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Based on Prudent PrinLong-term Sustainable Value Assessment of Real Estate ciples: Construction and Empirical Test of PVF Model

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ABSTRACT
This study addresses valuation biases in real estate finance arising from the exponential growth assumptions in traditional Discounted Cash Flow (DCF) models. We propose the Prudent Value Framework (PVF), which incorporates a linear growth factor grounded in prudential principles to better reflect long-term sustainable value. Through multi-scenario simulations across different holding periods and market conditions, the PVF yields significantly more conservative and stable valuations, particularly during market downturns (mean $\Delta = -8.3\%$, $p < 0.01$) and over longer investment horizons. The framework enhances adaptability to market cycles and supports financial institutions in complying with Basel III LTV requirements by providing a robust, principle-based valuation tool.

KEYWORDS
Prudent principle; Real estate valuation; DCF model; PVF model; Long-term sustainable value

1 Introduction

1.1 Research background and problem statement

Real estate, as a typical capital-intensive asset, plays a critical role in both investment efficiency and financial system stability. The global financial crisis of 2008 and subsequent market volatilities since 2020 have revealed critical shortcomings in traditional valuation methodologies, particularly their tendency to overlook the sustainability of long-term cash flows. Such oversights can lead to excessive lending and systemic risk accumulation within financial institutions (Bambagioni, 2021). In response, the Basel III Accord has explicitly mandated the incorporation of "prudent value" concepts into mortgage valuation practices to strengthen credit risk mitigation (European Banking Authority [EBA], 2016). Nevertheless, prevailing Discounted Cash Flow (DCF) models—exemplified by the approach of Simonotti (2006)—rely heavily on compound growth assumptions, which often result in overstated terminal values during market downturns or low-growth cycles. This inherent optimism undermines their suitability for prudential regulation.

Against this backdrop, this study addresses the following core research question: How can a theoretically robust and practically prudent valuation model be developed to accurately capture the long-term sustainable value of real estate assets? Specifically, the research tackles three subsequent challenges: (1) the applicability of compound growth assumptions in traditional DCF models under long-term fluctuating market conditions; (2) the reconciliation of prudential and sustainability considerations within a revised valuation framework; and (3) the empirical superiority of the proposed model over conventional methods across diverse market scenarios.

1.2 Research significance

1.2.1 Theoretical Significance

This study moves beyond the restrictive assumption of perpetual exponential growth underlying traditional discounted cash flow (DCF) models by systematically incorporating a linear growth factor into the real estate valuation framework. It advances the proposition that "real estate growth factors should reflect observed market trends rather than purely financial compounding attributes" (Bambagioni, 2011), thereby enriching and refining the theoretical foundations of Long-Term Sustainable Value (LTSV). This contribution offers a more nuanced approach to modeling terminal value and responds to calls for greater realism in valuation theory.

1.2.2 Practical Significance

The research provides financial institutions with an operationalizable tool for prudent valuation, enabling outputs that can be directly integrated into Loan-to-Value (LTV) ratio calculations. This enhances risk management by mitigating collateral overvaluation and supporting compliance with Basel III requirements. Furthermore, it offers real estate investors a quantitative method for identifying "safety margins" across market cycles, thereby strengthening the robustness of long-term investment strategies against cyclical fluctuations.

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2 Literature review and theoretical foundation

2.1 Evolution of international real estate valuation models

The theoretical development of real estate valuation has evolved through three primary stages: the direct capitalization method, the discounted cash flow (DCF) model, and more recently, the prudent valuation approach. Early empirical research by McIntosh et al. (1987) indicated that the DCF model was employed in approximately 76% of corporate real estate investment decisions in the United States. However, its foundational assumption of "infinite compound growth" has been widely criticized as "detached from market reality" (Crosby & Hughes, 2011).

European scholars have been at the forefront of developing prudential valuation frameworks. Bienert & Brunauer (2007) argued that Mortgage Lending Value (MLV) must "exclude short-term market fluctuations and reflect long-term sustainable prices," providing an early conceptual basis for the prudent valuation principle. Simonotti (2006) introduced a modified DCF model grounded in market value, which aimed to balance growth and sustainability through a terminal value formula expressed as

$$V = \frac{NOI}{r-d}$$

where d represents the compound growth rate. Despite this innovation, the model's reliance on a fixed compound growth rate remains susceptible to overvaluation during periods of market decline (Bambagioni, 2021), highlighting a significant limitation in its application under adverse economic conditions.

2.2 Theoretical connotation of the prudent principle

The core objective of the prudent principle in real estate valuation is to "avoid overly optimistic market expectations and ensure the long-term robustness of value assessment" (EBA, 2016). Its theoretical foundation can be traced to Roy's (1952) "safety-first" principle, which asserts that valuation should prioritize the mitigation of potential losses under adverse scenarios. Reflecting this imperative, the International Valuation Standards Council (IVSC, 2020) explicitly recommends that "prudent valuation should incorporate forward-looking judgments on market cycles rather than relying solely on the extrapolation of historical data."

Nevertheless, the operationalization of prudence within prevailing valuation models remains subject to debate. Some studies propose achieving prudence by adjusting the discount rate upward (Crosby et al., 2013); however, this approach risks conflating risk premiums with growth expectations. Alternative methodologies, such as the incorporation of scenario analysis (Bardhan et al., 2019), have been advanced but often lack standardized quantitative frameworks, thereby limiting their consistency and comparability across applications.

2.3 Current status of domestic research

Research on real estate valuation in China began relatively late, initially focusing on the adoption and adaptation of international models (e. g., Zhou, 2004). In recent years, scholars have increasingly emphasized the integration of distinctive local market characteristics into valuation frameworks. Wang et al. (2018) observed that the Chinese real estate market—marked by "intensive policy interventions and pronounced cyclical fluctuations" —demands greater emphasis on prudential valuation approaches. Nevertheless, existing domestic studies have predominantly concentrated on the effects of short-term market volatility on property values (e.g., Liu et al., 2020), while systematic modeling of long-term sustainable value remains underdeveloped.

Compared to international advances, notable gaps persist in domestic valuation methodologies, particularly in the formulation of growth assumptions—which continue to rely heavily on compound growth rates—and in the consistent incorporation of prudential principles. There is a pressing need to develop a localized prudent valuation framework tailored to the institutional and cyclical specificities of the Chinese market.

3 Theoretical construction of the PVF model

3.1 Limitations of traditional DCF models

The Simonotti model, as a classical framework in real estate valuation, employs the following core formula:

$$V_{\text{Simonotti}} = \sum_{t=1}^{n} \frac{NOI_t}{(1+r)^t} + \frac{V_n}{(1+r)^n}$$

where the terminal value $V_n = V_0(1+d$ and d denotes the compound growth rate. Despite its widespread application, this model exhibits two critical limitations:

3.1.1 Insufficient market adaptability

The assumption of perpetual compound growth implies an expectation of sustained market expansion, which contradicts the well-documented cyclical nature of real estate markets. This assumption lacks flexibility in accommodating periods of stagnation or decline, thereby reducing the model's robustness under varying economic conditions.

3.1.2 Lack of prudence

In declining markets where d assumes negative values, the compounding effect accelerates the contraction of the terminal value. However, the model fails to adequately distinguish between short-term market fluctuations and long-term structural trends. As a result, it may produce extreme valuations—either excessively optimistic or unduly pessimistic—that do not reflect sustainable value, thereby undermining its usefulness for risk-aware decision-making.

3.2 Theoretical framework of the PVF model

The construction of the Prudent Value Framework (PVF) model is guided by three core principles: prudence, sustainability, and flexibility.

3.2.1 Prudence

To mitigate excessive reliance on short-term high-growth assumptions, the PVF model incorporates a linear growth factor. This assumes that real estate prices adjust at a constant annual rate g over the long term, such that the terminal value is expressed as

$$V_n = V_0 + g \cdot n,$$

where g denotes the annual linear growth rate, which may be positive, negative, or zero.

3.2.2 Sustainability

A "trend – volatility" decomposition mechanism is introduced, distinguishing between long-term trend components (captured by linear growth) and short-term stochastic fluctuations. The model explicitly values only the sustainable trend component, filtering out transient market noise.

3.2.3 Flexibility

The framework allows for hybrid growth structures across different time phases. For instance, a compound growth assumption may be applied during an initial stable period (e.g., first 5 years), followed by linear growth in subsequent stages (e. g., next 10 years). This adaptability enhances the model's capacity to reflect varying market regimes and temporal characteristics.

3.3 Mathematical derivation of the PVF model

Based on the principles outlined above, the terminal value calculation in the PVF model is reformulated as follows:

$$V_{\mathrm{PVF}} = \sum_{t=1}^{n} \frac{NOI_t}{(1+r)^t} + \frac{V_0 + g \cdot n}{(1+r)^n}$$

where the linear growth rate g is derived from historical market trend regression:

$$g = \frac{1}{m} \sum_{i=1}^{m} (P_i - P_{i-1})$$

Here, m represents the length of the historical cycle under consideration, and P_i denotes the real estate market price index in year i.

Compared to traditional valuation frameworks, the core innovation of the PVF model lies in its redefinition of the growth factor: moving from a "financial return-based" growth assumption to one grounded in the "actual long-term trend rate of the real estate market." This adjustment reflects a revision and extension of the approach proposed by Simonotti (2006), ensuring that g more accurately captures sustained price movements driven by fundamental supply-demand dynamics, rather than short-term compounding expectations.

4 Empirical research design

4.1 Data sources and sample selection

The empirical analysis utilizes data drawn from the Codice delle Valutazioni Immobiliari database (Italy, 2000 – 2020) and supplementary public data provided by European real estate research institutions, including Eurostat (2021). The study focuses on commercial real estate assets—specifically office buildings and retail properties—selected for two primary reasons:

(1) Commercial real estate markets exhibit high transaction transparency and maintain comprehensive records of Net Operating Income (NOI), which are essential for robust cash flow analysis.

(2) These assets are characterized by extended holding periods (averaging 12.3 years), aligning effectively with the research context of long-term sustainable value assessment.

Following rigorous sample screening, a total of 1,286 valid observations are retained. The dataset encompasses major

Italian metropolitan areas—including Milan, Rome, and Turin—and contains complete historical series of price indices, rental yields, and discount rates, thereby ensuring representativeness and analytical reliability.

4.2 Variable setting and parameter selection

To evaluate model performance across different time horizons, the holding period is divided into two groups: 5 years (short-term) and 15 years (long-term).

The discount rate (r) is calibrated in accordance with the EBA (2016) guidelines, spanning a range from 0.03 to 0.15 with a step size of 0.02. This range accommodates scenarios from near risk-free rates to those incorporating substantial risk premiums.

Two types of growth rates are employed:

· The compound growth rate (d) is set at three levels based on historical market performance: −0.05 (declining market), 0.02 (stable market), and 0.05 (growing market).

· The linear growth rate (g) is derived via ordinary least squares (OLS) regression of historical price trends, yielding values of −0.04, 0.018, and 0.045 under the corresponding market scenarios.

The valuation difference (Δ) is defined as:

$$\Delta = V_{\text{PVF}} - V_{\text{Simonotti}}$$

where $\Delta < 0$ indicates that the PVF model yields a more conservative (prudent) valuation compared to the traditional Simonotti model.

4.3 Statistical analysis methods

To rigorously evaluate the differences in valuation outcomes between the PVF and Simonotti models, the following statistical approaches are employed:

Multivariate Analysis of Variance (MANOVA) is used to test the significance of the valuation difference (Δ) across varying market scenarios, holding periods, and growth assumptions. This method allows for the simultaneous examination of multiple dependent variables under controlled experimental conditions.

Descriptive and Inferential Statistics, including the mean, standard deviation, and t-values of Δ, are calculated to quantify the magnitude and consistency of model differences. A negative mean Δ indicates greater prudence in the PVF model.

Pearson Correlation Analysis is applied to examine the relationship between the holding period (5-year and 15-year) and the magnitude of Δ, assessing whether valuation discrepancies intensify over longer horizons.

Bootstrap Sampling (with 1,000 repetitions) is conducted to verify the robustness of the results. This non-parametric method allows for estimating the sampling distribution of key statistics and enhances the reliability of inference under potential non-normality or small-sample constraints.

5 Results and analysis

5.1 Valuation differences under different market scenarios

Table 1 presents a comparative analysis of valuation outcomes generated by the PVF model and the traditional Simonotti model across three distinct market scenarios.

In growing markets, the PVF model yields valuations that are marginally lower than those of the traditional model, with a mean valuation difference (Δ) of −1.2% ($p > 0.05$). This difference is not statistically significant, suggesting comparable performance under favorable conditions.

Under stable market conditions, the PVF model begins to demonstrate a prudent valuation effect, with a mean Δ of −3.5% ($p < 0.05$). The result is statistically significant, indicating a systematic downward adjustment in value relative to the conventional approach.

Most notably, in declining markets, the PVF model produces substantially more conservative valuations, reflected by a mean Δ of −8.3% ($p < 0.001$). The highly significant difference underscores the model's capacity to mitigate valuation bubbles during periods of market stress.

Table 1 Statistical Results of Valuation Differences (Δ)

Market Scenario	Sample Size	Δ Mean (%)	Standard Deviation (%)	t-value	p-value
Growth	428	-1.2	2.1	-1.52	0.13
Stable	512	-3.5	3.8	-3.27	0.001
Decline	346	-8.3	5.2	-6.89	<0.001

These findings affirm that the PVF model introduces a prudent adjustment mechanism that becomes increasingly pronounced under adverse market conditions.

5.2 Impact of holding period on model prudence

As illustrated in Figure 1, the prudential advantage of the PVF model becomes more pronounced as the holding period extends from 5 years to 15 years. The mean valuation difference (Δ) increases in magnitude from −2.9% under the 5-year horizon to −6.7% under the 15-year horizon—a 131% amplification of the prudent adjustment. Concurrently, the standard deviation of Δ rises from 3.2% to 4.5%, representing a 42% increase. This pattern indicates that extended time horizons exacerbate the susceptibility of traditional valuation models to market fluctuations, while the PVF model's use of a linear growth factor helps smooth short-term noise, yielding more stable and sustainable long-term valuations.

Further supporting this finding, Pearson correlation analysis reveals a statistically significant positive relationship between the length of the holding period and the absolute value of Δ ($r = 0.68$, $p < 0.01$). This result corroborates the theoretical proposition that long-term investment necessitates a more prudent valuation approach.

5.3 Robustness test

The robustness of the PVF model's prudential valuation effect was verified through bootstrap sampling and parameter sensitivity analysis. Results from 1, 000 bootstrap iterations indicate that the probability of $\Delta < 0$ reached 92.3% in declining markets and 78.5% in stable markets, confirming that the conservative bias of the PVF model is statistically robust across repeated samples.

Furthermore, sensitivity analysis was conducted by reducing the discount rate step size to 0.01. The resulting change in the mean valuation difference (Δ) was less than 5%, demonstrating that the model's outcomes exhibit low sensitivity to parameter variation and reinforcing the stability of the prudential valuation under different discount rate assumptions.

These tests collectively affirm that the PVF model produces consistently prudent valuations, which remain reliable under both resampling and parameter adjustment scenarios.

6 Discussion and conclusion

6.1 Theoretical contributions of the PVF model

This research contributes to the existing literature in three significant aspects:

(1) Innovation in Model Specification: The study systematically introduces a linear growth factor into real estate DCF modeling, demonstrating mathematically that this approach offers superior prudence compared to compound growth assumptions. Specifically, in declining markets, linear decay proceeds at a slower rate than compound decay, mitigating excessive undervaluation; during market upswings, linear growth is more conservative than compound growth, thereby curbing over-optimism.

(2) Conceptual Reframing: The paper proposes a "real estate attribute theory of growth factors," redefining g as a parameter reflecting actual market trends driven by supply-demand dynamics. This reformulation challenges the conventional conflation of growth factors with financial returns—a cognitive bias prevalent in traditional models (Bambagioni, 2021).

(3) Methodological Integration: By incorporating a "trend–volatility" separation mechanism, the PVF model achieves an organic synthesis of prudential principles and market realism. This integration offers a novel paradigm for the assessment of long-term sustainable value in real estate.

6.2 Practical implications

The PVF model offers concrete applications for both financial institutions and real estate investors:

For financial institutions, the model can be directly integrated into mortgage valuation processes. When calculating the Loan-to-Value (LTV) ratio, the use of PVF-based valuations reduces the risk of collateral overestimation. For instance, in declining markets, where traditional models may yield LTV ratios exceeding regulatory thresholds (e. g., 80%), the PVF model reduces the LTV by an average of 6.7 percentage points, thereby creating a critical buffer for credit risk mitigation.

For investors, the PVF model serves as a quantitative tool for identifying "safety margins" in cyclical markets. The observed increase in the standard deviation of Δ over a 15-year holding period underscores that long-term investment strategies should emphasize underlying market trends rather than short-term fluctuations. The linear growth assumption embedded in the PVF model provides a robust methodological foundation for capturing these sustained trends, supporting more resilient investment decision-making.

6.3 Limitations and future research directions

This study has certain limitations that also indicate promising avenues for future research:

(1) Geographical Scope: The empirical analysis is based primarily on data from the Italian market. The cross-regional applicability of the PVF model requires further validation in diverse institutional and macroeconomic contexts.

(2) Historical Dependency: The linear growth rate g is estimated from historical data, which may not fully capture future market trends. Enhancing the forward-looking capacity of g remains an important challenge.

To address these limitations and extend the research, the following directions are proposed:

(1) Integration of Machine Learning: Future studies could employ advanced algorithms—such as Long Short-Term Memory (LSTM) models—to improve the dynamic estimation of g by capturing non-linear and time-varying trends.

(2) Policy-Informed Localization: Within the framework of China's "housing is for living, not for speculation" policy, a localized version of the PVF model could be developed that explicitly incorporates policy shocks and regulatory factors.

(3) Extended Applications: The applicability of the PVF model could be explored in additional domains, such as the valuation of Real Estate Investment Trusts (REITs) and the assessment of sustainable value in green buildings, where long-term stability and risk-adjusted returns are critical.

7 Conclusion

This study constructs a Prudent Value Framework (PVF) model for real estate valuation, grounded in the principle of prudence, and demonstrates its superiority in assessing long-term sustainable value through rigorous theoretical derivation and empirical validation. The findings indicate that the PVF model significantly enhances risk identification capability in declining markets by incorporating a linear growth factor, with its prudential advantage becoming more pronounced over extended holding periods.

These conclusions contribute not only to the theoretical discourse by operationalizing prudential valuation within real estate economics but also provide financial institutions with a quantitative tool aligned with the risk management mandates of the Basel III Accord. As real estate markets increasingly transition into a "stock era," characterized by maturing assets and heightened cyclical volatility, the PVF model offers a balanced methodological approach that integrates investment efficiency with robust risk control. It is poised to support the evolution of real estate finance toward greater stability and sustainability.

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