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Rents, Prices and Interest Rates

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This article reports that after controlling the effect of the long-term real interest rate and extending forecasting horizons beyond the typical 3 months to 3 or 4 years found in most existing studies, I find that the rent-price ratio is significantly related to both the expected rent growth and price growth over five- to six-year horizons. The expected future price growth is more sensitive than the expected rent growth to each of the two predictors. The differences in the sensitivities are consistent with the mean reversion property of the rent-price ratio and the positive relationship between the current interest rate and the future rent-price ratio. The increasing predictive power for longer horizons is consistent with the implications of a vector autoregressive model for the two predictors that are highly persistent and interacting with each other.

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1. INTRODUCTION

In an arbitrage-free economy, the price of an asset is the present value of its expected future discounted cash flows. If the real estate market is efficient, the price of a house should be related to the expected rents that can be generated from the house over its future life and the cost of capital that is used to discount each of the future rents. In this efficient market, since the rent should cover the user cost of housing, the rent should be related to the house price and the interest rate as the opportunity cost of capital. The interest rate, as an important determinant of the cost of capital, however, is not constant over time. After adjusting for inflation, the aggregate national house prices in the United States falls by 36 percent from the local peak in March 2006 to the trough in February 2012 and subsequently rises by 74 percent from the trough through November 2024.

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The inflation-adjusted long-term interest rate, in the meantime, plunges from 2.4 percent to nearly zero in the first period and surges from zero to 3 percent in the second period. The high volatility of the interest rate suggests that the time series behavior of the interest rate and its co-movement with other factors like the rent-price ratio are potentially important in the study of the predictability of house prices and rents.

I examine the long-horizon predictability of house prices and rents in a two-factor model in this article. In this model, for any given time horizon, the future rent-price ratio, the future rent growth and the future price growth of any property are related to its current rent-price ratio and the current interest rate as two predictors. I illustrate that, if the data generating process of the predictors is assumed to be a bivariate vector autoregressive process and both predictors are highly persistent, the model predicts that the sensitivity of the expected future rent-price ratio to the current interest rate increases with time horizons while the effect of the lagged rent-price ratio on the expected future rent-price ratio diminishes over time horizons. As a result, the interest rate should be more important for predicting long run rent growth and price growth.

I use aggregate monthly U.S. national house prices, the national average rents and the 10-year real interest rate during the period from 1987 to November 2024 in long-horizon regressions over one-year to six-year time horizons. Consistent with the prediction of the bivariate model of the data generating process, I find a significantly positive relationship between the real interest rate and the future rent-price ratio three years or longer ahead, but an insignificant relationship between the current and future rent-price ratios in the long horizons. I also find that the expected future rent growth and price growth are negatively and significantly related to the current interest rate over three years or longer horizons. More interestingly, after controlling the effect of the interest rate, I find that the rent-price ratio is significantly related to both the expected rent growth and price growth over five- to six-year horizons. The expected future price growth is more sensitive than the expected rent growth to each of the two predictors. The differences in the sensitivities are consistent with the persistent and mean-reversion properties of the rent-price ratio and the positive relationship between the current interest rate and the expected future rent-price ratio. The results further show that the two-factor model explains approximately 27 of the variability of the realized rent-price ratio and approximately 55-65 percent of the variability of the realized rent growth or price growth over five- to six-year horizons.

Fama and French (2025) find that measuring rent growth regression variables net of their monthly cross-section (across-area) means substantially enhances the information about future rents that we extract from price-rent ratios and lagged changes in house prices. This paper shows that the information about future rents can be extracted from not only rent-price ratios but also other macroeconomic state variables like the interest rate. The approach here is consistent with the theory of intertemporal asset pricing (e.g., Merton (1973)) in which the interest rate is an important state variable in hedging against risks associated with changing investment opportunities. This paper thus offers a different approach to investigating the sources of time variation in expected future rent growth.

Plazzi, Torous, and Valkanov (2010) examine the long-horizon predictability of returns and rent growth rates in the commercial real estate market. Although they explore the implications of a structural data generating process with two variables for the rent growth rates, their empirical work is based on the model with the rent-price ratio as the sole predictor for both returns and the rent growth rates. They find that, for various types of commercial real estate, the rent-price ratio captures fluctuations in either the expected returns or expected rent growth, but not both. The limitation of the model with one predictor is that the implied conditional expectations of returns and rent growth are either uncorrelated or perfectly correlated, depending on whether returns and rent growth are both significantly related to the same predictor. Unlike the one-factor model, the two-factor model proposed here allows for any plausible correlations between the expected rent growth and the expected price growth for each time horizon. The estimation results in the paper suggest that the correlations implied by the two-factor model are less than 30 percent for one- to two-year forecasting horizons and less than 80 percent for longer horizons.

The two-factor model here is related to the model employed by Gallin (2008), who uses the rent-price ratio and the user cost of capital to predict the house price growth and rent growth in the U.S. national housing market over a four-year horizon. He assumes that the price and rent are cointegrated and price growth is autoregressive while in the structural data-generating process here, the rent-price ratio and the real interest rate are the underlying state variables described by a vector autoregressive model. The results here imply that the relationship between the rent-price ratio and the future rent growth in the two-factor model here is positive in the long horizons for the 1987-2024 full sample period and insignificant for a pre-2007 sub-period, which contradicts the negative relationship estimated from the two-factor model of Gallin (2008). In addition, the negative relationship between the real interest rate and the future rent growth shown in this paper contradicts a positive relationship between the user cost of capital and the future rent growth reported by Gallin (2008). Hence, there is evidence that different assumptions about the underlying data-generating process can lead to vastly different implications about time series properties of the rent growth. The results here, also contradict the finding of Clark (1995), who uses decennial census data on single-family homes to documents that, across areas the current rent-price ratio is negatively related to average future rent growth 10-years ahead.

To be more comparable to the sample periods studied by Gallin (2008), and Plazzi, Torous, and Valkanov (2010) and many references in the literature review by Piazzesi and Schneider (2016), I perform a subsample analysis including only the pre-2007 period excluding the 2007-2008 financial crisis and 2020-2023 COVID-19 pandemic. I find enhancements in the predictive power of the real interest rate, accompanied by reductions in the predictive power of the rent-price ratio for future rent growth and future price growth for both short and long horizons. The results here suggest that the real interest rate is the dominant predictor of the future long-horizon rent growth and price growth for the pre-2007 sub-period and one of the important predictors for the 1987-2024 full sample period, which suggests that the early studies that focus only on the predictive ability of the rent-price ratio are associated with the missing-variables problem.

The rest of the paper is organized as follows. The next section presents the model. Section 3 then discusses the data and summary statistics. Section 4 reports empirical results and the last section concludes.

2. THE MODEL

Let P_t be the price of a house (portfolio) at time t, R_t be the net rent from the property at time t and be the rent-price ratio at time t. In what follows, I use lower case letters to represent corresponding log variables. For instance, the log rent-price ratio is $x_t = \log(X_t) = r_t - p_t$. I omit the term "log" for log variables whenever no ambiguity arises.

I assume that the information about the housing market at time t is summarized by the rent-price ratio x_t and a second variable such as the interest rate, y_t. Let x_{t+T} denote the rent-price ratio at time $t+T$. The rent growth from time t to time $t+T$ is $\Delta r_{t,t+T} = r_{t+T} - r_t$ and the price growth over the same period is $\Delta p_{t,t+T} = p_{t+T} - p_t$. The future rent-price ratio, future rent growth and future house price growth are described by the following:

$$
\begin{aligned}
x_{t+T} &= \phi_0(T) + \phi_x(T)x_i + \phi_y(T)y_t + \varepsilon_{x,t+T}, &(1)\\
\Delta r_{t,t+T} &= \lambda_0(T) + \lambda_x(T)x_i + \lambda_y(T)y_t\varepsilon_{\Delta r,t,t+T}, &(2)\\
\Delta p_{t,t+T} &= \gamma_0(T) + \gamma_x(T)x_i + \gamma_y(T)y_t + \varepsilon_{\Delta p,t,t+T}, &(3)
\end{aligned}
$$

where all coefficients are assumed to be constants. The expected components of all variables here are related to the two predictive variables. The error terms in equations (1)-(3) represent the unexpected components, which have means of zero, conditional on information as of time t.

Since $\Delta x_{t,t+T} = \Delta r_{t,t+T-\Delta p_{t,t+T}}$, I obtain the following relationships on the coefficients in equations (1)-(3):

$$\gamma_x(t) - \lambda_x(T) = 1 - \phi_x(T), \tag{4}$$
$$\gamma_y(T) - \lambda_y(T) = -\phi_y(T). \tag{5}$$

In addition, $\gamma_0(T) - \lambda_0(T) = -\phi_0(T)$ and $\varepsilon_{\Delta p.t.t+T} - \varepsilon_{\Delta r,t,t+T} = -\varepsilon_{x,t+T}$. Equation (4) says that $\lambda_x(T) > 0$ if and only if $\gamma_x(T) > 1 - \phi_x(T) > 0$. Thus, for any time horizon, as long as the sensitivity of the expected future price growth to the rent-price ratio is low, a high rent-price ratio predicts low future expected rent growth. However, if the sensitivity of the expected future price growth to the rent-price ratio is high, a high rent-price ratio predicts high expected rent growth, in order to be consistent with the mean reversion of the future rent-price ratio. Equation (4) further implies $\gamma_x(T) > \lambda_x(T)$ if $0 \leq \phi_x(T) < 1$ This says as that as long as the future rent-price ratio is expected to revert to its mean, the sensitivity of the expected future price growth is higher than that of the expected rent growth.

In equation (5), $\gamma_y(T) < \lambda_y(T)$ if and only if $\phi_y(T) > 0$ Hence, if a high interest rate predicts low future rent growth:$\lambda_y(T) < 0$, it also predicts low price appreciation: $\gamma_y(T)$. Further, the sensitivity of the price change is higher in magnitude than that of rent growth to the interest rate: $|\gamma_y(T)| > |\lambda_y(T)|$. This is because a positive value of $\phi_y(T)$ implies that a rise in the interest rate predicts an increase in the expected future rent-price ratio in equation (1) and therefore any decrease in the rent growth as a results of the rise in the interest rate must be accompanied by a larger decrease in the price growth. In the extreme case that the future rent-price ratio is unrelated to the interest rate: $\phi_y(T) = 0$, the sensitivities are equalized: $\gamma_y(T) = \lambda_y(T)$. In such case, any change in the expected future rent growth as a result of a change in the interest rate is offset by the change in the expected future price growth so the rent-price ratio is not expected to rise or fall.

I now illustrate equation (1) in the context of a restricted bivariate vector AR(1) model as follows:

$$x_{t+1} = \phi_0 + \phi_1 x_t + \phi_y y_t + \varepsilon_{x,t+1}, \tag{6}$$
$$y_{t+1} = \theta_0 + \theta_y y_t + \varepsilon_{y,t+1}, \tag{7}$$

where ϕ_x, ϕ_y and θ_y are constants. In equation (7), I assume that y_t follows a univariate AR(1) process to simplify derivations. The AR(1) model here follows the real estate literature that employs the vector autoregressive model to describe the dynamics of the factors or forecasting variables (e.g., Li and Wang (1995), Campbell, Davis, Gallin, and Martin (2009)). From equation (6), $\phi_x(1) = \phi_x, \phi_y(1) = \phi_y$. Repeated substitutions and the law of iterated expectations imply equation (1) with $\phi_x(T) = \phi_x^T$, $\phi_y(2) = \phi_y(\phi_x + \theta_y)$ and $\phi_y(T) = \phi_y(\phi_x^{T-1} + \phi_x^{T-2}\theta_y + \cdots + \phi_x\theta_y^{T-2} + \theta_y^{T-1})$ for $T \geq 3$.

There are two notable implications here. First, if all slope coefficients in equations (6)-(7) are positive, then $\phi_x(T) > 0$ and $\phi_y(T) > 0$ for all T. This says that an increase in the rent-price ratio or the interest rate predicts increases in the expected rent-price ratio for all future time horizons. Second, if ϕ_x is less than one, $\phi_x(T)$ is decreasing in T. If $\phi_y \neq 0$, and ϕ_x and θ_y are both approximately one, then the magnitude of is increasing in T. Hence, the model here predicts that if both predictors are highly persistent, the effect of the interest rate is greater on the future expected rent-price ratio in the longer horizons while the effect of the lagged rent-price ratio diminishes over time horizons.

The two-factor model given by equations (1)-(3) is reduced to a one-factor model if $\phi_y(T) = \lambda_y(T) = \gamma_y(T) = 0$ for all T, in which the conditional expectations of the rent growth and price growth can be linearly related to only a single variable x_i and hence are either perfectly correlated if both slope coefficients are non-zero: $\lambda_x(T) \neq 0$ and $\gamma_x(T) \neq 0$, or uncorrelated if at least one slope coefficient $\gamma_x(T)$ or $\lambda_x(T)$ is zero. The two-factor model here allows for a flexible and plausible degree of correlation between the expected rent growth and the expected price growth for each time horizon.

3. DATA AND SUMMARY STATISTICS

I study monthly single-family house prices and rents in the aggregate U.S. market. The house price data are the S&P CoreLogic Case-Shiller National Index, which, unlike most data on house prices, are based on sale prices. All price indices are seasonally adjusted. For rent data I use the Rent of Primary Residence in U.S. City Average as a component of the U.S. Consumer Price Index (CPI) for All Urban Consumers from the U.S. Bureau of Labor Statistics. Rents are not seasonally adjusted. The Case-Shiller house price indices start in 1987, so the overall sample period is January 1987 to November 2024. The high frequency of the data here, coupled with a relatively long sample period, produces 454 observations, which facilitates the applications of asymptotic distributions of test statistics in long horizon regressions with overlapping observations.

I calculate real prices and real rents, using the CPI for All U.S. Urban Consumers as the inflation measure. For the real interest rate, I use the 10-year real interest rate, from the Federal Reserve Bank of Cleveland, whose estimates are calculated with a model that uses Treasury yields, inflation data, inflation swaps, and survey-based measures of inflation expectation. Unlike most interest rate data, the 10-year real interest rate data are available on monthly basis for the entire sample period studied here. The use of the 10-year real interest rate facilitates the comparisons of the results here with earlier studies (Gallin (2008), Campbell, et. al. (2009)). Changes in real prices and real rents are first differences of the logs of the variables. The log real interest rate is the log of one plus the real interest rate.

The Case-Shiller house price indices are scaled to January 2000 values of 100. The Bureau of Labor Statistics scales each CPI rent index so the average for 1982-1984 is 100. This scaling of indices means that it only possible to interpret changes in rather than levels of indices across areas. It also means that rents cannot be simply added to the price index to compute the total return. As a result, following most literature using house price indices, I study the log price changes rather than total returns. Like most house price indices, the Case-Shiller indices are produced monthly from repeat sales of single-family homes, with transactions reported in that month and the preceding two months. This imparts a moving average property to the indices that results spurious autocorrelation of monthly growth rates out to two months. For rent data, the CPI program collects rent data from each sampled unit every 6 months. Many rents change infrequently, being locked in place for a given lease term. Most rents included in the sample are continuing rents, and only a minority of observations are rents which have changed since the previous observation period. Given the construction methods for the price indices and rent indices, I use long-horizon regressions for changes in rents and prices over one year to six years.

TABLE 1.

Summary Statistics

Variables	Mean	SD	Lag 12	Lag 36	Lag 72
Rent growth, $\Delta r_{t,t+1} = r_{t+1} - r_r$	0.565	0.995	−0.007	0.008	0.097
Price growth, $\Delta p_{t,t+1} = p_{t+1} - p_t$	1.538	2.397	0.649	0.244	0.124
Rent-price ratio, $x_i = r_i - p_t$	0.432	0.199	0.922	0.574	0.113
Interest rate, y_t	1.953	1.363	0.904	0.765	0.642

Cross-Correlations

	Rent growth	Price growth	R/P
Price growth	0.105		
Rent-price ratio	−0.061	−0.083	
Interest rate	−0.114	−0.132	0.414

The house price is the S&P CoreLogic Case-Shiller National Index. Rent is the Rent of Primary Residence in U.S. City Average. Price and rent are adjusted by the CPI for All U.S. Urban Consumers. The real interest rate is the 10-year real interest rate. Means and SD are annualized in percent for all variables except the log rent-price ratio. All variables are in logs. The sample period is 1987:01-2024:11 (454 monthly observations).

Table 1 reports summary statistics for monthly data on log real rent growth, log real price growth, log rent-price ratio for the aggregate U.S.

housing market and the 10-year real interest rate for the period from January 1987 to November 2024. The means (multiplied by 12) and standard deviations (multiplied by the square root of 12) are annual percentage rates for all variables, except for the log rent-price ratio. The autocorrelations are reported for lags 12, 36 and 72.

The mean and standard deviation of the rent growth in the U.S. national market are 0.565 and 0.995 percent annually, which are considerably lower than the mean of 1.538 and standard deviation of 2.397 percent annually for the price growth. The standard deviation of the log rent-price ratio is 0.199 percent, which is much lower than 1.363 percent for the real interest rate. The first-order autocorrelation of the price growth (0.649) is much higher than that of rent growth (−0.007), but lower than that of the rent-price ratio (0.922) and that of the real interest rate (0.904). The autocorrelation of the real interest rate decays more slowly to 0.642 at the lag of 72 months, compared with that of the rent-price ratio of 0.113. This is consistent with my earlier assumption that both the rent-price ratio and the interest rate are highly persistent. Finally, most of the cross-correlations between any pairs of the four series are small in magnitude. The highest is between the interest rate and the rent-price ratio of 0.414.

FIG. 1. Real Rent and Price for U.S. Single-Family Homes

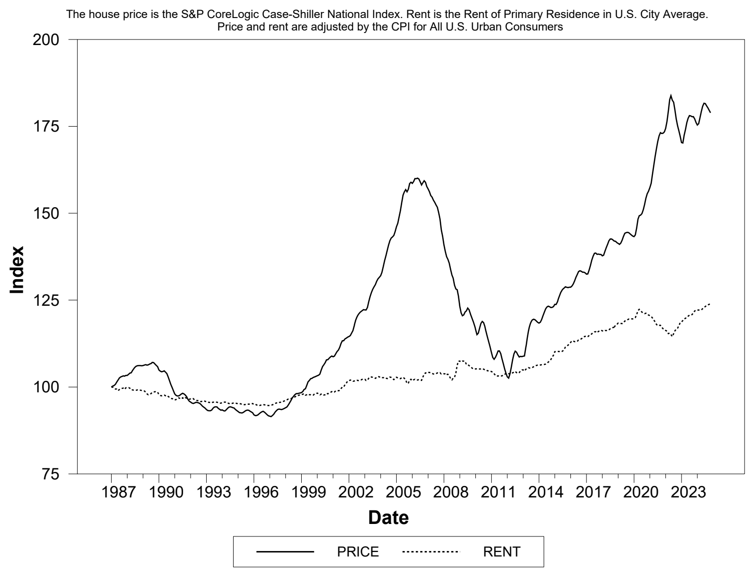
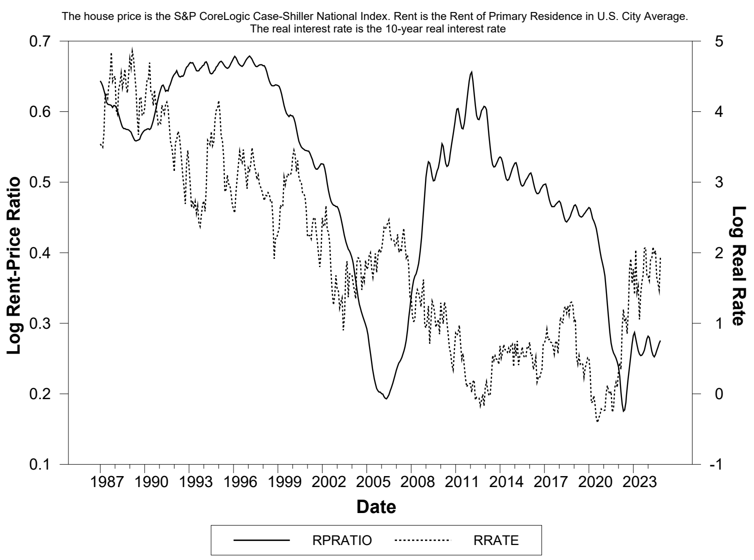


Figure 1 shows real house prices and real rents in the U.S. national housing market. To simplify the plots, I scale all indices to 100 in January 1987. The most notable is the boom in house prices from January 1998 to the local peak in March 2006 and the bust from the 2006 peak to the trough in February 2012. This boom-bust cycle has been widely examined by many researchers (e.g., Burnside, Eichenbaum, and Rebelo 2016, Nathanson and Zwick 2018, and Kaplan, Mitman, and Violante 2020, Fama and French 2024). The national real house prices fall by 36 percent from the 2006 peak to the 2012 trough and subsequently rise by 74 percent by November 2024. The national average real rents, however, move up by 2 percent and 19 percent, respectively in the two periods. It is evident that the volatility of real rents is low as compared to that of real prices. Real rents fall by 3.5 percent (nominal rent fall by 15 percent) from early 2009 to late 2011 in the aftermath of the financial crise and fall by 6 percent (nominal rent rise 22 percent) from mid-2020-to mid-2022 during the 2020-2023 COVID-19 pandemic. Figure 2 shows the rent-price ratio and the real interest rate. Overall, both variables exhibit long-term co-movements from the beginning to the end of the sample period, which is in accord with the positive correlation between them. However, the real interest rate shows more high frequency fluctuations than the rent-price ratio. While the rent-price ratio tends to move in opposite directions to the house prices, the real interest rate, plunges from 2.4 percent to nearly zero from the 2006 peak of house prices to the 2012 trough and rises up to 3 percent by November 2024. This explains why the correlation between them is positive but not high.

FIG. 2. Log Rent-Price Ratio and Log Real Interest Rate



4. EMPIRICAL RESULTS

Since the error terms in the long-horizon model for the ren-price ratio, rent growth and price growth in equations (1)-(3) are linearly related, a simultaneous estimation of the three equations results in singularity of the variance-covariance matrix of residuals. Instead, I first estimate each of them individually for each horizon T using the Ordinary Least Squared (OLS) method. In order to obtain statistical inferences about differences between parameters across equations for each horizon, I also estimate equations (2)-(3) together using the generalized method of moments (GMM). This method uses the error terms in equations (2)-(3) and error terms multiplied by the right-hand side variables as instruments. In this way, the moments are the OLS orthogonality conditions, and the parameter estimates from the GMM method are the same as those from the OLS method. In either OLS or GMM estimation, I use t-statistics (OLS method) or $t(M)$-statistics (the multivariate GMM method) that are consistent with heteroscedasticity and residual autocorrelations up to lags of $T-1$ due to overlapping observations, based on the Newey-West/Bartlett method. For equation (1), I use the lags of $2T$ to accommodate additional residual autocorrelations resulting from the lagged dependent variable on the right side of the equation.

4.1. Predicting Rent-Price Ratio

In Tables 2-5, panel A is for the one-factor model with the rent-price ratio as the sole predictor and panel B is for the full two-factor model. The time horizons include $T = 12$ months (one year) to $T = 72$ months (six years). The results of estimating equation (1) are summarized in Table 2. Given the sample size of 454 monthly observations, the t-statistics have two-sided critical values of 2.587, 1.965 and 1.648 at the 1 percent, 5 percent and 10 percent levels, respectively. The adjusted are reported at the bottom of each panel. Coefficients significant at the 5 (or 1) percent level are highlighted in bold (bold italic).

The results of estimating a reduced one-factor model of equation (1) show that the rent-price rate predicts its expected future value one-to three years ahead. The estimated slope coefficients $\phi_x(T)$ associated with the predictor are 0.947, 0.798 and 0.616 for 12, 24, and 36 months with t-statistics all exceeding 2.230. Thus, the estimates are statistically significant at a 5 percent or a 1-percent level. The adjusted R^2 are 0.850, 0.562 and 0.290 for the three horizons. For longer horizons, the predictor loses its forecasting power as the estimates of the slope coefficients, t-statistics and adjusted are much smaller, with the estimated intercepts significant only. The fact that the slope coefficients are lower for longer time horizons is consistent with the AR(1) model for the predictor.

TABLE 2.

Regressions of Future Rent-Price Ratio on Rent-Price Ratio and Interest Rate

	$x_{t+T} = \phi_0 + \phi_x(T)x_t + \phi_y(T)y_t + \varepsilon_{x,t+T}(1)$					
	Horizon T (months)					
	12	24	36	48	60	72
	One-factor model ($\phi_y(T) = 0$)					
$\phi_0(T)$	0.017	0.084	0.170	0.291	**0.401**	**0.486**
t-stat	0.351	0.828	1.067	1.558	2.220	3.157
$\phi_x(T)$	**0.947**	**0.798**	**0.616**	0.374	0.155	−0.016
t-stat	11.557	4.743	2.230	1.097	0.442	−0.049
Adj. R^2	0.850	0.562	0.290	0.098	0.015	−0.002
	Two-factor model					
$\phi_0(T)$	0.019	0.093	0.187	**0.297**	**0.395**	**0.472**
t-stat	0.424	1.130	1.750	2.621	3.604	4.874
$\phi_x(T)$	**0.893**	**0.663**	**0.410**	0.148	−0.075	−0.239
t-stat	10.886	4.686	2.247	0.787	−0.427	−1.510
$\phi_y(T)$	1.293	**3.075**	**4.508**	**5.465**	**5.993**	**6.106**
t-stat	1.927	2.709	3.018	3.158	3.221	2.972
Adj. R^2	0.862	0.632	0.441	0.317	0.271	0.266

The table reports the results of OLS estimates of linear regressions for each time horizon. The t-statistics are consistent with heteroscedasticity and residual autocorrelations up to lags $2T$ due to overlapping observations and the lagged dependent variable on the right side of the equation with the Newey-West/Bartlett method. The two-sided critical values are 2.587, 1.965 and 1.648 at the 1 percent, 5 percent and 10 percent levels, respectively. Coefficients significant at a 5 (or 1) percent level based on the t-statistics are highlighted in bold (or bold italic).

In the two-factor model of equation (1), there are two main predictions from the bivariate AR(1). First, if the sloe coefficients of the bivariate AR(1) are all positive, then a high rent-price ratio or the interest rate is associated with high future expected rent-price ratio for all horizons. Second, the effect of the interest rate on the future expected rent-price ratio is greater in the longer horizons while the effect of the lagged rent-price ratio diminishes over time horizons. The results of estimating the two-factor model indicate that, the estimated slope coefficients $\phi_x(T)$ associated with the rent-price ratio are 0.893, 0.663 and 0.410 for 12, 24, and 36 months and much smaller in the longer horizons. While they are still significant up to 36 months like those in the one-factor model, they decline more quickly here with time horizons. In contrast, the estimates of the slope coefficients $\phi_y(T)$ associated with the interest rate increases rapidly from 1.293 for 12 months to 4.508 for 36 months and 6.106 for 72 months and they are significant at a 1 percent level for 24 months to 72 months. The results here are largely consistent with the two predictions of the bivariate vector AR(1). For 12 to 24 months, the adjusted R^2 here are only slightly higher than those in the one-factor model. For 36 to 72 months, the adjusted are much higher. For instance, for 60 and 72 months, they are 0.271 and 0.266 here, while they are 0.015 and −0.002, respectively, in the one-factor model. This says that the two-factor model explains approximately 27 of the variability of the rent-price ratio five to six years ahead but the lagged rent-price ratio only captures little of the long-horizon variability of the rent-price ratio.

4.2. Predicting Rent Growth and Price Growth

In Tables 3 and 4, the t-statistics from the multivariate GMM estimation are reported below those from the univariate OLS estimation. Given the low correlation between the rent growth and the price growth reported in Table 1, the t-statistics form the two methods of estimation are quite similar, with very few exceptions. I first examine the results of estimating equation (2) in Table 3. The results of estimating a reduced one-factor model indicate that the estimated coefficients $\lambda_x(T)$ associated with the sensitivity of the expected future rent growth to the rent-price ratio are for small and insignificant at a 10 percent or lower level for each of the horizons. The weak relationship for the aggregate U.S. market is consistent with what Piazzesi, Torous, and Valkanov (2010) find for apartments, industrial, or retail commercial real estates for one-quarter to 12-quarters forecasting horizons and consistent with what Fama and French (2025) report for the national or cross-area metro area Case-Shiller home price indices for 3-months to 1-year forecasting horizons. The results here, however, contradict the finding of Clark (1995), who use decennial census data on single-family homes to documents that, across areas the current rent-price ratio is negatively related to average future rent growth 10-years ahead. The insignificant relationship here for single-family homes also contradicts the negative relationship reported by the Piazzesi, Torous, and Valkanov (2010) for commercial real estate like office buildings across U.S. metro areas over one to three years (12 quarters) ahead.

Next, I examine the results of estimating the full two-factor model of equation (2) for predicting rent growth. The estimates of $\lambda_y(T)$ associated with the interest rate sensitivity of rent growth are negative for all horizons and significant at a 5 or 10 percent level for 36- to 72-month horizons. The point estimates are −1.109 ($t = -2.411$, $t(M) = -2.579$) for 36 months and −2.754 ($t = -6.082$, $t(M) = -6.212$) for 72 months. Clearly, the coefficients are monotonic, which is not surprising given the similar pattern seen in predicting the future rent-price ratio. For time horizons of 12 to 24 months, the point estimates of $\lambda_x(T)$ associated with the rent-price ratio are negative but insignificant, like those in the one-factor model. However,

TABLE 3.

Regressions of Future Rent Growth on Rent-Price Ratio and Interest Rate

	$\Delta r_{t,t+T} = \lambda_0(T) + \lambda_x(T)x_t + \lambda_y(T)y_t + \varepsilon_{\Delta_{t,t+T}}$ (2)					
	Horizon T (months)					
	12	24	36	48	60	72
	One-factor model					
$\lambda_x(T)$	−0.022	−0.036	−0.014	0.020	0.050	0.075
t-stat	−1.418	−1.600	−0.607	0.182	0.514	0.687
$t(M)$-stat	−1.361	−1.079	−0.258	0.270	0.561	0.724
Adj. R^2	0.034	0.042	0.004	−0.002	0.005	0.011
	Two-factor model					
$\lambda_x(T)$	−0.012	−0.014	0.032	0.079	**0.116**	**0.141**
t-stat	−0.815	−0.598	0.891	1.658	2.678	3.690
$t(M)$-stat	−0.734	−0.416	0.692	1.477	2.284	2.942
$\lambda_y(T)$	−0.220	−0.537	−1.109	−1.711	−2.309	−2.754
t-stat −1.226	−1.452	−2.411	−3.406	−4.867	−6.082	
$t(M)$-stat	−1.276	−1.616	−2.579	−3.598	−5.005	−6.212
Adj. R^2	0.061	0.116	0.231	0.395	0.546	0.646

The table reports OLS estimates of linear regressions for each time horizon. The t-statistics are from the univariate OLS method. The $t(M)$-statistics are from the multivariate GMM estimation of the system of equation (2) in Table 3 and equation (3) in Table 4 using the OLS orthogonality conditions. The t- and $t(M)$-statistics are consistent with heteroscedasticity and residual autocorrelations up to lags $T - 1$ due to overlapping observations with the Newey-West/Bartlett method. The two-sided critical values are 2.587, 1.965 and 1.648 at the 1 percent, 5 percent and 10 percent levels, respectively. Coefficients significant at a 5 (or 1) percent level based on the $t(M)$-statistics are highlighted in bold (or bold italic).

for time horizons 60 and 72 months (five and six years), the point estimates of are 0.116 ($t = 2.678$, $t(M) = 2.284$) and 0.141 ($t = 3.690$, $t(M) = 2.942$), respectively. This implies that after controlling for the effect of the interest rate, a high rent-price ratio predicts high expected rent growth five to six years ahead. The positive and significant relationship contradicts the insignificant or negative relationship in the literature using the one-factor model discussed earlier for time horizons of three months up to 10 years. The results also contradict the negative relationship between the rent-price ratio and the four-year (16-quarters) ahead rent growth in the one- and two-factor models of Gallin (2008), who uses the rent-price ratio and the user cost of capital as the predictors. The differences between the results in the one- and two-factor models here can be understood once I discuss the results in the next table.

The adjusted R^2 are also monotonic and reaching 0.546 and 0.646 for 60 and 72 months in the two-factor model, much higher than 0.005 and

0.011 in the one-factor model. Thus, with the interest rate as the second predictor, the expected variability of the rent growth accounts for 55-65 percent of the variability of the realized rent growth in the long horizons of five to years. Hence, controlling for the interest rate effect significantly affects not only the statistical inferences about the relationship between the rent-price ratio and the expected long-term rent growth but also the portion of the variability of the realized rent growth that is explained by the expected rent growth.

The results of estimating equation (3) for predicting price growth are in Table 4. The point estimates of $\gamma_x(T)$ are all positive and monotonic in time horizons but they are significant at a 5 or 1 percent level for 48-month or longer horizons in the one-factor model. The estimated coefficients in the one-factor model are 0.695 ($t = 1.874$, $t(M) = 2.005$) for 48 months, 0.980 ($t = 2.477$, $t(M) = 2.468$) for 60 months and 1.199 ($t = 3.154$, $t(M) = 2.829$) for 72 months. For the 48-month horizon, the estimated coefficient is significant at a 10 percent level with the univariate OLS method and 5 percent with the multivariate GMM method. The latter is more reliable as it takes into account the correlation between residuals in the price and rent equations. The results are consistent with the existing literature. For example, Gallin (2008) documents this relationship for the four years (16 quarters) ahead price growth in the U.S. national housing market. Piazzesi, Torous, and Valkanov (2010) report this relationship for up to 12-quarter-ahead price growth of apartments and other property types across U.S. metro areas. Fama and French (2025) confirm this relationship for 3-month- or 12-month-ahead price growth of single-family homes across U.S. metro areas after controlling for the serial correlation of the price growth. The adjusted R^2 are 0.207, 0.302 and 0.377, respectively, for 48, 60 and 72 months.

Next, I examine the results of estimating the two-factor model of equation (3) for predicting price growth. The estimates of $\gamma_y(T)$ associated with the interest rate sensitivity of price growth are significant at a 1 or 5 percent level for all horizons. The point estimates are -1.513 ($t = -2.849$, $t(M) = -2.404$) for a 12-month horizon and -8.860 ($t = -3.541$, $t(M) = -2.963$) for a 72-month horizon. The magnitudes of the coefficients are monotonic in time horizons, similar to those in predicting the rent-price ratio and rent growth. For time horizons of 24 months or longer, the point estimates of $\lambda_x(T)$ associated with the rent-price ratio are positive and significant at a 5 percent or lower level, unlike those in the one-factor model, where they are significant only for 48-months or longer horizons. The magnitudes of the coefficients here are larger than those in the one-factor model for each horizon. For instance, the point estimates are 0.931, 1.191 and 1.380 for 48, 60 and 72 months, respectively, which are approximately 34, 22, and 15 percent higher than the corresponding estimates in the one-factor model.

TABLE 4.

Regressions of Future Price Growth on Rent-Price Ratio and Interest Rate

	$\Delta p_{t,t+T} = \gamma_0(T) + \gamma_x(T)x_t + \gamma_y(T)y_i + \varepsilon_{\Delta p_{t,t+T}}$					
	Horizon T (months)					
	12	24	36	48	60	72
	One-factor model					
$\gamma_x(T)$	0.034	0.179	0.394	**0.695**	**0.980**	**1.199**
t-stat	0.492	1.000	1.336	1.874	2.477	3.154
$t(M)$-stat	0.564	1.180	1.537	2.005	2.468	2.829
Adj. R^2	0.004	0.047	0.111	0.207	0.302	0.377
	Two-factor model					
$\gamma_x(T)$	0.095	**0.323**	**0.622**	**0.931**	**1.191**	**1.380**
t-stat	1.405	2.187	3.214	4.613	6.416	8.324
$t(M)$-stat	1.533	2.216	2.697	3.233	3.846	4.424
$\gamma_y(T)$	−1.513	−3.612	−5.617	−7.176	−8.302	−8.860
t-stat	−2.849	−3.542	−4.410	−4.326	−3.784	−3.541
$t(M)$-stat	−2.404	−2.500	−2.628	−2.744	−2.829	−2.963
Adj. R^2	0.122	0.249	0.371	0.484	0.574	0.635

The table reports OLS estimates of linear regressions for each time horizon. The t-statistics are from the univariate OLS method. The $t(M)$-statistics are from the multivariate GMM estimation of the system of equation (2) in Table 3 and equation (3) in Table 4 using the OLS orthogonality conditions. The t- and $t(M)$-statistics are consistent with heteroscedasticity and residual autocorrelations up to lags $T-1$ due to overlapping observations with the Newey-West/Bartlett method. The two-sided critical values are 2.587, 1.965 and 1.648 at the 1 percent, 5 percent and 10 percent levels, respectively. Coefficients significant at a 5 (or 1) percent level based on the $t(M)$-statistics are highlighted in bold (or bold italic).

This implies that after controlling for the effect of the interest rate, the expected future price growth is more sensitive to the rent-price ratio. The adjusted R^2 are also monotonic here, ranging from 0.122 for 12 months to 0.574-0.635 for 60-72 months in the two-factor model, which are sharply higher than 0.004 for 12 months, and 0.302-0.377 for the corresponding 60-72 months in the one-factor model. The portion of the variability of the realized price growth explained by the expected price growth is remarkably similar to that of the realized rent growth explained by the expected rent growth. Hence, controlling for the interest rate effect not only affects the estimated sensitivity of the expected long-term rent growth to the rent-price ratio but also enhances the estimated sensitivity of the expected price growth to the rent-price ratio and the explanatory power of the expected price growth for the realized price growth for all horizons.

I now examine the links between the estimated coefficients across the three equations. Table 1 reports that the effect of the rent-price ratio on its future value diminishes to an insignificant level in the long run. Table 2 reports a positive relationship between the rent-price ratio and the expected long-run rent growth and Table 3 reports a positive relationship between the rent-price ratio and the expected long-run price growth. The results are consistent with the prediction of equation (4). A rise in the rent-price ratio is followed by an increase in the long run rent growth to offset its effect on the long-run price growth.

The results of estimating equation (1) show a positive relationship between the interest rate and the expected future rent-price ratio. By comparing the results in Tables (3) and (4), one finds that the interest rate sensitivity of the price growth is greater in magnitude than that of the rent growth for each horizon. For example, $\gamma_y(T)$ is -8.302 and $\lambda_y(T)$ is -2.309 for 60 months; $\gamma_y(T)$ is -8.860 and $\lambda_y(T)$ is -2.754 for 72 months. The results are consistent with the implication of the model presented earlier as the estimates of $\phi_y(T)$ in Table 2 are 5.993 and 6.106 for respective horizons. A rise in the interest rate is followed by more declines of price growth than rent growth to lead to a rise of the future rent-price ratio.

TABLE 5.

Differences between Coefficients in Rent Growth and Price Growth Regressions

	Horizon T (months)					
	12	24	36	48	60	72
	One-factor model					
$\gamma_x(T) - \lambda_x(T)$	0.056	0.215	0.407	**0.675**	**0.930**	**1.124**
$t(M)$-stat	0.909	1.481	1.727	2.182	2.714	3.181
	Two-factor model					
$\gamma_x(T) - \lambda_x(T)$	0.107	**0.337**	**0.590**	**0.852**	**1.075**	**1.239**
$t(M)$-stat	1.677	2.321	2.611	3.042	3.589	4.142
$\gamma_y(T) - \lambda_y(T)$	−1.293	−3.075	−4.508	−5.465	−5.993	−6.106
$t(M)$-stat	−1.987	−2.139	−2.155	−2.154	−2.123	−2.146
Correlation						
$E_t(\Delta r_{t,t+T}), E_t(\Delta p_{t,t+T})$	0.262	0.286	0.702	0.783	0.772	0.742

The $t(M)$-statistics are from the GMM estimation of the system of equation (2) and equation (3). The two-sided critical values are 2.587, 1.965 and 1.648 at the 1 percent, 5 percent and 10 percent levels, respectively. Coefficients significant at a 5 (or 1) percent level based on the $t(M)$-statistics are highlighted in bold (or bold italic).

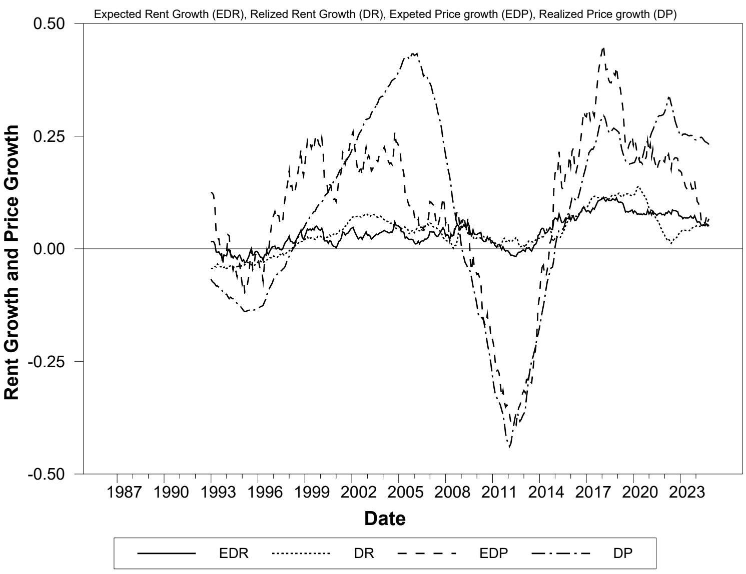
Table 5 reports the differences between the slope coefficients in equations (2) and (3). Note that equations (4)-(5) follow from the definition of the rent-price ratio and hence hold exactly when equations (1)-(3) are estimated with the OLS exactly identified systems. This turns out to be true here. Thus, I can compare the differences between the slope coefficients across equations (2)-(3) with the slope coefficients in equation (1).

In the one-factor model, the differences associated with the rent-price ratio, $\gamma_x(T) - \lambda_x(T)$, are similar to the estimates of $\gamma_x(T)$ associated with price growth in Table 4, as the estimates of $\gamma_x(T)$ associated rent growth in Table 3 are small and insignificant. For the slope coefficients associated with the rent-price ratio in the two-factor model, the difference, $\gamma_x(T) - \lambda_x(T)$, increases from 0.337 ($t(M) = 2.321$) for the 24-month horizon to 1.075 ($t(M) = 3.589$) for the 60-month horizon and 1.239 ($t(M) = 4.142$) for the 72-month horizon. This implies that the price growth is significantly more sensitive than the rent growth to the rent-price ratio for 24-month or longer horizons. For up to 48 months, most of the differences reflect the sensitivities of price growth as the sensitivities of rent growth are small and insignificant. Like slope coefficients $\phi_x(T)$ in Table 2, most of the differences lie between zero and one, except for the 72-month horizon, where the estimate in Table 2 is imprecise and the difference here is statistically indistinguishable (within two standard errors) from one. As discussed earlier, equation (4) implies that, to be consistent with mean reversion in the rent-price ratio, future price growth is expected to be higher than the expected future rent growth following an increase in the rent-price ratio.

The differences associated with interest rate, $\gamma_y(T) - \lambda_y(T)$, lie between -1.293 ($t(M) = -1.987$) for 12 months and -6.106 ($t(M) = -2.146$) for 72 months, so they are all significant at a 5 percent level. The fact that the differences here are significant and monotonic is consistent with the fact that the slope coefficients associated with the interest rate are significant and monotonic in Table 2 in the two-factor model. The differences here are exactly equal to $-\phi_y(T)$ reported in Table 2, as predicted by equation (5). As discussed earlier, a positive value of $\phi_y(T)$ implies that a rise in the interest rate predicts an increase in the expected future rent-price ratio in equation (1). Equation (5) then says that, to be consistent, any decrease in the rent growth is accompanied by a larger decrease in the price growth following the rise in the interest rate. Hence, the expected future price growth is more sensitive than the expected future rent growth to the interest rate.

As stated earlier, the expected rent growth and the expected price growth for each of time horizons are perfectly (positively or negatively) correlated unless one or more of the estimated slope coefficients are exactly zero from regressions with one predictor, but the two-factor model provides more flexible degrees of correlations. At the bottom row of Table 5, I report the implied correlations between the expected rent growth and the expected price growth. They are 0.262-0.286 for 12-24 months, 0.702-0.783 for 36-48 months, and 0.772-0.742 for 60-72 months. The increase in the correlation with time horizons is consistent with the increases in the R^2 in the Tables 3 and 4. Figure 3 illustrates the goodness of fit by plotting the realized and expected values of the rent growth and the price growth over the 72-month

FIG. 3. Expected vs. Relized Growth of Rents and Prices over 72-Month Horizon



horizon. For periods of rising rents, the expected rent growth generally tracks the realized growth. For periods of falling rents, the expected change captures the realized change better for the period after the 2007-2008 financial crisis than the period during the 2020-2023 COVID-19 pandemic, which may be attributed to the unexpected high inflation that caused the nominal rents rising less than the cost of living around that time. Even with the high volatility of house prices, the expected price change tracks the realized price change well overall and around the house price trough of early 2012. But the expected price change underestimates the realized price change around the 2006 house price peak and the house price surge during the 2020-2023 COVID-19 pandemic, indicating that both periods of escalating prices are largely unanticipated.

4.3. Robustness Checks

I conduct several robustness checks to ensure the reliability of the reported empirical results. One exercise to use S&P CoreLogic Case-Shiller 10-City Home Price Index. I summarize the results of estimating equations (1)-(3) for the two-factor model in Table 6. Even though the coverage of the metro areas in this index is much smaller than that of the National Home Price Index, the results of long-horizon regressions are in general agreement with my previous findings. Another exercise is to use the one-year real interest rate instead of the 10-year real interest rate. The results are reported in Table 7. I find that the effect of the one-year real interest rate on the long-run rent-price ratio, long-run price growth and, to a lesser extent, long-run rent growth to be weaker than using the 10-year real interest rate. For example, the estimated $\phi_y(T)$ is not significant at a 5 percent level for $T = 72$ months, and estimates of $\gamma_y(T)$ are not significant at the same level for $T = 48$ months or longer. The results show that it is critical to use the long-term real interest rate that is more comparable with the duration of homeownership and the terms of home mortgage loans.

TABLE 6.

Regressions using the Case-Shiller 10-City Home Price Index

	Horizon T (months)					
	12	24	36	48	60	72
	Future Rent-Price Ratio: $x_{t+T} = \phi_0(T) + \phi_x(T)x_t + \phi_y(T)y_t + \varepsilon_{x,t+T}$(1)					
$\phi_x(T)$	**0.875**	**0.629**	**0.379**	0.140	−0.070	−0.222
t-stat	9.006	3.994	2.466	1.085	−0.607	−1.752
$\phi_y(T)$	1.651	**4.262**	**6.375**	**7.851**	**8.869**	**9.204**
t-stat	1.843	3.126	3.798	3.823	3.395	2.839
Adj. R^2	0.860	0.640	0.469	0.353	0.305	0.294
	Future Rent Growth: $\Delta r_{t,t+T} = \lambda_0(T) + \lambda_x(T)x_t + \lambda_y(T)y_t + \varepsilon_{\Delta r,t,t+T}$(2)					
$\lambda_x(T)$	−0.007	−0.008	0.020	0.052	**0.080**	**0.101**
$t(M)$-stat	−0.575	−0.321	0.613	1.427	2.405	3.379
$\lambda_y(T)$	−0.224	−0.544	−1.114	−1.758	−2.421	−2.919
$t(M)$-stat	−1.261	−1.593	−2.516	−3.602	−5.254	−6.970
Adj. R^2	0.057	0.114	0.228	0.389	0.550	0.663
	Future Price Growth: $\Delta_{p_{t,t+t}} = \gamma_0(T) + \gamma_x(T)x_t + \gamma_y(T)y_t + \varepsilon_{\Delta p,t,t+T}$(3)					
$\gamma_x(T)$	0.118	**0.363**	**0.641**	**0.911**	**1.150**	**1.323**
$t(M)$-stat	1.819	2.495	2.946	3.443	4.026	4.575
$\gamma_y(T)$	−1.875	−4.805	−7.489	−9.609	−11.290	−12.123
$t(M)$-stat	−2.049	−2.367	−2.538	−2.651	−2.755	−2.873
Adj. R^2	0.103	0.252	0.381	0.487	0.577	0.637

See notes to Tables 1-4 for explanations.

Finally, I perform a sub-period analysis by limiting the sample period to the end of 2006. This pre-2007 period excludes the 2007-2008 financial crisis and 2020-2023 COVID-19 pandemic and is more comparable to the sample periods studied by Gallin (2008), Plazzi, Torous, and Valkanov (2010), and others. I summarize the results in Table 8, which show that the 10-year real interest rate is now significant at a 1 percent level for predicting the rent-price ratio, the rent growth and the price growth over all horizons studied here. When I compare the top panel of Table 8 with the lower panel of Table 2, I find that each slope coefficient in the pre-2007 period is estimated more precisely and statistically significant at lower levels. The adjusted R^2 in

TABLE 7.

Regressions using the 1-Year Real Interest Rate

	Horizon T (months)					
	12	24	36	48	60	72
	Future Rent-Price Ratio: $x_{t+T} = \phi_0(T) + \phi_x(T)x_t + \phi_y(T)y_t + \varepsilon_{x,t+T}(1)$					
$\phi_x(T)$	**0.924**	**0.724**	**0.526**	0.300	0.083	−0.091
t-stat	11.878	4.813	2.361	1.121	0.315	−0.414
$\phi_y(T)$	0.658	**1.642**	**2.506**	**2.814**	**2.825**	2.916
t-stat	1.650	2.056	2.256	2.461	2.039	1.551
Adj. R^2	0.856	0.600	0.374	0.199	0.116	0.108
	Future Rent Growth: $\Delta r_{t,t+t} = \lambda_0(T) + \lambda_x(T)x_t + \lambda_y(T)y_t + \varepsilon_{\Delta r,t,t+T}(2)$					
$\lambda_x(T)$	−0.017	−0.017	0.008	0.036	0.062	0.082
$t(M)$-stat	−1.077	−0.532	0.174	0.622	1.007	1.232
$\lambda_y(T)$	−0.123	−0.450	−0.736	−1.049	−1.401	−1.633
$t(M)$-stat	−1.109	−2.012	−2.409	−2.824	−3.404	−3.619
Adj. R^2	0.051	0.142	0.187	0.260	0.365	0.417
	Future Price Growth: $\Delta p_{t,t+T} = \gamma_0(T) + \gamma_x(T)x_t + \gamma_y(T)y_t + \varepsilon_{\Delta p,t,t+T}(3)$					
$\gamma_x(T)$	0.059	0.259	**0.482**	**0.736**	**0.979**	**1.173**
$t(M)$-stat	0.996	1.774	2.063	2.397	2.851	3.274
$\gamma_y(T)$	−0.781	−2.092	−3.242	−3.862	−4.226	−4.549
$t(M)$-stat	−1.929	−2.112	−2.154	−1.960	−1.872	−1.888
Adj. R^2	0.069	0.175	0.268	0.347	0.429	0.500

See notes to Tables 1-4 for explanations.

the pre-2007 period is approximately twice of that in the full sample period for each of the 3-year and longer horizons. Further, the enhancements in the predictive power of the real interest rate are accompanied by reductions in the predictive power of the rent-price ratio for future rent growth and future price growth. For each time horizon here, the estimates of $\lambda_x(T)$ and $\gamma_x(T)$ are insignificant at a 5 or even a 10 percent level. The increase in the predictive power of the real interest rate is also reflected in the adjusted R^2s in middle and bottom panels of Table 8, which are higher than those in Tables 3 and 4 for 12- to 48-month horizons in the two-factor model. For 60- to 72-month horizons, the adjusted R^2s in Table 8 are similar to the corresponding values in Tables 3 and 4. As the rent-price ratio loses its significance in Table 8 for predicting the rent growth and the price growth, the results here indicate that the lost predictive power of the rent-price ratio is offset by an increased predictive power of the real interest rate for the long horizons of 60 to 72 months for the pre-2007 period.

TABLE 8.

Regressions for a Sub-Period up to the End of 2006

	Horizon T (months)					
	12	24	36	48	60	72
	Future Rent-Price Ratio: $x_{t+T} = \phi_0(T) + \phi_x(T)x_t + \phi_y(T)y_t + \varepsilon_{x,t+T}(1)$					
$\phi_x(T)$	**1.065**	**1.189**	**1.341**	**1.589**	**1.789**	**1.889**
$t(M)$	15.477	10.763	10.044	12.275	7.364	3.202
$\phi_y(T)$	**2.431**	**5.467**	**8.533**	**12.030**	**15.834**	**20.076**
$t(M)$	2.738	4.845	8.361	10.386	12.217	6.149
Adj. R^2	0.964	0.924	0.873	0.791	0.686	0.537
	Future Rent Growth: $\Delta r_{t,t+T} = \lambda_0(T) + \lambda_x(T)x_t + \lambda_y(T)y_t + \varepsilon_{\Delta r,t,t+T}(2)$					
$\lambda_x(T)$	0.023	0.064	0.118	0.152	0.183	0.234
$t(M)$-stat	1.303	1.325	1.314	1.265	1.271	1.287
$\lambda_y(T)$	−0.575	−1.098	−1.686	−2.480	−3.373	−3.960
$t(M)$-stat	−2.625	−2.323	−2.491	−3.104	−3.839	−3.871
Adj. R^2	0.173	0.230	0.315	0.437	0.568	0.636
	Future Price Growth: $\Delta p_{t,t+T} = \gamma_0(T) + \gamma_x(T)x_t + \gamma_y(T)y_t + \varepsilon_{\Delta p,t,t+T}(3)$					
$\gamma_x(T)$	−0.043	−0.124	−0.223	−0.437	−0.606	−0.655
$t(M)$-stat	−0.768	−0.867	−0.773	−0.949	−0.901	−0.680
$\gamma_y(T)$	−3.006	−6.566	−10.218	−14.510	−19.208	−24.035
$t(M)$-stat	−4.315	−4.695	−4.693	−4.710	−4.603	−4.250
Adj. R^2	0.543	0.670	0.676	0.641	0.611	0.573

See notes to Tables 1-4 for explanations.

5. CONCLUSIONS

In this article I use the rent-price ratio and the long-term real interest rate in a two-factor model to predict the future rent-price ratio, the future rent growth and the future price growth of single-family homes in the U.S. national housing market. By extending forecasting horizons beyond the typical 3 months to 3 or 4 years found in most existing studies, I find that a significantly positive relationship between the real interest rate and the future rent-price ratio but a weak relationship between the current and future rent-price ratios in the long horizons. I also find that the expected future rent growth and price growth are negatively and significantly related to the current interest rate in the long horizons. Moreover, the expected future rent growth and future price growth are positively related to the current rent-price ratio over long horizons. Consistent with the time-series behavior of the rent-price ratio, the expected future price growth is more sensitive than the expected rent growth to each of the two predictors. The results suggest that housing market forecasting, real estate investment strategy, and macroeconomic policy should take into consideration the effect of the long-term real interest rate in addition to the rent-price ratio and the time horizons for housing market plannings and decision-making should extend to five to six years ahead, whenever possible.

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