

Dynamic Impact of Macroeconomic Indicators on U.S. Housing Market: A Panel Data Analysis from 2003 to 2022

Juntao Wang^{1,a,*}

¹*Institute of Problem Solving, University of Southampton, University Road, Southampton Town, SO17 1BJ, United Kingdom*

a. juntaowang990123@ldy.edu.rs

**corresponding author*

Abstract: This research examines the effect of several economic factors, such as the unemployment rate, producer price index, bank benchmark lending rate, mortgage interest rate, and S&P/Case-Shiller house price index, on the median home price in the United States. By employing panel data spanning from 2003 to 2022, this study utilizes multiple regression models to uncover the influence of various factors on house prices over several economic cycles. The findings indicate a strong and positive correlation between the S&P/Case-Shiller home price index and median house prices. Simultaneously, there is a strong and negative correlation between the unemployment rate, bank lending rates, and mortgage rates and median home prices. Additionally, rises in the producer price index are the main driver of house price increases. The study emphasizes the critical need for dynamic adjustment of economic policies and suggests policy recommendations such as focusing on interest rate policies, promoting employment and controlling construction costs to achieve a stable and sustainable housing market. At the same time, the study also suggests that other factors that may affect house prices be further explored in the future.

Keywords: Housing prices, economic indicators, macroeconomic Variables.

1. Introduction

The fluctuation of housing prices in the United States has been an essential subject of interest in the fields of economics and real estate studies. House prices serve as a crucial measure of the interplay between supply and demand in the housing market. Additionally, they have a significant influence on macroeconomic stability and the amount of wealth tied to residential properties. Fluctuations in property values directly affect consumers' consumption, savings, and investment choices, as well as overall economic development. Increased property prices often lead to a wealth effect on households, which in turn stimulates consumption and economic growth; conversely, falling house prices can trigger recessions and financial instability. Therefore, studying the key factors affecting house prices in the United States has important academic and policy implications [1].

Several research papers in the extant literature have examined the influence of various economic factors on housing prices. These factors include the mortgage rates, producer price index, benchmark bank lending rates, unemployment rate, and the S&P/Case-Shiller home price index [2, 3]. However, most of these studies have focused on specific periods or regions, needing more comprehensive analyses of factors over longer time horizons and within broader geographic areas [4]. In addition,

some of the studies have methodological limitations and fail to fully consider the issue of multicollinearity between variables, which affects the reliability of the findings [5]. In the context of globalisation and the increasing complexity of financial markets, the interactions between economic variables significantly impact house prices, which requires a more macro and integrated perspective [6, 7].

The objective of this study is to address this void by conducting a quantitative analysis of the primary economic factors that influence house prices in the United States, utilizing data from 2003 to 2022. As independent variables, the study selected the S&P/Case-Shiller U.S. National House Price Index (S.P.), Producer Price Index (PPI), Bank Base Lending Rate (BLR), Mortgage Rate (M.R.), and Unemployment Rate (U.R.). The dependent variable was the Median Sales Price of Houses Sold for the United States. By constructing a panel data model and combining descriptive statistics, Pearson correlation analysis, multiple covariance diagnosis (VIF) and multiple regression analysis to systematically explore the mechanism of the impact of these variables on U.S. house prices.

Preliminary results show that the S&P/Case-Shiller house price index is significantly and positively correlated with median house prices, suggesting that market expectations and investment behaviour directly impact house prices. The unemployment rate is significantly negatively correlated with median house prices, suggesting that high unemployment rates are usually accompanied by declining house prices, reflecting weakened demand for homeownership during economic downturns. The rise in the producer price index pushed up house prices significantly, reflecting the impact of higher construction costs on house prices. Meanwhile, increases in benchmark bank lending rates and mortgage rates significantly dampened house price increases. This study provides new insights for policymakers, real estate market participants, and academics to understand better and respond to U.S. house prices' volatility and the critical elements behind them.

2. Methodology

2.1. Data Source

This study analyses the key factors affecting U.S. house prices between 2003 and 2022 using data from authoritative databases such as Kaggle, WRDS (Compustat-Capital IQ), and the World Bank. The study period encompasses multiple Federal Reserve policy cycles, such as the negative interest rate environment that existed during the 2008 Global Financial Crisis and the Covid-19 Epidemic. Data selection prioritized quality and availability. Mature data systems and strict regulation in developed countries ensure data transparency and analytical robustness [8]. Compared to developing countries, the U.S. market's data strength provides diverse perspectives and reliable results.

2.2. Variables Explanation

This study selects the 'Median Sales Price of Houses Sold for the United States' as the dependent variable while analyzing the factors that impact house prices in the U.S. Median prices for houses offer a more precise indication of the average price level in the market, mitigating the impact of outliers and presenting a more accurate representation of market conditions. The S&P/Case-Shiller Home Price Index is a crucial metric for measuring price fluctuations in the real estate sector. It serves as an independent variable and takes into account factors such as market demand, economic growth, and family income. This index effectively captures both the long-term and short-term dynamics of the housing market. Unemployment, being a crucial gauge of the economy's well-being, exerts a complex impact on property values. A high unemployment rate usually weakens household incomes. It reduces the demand for homeownership, leading to a decline in house prices, while a low unemployment rate enhances homeownership and pushes up house prices. In addition, the Producer Price Index (PPI), an important supply-side variable, has a significant impact on house prices through

its influence on construction costs, supply chain stability and inflationary trends; an increase in the Producer Price Index (PPI) typically results in an escalation of building materials and labor expenses, which in turn leads to higher housing costs. Conversely, a decrease in the PPI can reduce the cost of new housing, causing a decline in house prices. Bank prime lending rates, the benchmark rate in the credit market, dramatically impact the cost of lending for home purchases. Higher interest rates raise borrowing costs, dampen demand for homes and depress house prices, while lower interest rates do the opposite. Mortgage rates are also a key financing cost factor. High rates increase the cost of homeownership and reduce purchasing power, discouraging demand and depressing house prices. In contrast, low rates reduce the cost of homeownership, increase purchasing power, and push house prices. This study seeks to analyze these variables in order to uncover the complex dynamics and their interplay that influence home prices in the United States. Its goal is to offer both theoretical and empirical evidence to promote the achievement of a stable and sustainable housing market development.

This study contains 240 observations. The panel data shows strong balance and stability, suggesting no missing data issues, and the entire sample can be fully analysed. For both the dependent and the independent variables, the descriptive statistics are shown in Table 1. The low standard deviations for most variables indicate less volatility in the data, which means that predictive accuracy is likely to be high, thereby reducing the risk of multicollinearity and enhancing the statistical power of the model. The concentrated data distribution means that the regression results for the sample of U.S. housing markets are minimally biased in their impact, enhancing the predictive reliability of the model and the credibility of the findings. However, conducting additional diagnostic tests is critical to fully validating the model.

Some of the independent variables in this investigation are as follows: The S&P/Case-Shiller U.S. National Home Price Index (SP) measures the overall movement of home prices in the United States. The S&P/Case-Shiller Home Price Index has a standard deviation of 0.2340 and a mean value of 0.2961, with values between 0 to 1. It is a robust indicator of the national home price trend, reflecting the market dynamics and investor sentiments, influencing housing market expectations and pricing behaviour. Unemployment Rate (UR): The standard deviation of the unemployment rate is 0.1816, with a mean of 0.2242, ranging from 0 to 1. This variable reflects labour market conditions, affecting household incomes and housing affordability and demand. Goods Producer Price Index (PPI): The data has a deviation by standard deviation of 0.1911 and a mean value of 0.3760, with values fluctuating between 0 to 1, the PPI measures the average change over time in the price at which domestic producers sell their products. It affects construction costs and housing supply dynamics. Bank Base Lending Rate (BLR): The standard deviation of the BLR is 0.3073, with a mean of 0.2293 and a range from 0 to 1. As a benchmark rate, it directly affects mortgage rates and borrowing costs. Changes in the BLR can significantly affect housing demand and prices. The Mortgage Rates (MR) have a standard deviation of 0.2634 and a mean value of 0.4742, with values fluctuating between 0 to 1, mortgage rates are a key determinant of housing affordability. Fluctuations in mortgage rates affect the cost of financing home purchases, affecting consumer behaviour and market activity.

Table 1: Descriptive Test.

Stats	Sd	N	P50	Mean	Min	Max
SPHS	0.2248	240	0.2450	0.3174	0	1
SP	0.2340	240	0.2498	0.2961	0	1
UR	0.1816	240	0.1696	0.2242	0	1
PPI	0.1911	240	0.3974	0.3760	0	1
BLR	0.3073	240	0.0610	0.2293	0	1
MR	0.2634	240	0.4205	0.4742	0	1

In summary, the descriptive statistics in Table 1 provide a detailed overview of the concentration trends and variability of the variables in the study. The data's comparatively low standard deviation suggests that the results are stable and exhibit less volatility, which enhances the dependability of the future regression analysis. Conducting thorough diagnostic tests will further validate the model and ensure the accuracy and credibility of the findings.

2.3. Empirical Model

The basic regression equation:

$$Y_{i,t} = \alpha + \beta X_{i,t} + \mu_{i,t} \quad (1)$$

According to H1, the main equation is as follows:

$$SPHS_{i,t} = \alpha + \beta_1 SP_{i,t} + \beta_2 UR_{i,t} + \beta_3 PPI_{i,t} + \beta_4 BLR_{i,t} + \beta_5 MR_{i,t} + \varepsilon_{i,t} \quad (2)$$

The dependent variable used for this study is the Median Sales Price of Houses Sold in the United States (SPHS). It represents the median price of homes sold in each region over a certain time period. The SPHS serves as a fundamental measure of the United States property market's well-being, properly capturing the real changes in home prices while mitigating the impact of extreme price fluctuations on the average. The S&P/Case-Shiller House Price Index (SP) is an essential component that measures the overall movement of house prices in the country, and it directly affects the median home price. The Unemployment Rate (UR), another key independent variable, reflects unemployment by region and is usually negatively correlated with house prices. The Producer Price Index (PPI) measures changes in the cost of production, particularly fluctuations in the cost of construction materials and labour, and usually drives house prices. The Bank Base Lending Rate (BLR) represents the cost of borrowing, with higher interest rates dampening demand for homeownership and depressing house prices. Mortgage rates (MR) reflect the cost of purchasing a home; higher rates increase the burden on homebuyers, suppressing demand and ultimately depressing house prices. The error term captures other factors not included in the model. Through the regression model, this study reveals the complex mechanisms by which each economic variable affects house prices.

3. Results and Discussion

3.1. Correlation Analysis

Table 2 demonstrates the correlation matrix of the independent variables, which includes the S&P/Case-Shiller U.S. National House Price Index (SP), Unemployment Rate (UR), Commodity Producer Price Index (PPI), Bank Benchmark Lending Rates (BLR), and Mortgage Rates (MR), in order to quantify the direct correlation between the variables within the regression framework. The results rule out the possibility of multicollinearity among the explanatory variables.

The correlation between the S&P/Case-Shiller house price index (SP) and the producer price index (PPI) is 70.1%, which is the highest seen. This indicates a statistically significant positive association. Furthermore, the correlation coefficient among the unemployment rate (UR) and the S&P/Case-Shiller house price index (SP) is -50.6%, indicating a negative correlation. This suggests a connection between increasing unemployment and decreasing house prices. The correlation coefficient involving the unemployment rate and the Producer Price Index (PPI) was precisely -13.3%, showing a small negative association. The correlation coefficient around the benchmark bank lending rate and the unemployment rate was -51.8%, showing a strong and substantial negative association. The correlation coefficient of the mortgage interest rate and the producer price index was -45.8%, showing

a significant and severe negative link. The correlation coefficient between the rate of interest on mortgages and the bank base rate of lending was 70.3%, showing a strong positive link.

In exploring the factors influencing house prices, some factors, such as bank-based lending rates and mortgage rates, work together to influence house prices. The correlation coefficients in Table 2 show the bivariate relationships between these variables and house prices. Traditional univariate correlation analyses aim to capture linear relationships and tend to ignore external variables that may affect these correlations. This limitation prompted this study to employ more sophisticated statistical methods, particularly panel data modelling, to understand these relationships better. With all correlation coefficients at moderate levels, the predictor variables in the multiple regression model are far from perfectly correlated, thus mitigating the problem of multicollinearity in this study.

Table 2: Pearson Correlation Test.

	SP	UR	PPI	BLR	MR
SP	1				
UR	-0.506**	1			
PPI	0.701**	-0.133*	1		
BLR	0.154*	-0.518**	-0.256**	1	
MR	-0.219**	-0.185**	-0.458**	0.703**	1

3.2. Multicollinearity Test

Multicollinearity is a common statistical problem in regression analysis that can lead to imprecise parameter estimates. A strong correlation between variables leads to an increase in the standard error and a decrease in the power of statistical tests. This makes it more difficult to identify the vital factors that predict that impact the dependent variable. The variance inflation factor (VIF) is a frequently employed diagnostic technique for identifying multicollinearity. The method measures the extent of correlation among the independent variables and effectively detects and addresses the issue of multicollinearity, enhancing the prediction accuracy of the model. By quantitatively assessing the degree of multicollinearity, the model can be simplified by removing or combining high VIF variables to improve the robustness of parameter estimates and avoid misleading conclusions. A VIF value below 10 (sometimes 5) indicates that multicollinearity is not significant. If the VIF exceeds this threshold, further investigation is required to remove some of the non-significant variables to mitigate multicollinearity.

Based on the findings shown in Table 3, the Variance Inflation Factor (VIF) values for the variables are much lower than the crucial level of 5. This indicates that there is no substantial association among the independent variables in this research. Hence, the panel data model may be subjected to multiple regression analysis to enhance the study's dependability in terms of confidence and outcomes. Table 3 presents the Variance Inflation Factor (VIF) values for the independent variables. The S&P/Case-Shiller U.S. National House Price Index (SP) has a Variance Inflation Factor (VIF) value of 3.271 and an inverse VIF (1/VIF) value of 0.306. The Unemployment Rate (UR) has a Variance Inflation Factor (VIF) value of 1.877 and an inverse VIF value of 0.533. The Goods Producer Price Index (PPI) has a Variance Inflation Factor (VIF) value of 2.747, with an inverse of the VIF value (1/VIF) of 0.364. The VIF (Variance Inflation Factor) value for the Bank Base Lending Rate (BLR) is 3.145, and its inverse value (1/VIF) is 0.318. The VIF (Variance Inflation Factor) value for the Mortgage Rate (MR) is 2.564, and the inverse of the VIF value is 0.390.

The multiple regression analysis of this study does not contain any significant issues with multicollinearity, as indicated by the VIF values in Table 3. As a result, the panel data model's regression analysis can be conducted with confidence to investigate the influence of the

aforementioned variables on US house prices and to derive scientifically credible conclusions from the study.

Table 3: VIF Test.

	VIF	1/VIF
SP	3.271	0.306
UR	1.877	0.533
PPI	2.747	0.364
BLR	3.145	0.318
MR	2.564	0.390
Mean VIF		2.91

3.3. Multivariate Regression Results

Table 4 displays the R-squared statistic of the model, which is 0.970. This number indicates a strong match between the model and the sample data. The F-statistic of 1491.674 indicates a high level of statistical significance between the predictor and dependent variables in the context of the panel data regression model. The p-values of the key variables, namely the Mortgage Rates (MR), Unemployment Rate (UR), Producer Price Index (PPI), Bank Benchmark Lending Rates (BLR), and S&P/Case-Shiller U.S. National House Price Index (SP), are all below the critical value of 0.05. This aligns to the F-statistic and confirms that the relationships between these variables are statistically significant at the 5% level of significance. Thus, the overall performance of the econometric model employed is satisfactory from a macroeconomic perspective.

This study employs multiple regression analysis to examine the impact of various factors on house prices. The S&P/Case-Shiller house price index (SP), unemployment rate (UR), producer price index (PPI), bank benchmark lending rate (BLR), and mortgage interest rate (MR) are used as independent variables, while the SPHS is used as the dependent variable. Table 4 shows the regression coefficient for SP, which is 0.674. This coefficient reflects a statistically significant relationship between the change in the S&P/Case-Shiller house index of prices and SPHS at a significance level of 5% (p-value = 0.000). When doing a regression analysis on the UR variable, the coefficient for UR is -0.189. This indicates a statistically significant negative correlation between the unemployment rate and SPHS at a 5% significance level (p-value = 0.000). Furthermore, the regression coefficient of PPI is 0.243, which suggests that a rise in the Producer Price Index has a substantial impact on the growth in home prices, with a high degree of statistical significance (p-value=0.000). The regression coefficient of BLR is -0.079, showing that a rise in the benchmark bank lending rate has a statistically significant and negative effect on property prices (p-value=0.000). The regression coefficient for MR is -0.126, which signifies that an increase in mortgage interest rates has a substantial and statistically significant adverse effect on SPHS (p-value = 0.000). The regression coefficient for the constant term is 0.147, which means that when all other factors are not included, the median home price (SPHS) has a baseline level of 0.147. This coefficient is highly statistically significant, as shown by a p-value of 0.000.

Overall, the findings from the regression analysis confirm that the economic factors indicated earlier have a substantial impact on the pricing of houses in the United States. High S&P/Case-Shiller house price index and PPI are significantly associated with house price increases. In contrast, high unemployment rates, bank benchmark lending and mortgage rates are significantly associated with house price decreases. These findings validate the model's hypotheses and provide insights into the determinants of US house prices, which can help formulate effective economic policies and real estate market strategies.

Table 4: Regression Result

Variables	Coef	Std. Err	t	p	95% CI
Constant	0.147	0.012	12.517	0.000**	0.124 ~ 0.170
SP	0.674	0.02	34.017	0.000**	0.635 ~ 0.713
UR	-0.189	0.019	-9.769	0.000**	-0.227 ~ -0.151
PPI	0.243	0.022	10.925	0.000**	0.199 ~ 0.286
BLR	-0.079	0.015	-5.325	0.000**	-0.108 ~ -0.050
MR	-0.126	0.016	-8.094	0.000**	-0.157 ~ -0.096
F (5,234)=1491.674,p=0.000					
R2=0.970,R2(within)=0.000					
* p<0.05 ** p<0.01					

3.4. Discussion

This study validates the results of previous research by doing a statistical analysis to determine the major influence of various economic factors on the median home price (SPHS) in the United States. The S&P/Case-Shiller house price index (SP) and SPHS have a notable positive correlation. This implies that when the index increases, there is a strong likelihood of an increase in median house price. This suggests that the house price index influences market expectations and demand for homeownership, thereby driving up house prices.[9]. Second, the unemployment rate (UR) is significantly and negatively correlated with median house prices, reflecting that high unemployment weakens the population's purchasing power and suppresses the demand for housing, leading to a decline in house prices. This is consistent with a common phenomenon during recessions, validating the role of the unemployment rate as a key variable affecting house prices [10]. Third, the positive correlation between the Producer Price Index (PPI) and median house prices suggests that rising production costs drive house price increases. This aligns with the notion of supply-side economics, which posits that any rise in building costs will be passed on to the pricing of houses. Rising PPI may also signal inflationary pressures, further stimulating homeownership demand [11]. Finally, the negative correlation between the bank base lending rate (BLR), mortgage rate (MR), and median house prices suggests that a high interest rate environment increases borrowing costs and reduces demand for house purchases, depressing house prices [12]. In addition, high interest rates may lead homeowners to sell their properties due to increased repayment pressure, further increasing market supply and depressing house prices [13]. These findings have important practical implications for policymakers and market participants. During a recession, the housing market can be stabilised by lowering interest rates and increasing economic incentives. In contrast, during a period of overheating, the property market can be prevented from overheating by raising interest rates and controlling production costs [14].

4. Conclusion

This research aims to assess the influence of five crucial economic factors on median house prices using an empirical analysis of housing market data in the United States from 2003 to 2022. The variables included in this set are the S&P/Case-Shiller home price index, the unemployment rate, the producer price index (PPI), the bank benchmark lending rate, and the mortgage rate. A significant positive association has been shown between the S&P/Case-Shiller house price index and the median house price, suggesting that house prices are influenced by market demand and investment behavior. The negative correlation between the unemployment rate and the median house price demonstrates how the job market has a suppressing impact on the demand for property. The increase in bank

benchmark lending and mortgage rates had a substantial impact on house values, since it led to greater borrowing expenses and reduced desire for homeownership. Furthermore, there exists a direct relationship between the upward trend in Producer Price Index (PPI) and the growth in housing prices, indicating the recognized significance of building expenses in the determination of housing prices. Although this study reveals the far-reaching impact of several variables on house prices, there are limitations, such as the generalisability of the findings may be limited by the US-specific economic environment, and the economic volatility during the study period may impact the stability of the results. In order to enhance the generalizability of the research, it is recommended to broaden the sample coverage by include more nations and regions in future research. Moreover, it is advisable to use diverse economic models. In order to establish a housing market that is both stable and sustainable, it is essential for policymakers, property developers, and financial institutions to consider these elements.

References

- [1] Moramarco, G. (2024) *Financial-cycle ratios and medium-term predictions of GDP: Evidence from the United States*. *International Journal of Forecasting*, 40(2), 777-795.
- [2] Abasimi, I., Aulia, A.R. and Khasanah, U. (2023) *Analysis of house price determination in 13 G20 countries: Random effect model*. *Journal of Asset Management and Public Economy*, 2(2), 65-81.
- [3] Tariq, M., Khan, M.A. and Ali, N. (2024) *Does monetary policy contribute to housing price booms? Empirical evidence from the US economy*. *International Journal of Housing Markets and Analysis*.
- [4] Francke, M., Rolheiser, L. and Van de Minne, A. (2023) *Estimating census tract house price indexes: A new spatial dynamic factor approach*. *The Journal of Real Estate Finance and Economics*, 1-32.
- [5] Boug, P., Hungnes, H. and Kurita, T. (2024) *The empirical modelling of house prices and debt revisited: A policy-oriented perspective*. *Empirical Economics*, 66(1), 369-404.
- [6] Sanchaniya, R.J., Sanchaniya, J.V. and Bhalodi, P.P. (2023) *Comparative analysis of the Indian and Canadian real estate markets*. *Baltic Journal of Real Estate Economics and Construction Management*, 11(1), 1-13.
- [7] Zhang, X., Yang, E. and Wang, Y. (2023) *Time series observation of relationship between United States private residential construction spending and its indicators*. *International Journal of Housing Markets and Analysis*.
- [8] Deng, Y., Wang, Y. and Zhou, T. (2024) *Macroeconomic expectations and expected returns*. *Journal of Financial and Quantitative Analysis*, 1-70.
- [9] Anastasiou, D., Kapopoulos, P. and Zekente, K.M. (2023) *Sentimental shocks and house prices*. *The Journal of Real Estate Finance and Economics*, 67(4), 627-655.
- [10] Graham, J. and Makridis, C.A. (2023) *House prices and consumption: A new instrumental variables approach*. *American Economic Journal: Macroeconomics*, 15(1), 411-443.
- [11] Carro, A. (2023) *Taming the housing roller coaster: The impact of macroprudential policy on the house price cycle*. *Journal of Economic Dynamics and Control*, 156, 104753.
- [12] Leung, C.K.Y. and Tang, E.C.H. (2023) *The dynamics of the house price-to-income ratio: Theory and evidence*. *Contemporary Economic Policy*, 41(1), 61-78.
- [13] Chodorow-Reich, G., Guren, A.M. and McQuade, T.J. (2024) *The 2000s housing cycle with 2020 hindsight: A neo-Kindlebergerian view*. *Review of Economic Studies*, 91(2), 785-816.
- [14] Anenberg, E. and Ringo, D. (2024) *Volatility in home sales and prices: Supply or demand?* *Journal of Urban Economics*, 139, 103610.