February 16, 2023

Current Policy Perspectives

Forecasting CPI Shelter under Falling Market-Rent Growth

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Shelter (housing) costs constitute a large component of price indexes, including 42 percent of the widely followed core Consumer Price Index (CPI). The shelter prices measured in the CPI capture new and existing renters and tend to lag market rents. This lag explains how in recent months the shelter-price index (CPI shelter) has accelerated while market rents have pulled back. We construct an error-correction model using data at the metropolitan statistical area level to forecast how CPI shelter will evolve. We forecast that CPI shelter will grow 5.88 percent from September 2022 to September 2023 and 3.91 percent over the subsequent 12 months. We demonstrate that the most important factor supporting high future CPI-shelter growth is that a large part of past growth in market rents had not been captured in CPI shelter as of September 2022. We estimate that the headline CPI and core CPI will be 1.05 and 1.34 percentage points higher, respectively, from September 2022 to September 2023 as a result of above-average shelter inflation.

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The authors are grateful to Giovannni Olivei for his valuable suggestions and feedback..

1 Introduction

The cost of shelter, the service that a housing unit provides its occupants, constitutes 33 percent of the headline Consumer Price Index (CPI) and 42 percent of the core CPI, making it the largest expenditure category in each index.[1] Shelter also makes up a significant portion of the Personal Consumption Expenditures (PCE) Price Index, another important measure of prices. It accounts for 15 percent of the headline PCE and 17 percent of the core PCE. As a result, movement in the price index for shelter is a crucial determinant of how broader price indexes will move. The importance of shelter prices measured in the CPI (CPI shelter) can be seen in recent data, where they have accelerated. CPI shelter grew 0.75 percent month-over-month in September 2022, which is the highest monthly rate since 1990. If it did not include shelter prices, the headline CPI would have grown 0.21 percent (2.5 percent annualized), which is close to the Federal Reserve's 2 percent inflation target. Instead, the headline CPI grew 0.39 percent (4.8 percent annualized), which is far above the Federal Reserve's inflation target.

To predict future movements in the price index for shelter, we can turn to market-based measures of rents. CPI shelter is made up of two main components: (1) direct costs to renters of renting a home and (2) indirect costs to owners of living in a home (owners' equivalent rent), which captures the rent a person would have to pay if they rented rather than owned their home. Therefore, CPI shelter might be expected to closely follow market-based measures of rent. However, unlike CPI shelter growth, market-rent growth peaked in 2021 and has recently begun to pull back as the economy slows. Indeed, CPI shelter typically lags market rents because (1) CPI shelter updates more slowly, and (2) market rents capture only new rentals, whereas CPI shelter also captures existing rentals, which respond more slowly to market changes.

Since CPI shelter typically lags market rents, we can use market rents to forecast how CPI shelter will change in the near future. This leads to the two policy questions we focus on in this paper. First, how should we expect CPI shelter to evolve? Second, what are the implications for inflation more broadly?

We use CPI-shelter and market-rent data at the metropolitan statistical area (MSA) level to model and forecast how CPI shelter will evolve. Using MSA-level data allows us to control for both MSA and month fixed effects, and it gives us a much larger number of data points, which can improve our estimates. Our market-rent measure comes from CoreLogic's Single-Family Rent Index. This measure and CPI shelter are jointly available across 16 MSAs. We explain changes in CPI shelter using three factors: past changes in CPI shelter, past changes in market rents, and the difference between market rents and CPI shelter. The final term, the difference between market rents and CPI shelter, captures how CPI shelter is likely to catch up to market rents. The further the two are apart, the quicker we expect CPI shelter to rise. In this sense, the simple error-correction model we run assumes that CPI shelter and market rents follow a long-term relationship and that CPI shelter will eventually catch up to market rents.

Our model seems to provide strong explanatory power for how CPI shelter will evolve. Past changes in CPI shelter, past changes in market rents, and the difference between market rents and CPI shelter all significantly predict how CPI shelter will evolve. We find that a 1 percentage point rise in the preceding year-over-year change in CPI shelter, the preceding year-over-year change in market rents, and the log difference between current market rents and CPI shelter suggest that the next year-over-year change in CPI shelter will rise 0.12 percentage points, 0.20 percentage points, and 0.18 percentage points, respectively. We find a high R-squared

[1] Core CPI is the CPI index excluding energy and food prices, which are more volatile than other prices.

of more than 50 percent .

We use this model to forecast how CPI shelter will evolve over the next two years. We forecast that CPI shelter will grow 5.88 percent from September 2022 to September 2023 and 3.91 percent in the subsequent 12 months. We find the growth rates will be particularly elevated through the first half of 2023. CPI-shelter growth will then decline but remain elevated through the end of 2024. We conduct several robustness checks to verify our results.

Our approach has limitations. We model CPI shelter as being driven by, among other factors, past changes in market rents. Market-rent growth was elevated until recently, so our forecasts may capture this fast growth but partly ignore the recent slowing. To investigate this further, we decompose how each of the explanatory variables affects our forecasts and separate out those effects. We find that high recent market-rent growth raises the forecast of CPI shelter growth from September 2022 to September 2023 by 1.39 percentage points. However, the largest contribution to the forecast for high CPI-shelter growth comes from market rents being elevated relative to CPI shelter. It raises the forecast for CPI-shelter growth from September 2022 to September 2023 by 1.47 percentage points. Unlike with past high market-rent growth, this explanatory variable is not backward-looking and will raise CPI-shelter growth in the medium term, all else being equal, even if market-rent growth declines. The idea is simple: If CPI shelter has not yet incorporated past high market-rent growth, then CPI shelter will be higher in the future as it incorporates this high past market-rent growth. We also conduct a simulation to investigate our model's predictions for how CPI shelter will evolve under different realizations of market rents. We assume that market rents will grow at a constant rate and then forecast the evolution of CPI shelter one month at a time. When we assume market rents will grow –1 percent and 3 percent, we predict that CPI shelter will grow 5.24 percent and 5.99 percent, respectively, from September 2022 to September 2023 and 2.37 percent and 4.50 percent, respectively, over the subsequent 12 months.

High CPI shelter is likely to place upward pressure on inflation in the medium term. We forecast that the headline CPI, core CPI, headline PCE, and core PCE inflation will be 1.05, 1.34, 0.48, and 0.54 percentage points higher, respectively, over the 12-month period beginning in September 2022 than if CPI shelter grew at its pre-pandemic average rate. We also find that high CPI-shelter growth will affect price indexes even further into the future. We forecast that the headline CPI, core CPI, headline PCE, and core PCE inflation will be 0.40, 0.51, 0.18, and 0.21 percentage points higher, respectively, from September 2023 to September 2024 than if CPI shelter grew at its pre-pandemic average rate. Under the optimistic assumption of low market-rent growth, we continue to find CPI shelter will raise inflation considerably in 2023, but the effects will then ease.

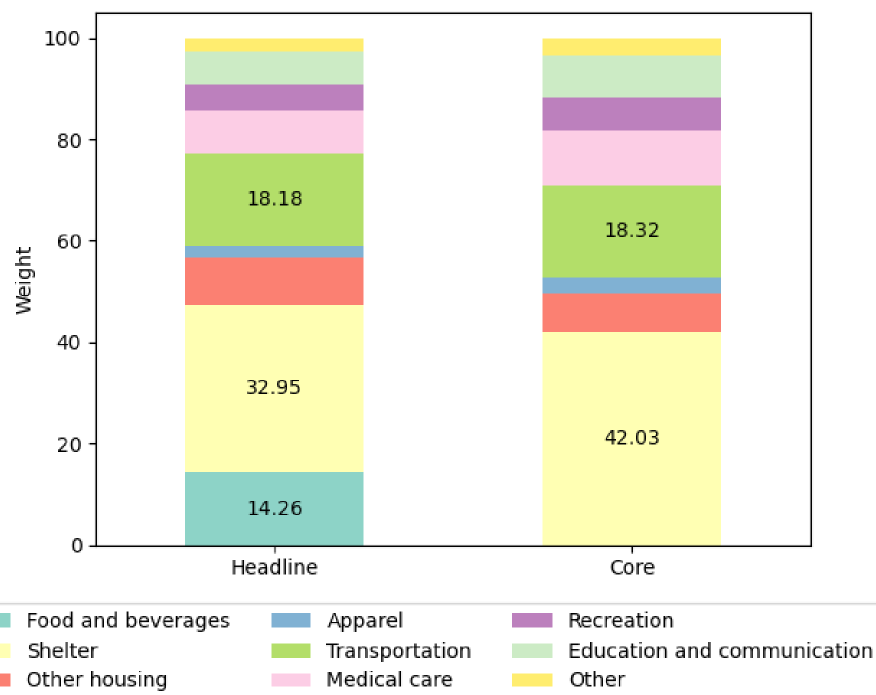
Our work relates to other recent papers that predict how CPI shelter will evolve and to papers that look at the relationship between CPI shelter and market rents. Lansing, Oliveira, and Shapiro (2022) use MSA-level data on Zillow house and rent prices plus other variables capturing the economic conditions in the MSAs to forecast future CPI-shelter inflation and find that CPI-rent growth, which is approximately the same as CPI-shelter growth, will be 3 to 4 percentage points higher than average in 2022 and 2023. Zhou and Dolmas (2021) use a vector autoregressive (VAR) model on national data to forecast rent inflation and find that CPI rent will reach about 7 percent on a year-over-year basis in 2023. They provide an update to this analysis in Zhou and Dolmas (2022), where they predict CPI-shelter growth will moderate in mid-2023. Brescia (2021) uses a simple linear model to predict that CPI shelter will increase significantly in 2022 and raise overall inflation levels. The largest difference between our paper and these papers is that we include an explanatory variable for how much market rents exceed CPI shelter when predicting the future growth of CPI shelter. The idea behind this variable is that if market rents are elevated relative to CPI shelter, then CPI shelter will catch up in the medium term. We find this variable is the strongest predictor of high CPI shelter. Other differences between our paper and at least some of these other papers include our use of MSA-level data, the time period of focus, the use of CoreLogic market-rent data, and the decomposition of variables that lead to forecasts of high CPI shelter. Another recent paper, Adams et al. (2022), analyzes more generally the relationship between CPI shelter and market rents and shows that because CPI shelter measures the increase in rents for all tenants rather than just new tenants, it measures rents with a lag of four quarters relative to market-rent measures.

We start by providing background information on inflation, market rents, and CPI shelter in section 2. We outline our empirical methodology in section 3. We discuss our model and provide forecasts of CPI shelter in section 4. We explain the policy implications of these results in section 5 before concluding in section 6.

2 Background

Shelter costs make up a large share of both the headline and core Consumer Price Index. Figure 1 shows the breakdown of weights for headline and core CPI by aggregated expenditure categories. Shelter is the largest category in both the headline and core CPI. Headline CPI captures changes in prices across all consumer goods and services, whereas core CPI excludes food and energy prices, both of which are highly volatile. Shelter costs make up 33 percent of the headline CPI and 42 percent of the core CPI.

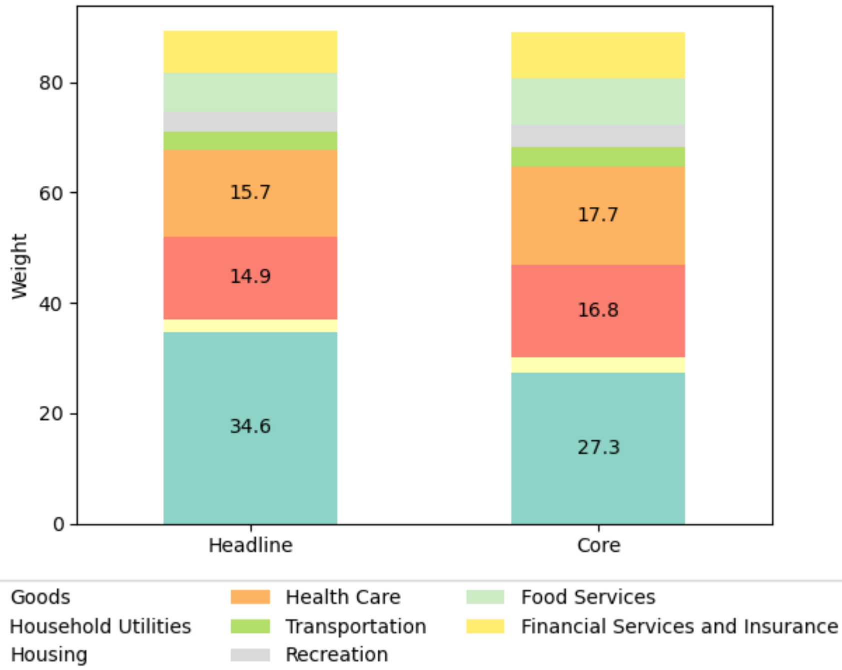
Figure 1: CPI Weights



Source: US Bureau of Labor Statistics

Shelter costs make up a smaller, but still large, share of the Personal Consumption Expenditures Price Index, a measure produced by the US Bureau of Economic Analysis (BEA) as a companion to its gross domestic product

Figure 2: PCE Weights



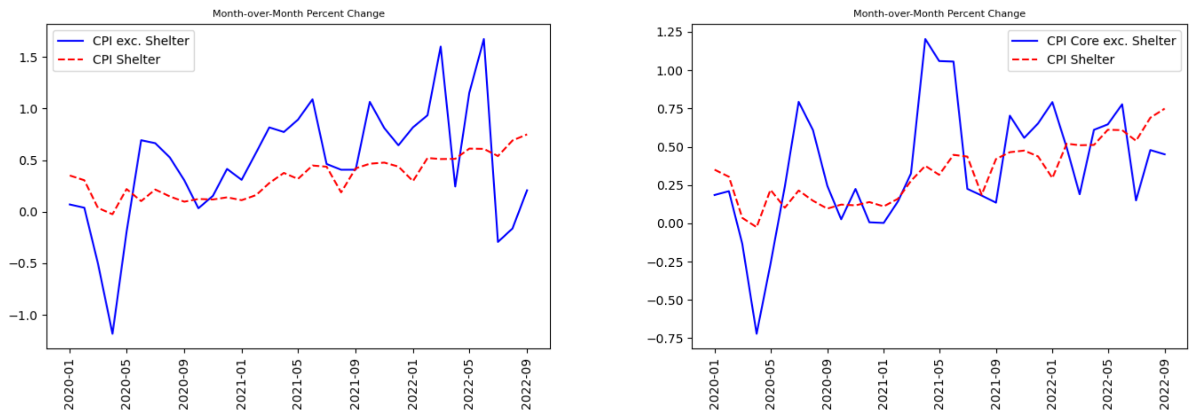
Source: BEA

statistics. Markets do not follow the PCE as closely as they follow the CPI, but the PCE is the primary price index used by the Federal Reserve. Figure 2 shows that housing costs account for 15 percent and 17 percent of the headline and core PCE, respectively. Therefore, although this analysis focuses on the CPI, the relationship between housing costs and overall prices is also relevant to PCE measures.

Shelter costs have played an important role in driving recent inflation dynamics, as shown in figure 3. Until recently, CPI shelter was growing at a below-average rate relative to other inflation categories, implying that both the headline CPI and core CPI would have been higher if CPI shelter were excluded. However, CPI shelter has accelerated recently, while other inflation components have pulled back. CPI shelter grew 0.75 percent from August to September 2022, which is the last month we use in our analysis. As a result, both the headline CPI and core CPI would now be lower if they excluded shelter costs. The headline CPI excluding shelter costs grew 0.21 percent (2.5 percent annualized) from August to September 2022 and 0.39 percent (4.9 percent annualized) including shelter costs. Thus, with shelter costs, the headline CPI was far above the Federal Reserve's inflation target, but without shelter costs, prices increased at a rate much closer to the inflation target. The core CPI grew at a fast rate of 0.57 percent from August to September 2022, so excluding shelter costs lowers the core CPI growth to only 0.45 percent . From September to October 2022, the core CPI including shelter costs grew 0.27 percent (3.2 percent annualized) but fell 0.08 percent when shelter costs are included. Therefore, in October 2022, the core CPI including shelter costs was above the inflation target, but excluding shelter costs, it was falling. It is therefore important to understand how CPI shelter will evolve in the near future to better understand inflation dynamics more broadly.

Two subcategories, rent of primary residence and owners' equivalent rent (OER), constitute 96 percent of CPI shelter. Rent of primary residence makes up 23 percent of CPI shelter and 7 percent of headline CPI. This

Figure 3: CPI and Shelter



(a) Headline CPI

(b) Core CPI

Source: US Bureau of Labor Statistics

Table 1: Correlation between CPI Shelter and Lagged Market Rents

$Corr(\Delta CPIShelter_t, \Delta CoreLogicRent_{t-lag})$	0	3	6	9	12	15	18
Month/Month	0.25	0.38	0.32	0.46	0.31	0.26	0.12
Year/Year	0.67	0.80	0.86	0.87	0.81	0.69	0.53

Sources: US Bureau of Labor Statistics, CoreLogic, authors' calculations. Formulaically, the table measures the correlation between $\Delta CPIShelter_t$ and $\Delta CoreLogicRent_{t-lag}$), where the CoreLogic Single-Family Rent Index is the market rent measure and time is measured in months. The CoreLogic Single-Family Rent Index shows a strong seasonal pattern, so we adjust it using X13ARIMA-SEATS. We use the non-seasonally adjusted CPI shelter measure, which does not show an obvious seasonal pattern.

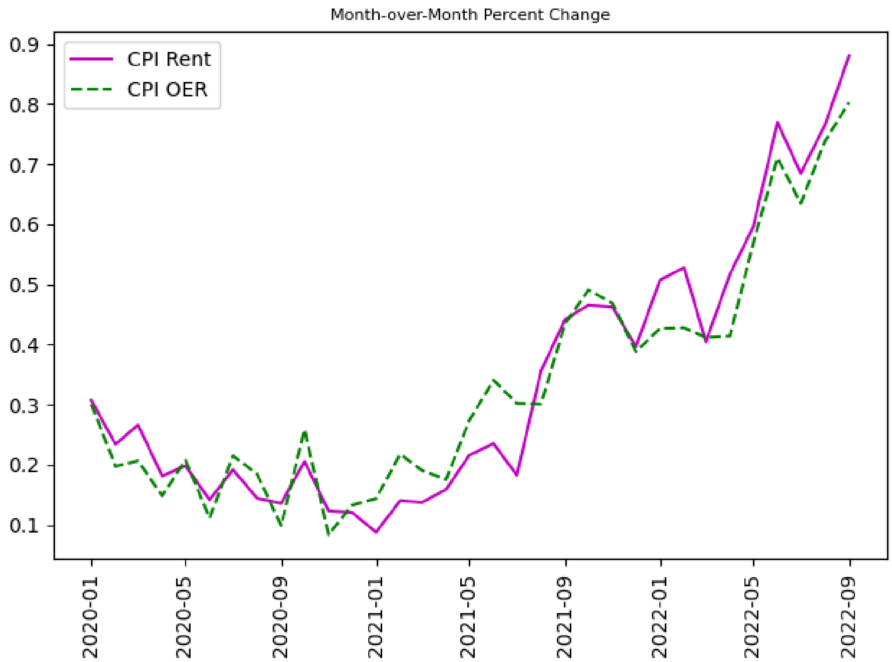
represents the amount that renters pay to rent their home. OER makes up 74 percent of CPI shelter and 24 percent of headline CPI. This represents the amount that owners would have to pay if they rented their home (but do not actually pay).[2] As shown in figure 4, OER is closely related to rent of primary residence. Therefore, CPI shelter is effectively a measure of the rent that people pay (or would pay) to live in their homes.

CPI shelter closely follows market-rent indexes but with a lag. Since CPI shelter is effectively a measure of the rent that renters pay and homeowners would pay, it should closely relate to market-rent indexes. Table 1 shows the correlation between changes in CPI shelter and the seasonally adjusted CoreLogic Single-Family Rent Index, which is a standard measure of market rents. We show the contemporary correlation as well as the correlation when we lag the market rents by different numbers of months. We do this for both the year-over-year changes and the month-over-month changes. In both cases, the correlation between the change in CPI shelter and the change in market rents nine months prior is the highest. Figure 5 shows that there was a similar pattern during the Great Recession, when market rents started to fall, bottomed out, and began to grow earlier than CPI shelter.

The construction of CPI shelter can explain why it lags market rents. The US Bureau of Labor Statistics (BLS) obtains measures of CPI shelter components through its Consumer Price Index Housing Survey, which assesses the rental prices that tenants pay for their housing. Two features of this survey imply that CPI shelter lags

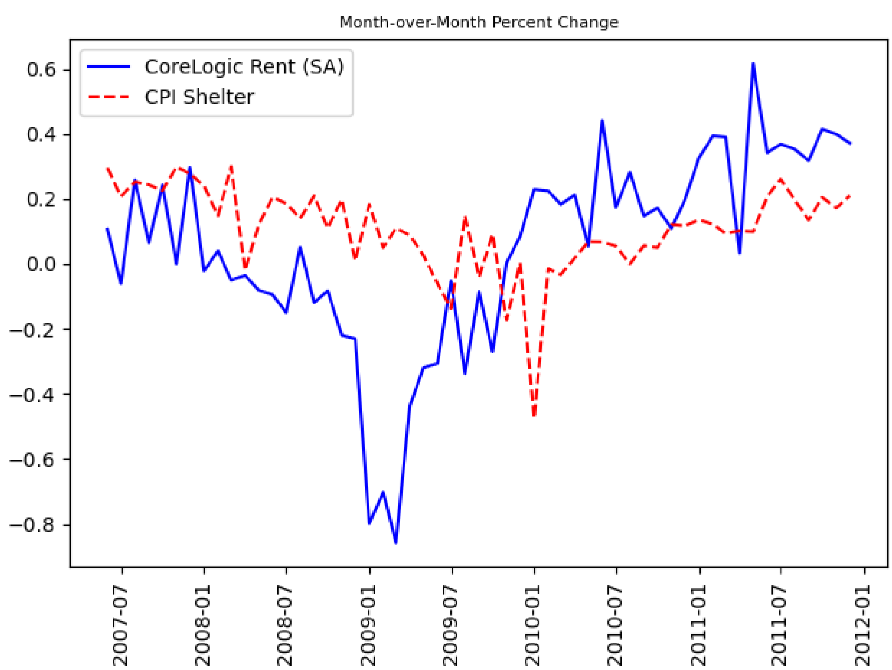
[2]The remaining portion, which makes up 3 percent of CPI shelter and 1 percent of headline CPI, comes from costs of other lodging away from home, including hotels.

Figure 4: Rent and Owners' Equivalent



Source: US Bureau of Labor Statistics

Figure 5: Shelter and Market Rents



Sources: US Bureau of Labor Statistics, CoreLogic market rent. First, each month, the BLS surveys a sixth of its sample pool. These households were last surveyed six months beforehand. The BLS sets the month-to-month change in CPI shelter to be one-sixth of the change in rent for these households in the six months since they were last surveyed. Therefore, if every household in the sample experiences a large rise in their rent in a specific month, it will take an additional five months for this increase to fully pass through into CPI shelter. Second, the housing survey measures average rental prices for all renters—new and existing—whereas market rents measure only rental prices for new tenants. Rents for existing tenants are likely to lag rents for new tenants because landlords pass on rent increases slowly.[3]

Market rents rose rapidly as the COVID-19 pandemic eased but has slowed recently, leading to uncertainty about how CPI shelter will evolve. Figure 6 plots recent monthly changes in market rents and CPI shelter. As the economy recovered from the pandemic, market rents measured by the seasonally adjusted CoreLogic national index grew quickly, reaching a peak month-over-month growth rate of 1.38 percent in November 2021. Throughout 2021 and the first half of 2022, CPI shelter grew much more slowly than market rents, suggesting that CPI shelter still has room to catch up with past high market-rent growth. However, market rents have recently begun to decelerate. In September 2022, monthly market-rent growth according to the seasonally adjusted CoreLogic national measure was 0.32 percent, which is significantly below the CPI shelter growth recorded in the same month (0.75 percent). The outlook is uncertain. The November 2022 month-over-month release for the national Zillow Observed Rent Index (ZORI) showed the largest decrease in the seven-year history of the index, 0.4 percent . Although November is typically the slowest month for rent increases (Zillow Research, 2022), the Zillow data imply slow market-rent growth or even declines in market-rent growth going forward. However, Yardi Matrix, an organization that provides services for property managers, forecasts market-rent growth of 3.5 percent in 2023 (Salmonsen, 2023). While the outlook is uncertain, it appears likely that market-rent growth will not be as high going forward, which suggests that growth in CPI shelter will decelerate in the long term. Therefore, it is unclear how CPI shelter will evolve in the medium term. On the one hand, CPI shelter still has not caught up with the high market-rent growth recorded in 2021 and the first half of 2022, but on the other hand, market-rent growth is likely to slow going forward, leading to a long-term deceleration in CPI-shelter growth.

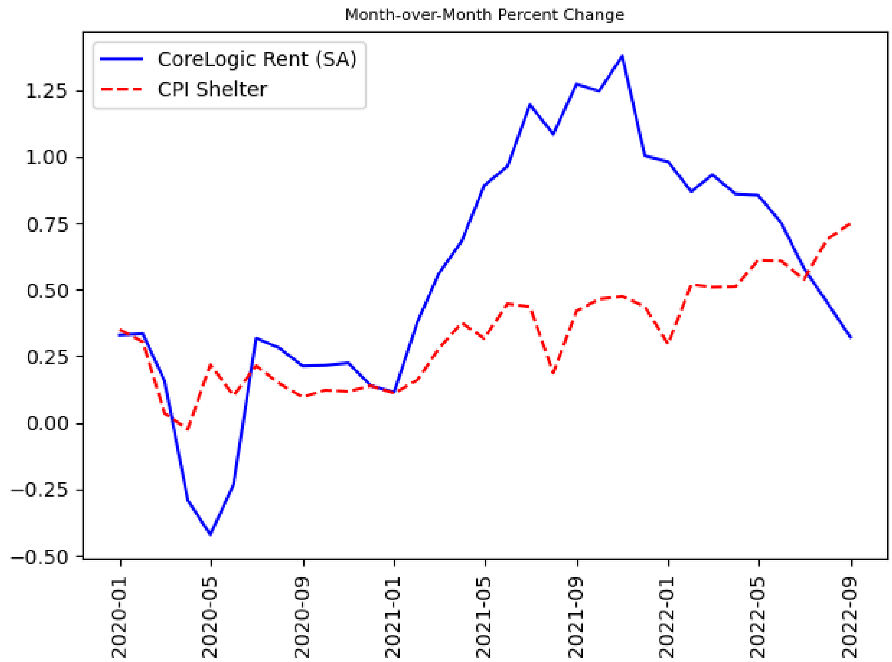
3 Methodology

We use an MSA-level error-correction approach to explain how CPI shelter evolves and forecast its movements. Using MSA-level data allows us to control for both MSA and month fixed effects, and it gives us a much greater number of data points, enabling us to improve our estimates. The error-correction approach allows us to control for not just past changes in market rents and CPI shelter but also for how much market rents currently exceed CPI shelter and how much this difference implies CPI shelter will catch up.

We use MSA-level data on CPI shelter and market rents from the BLS and CoreLogic, respectively. We have data on CPI shelter and market rents for 16 major US MSAs and at the national level. Table 2 presents details on the areas, populations, and start month for each MSA. The data for the majority of MSAs begin prior to 2010, but for some MSAs, the data do not start until the end of 2017. CPI shelter comes from the MSA-level CPI shelter indexes for major MSAs constructed by the BLS from its monthly Consumer Price Index Housing Survey. The CPI shelter measure does not show a seasonal pattern. Market rents are from CoreLogic, which

[3] It is worth noting that rents are likely to reset to the market price when tenants move. However, the COVID-19 pandemic may have changed the frequency with which tenants move, which would in turn change the frequency with which rents reset.

Figure 6: Shelter and Market Rents



Sources: US Bureau of Labor Statistics, CoreLogic. The CoreLogic Single-Family Rent Index shows a strong seasonal pattern, so we adjust it using X13ARIMA-SEATS. We use the non-seasonally adjusted CPI shelter measure, which does not show an obvious seasonal pattern.

provides estimates of market rents in major US MSAs using the latest rental-price listings. Market rents show significant seasonal variation, so we seasonally adjust them separately for each MSA as well as nationally using X13 with default parameters. Figure A.1 shows the non-seasonally adjusted and seasonally adjusted national market-rent data.

Table 2: MSA Details

MSA Name	First Date	Population (thousands)
Atlanta-Sandy Springs-Roswell, GA	200812m	6144
Baltimore-Columbia-Towson, MD	200802m	2838
Boston-Cambridge-Newton, MA-NH	200605m	4899
Chicago-Naperville-Elgin, IL-IN-WI	200501m	9509
Dallas-Fort Worth-Arlington, TX	200401m	5217
LA-Long Beach-Anaheim, CA	200401m	12997
Miami-Ft Laud-West Palm Beach, FL	200911m	2662
NY-Newark-Jersey, NY-NJ-PA	200401m	12076
Phil-Camden-Wilmington, PA-NJ-DE-MD	200802m	2150
Phoenix-Mesa-Scottsdale, AZ	201712m	4946
Riverside-San Bernardino-Ontario, CA	201712m	4653
St. Louis, MO-IL	201712m	2809
San Diego-Carlsbad, CA	201712m	3286
Seattle-Tacoma-Bellevue	200401m	3085
Tampa-St. Petersburg-Clearwater, FL	201712m	3219
Washington-Arlington-Alexandria, DC-VA-MD-WV	200401m	6356

Sources: US Bureau of Labor Statistics, US Census Bureau, CoreLogic.

We use an MSA-level error-correction model to model how CPI shelter will evolve. Error-correction models capture scenarios in which two variables are cointegrated. In this case, we expect that CPI shelter will rise in line with market rents in the long term. In the short term, however, there may be deviations between these two variables. Therefore, recent changes in CPI shelter and market rent may also predict future movements in CPI shelter. Our primary specification is an error-correction model given in equation 1. We use the notation that Δ_t^τ indicates the change in a variable from time t to time τ. We predict the change in the log of CPI shelter for an MSA over the subsequent 12 months using controls for the change in log CPI shelter in that MSA over the preceding 12 months, the change in the log of market rents in that MSA in the preceding 12 months, and the log difference between market rents and CPI shelter in that MSA. The last term captures the degree to which CPI shelter, if it lags market rents, will catch up in the subsequent 12 months. Note that we assume there is a 1-to-1 relationship in the long term between market rents and CPI shelter. We also include MSA and monthly time fixed effects, which allow us to verify that persistent differences across MSAs or large movements in specific time periods are not driving the results.

$$\begin{aligned}\Delta_t^{t+12}\log(CPIShelter_{msa}) = \gamma_{msa} + \gamma_t + \beta_1\Delta_{t-12}^t\log(CPIShelter_{msa}) + \beta_2\Delta_{t-12}^t\log(MarketRent_{msa}) \\ +\beta_3(\log(MarketRent_{msa,t}) - \log(CPIShelter_{msa,t})) + u_{msa,t}\end{aligned} \quad (1)$$

We use the estimated model to forecast how CPI shelter will evolve. Our primary method for computing forecasts involves the use of national data, because we ultimately wish to determine how CPI shelter will evolve at the national level. Therefore, we apply the coefficients we determine from equation 1 to the values of the variables at the national level. We obtain the constant using the mean of the change in the log of CPI shelter in national data.[4] We also compute the forecasts for the change in log CPI shelter for each MSA over the next 12 months by applying the model to each MSA and then aggregate these MSA-level forecasts to get a national forecast using either the unweighted mean or the mean weighted by MSA-level population.

We consider several additional model specifications. We determine how the results change when we use alternative lags, when we forecast subcomponents of CPI shelter separately, and when we do not seasonally adjust market rents. Across our main approach and these alternative approaches, we generally forecast that CPI shelter will continue to grow quickly in the medium term. One concern with this result is that it may be driven by the backward-looking nature of our forecasts; that is, because market rents grew quickly over the past 12 months, we forecast that CPI shelter will grow quickly, even though rental markets may behave differently going forward. Therefore, we consider two additional approaches. First, we decompose the impact of each explanatory variable on the predicted change in CPI shelter. This allows us to isolate how much CPI shelter will evolve due purely to the error-correction term, which is not backward-looking. Second, we conduct a simulation of how CPI shelter would evolve under different market-rent-growth rates, allowing us to estimate what would happen to CPI shelter if market rents grow slowly going forward.

[4] We compute the constant to be $\bar{y} - \beta_1\bar{x}_1 - \beta_2\bar{x}_2 - \beta_3\bar{x}_3$ where y represents the dependent variable, x_1, x_2, x_3 represent the independent variables, and the bars represent the mean.

4 Results

In this section, we construct a model for how CPI shelter will evolve in the near future and use it to obtain forecasts for CPI shelter.

We outline the model results in table 3. In the primary specification, model (4), a 1 percentage point rise in CPI shelter in the preceding 12 months is associated with a 0.105 percentage point rise in CPI shelter in the next 12 months, a 1 percentage point rise in market rents in the preceding 12 months is associated with a 0.194 percentage point rise in CPI shelter in the next 12 months, and a 1 percentage point increase in the gap between market rents and CPI shelter is associated with a 0.207 percentage point rise in CPI shelter in the next 12 months. All three of these variables are highly significant, with a t-statistic of <0.001. Indeed, the model has an R^2 of 0.538, which is very high and shows that the model has strong explanatory power.

We consider other variations on equation 1 in table 3 that also explain a large share of future changes in CPI shelter. In model (1), we explain future changes in CPI shelter using only past changes in CPI shelter. Introducing past changes in market rents from model (1) to model (2) reduces the coefficient on past changes in CPI shelter because the change in market rents and the change in CPI shelter are correlated. Similarly, introducing the error-correction term from model (2) to model (3) slightly reduces the coefficients on past changes in CPI shelter and market rents presumably because the error-correction term correlates somewhat with past changes in market rents and CPI shelter. Controlling for MSA dummies reduces the coefficients on past changes in CPI shelter and market rents. This is presumably because some MSAs in our sample have faster growth rates than others, and this is captured by the CPI-shelter and market-rent controls unless MSA dummies are introduced. As a result, the CPI-shelter control is no longer significant in model (4). Controlling for time dummies from model (4) to model (5) reduces the coefficient on market rents further presumably because changes in market rents are correlated across MSAs and therefore are captured by the time dummies. Consequently, the market-rent control is not significant at the 95 percent level in model (5), though it remains significant at the 90 percent level. The error-correction term is highly significant across all the regressions in which it is included. We focus primarily on model (4) without time dummies because when forecasting, we do not know which time dummy is appropriate. It is worth noting that the error-correction term has a very similar coefficient regardless of whether time dummies are included.

Before computing the forecasts, we can examine how the explanatory variables have evolved recently. Figure 7 shows the path of each of the three main explanatory variables measured at a national level throughout the time period we consider. All three indexes dipped during the Great Recession, with CPI shelter lagging the change in market rents and the error-correction term. Market rents and the error-correction term also fell slightly at the start of the COVID-19 pandemic and were followed by CPI shelter. However, market rents and the error-correction term then spiked. On a year-to-year basis, market rents and the error-correction term have peaked, but CPI shelter continues to grow. The mean, standard deviation, and latest value for each of these variables is presented in table 4. Panel A shows the national data, which we use primarily when constructing our forecasts. We see that all three of the explanatory variables had high values in September 2022 (the last month of data on which these forecasts are based). The high values for the explanatory variables are the reason why our forecasts for the future path of CPI shelter are high.

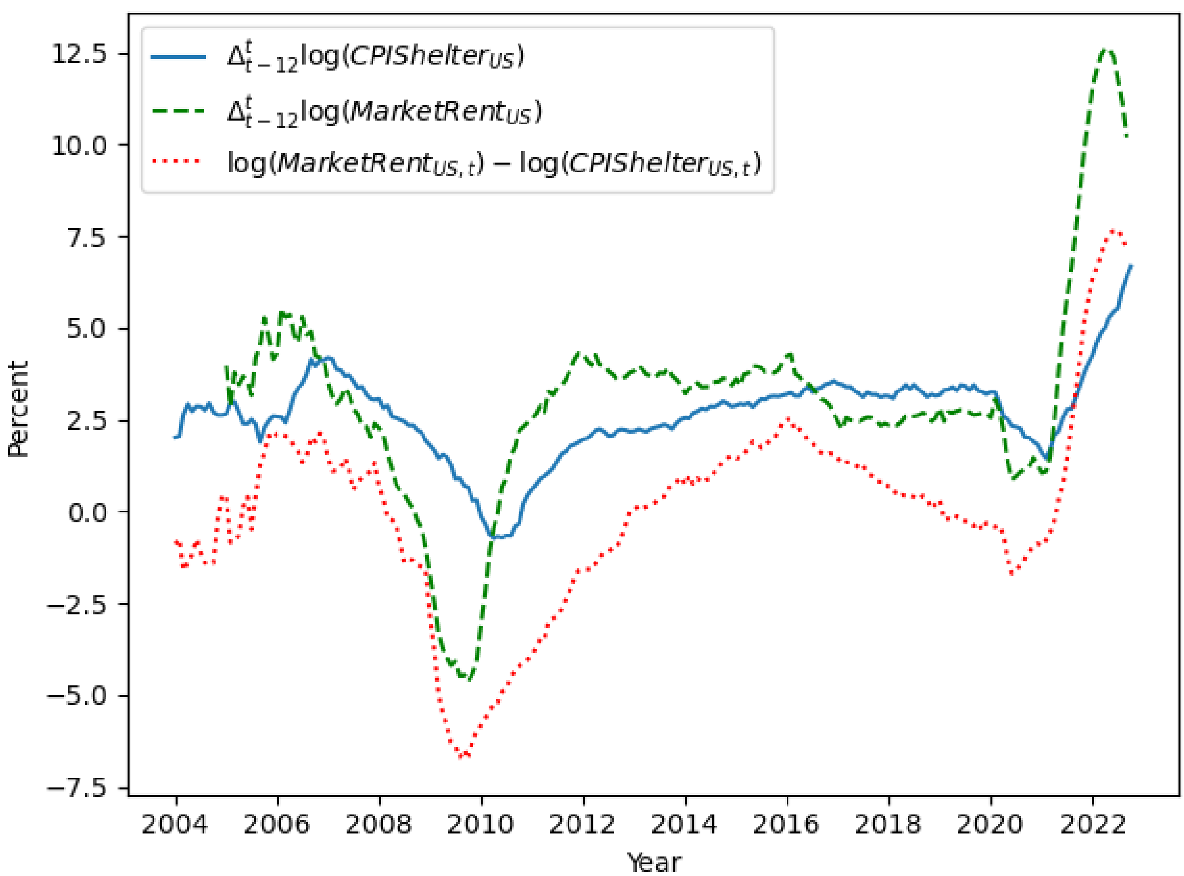
We find that the models forecast high CPI shelter for the next two years, from September 2022 to September 2024. We apply each model to the national data shown in figure 7 and panel A of table 4 to forecast how

Table 3: Primary Specification Results

$\Delta_t^{t+12}\log(CPIShelter_{msa})$	(1)	(2)	(3)	(4)	(5)
$\Delta_{t-12}^{t}\log(CPIShelter_{msa})$	0.538***	0.298***	0.252**	0.105	0.095
	(0.078)	(0.075)	(0.084)	(0.097)	(0.091)
$\Delta_{t-12}^{t}\log(MarketRent_{msa})$		0.381***	0.320***	0.194**	0.085
		(0.072)	(0.075)	(0.061)	(0.046)
$\log(MarketRent_{msa,t}) - \log(CPIShelter_{msa,t})$			0.106**	0.207***	0.210***
			(0.038)	(0.046)	(0.044)
N	2130	2130	2130	2130	2130
R^2	0.185	0.428	0.447	0.538	0.759
MSA Dummies				*	*
Month Dummies					*

Sources: US Bureau of Labor Statistics, CoreLogic, authors' calculations. Measured from our last month of data in September 2022. Standard errors are clustered by MSA and date. *, **, and *** represent significance levels of <0.05, <0.01, and <0.001, respectively.

Figure 7: Explanatory Variable Evolution



Sources: US Bureau of Labor Statistics, CoreLogic. This graph shows the three explanatory variables we consider: the year-over-year percentage change in CPI shelter, the year-over-year percentage change in market rents, and the error-correction term.

Table 4: Explanatory Variable Summary

Variable	Mean	SD	2022M09
Panel A: National			
$\Delta_{t-12}^{t} \log(CPIShelter_{US})$	2.63	1.19	6.39
$\Delta_{t-12}^{t} \log(MarketRent_{US})$	3.04	2.91	10.19
$\log(MarketRent_{US,t}) - \log(CPIShelter_{US,t})$	0.00	2.68	7.11
Panel B: Local Mean			
$\Delta_{t-12}^{t} \log(CPIShelter_{msa})$	2.87	1.41	7.79
$\Delta_{t-12}^{t} \log(MarketRent_{msa})$	3.31	2.86	9.80
$\log(MarketRent_{msa,t}) - \log(CPIShelter_{msa,t})$	0.15	2.49	4.82
Panel C: Local Weighted Mean			
$\Delta_{t-12}^{t} \log(CPIShelter_{msa})$	2.85	1.38	6.96
$\Delta_{t-12}^{t} \log(MarketRent_{msa})$	3.12	2.71	9.59
$\log(MarketRent_{msa,t}) - \log(CPIShelter_{msa,t})$	0.10	2.54	4.61

Sources: US Bureau of Labor Statistics, CoreLogic, authors' calculations. The second, third, and fourth columns show, respectively, the mean, standard deviation, and value in September 2009 of each of the variables. Panel A shows the values nationally, panel B shows the unweighted mean of the MSA-level values, and panel C shows the mean of the MSA-level values weighted by MSA population.

Table 5: Baseline Annual Forecasts

Year	(1)	(2)	(3)	(4)	(5)
0-12 Months	4.50	6.47	6.62	5.88	5.09
12-24 Months	3.69	4.85	4.81	3.91	4.28

Sources: US Bureau of Labor Statistics, CoreLogic, authors' calculations. Measured from September 2022, our last month of data.

CPI shelter will evolve from September 2022 to September 2023. Additionally, by running the regression in equation 1 for the dependent variable Δ_{t+12}^{t+24} rather than Δ_{t}^{t+12}, we can forecast the growth in CPI shelter from September 2023 to September 2024. In table 5, we observe that all five models forecast above-target inflation for the next two years. With the exception of the first model, which controls for only CPI shelter, the models predict that inflation will be about 5 to 7 percent in September 2023 and 3 to 5 percent in September 2024, suggesting that inflation will remain elevated but start to fall. By further adjusting the dependent variables, we can forecast how CPI shelter will evolve in the coming quarters, as shown in table 6. These forecasts show a pattern that is broadly similar to forecasts of CPI shelter beginning to decline in 2023Q3 but remaining elevated through 2024Q4.[5]

We decompose which factors are driving the forecasts. One potential issue with our baseline forecasts is that one of our explanatory variables is the past change in market rents, which is currently very high and fails to capture the recent rise in pessimism in the real estate sector. We therefore decompose which factors are driving the high forecasts we obtain by separating out the contribution of each of the demeaned explanatory variables.[6] The high recent levels of market rents do contribute to the forecasts of high growth in CPI shelter, raising the forecast for growth from September 2022 to September 2023 by 1.39 percentage points. However, the largest contributions to the forecasts of high CPI-shelter growth come from the error-correction term. Nationally, market rents were approximately 7 percent above CPI shelter in September 2022 (table 4), which implies that CPI shelter will rise by an additional 1.47 percentage points from that month to September 2023. The error-

[5]These forecasts do not perfectly line up with the results in table 6 because the explanatory variables as well as the dependent variables change between the regressions, so the coefficients change. However, the results are not very different.

[6]Here is an example of how we do this: The contribution of CPI shelter in panel A of table 7 (0.39) equals the latest value of CPI shelter (6.39) minus the mean value of CPI shelter (2.63), which are both in panel A in table 4 multiplied by the coefficient for CPI shelter (0.105) in model (4) in table 3.

Table 6: Baseline Quarterly Forecasts

Quarter	(1)	(2)	(3)	(4)	(5)
2022Q4	5.23	6.84	7.16	6.70	5.43
2023Q1	5.02	7.00	7.21	6.67	5.43
2023Q2	4.76	6.98	7.08	6.43	5.61
2023Q3	4.34	6.43	6.43	5.58	5.25
2023Q4	3.62	5.78	5.80	4.67	5.09
2024Q1	3.67	5.04	4.99	3.81	4.52
2024Q2	3.61	4.75	4.62	3.51	4.18
2024Q3	3.61	4.44	4.26	3.15	3.80
2024Q4	3.53	4.48	4.31	3.16	3.69

Sources: US Bureau of Labor Statistics, CoreLogic, authors' calculations. Measured from September 2022, our last month of data.

Table 7: Disaggregated Forecasts

	Constant	CPI	Market	Error Correction	Total
Panel A: National					
0-12 Months	2.63	0.39	1.39	1.47	5.88
12-24 Months	2.63	0.05	0.39	0.83	3.91
Panel B: Local Mean					
0-12 Months	3.62	0.52	1.26	0.97	6.37
12-24 Months	4.03	0.07	0.36	0.54	5.00
Panel C: Local Weighted Mean					
0-12 Months	3.39	0.43	1.26	0.93	6.01
12-24 Months	3.64	0.06	0.35	0.53	4.58

Sources: US Bureau of Labor Statistics, CoreLogic, authors' calculations. Measured from September 2022, our last month of data. The forecasts are created using model (4). The contribution of each explanatory variable is relative to its mean as given in table 4.

correction term is not past-looking. Indeed, it makes sense that if CPI shelter lags market rents and market rents are currently higher than CPI shelter, this will very likely raise CPI-shelter growth going forward as CPI shelter catches up with market rents. We also see in table 7 that the error-correction term is the biggest driver of the forecast for high CPI-shelter growth from September 2023 to September 2024, raising the forecast 0.83 percentage points compared with 0.39 percentage points for the past market-rent growth.

We also provide the forecasts computed by aggregating the MSA-level forecasts by the unweighted mean and population-weighted mean in panels B and C, respectively, of table 7. These estimates are higher than those from the national data. However, this is due primarily to higher constants. The constant in panels B and C represents the mean of the MSA constants, which is in turn the average of the mean CPI-shelter growth by MSA. This constant is higher than that for the national-level data because some of the MSAs for which we have only recent data, such as Tampa, had very high CPI-shelter growth in the period for which we have data, which raises the mean relative to the national sample. Including only the MSAs for which we have data prior to 2010 lowers the constants, giving us estimates for the forecasts that are slightly lower than in the national case, though still high (see table A.4). The reason for this is that the aggregated error-correction term for MSAs is lower (4.8 percent and 4.6 percent with the unweighted and population-weighted means, respectively) than it is for the national data (7 percent), which implies that CPI shelter will not rise as much going forward. In the MSA-level data, there are only 16 MSAs that are likely to cover cities that had high populations in the past. As a result, some fast-growing metropolitan areas, such as Austin and Houston, are missing. Moreover, the pandemic may have raised rents more in non-metropolitan areas to which people relocated as their ability to

Table 8: Forecast Simulation of Fixed Market-Rent Growth

Market-Rent Growth (% Annual)	CPI Shelter % Change 0-12 Months	CPI Shelter % Change 12-24 Months
-1	5.24	2.37
0	5.43	2.90
1	5.62	3.43
2	5.81	3.97
3	5.99	4.50

Sources: US Bureau of Labor Statistics, CoreLogic, authors' calculations

work from home increased. These factors could lead to error-correction terms for the MSAs for which we have data that are lower than in the national data, which is why we focus primarily on the national estimates.

We also conduct a simulation to consider how a shift in market-rent growth might affect CPI shelter going forward. This is to help further investigate how a change in the real estate market toward lower market-rent growth might play out. We show the results in table 8. To conduct this simulation, we assume that market rents will grow at the constant annualized rate shown in the first column. We then estimate a model similar to equation 1 except that we compute CPI shelter only one month ahead. We repeat this exercise one month at a time to forecast CPI-shelter growth for the next two years. We consider how CPI shelter would evolve under different market-rent growth rates of –1 to 3 percent. We think of –1 percent as a relatively promising outlook for market rents and 3 percent as a relatively pessimistic outlook for market rents, providing us with approximate ranges for forecast CPI shelter. With high market-rent growth of 3 percent, CPI shelter is forecast to grow 5.99 percent from September 2022 to September 2023 and then 4.50 percent in the subsequent 12 months. With low market-rent growth of –1 percent, CPI shelter would remain high, with a growth rate of 5.24 percent , from September 2022 to September 2023 and then fall to 2.37 percent growth over the subsequent 12 months. It makes sense that CPI shelter may remain high in the short term even under low market-rent growth because CPI-shelter growth and the error-correction term both start from high levels. Our baseline estimates in table 5 suggest that CPI shelter will grow 5.88 percent from September 2022 to September 2023 and 3.91 percent in the subsequent 12 months. Both of these estimates are similar to the forecasts produced by our simulation under a modest market-rent growth of 2 percent . In table A.5, we show that the simulation results are similar if we forecast the CPI shelter growth by MSA and then compute the unweighted mean across MSAs, rather than using national data.

We conduct several additional robustness checks. In table A.1, we show that running the model with non-seasonally adjusted market-rent data yields results similar to those from running the model with seasonally adjusted data. In table A.2, we demonstrate that the model results are similar whether we consider CPI primary rent or CPI owners' equivalent rent, the two primary components of CPI shelter. In table A.3, we consider how changing the lag structure affects the forecasts. In the first row, we use the 0-to-12-month lags for CPI shelter and market rents, which is our default specification. In the second row, we use the 0-to-12-month lag and the 12-to-24-month lag. In the third row, we use the 0-to-1-month, 1-to-2-month, . . . , 11-to-12-month lags. We find similar forecasts across the models. Therefore, allowing for more controls for the past or allowing for more frequent lags does not appear to affect the results.

5 Policy Implications

We can examine how much CPI shelter will contribute to inflation. CPI shelter grew an average of 2.69 percent annually from 2000 through 2019. We note in table 5 that from September 2022 to September 2023, CPI shelter is estimated to grow 5.88 percent, which is 3.19 percentage points above its pre-pandemic average. Shelter costs make up 33 percent of the headline CPI, 42 percent of the core CPI, 15 percent of the headline PCE, and 17 percent of the core PCE. Therefore, we forecast that the headline CPI, core CPI, headline PCE, and core PCE will be 1.05, 1.34, 0.48, and 0.54 percentage points higher, respectively, from September 2022 to September 2023 than if CPI shelter grew at its pre-pandemic average rate. Over the subsequent 12 months, we estimate, shelter inflation will be 3.91 percent, or 1.22 percentage points above its pre-pandemic average. We therefore forecast that the headline CPI, core CPI, headline PCE, and core PCE will be 0.40, 0.51, 0.18, and 0.21 percentage points higher, respectively, from September 2023 to September 2024 than if CPI shelter grew at its pre-pandemic average rate.[7]

Even in the optimistic case where market rents grow slowly or fall, we forecast that CPI shelter will continue to contribute to higher inflation in the short term. In table 8, we estimated that if market rents grow –1 percent, which is a relatively low forecast for market-rent growth, CPI shelter will grow 5.24 percent from September 2022 to September 2023 and 2.37 percent over the subsequent 12 months. In this case, the headline CPI, core CPI, headline PCE, and core PCE will be 0.84, 1.07, 0.38, and 0.43 percentage points higher, respectively, from September 2022 to September 2023 than if CPI shelter grows at its pre-pandemic average rate. Over the subsequent 12 months, CPI shelter will fall back to approximately its pre-pandemic average rate of growth and will in this case be less inflationary. Therefore, under low market-rent growth, CPI shelter will place considerable upward pressure on inflation through September 2023, but the impact will then diminish.

6 Conclusion

Shelter costs play an important role in price indexes. Therefore, to understand how inflation will move, it is important to consider how the price of shelter will evolve. At this moment particularly, there is uncertainty about the movement of the price of shelter. Rental prices have increased significantly in the last two years, but their growth rate has declined recently. CPI shelter tends to lag changes in market rents because the measurements of the two are staggered, and because different samples of renters are considered. Therefore, it is unclear how the substantial variation in market rents in recent years will feed into the price of shelter. In this paper, we analyze the movement of shelter in the Consumer Price Index. We use an error-correction model comprising past changes in CPI shelter, past changes in market rents, and the difference between market rents and CPI shelter. The last term allows us to investigate how quickly CPI shelter is likely to catch up with market rents when there are deviations. We conduct this analysis at the metropolitan statistical area level, which provides us with a larger panel of data points and enables us to control for how common effects across MSAs affect the relationship. We then use this model to forecast how CPI shelter will evolve in the near future.

[7] An alternative way of expressing these numbers is to note that we forecast CPI shelter will grow 5.88 percent, which is 3.88 percentage points above the Federal Reserve's 2 percent inflation target. Therefore, we forecast that the headline CPI, core CPI, headline PCE, and core PCE will be 1.28, 1.63, 0.58, and 0.66 percentage points higher, respectively, from September 2022 to September 2023 than they would be if CPI shelter grew at the Federal Reserve's 2 percent target rate. And we forecast that the headline CPI, core CPI, headline PCE, and core PCE will be 0.63, 0.80, 0.29, and 0.32 percentage points higher, respectively, from September 2023 to September 2024 than they would be if CPI shelter grew at 2 percent .

Our model appears to fit the data well, and the baseline specification is able to explain more than 50 percent of future movements in CPI shelter. Past changes in CPI shelter, past changes in market rents, and the difference between market rents and CPI shelter each play a role in predicting future CPI shelter. We apply these estimates to forecast CPI shelter. We find that CPI shelter will grow 5.9 percent from September 2022 to September 2023 and then 3.9 percent over the subsequent 12 months. These numbers suggest that CPI shelter will remain elevated. One potential concern with our approach is that our forecasts are partially based on past growth in market rents and that with the large recent rise in interest rates, market rents could follow a markedly different pattern going forward. We respond to this concern in two ways. First, we decompose the contribution of each explanatory variable to the forecast. We focus on how much the deviation between market rents and CPI shelter is likely to contribute to CPI-shelter growth going forward because this component is not backward-looking. This deviation alone suggests that CPI shelter will be 1.5 percent higher from September 2022 to September 2023 and 0.8 percent higher in the subsequent 12 months. Second, we conduct a simulation of how CPI shelter will evolve under different levels of market rents. Even with low market rents, we find, CPI-shelter growth will still be elevated in the medium term. In all, we find that high CPI shelter is likely to place upward pressure on inflation in the medium term under different assumptions about market-rent growth. Under a scenario of low market-rent growth going forward, shelter will continue to provide upward pressure to overall inflation until later this year, but then its impact will diminish considerably in 2024.

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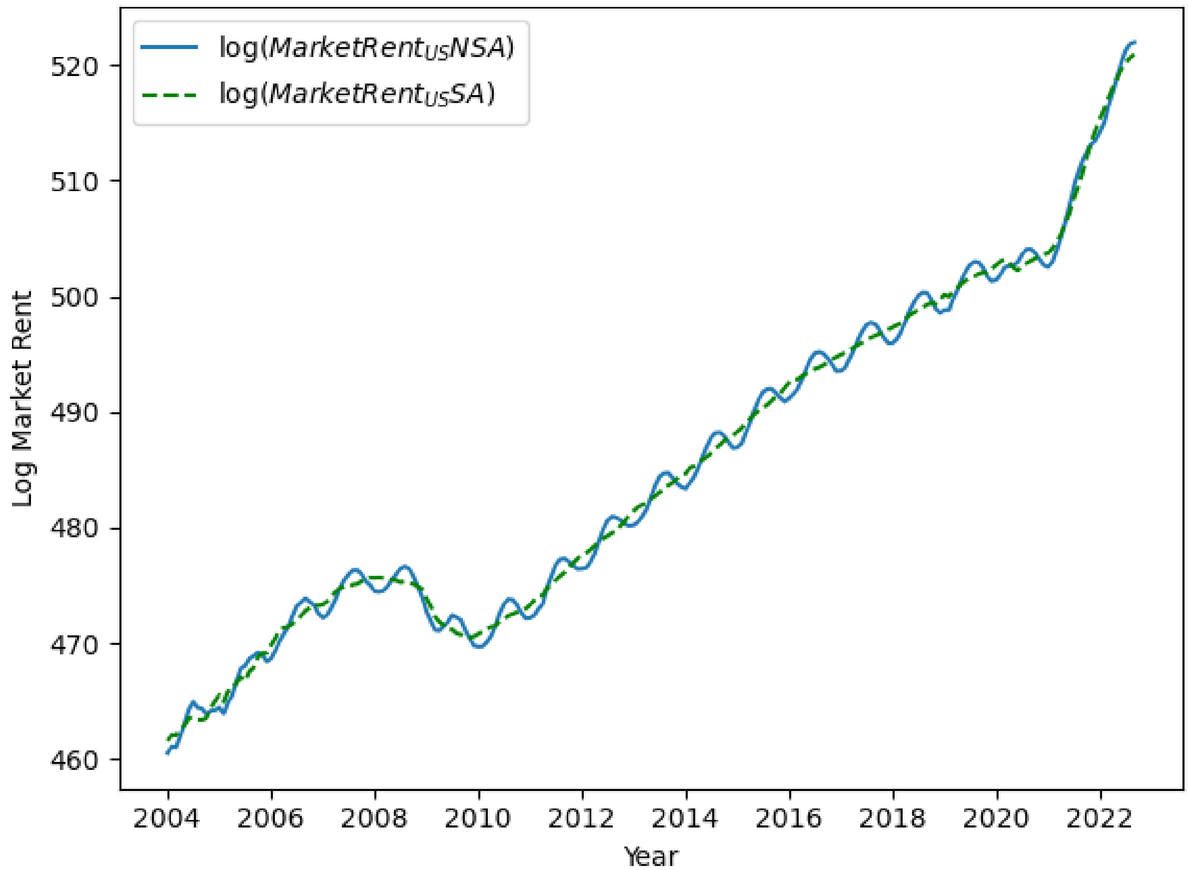
A Additional Analysis

Figure A.1: Seasonal Adjustment of National Market Rents



Source: CoreLogic. Seasonal adjustment conducted using X13SEATS-ARIMA with default parameters.

Table A.1: Model Results: With and Without Seasonal Adjustment

$\Delta_t^{t+12}\log(CPIShelter_{msa})$	(1)	(2)
$\Delta_{t-12}^{t}\log(CPIShelter_{msa})$	0.105	0.121
	(0.097)	(0.091)
$\Delta_{t-12}^{t}\log(MarketRent_{msa})$	0.194**	
	(0.061)	
$\log(MarketRent_{msa,t}) - \log(CPIShelter_{msa,t})$	0.207***	
	(0.046)	
$\Delta_{t-12}^{t}\log(MarketRent_{msa}^{NSA})$		0.204***
		(0.060)
$\log(MarketRent_{msa,t}^{NSA}) - \log(CPIShelter_{msa,t})$		0.184***
		(0.038)
N	2130	2130
R^2	0.538	0.531
MSA Dummies	*	*
Month Dummies		

Sources: US Bureau of Labor Statistics, CoreLogic, authors' calculations. *, **, and *** represent significance levels of <0.05, <0.01, and <0.001, respectively. The specification is the same as that of model (4) in table 3.

Table A.2: Model Results: Alternative Dependent Variables

	$\Delta_t^{t+12}\log(CPIShelter_{msa})$	$\Delta_t^{t+12}\log(CPIRent_{msa})$	$\Delta_t^{t+12}\log(CPIOER_{msa})$
$\Delta_{t-12}^{t}\log(MarketRent_{msa})$	0.194**	0.330***	0.184**
	(0.061)	(0.078)	(0.060)
$\Delta_{t-12}^{t}\log(CPIShelter_{msa})$	0.105		
	(0.097)		
$\log(MarketRent_{msa,t}) - \log(CPIShelter_{msa,t})$	0.207***		
	(0.046)		
$\Delta_{t-12}^{t}\log(CPIRent_{msa})$		0.180	
		(0.104)	
$\log(MarketRent_{msa,t}) - \log(CPIRent_{msa,t})$		0.108**	
		(0.037)	
$\Delta_{t-12}^{t}\log(CPIOER_{msa})$			0.125
			(0.095)
$\log(MarketRent_{msa,t}) - \log(CPIOER_{msa,t})$			0.194***
			(0.050)
N	2130	2130	2130
R^2	0.538	0.545	0.535
MSA Dummies	*	*	*
Month Dummies			

Sources: US Bureau of Labor Statistics, CoreLogic, authors' calculations. *, **, and *** represent significance levels of <0.05, <0.01, and <0.001, respectively. The specification is the same as that of model (4) in table 3.

Table A.3: Annual Forecast: Alternative Lag Structure

Lags	CPI Shelter % Change 0-12 Months	CPI Shelter % Change 12-24 Months
1 Year Lag - Over 1 Year	6.37	5.00
1 Year Lags - Over 2 Years	6.17	5.57
1 Month Lags - Over 1 Year	5.71	4.90

Sources: US Bureau of Labor Statistics, CoreLogic, authors' calculations. The forecasts are constructed using model (4) in table 3 and by aggregating MSA forecasts using an unweighted mean, that is, similar to panel B in table 7.

Table A.4: Disaggregated Forecasts: Pre-2010 MSAs

	Constant	CPI	Market	Error Correction	Total
Panel A: National					
0-12 Months	2.63	0.58	1.25	1.28	5.75
12-24 Months	2.63	0.19	0.55	0.69	4.07
Panel B: Local Mean					
0-12 Months	2.85	0.76	1.14	0.84	5.59
12-24 Months	2.90	0.25	0.50	0.45	4.10
Panel C: Local Weighted Mean					
0-12 Months	2.76	0.64	1.14	0.81	5.35
12-24 Months	2.76	0.21	0.50	0.44	3.91

Sources: US Bureau of Labor, CoreLogic, authors' calculations. This table is similar to table 7 except that we consider only the 11 MSAs for which we have data before 2010.

Table A.5: Forecast Simulation of Fixed Market-Rent Growth: MSA Mean

Market-Rent Growth (% Annual)	CPI Shelter % Change 0-12 Months	CPI Shelter % Change 12-24 Months
-1	5.12	2.07
0	5.28	2.59
1	5.43	3.10
2	5.59	3.62
3	5.75	4.13

Sources: US Bureau of Labor Statistics, CoreLogic, authors' calculations. This table is similar to table 8 except that, instead of using national data, we simulate out CPI-shelter growth for each MSA separately and then compute the unweighted mean.