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A Digital Economy Approach to Enhance Transparency in Property Valuation via Proptech

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Abstract: Property valuation, a foundational method for governments, financial institutions, and insurers to gauge economic stability, remains hindered by opaque, fragmented data practices. Despite technological advancements like Artificial Inteligence (AI) and Web3, valuation processes rely on siloed, non-standardized data that institutions rarely share—even internally. This paper identifies systemic barriers to global transparency and proposes a Proptech framework to resolve this disconnect. Unlike market valuation, which leverages AI and algorithms to predict prices, housing valuation depends on manual audits and confidential metrics. This lack of transparency limits governments' capacity to preempt real estate crises or curb speculative risks. By integrating blockchain-enabled data sharing and AI analytics, a decentralized Proptech platform, sharing a global network, could standardize and democratize valuation data, enabling real-time insights for crisis management and evidence-based policymaking. The study highlights how such innovation could transform urban planning, financial markets, and economic resilience, positioning Proptech as a catalyst for equitable, transparent valuation ecosystems.

Keywords: real estate, proptech, market crisis, crowdsource and data transparency, AI and machine learning, digital economy

1. Introduction

The lack of standardized and transparent property valuation data directly affects market stability, as well as effective governance and citizens' self-awareness of real value. Transparency in property valuation is critical for economic stability and equitable access to housing markets. For citizens, understanding property value extends beyond transactional metrics or listings advertised by real estate agencies. Despite significant fees paid to professional evaluators based on calculations and certifications such as RICS or TEGOVA [1], governments, institutions, and individuals lack access to comprehensive, standardized valuation data at scale—even for large asset portfolios. This opacity persists within the industry itself: evaluators often duplicate efforts or withhold data, stifling comparability at regional or national scales [2].

Accurate property valuation is essential to ensure fiscal equity and public trust, preventing housing bubbles and supporting evidence-based policymaking [3, 4]. Citizens' financial literacy growth and knowledge on household market transparency are fundamental to the future of society [5, 6]. Systemic undervaluation or overvaluation distorts housing affordability, tax equity, and urban planning. For example (following important retrieved data by CEIC2025), speculative market pricing [1, 7]—driven by subjective trust rather than empirical benchmarks—can inflate housing bubbles, whereas regulated valuation methods anchor prices to tangible criteria [8]. This sounds like a typical case scenario of asymmetric information theory, or, as it was written before, Akerlof's lemons problem [9–11]. In this case, it is aggravated because the seller ends up being at the same level of knowledge as the buyer, and the only ones who hold are a very small group of stakeholders. The risks are significant: real estate crises incur prolonged recovery periods, with cascading effects on employment, public debt, and social stability [12].

Current valuation practices rely on hyperlocal market trends, which serve as unstable anchors prone to speculative distortion [13]. While evaluators apply controlled methodologies, their findings remain siloed. In contrast, speculative market values—untethered from audit-based frameworks—fuel volatile price escalations. This disconnect undermines crisis prevention, as governments lack granular data to intervene before speculation destabilizes markets, as documented in repeated warnings from the International Monetary Fund (IMF), which highlights how inadequate real estate data hampers macroprudential regulation [14, 15].

2. Position of the Economic Perspective

All markets exhibit cyclical fluctuations of "ups" and "downs," and real estate is no exception (Figure 1). However, compared to other markets—such as equities, where daily volatility and rapid recoveries are common (Figure 2)—real estate cycles are

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Figure 1
Shiller's real house price index, annualized, 1890–2016

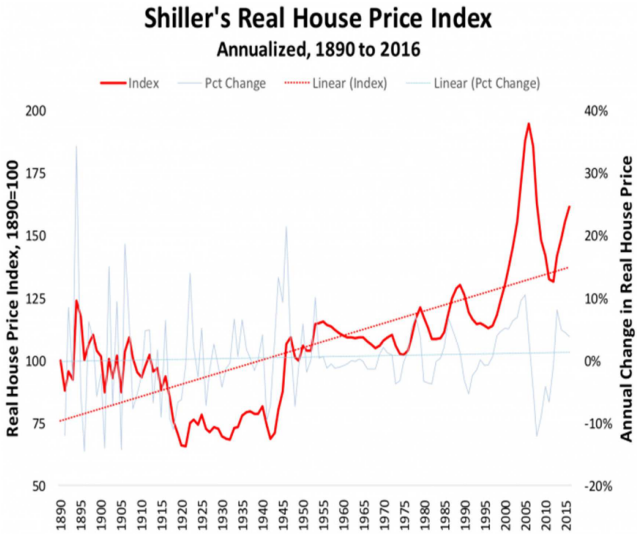


Figure 2
Tech stock market evolution in the last 30 years

characterized by prolonged stability punctuated by severe, intractable crises. Once a real estate market enters a downturn, governments face significant uncertainty about its duration, as recovery timelines often span years rather than days [16, 17].

Real estate crises are uniquely systemic, acting as economic "drag multipliers" that exacerbate downturns across sectors. For instance, during the Great Depression (1929–1933), collapsing property values compounded stock market losses, as mortgage defaults crippled household spending and banking liquidity [12, 18]. This interdependence contrasts with equity markets, which can rebound independently of broader economic conditions.

The pace of post-crisis recovery varies inversely with pre-crisis speculation levels. Economies with excessive property speculation, such as the United States during the 2008 subprime crisis, experience sharper initial declines but faster recoveries due to market corrections and policy interventions [19, 20, and 21]. Conversely, markets with historically restrained speculation, like Portugal, endure slower recoveries. Portuguese property prices, for example, bottomed out in 2014 and only regained pre-crisis levels by 2019 (reported by the Bank of Portugal report in 2020). This divergence underscores the role of speculative "overhang" in shaping post-crisis trajectories [22]. A country such as Portugal needing a whole decade to recover its economy just by the influence of external real estate can be truly damaging and has a strong impact on generations to come.

2.1. What is the purpose to control speculation?

It is understandable to assume that speculation helps the economy, and regulating in the opposite direction can be a brake to economic scaling, and it is something considered impossible to stop once it starts.

Regulating can be or not a brake on economic scaling; however, the main problem is social constrain implemented into society, diminishing their freedom of choice or their motivation to invest. In simple words, an investor always seeks the market that gives more money, but regulation makes it less appealing for investment. But the intention might not be to prevent, regulate, able to stop, or control the speculation but just centered on the awareness.

The purpose of this paper is to answer questions such as: What if the stakeholders, from the small citizen investor to the government's leadership, had immediate access, which includes public awareness of all the property values?

3. Research Methodology

3.1. Research design – Project Astrolaby

3.1.1. Background

The transformative potential of real-time data systems in public decision-making is exemplified by the evolution of navigation technologies, which was essential for the democratization of decision-making in real-time urban mobility. In 2006, FreeMap Israel launched a crowdsourced satellite navigation platform, later rebranded as *Waze* [23]. Unlike conventional GPS systems, Waze leveraged user-generated data to provide real-time traffic updates, empowering drivers to bypass congestion without directly addressing the root causes of traffic jams [24]. This model of *awareness-driven transparency* offers a critical precedent for addressing opacity in other sectors, such as real estate.

The development and deployment of FreeMap perfectly demonstrate the transformative potential of crowdsourced systems, grounded in the "wisdom of crowds" and the principle of collective intelligence [25]. A similar principle can be applied to property valuation, whereby real-time, distributed contributions enable more adaptive and accurate decision-making, while reducing valuation error. The fact that ordinary users contribute data through a broad network to a shared database could significantly reduce valuation errors and increase market transparency. Conversely, when decision-making in the real estate market is concentrated within a small group of so-called experts who share limited information, the market tends to follow iterative cycles of biased judgment. According to the Theory of Fads, Fashion, Custom, and Cultural Change as Informational Cascades [26], such informational asymmetry can perpetuate speculative bubbles, even when fundamental indicators suggest a misprice. It should be this dynamic system under a global network that helps to explain the persistence of speculative bubbles, even when underlying indicators signal mispricing. Thus, the lack of transparency does not just reflect inefficiency but actively contributes to systemic risk.

Project Astrolaby adopts a similar paradigm. By aggregating and disseminating real-time property valuation data, the platform does not seek to prevent market crises but to equip stakeholders—governments, investors, and citizens—with actionable insights to mitigate speculative risks. Just as Waze shifted drivers' perceptions

of traffic management, Astrolaby aims to recalibrate market participants' understanding of property value dynamics. For instance, transparent access to valuation trends could enable earlier detection of speculative bubbles, allowing policymakers to implement targeted interventions [27–29].

The analogy extends to limitations: like Waze, Astrolaby cannot eliminate systemic crises, but it can reduce their societal impact through democratized data access [30–32]. The platform's effectiveness depends on stakeholder engagement, as its value grows with the breadth and accuracy of contributed data [25]. This approach aligns with broader movements toward open-data governance, where transparency is framed as a public good rather than a regulatory constraint [1, 33]. An emerging consensus in financial and technology governance literature supports that AI, real-time information, and machine learning are essential for promoting economic transparency [34] and maintaining balance in the global economy [35–37].

3.1.2. Method for development

Real estate evaluation follows several different types of calculations; however, it has common patterns, which include the market value research. International institutions, such as TEGOVA, RICS, and others that include consulting companies such as Deloitte or banking and insurance, commonly have their own calculation method. These patterns share common fields although not always surveyed same way, for example, "Location," "Yield," "dimension and type of property," or "prospecting."

Therefore, demands on surveys and calculations can be different; these patterns share common fields, which can be adjusted in computing development.

Most of the fields can be achieved by documents and prospecting platforms; however, a critical element is missing, which is the interior of the property, such as inside a house, not only the dimensions but all the content and its state. This is one of the most crucial parts because it's the only way to determine the real value. Without that information, it's not possible to understand if the property (apartment) can be habitable or if it has a very good shape with high-quality equipment and furniture. It's also the most expensive part of the evaluation because it requires the expert (real estate evaluator) to move to the property. These assessments typically require on-site visits by certified evaluators, making them the costliest and logistically complex component of valuation.

3.1.3. Introducing machine learning in house evaluation – Project Astrolaby

If the idea is to prevent the expert from moving to the premises, the only possible option is to replace them with a machine. Astrolaby aims to enable end-users to perform full interior scans of residential properties using a standard smartphone camera. It is simply done by any person who has a smartphone [38]. A 5–10 min video maps walls, windows, equipment, and furniture, while also giving automatic data such as precise location and timing.

The process to achieve a developed state such as Astrolaby required computation of computer vision and machine learning for a period of time using validation methods. If the platform needs to return input without an expert to correct it, it means that it needs to learn until performances such as measurements and identification are acceptable with minimum discrepancies.

The method explained in the paper presented at 3rd ICICML 2025 [39] about object classification and further studies to help correct the dimensions into acceptable boundaries and use the resources in a more efficient way have been applied, so it can be used with a low margin for errors.

3.1.4. Outcome development

Once the interior is mapped, Astrolaby will apply valuation formulas from any global institutions using machine learning-based reverse engineering—either over the methods used or the calculation sheets imported, such as those typically used by banks. This information will not be acquired immediately; it will also depend on the system's capacity to search and/or cooperate with institutions.

However, the outcome goes beyond a single property valuation—it is integrated into a general valuation grid. The system transforms individual property scans into a distributed valuation network, where users contribute brief home videos in exchange for automated, credible value estimates—either credentialed by a RICS evaluator or received as unofficial, yet still informative assessments.

This crowdsourced approach mirrors the principles behind navigation apps like Waze or Gaode, which aggregate user-reported traffic data to optimize route accuracy. By decentralizing valuation inputs, Astrolaby mitigates speculative distortions, as Price Per Square Meter (PPSM) estimates reflect collective user contributions rather than market sentiment alone. Astrolaby 2025 thus offers a novel platform for transparent, real-time property valuation through decentralized data aggregation and AI-enhanced analysis.

3.2. Participants and instruments

Mapping the interior of a house, like the project Astrolaby is doing, requires the process of a large amount of data stack, with supervised data selected for several fields such as walls, windows, or furniture.

The classification method [38] is based on 3 main classes: [Types of construction, Equipment, and Furniture] that require over 300 fields, and subfields such as "furniture" require type, state, or age. The evaluation requires knowing the kind of wall, as well as the state of a closet or the age of a refrigerator. All this is generated into a typical algorithm of any housing evaluation.

This large dataset needed to be taught and tested using a self-made dedicated server composed of 3 Nvidia 4060 Ti 16GB GPUs (with a similar process like AWS EC2 g4dn.4xlarge) and a serverless setup.

Without a proper classification cascade method, the possibilities to reach 1 result out of 300 classes would be 2.037×10^{89}; this would create an impossible capacity or unnecessary use of resources to assemble and cluster all the unsupervised data until the machine reaches a strong accuracy, which is not possible to do with only 3 GPUs.

The data stack and supervised/unsupervised data were developed on platforms such as Supervisely and Cloudinary; the learning process used YOLO/Ultralytics to train and deploy the object identification system (Figure 3). Several improvements were made to enhance object classification by using multiple classification types. As training progressed, classification accuracy also increased (Figure 4). The current stage of development is integrating new technologies such as SpatialLM, which will enhance on-site spatial detection and enable faster classification [39].

Data have been and will continue to be collected on-site through video recording, while the app identifies objects in real time, until it can recognize the entire house. All real estate evaluations are considered valid for six months for investment groups, banks,

Figure 3
Object detection using YOLOv8 (windows and walls)

Figure 4
Object detection improvement using wider classification

governments, and large rental companies. However, no one expects to carry out continuous audits with the physical presence of real estate experts, as this would be prohibitively expensive—despite being a directive in several developed countries. Astrolaby addresses this challenge by allowing the same video to be repeated every six months. It detects changes and updated valuations in just a few minutes.

4. Conclusion and Discussions

4.1. About the acceptance between world leaders, institutions, and governments

The principle of crowdsource applications has been tested for more than ten years, both as a product and as a social benefit, and is in the principle of collective minds [25]. The potential outcomes of apps like Astrolaby can be anticipated by drawing comparisons such as Waze or Gaode; however, while the logic may be sound, success is not guaranteed—implementation will take time, just as it did for FreeMap.

In this particular case, the potential outcomes extend far beyond traffic control, as the system could influence economic governance itself.

The core question lies in the acceptance of this method by institutions such as high-tier consulting groups that hold this information or high-tier trust funds that basically belong to the only cluster capable to understand the real value of property and plan long-term environments, as well as what-if scenarios. It is common to understand that when something becomes transparent, some strategic value will be lost, even if, economically, everyone can take some benefit. The fact that Proptech evaluation apps can simply return very accurate data of property value might create some tension among certain groups who will be simply afraid of losing importance in their main field.

The idea is to give important information to the citizens, which doesn't remove the need for official validation or precise data reporting. The difference is the quickness for validation; once it is proven that the expert is no longer necessary at the premises, and the improvement in results is even better, it will also decrease the cost of the official reporting. This is a full democratization and disruption of the real estate market evaluation. On the other hand, it is also likely that many global institutions, including banks and governments, will welcome public access to such data, as their primary interest lies in the economic clusters.

Prototype tests were carried out in Lisbon using real audit data from the last five years' audits (Figure 5) and in Shenzhen using synthetic data, but same methodological principles (Figure 6), to assess the level of correction and social impact. In the city of Lisbon, it became evident that certain areas are overpriced relative to their housing conditions. In some cases, market pricing may mislead buyers by masking physical depreciation or poor quality. However, this remains a theoretical framework requiring further research and publication. It is difficult to predict how key real estate stakeholders will respond to increased transparency in property valuation.

However, this is still a theory for discussion for further research and publication. It is very hard to predict how key stakeholders in real estate will act for property value transparency. When Waze, still operating under its original name FreeMap, was in its early development phase, public discussions centerer on concerns over data sharing and personal privacy. Over time, it has been shown that the majority of people simply didn't care about it as they preferred to know more about the traffic than their personal data. Will a similar happen with apps such as Astrolaby?

4.2. About world accuracy

The fact that an app such as Waze can give us at any time in any city the traffic in real time and suggest new routes immediately if possible is definitely a benefit and easy to understand the utility. The fact is, it works and gives the user better routes and better perception.

Figure 5
Map of Lisbon districts with market property with corrected index data using Astrolaby data

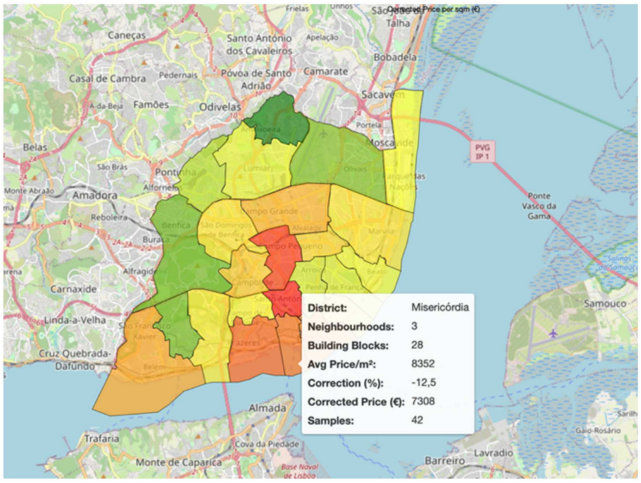
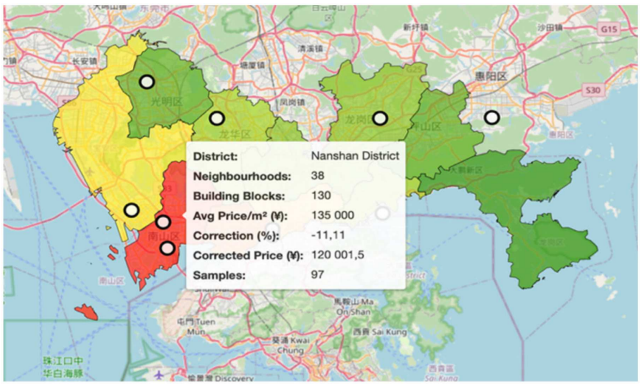


Figure 6
Map of Shenzhen districts with market property with corrected index data using Astrolaby dataset



Astrolaby and other Proptech possible and future applications need accuracy, which is dependent on world usage. Less users, less accuracy; therefore, its acceptance by users everywhere will make all the difference.

Currently, certain applications, such as the Portuguese platform Reatia [40], have achieved high accuracy (probably one of the highest in Europe) and market recognition by the real estate agencies to achieve market Prices Per Square Meter (PSQM). This accuracy is reduced once the area of influence with the users is wider and has fewer houses to build prospection data. As user activity increases, the system's accuracy improves correspondingly, since frequent usage continuously updates and refines property values. Market values are volatile, and after six months, they are still valid but more outdated, requiring some new updates [41]. It is the current procedure for governments, banking, and investment funds to request an evaluation update; with Astrolaby, it will be quicker as it only needs to detect the changes and report on the first evaluation.

Therefore, the capacity to detect the market value or its own algorithm can be irrelevant if the crowdsource is not enough. There is no prediction for this situation except the testing on real environments at a large full-world scale.

4.3. Final statements

The digital economy is essential for the future, and the application of machine learning can help institutions and citizens make more informed investment and planning decisions—avoiding deceptive information and reducing the need for reactive regulation or market intervention by governments.

Market value evolves freely, driven by public perception and collective awareness. In contrast, real estate property evaluation often lacks transparency—even within the consulting firm—and is even less coordinated across public institutions, despite the fact that much of this data should be publicly accessible.

The kind of awareness platforms like Waze and Gaode introduced more than 15 years ago—making real-time traffic problems visible to users that previously relied on radio—parallels the type of awareness now needed in real estate. It's about enabling individuals to understand the real value of a property they're considering for purchase or investment, aligning market price with actual value.

Awareness itself doesn't directly solve problems, but it enables stakeholders to prepare or plan more effectively. The day we are able to consistently align real property value with market price will signal a fairer and more transparent system. It will also help shorten the severity of market surges or crashes, reduce fear of uncertainty, and support better decisions by governments, central banks, and even real estate developers.

Recommendations

Besides the accuracy of object detection and cascade classification, these kinds of products are fully dependent on their crowdsource. The user's data need to be enough for an effective application of the product.

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Ethical Statement

This study does not contain any studies with human or animal subjects performed by any of the authors.

Conflicts of Interest

The authors declare that they have no conflicts of interest to this work.

Data Availability Statement

The data that support this work are available upon reasonable request to the corresponding author.

Author Contribution Statement

Pedro Faria: Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Resources, Data curation,

Writing – original draft, Writing – reviewing & editing, Visualization, Supervision, Project administration. **Peter Finn:** Conceptualization, Validation, Investigation, Resources, Writing – reviewing & editing. **Tiago Marques:** Conceptualization, Resources, Writing – reviewing & editing, Visualization, Supervision.

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