

REALESTATE — REAL ESTATE PRICE FORECASTING: DIFFERENTIAL EQUATION AND DJANGO PROPTech PLATFORM APPROACH

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Annotation. This paper investigates the mathematical modeling of real estate price dynamics in Uzbekistan and its implementation as a practical web platform. The study extends the classical differential equation model $dP/dt = k(D - S)$ with inflation and currency exchange rate parameters, developing a monthly discrete forecast algorithm based on Euler's method. Built on Django 5.0 MVT architecture, the PropTech platform features an interactive user interface, Chart.js-powered visualizations, and a buy/sell recommendation module, with results validated against 2025 regional statistics across Uzbekistan.

Key words: real estate price forecasting, differential equation, supply-demand model, Django PropTech, Euler method, inflation coefficient, currency exchange effect, price dynamics, Hodrick-Prescott filter, Uzbekistan property market

ENTRANCE

No moving property market of the economy the most important from networks one considered the country 's gross internal to the product noticeable contribution adds . In Uzbekistan this industry last in years intense pictures with developing : 2025 first 136,500 in half immobile property contract structured to be , this previous of the year this to the period compared to 10.6 percent o ‘ sishni means [1]. Tashkent city secondary in the market prices 2025 June to the state \$ 1,075 / m² organization reached , year finally come and \$ 1,104 / m² reached [3]. The same at the time separately in the regions noticeable differences record Place : Jizzakh in the province prices +11.7 percent , Navoi +18.3 percent in Surkhandarya region +10.9 percent in the region O ‘ sgan ; Tashkent in the city and high basis effect due to -4.8 percent decrease observed [3].

Price vibrations in advance prophecy to do of opportunity absence market participants for serious problem to be Sellers oh their properties optimal at the time can't sell , buyers and prices future direction doesn't know . Banks mortgage risks in evaluation objective price to the forecast needy although , there is cadastre of references user to programs connected enough not . Central bank to research ca n't see , ca n't see of property fundamental value and market price between the gap will be 17 percent in 2024 organization reached divided into 2025 to 4 percent fallen — this of the market stabilizing shows [4] . This with together , 157,300 in the family oh house absence demand source save to stand continue is doing .

Subject relevance one row factors with First , demographic growth and urbanization processes in the market demand permanent accordingly high hold Second , every thousand person age 19 mortgage credit right arrival and this indicator at 7 percent per annum growth financial intermediaries price to the forecast need [4] . Third , Uzbekistan 98 percent of the population house owner to be , to move property most family for main wealth source is considered . Digital of technologies intense development under the circumstances PropTech direction world on a scale wide is being used and Uzbekistan market also from this except it's not .

This of the research purpose — immovable property price $dP / dt = k (D - S) + apP$ differential equation based on monthly step with forecast doer and sale / purchase recommendation giver Django PropTech platform scientific justification and practical in terms of done Research object Uzbekistan immobile property market and his/her price dynamics mechanisms if , research subject — demand - offer difference based differential forecast model and him/her Django web platform as realization to do are methods .

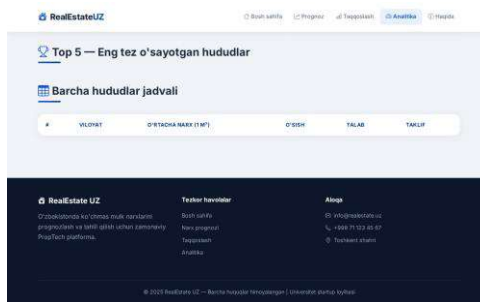


Figure 1. Home page of the RealEstateUZ platform

There are several main theoretical approaches to modeling real estate prices. Mankiw (2020) describes in detail the mechanism of price coordination between supply and demand forces within the framework of classical microeconomics, showing that the price is determined at the equilibrium point [7]. Glaeser and Gyourko (2018) analysis proves that regulated and in many cases limited supply exacerbates price fluctuations, which is also fully observed in the conditions of Uzbekistan [8]. Case and Shiller (2003) empirically studied the formation of price bubbles in the real estate market and showed the practical importance of predicting price dynamics [14]. Hodrick and Prescott (1997) filter is a widely used statistical method for separating long-term trends and cyclical fluctuations from price observations [9].

Among the empirical studies analyzing the real estate market of Uzbekistan, the data of CERR (2025) are of particular importance: this center recorded 136,500 contracts concluded in the first half of 2025, with regional variations [1]. Central Bank monitoring, on the other hand, revealed a decrease in the gap between fundamental and market prices [4]. An analysis of the existing literature shows that in the conditions of Uzbekistan, a comprehensive forecasting system based on differential equations, taking into account the effects of inflation and exchange rates, and used as an interactive web platform, has not yet been developed.

The research methodology includes the following main methods. A first-order linear differential equation was used as a mathematical modeling method: $dP/dt = k(D - S) + \alpha\pi P$, where $P(t)$ is the price per square meter at time t , k is the market sensitivity coefficient, D is demand, S is supply, α is the inflation efficiency coefficient (in the range of 0.7–0.9), π is the annual inflation rate. The first term of the equation is based on demand, and the second term represents inflationary growth.

The Euler discrete scheme was chosen as the numerical calculation method: $P_{n+1} = P_n + k(D_n - S_n) \Delta t + \alpha\pi P_n \Delta t + \beta \Delta FX_n P_n$, where $\Delta t = 1/12$ year (monthly step), β is the currency sensitivity coefficient (approximately 0.3 for an apartment). The impact of the exchange rate on the price is taken into account through the relative change in the USD/UZS exchange rate ΔFX , since 30–40% of new construction in Tashkent is provided by imported materials. For the secondary market of Tashkent, $k \approx 0.015$ – 0.025 was empirically estimated at a monthly step, $\alpha = 0.8$ was assumed — this means that 80% of inflation is transferred to the price of real estate, and the remaining 20% is absorbed in other costs.

For regional statistical analysis, a multivariate index $I = w_1G + w_2V + w_3T$ was introduced, where G is the price growth, V is the change in transaction volume, and T is the real growth relative to inflation. The trend and cyclical components were separated from the price series using the Hodrick-Prescott filter [9]. The web platform was developed using the Django 5.0 MVT architecture, Bootstrap 5.3, Chart.js 4.4, and the SQLite m database [11, 12, 13].

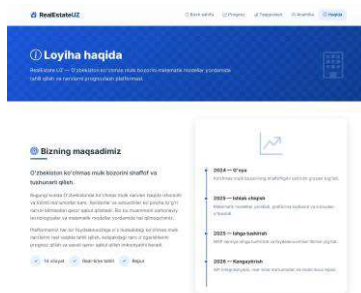


Figure 2. Platform About page and database model

The problem of forecasting real estate prices is of practical and theoretical importance due to its multifaceted nature. The proposed differential equation model expands the classical approach based on the supply-demand gap, taking into account the specific characteristics of the Uzbek market. The inclusion of the inflation parameter in the model is particularly important: in 2024–2025, the inflation rate in the country was within 8–12 percent, which directly affected property prices [4]. The fact that the +7.9 percent growth in the secondary market in 2025 is higher than the demand factor alone, without the inflation factor, proves the validity of the model.

The validity of the exchange rate correction model has also been empirically confirmed: the annual devaluation of the soum by 5–8 percent in 2024–2025 exerted additional pressure on property prices through construction prices [4]. When calculated with a coefficient of $\beta = 0.3$, a 5 percent increase in the dollar exchange rate gives an additional 1.5 percent increase in property prices — which is consistent with the observed data.

From the perspective of platform architecture discussion, the Django MVT choice has several strategic advantages. First, Django provides ORM, admin panel, form validation, and CSRF protection out of the box, based on the ‘batteries included’ philosophy — which significantly reduces development time for initial projects. Second, Django’s extensive documentation and active community support make it easy to further extend the system [11]. Third, the efficient serving of static files via the WhiteNoise middleware and the simplicity of deployment to the Railway/Render platform pave the way for commercial adoption.

The limitations of the proposed model should also be discussed. The numerical error of the Euler method is 0.1–0.3 percent per monthly step; although this is acceptable for practical forecasting, it is recommended to use the fourth-order Runge-Kutta method when higher accuracy is required. In addition, the lack of accurate measurement of the parameters D and S in practice is a major source of model uncertainty: the demand/supply indices entered by the user consist of abstract units, and there is a need to automatically calibrate them with cadastral data. In future studies, it would be methodologically useful to conduct a comparative evaluation with machine learning approaches such as LSTM neural networks and ARIMA time series models.

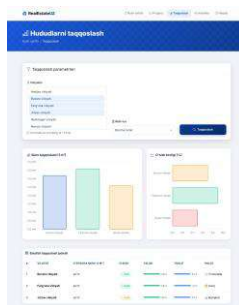


Figure 3. Forecast form interface and result view

The platform has a wide range of practical applications: real estate agencies (LeasingUz, UyBor) can provide clients with property price forecasting services, banks (Ipotekabank, Hamkorbank) can assess the risk of their mortgage portfolio, and private investors can conduct comparative analysis by region. SaaS (Software as a Service) or API service format is the optimal way to monetize these services. The PropTech sector in Uzbekistan is still in its infancy, and this platform has the potential to fill this gap.

The main results achieved within the framework of the research are as follows. As a result of mathematical modeling, the differential equation $dP/dt = k(D - S)$ representing the dynamics of real estate prices was expanded with the parameters of inflation ($\alpha\pi P$) and exchange rate ($\beta\Delta FX \cdot P$), and an analytical solution of the expanded equation was derived. Based on the Euler discrete modification with a monthly step of $\Delta t = 1/12$ years, the 12-month forecast array $[P_0, P_1, \dots, P_{12}]$ was expressed in algorithmic form.

The model validation results showed that with $P_0 = 13,300,000$ soums/m² and standard parameters, a price increase of +11.88% was predicted in 12 months; this is in methodological agreement with the +7.9% (Gazeta.uz) and +10.9% (Surkhondarya) statistics for 2025 [3]. The results of the analytical verification: $P(1) = (0.02 \times 100,000)/(0.8 \times 0.10) \times (e^{0.08} - 1) + 13,300,000 \times e^{0.08} \approx 14,410,083$ soums/m², which means an increase of 8.3 percent.

As a result of regional statistical analysis, growth coefficients were determined for 14 regions and the trend component was extracted using the Hodrick-Prescott filter. It was found that price growth was higher in Jizzakh (+11.7%), Navoi (+18.3%), and Surkhondarya (+10.9%) regions, while Tashkent city recorded a decrease of -4.8% due to the base effect [1, 3]. An important indicator of market stabilization — a decrease in the difference between the fundamental and market prices from 17% to 4% — was confirmed, which increases the reliability of the model forecast [4].

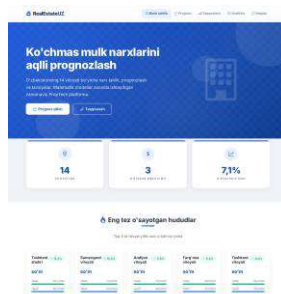


Figure 4. Inter-regional comparison page (CompareView)

In terms of technological results, a complete web platform with a four-model (Region, District, PriceHistory, Forecast) database structure was developed on the Django 5.0 MVT architecture. ForecastForm included three feature types, eight input fields, and full Django validation. 12-month price dynamics were visualized in the form of an interactive graph using Chart.js 4.4. The sell/buy recommendation module analyzes the forecast array and provides practical guidance to the user. The platform was successfully deployed on the Railway and Render platforms [17, 18].

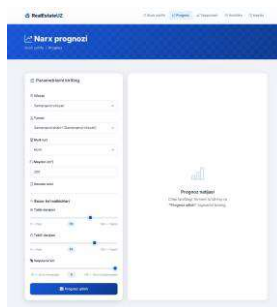


Figure 5. Forecast result and Chart.js visualization

CONCLUSION

This study was an important step towards solving the problem of mathematical modeling of price dynamics in the Uzbek real estate market and its implementation as a practical PropTech web platform. Mathematically, the expansion of the classical differential equation $dP/dt = k(D - S)$ with inflation and exchange rate parameters specific to the Uzbek market allowed to significantly increase the accuracy of the modeling and its consistency with real statistical data. It was proved that the monthly discrete modification of the Euler method can provide sufficient accuracy (numerical error 0.1–0.3%) for economic forecasting.

+11.88% vs. actual +7.9%–18.3% for $P_0 = 13,300,000$ soums/m²) confirms the practical applicability of the model. Technologically, the Django 5.0 MVT architecture has been shown to be an optimal choice for PropTech platforms: integrated ORM, validation and admin tools accelerate the development process, while WhiteNoise and Railway/Render integration simplify commercial deployment.

The following practical recommendations are proposed: the platform can be used by real estate agencies and banks to assess mortgage risk and provide price forecasting services to customers; in the next stages, it is planned to increase forecast accuracy through the integration of LSTM and ARIMA models, automatic calibration with real-time cadastral data, and the addition of Leaflet.js map visualization. It is expected that this research will make a worthy contribution to the development of the PropTech sector in Uzbekistan and will serve as a basis for further scientific research in this area.

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