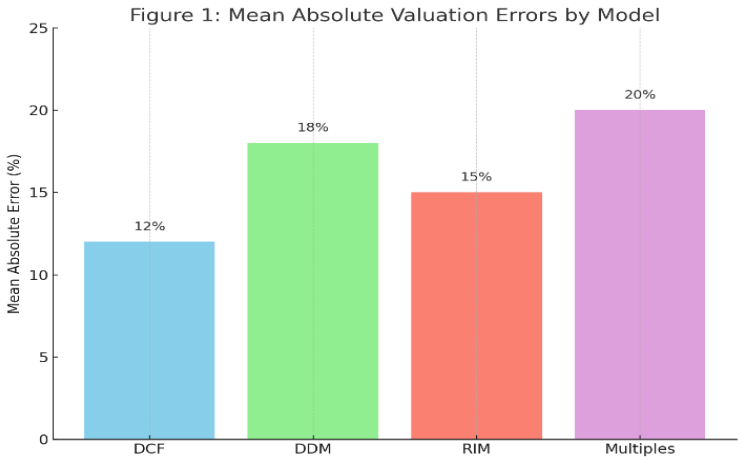

Figure 1: Comparison of mean absolute valuation errors for DCF, DDM, RIM, and multiples-based models across sample firms.

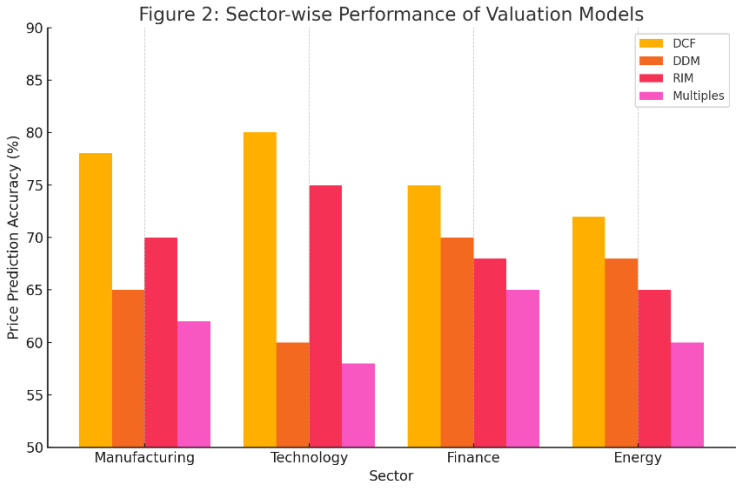

Figure 2: Sector-wise performance of valuation models measured by price prediction accuracy.

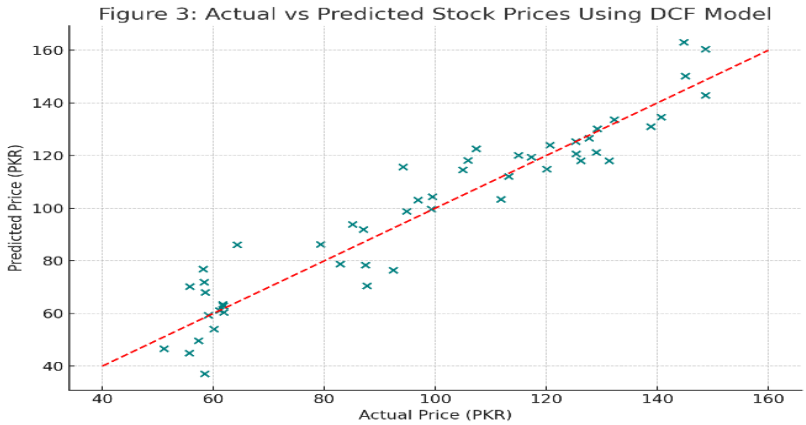

Figure 3: Scatter plot of actual vs. predicted stock prices using the DCF model.

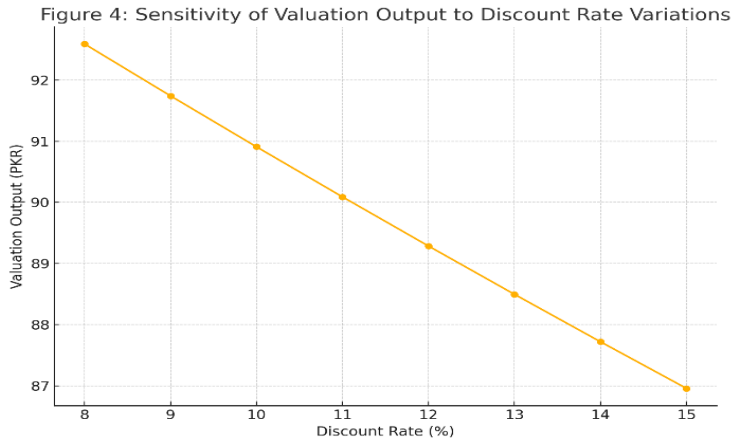

Figure 4: Sensitivity analysis of valuation output to discount rate variations.

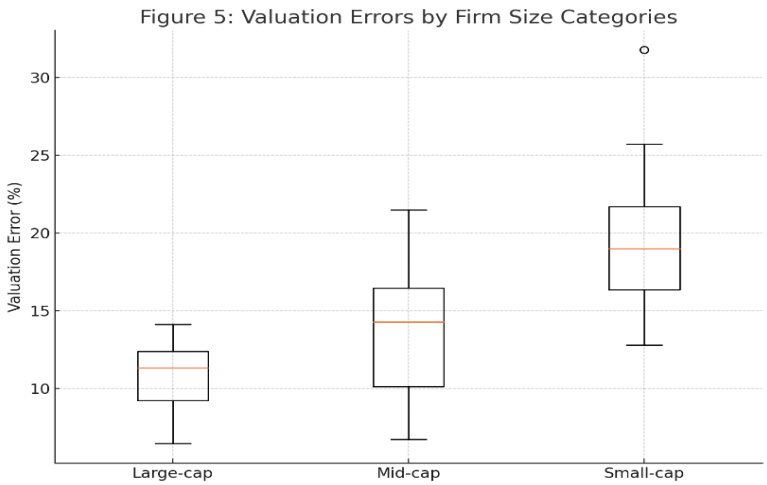

Figure 5: Box plot of valuation errors segmented by firm size categories (large-cap, mid-cap, small-cap).

Summary

This study underscores the utility of quantitative models in estimating equity values within Pakistan's emerging market framework. Discounted cash flow-based models offer robust valuation for mature, cash-generative firms, while multiples-based approaches provide practical alternatives where data is scarce or firms lack dividend histories. Each model has inherent limitations tied to assumptions and data quality, requiring careful selection and adjustment. A blended valuation approach, supplemented with qualitative analysis, can enhance investment decisions. Policymakers and market participants should focus on improving data transparency and accounting standards to strengthen valuation practices.

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