Beyond Traditional Metrics: Pioneering Approaches to Housing Inflation

A Pennsylvania State University & Truflation research paper on a new way forward for measuring housing as part of inflation.

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1. Summary

This research paper addresses the differences and shortfalls in the methods used by the Personal Consumption Expenditure Price Index (PCE) and the Consumer Price Index (CPI) to calculate the inflation in the shelter category, and proposes an alternative metric that better reflects the real rate of inflation in this important category.

The authors independently publish two sets of alternative inflation indexes: The Pennsylvania State University ACY Inflation Index by Ambrose and Yoshida and the Truflation Index by Rust and Jelic. We collaborate in this article to provide new insight into a better measurement of shelter inflation in the United States.

Shelter makes up 42.4% and 32.9% of the CPI-U index and the PCE Price Index, according to their most recent figures of relative importance for the respective categories. While Truflation's definition is different, housing is still a significant portion of Truflation's real-time US CPI index at 23.2%. As such, it is incredibly important to ensure that this portion of the index is an accurate representation of the situation on the ground.

Both the PCE and CPI indexes have shown continuous increases in the shelter category over the past few years, with the CPI reporting nearly four straight years of monthly increases in the price of shelter.

Truflation's housing index, however, has shown a gradual slowdown over the past year, from 6.29% year-over-year (YoY) at the end of March 2023 to 1.55% on July 7th, 2024. Moreover, the Penn State ACY Marginal Rent Index (MRI) has shown negative YoY growth between December 2022 and November 2023. Though a re-acceleration has been seen in Truflation housing prices and ACY MRI in the early months of 2024 and these indexes fail to reflect anything like the steady price increases in the CPI-U shelter index is showing over the last few years.

This paper delves into the reasons for this discrepancy, the effect it has on the overall inflation figure, and the rationale for an improved housing metric that better reflects the state of the US housing market.

By analyzing the composition of the PCE, CPI, ACY-MRI, and Truflation US indexes and reviewing their key differences, we present a comprehensive picture of the inflation

measurement landscape and set the scene for the ensuing discussion regarding the shelter/housing index methodology.

2. Traditional Inflation Metrics

In the intricate tapestry of economic analysis, understanding the ebb and flow of an economy's health is of paramount importance. Economic indicators serve as compass points, helping policymakers, business leaders, and even the general public navigate the financial landscape. These indicators provide insights into the current state of an economy, predict potential future trends, and shape decisions that have far-reaching consequences. Among these indicators, measures of inflation stand out due to their direct impact on purchasing power, monetary policy, and overall economic stability.

The Personal Consumption Expenditures (PCE) Price Index and the Consumer Price Index (CPI) are the key inflation metrics used in the US, each offering a unique lens through which to view the intricate dynamics of price changes within an economy. While the PCE and CPI have long held the spotlight, Truflation's and Penn State's ACY housing indexes emerge as alternative data sources, promising fresh perspectives for understanding inflationary trends.

Inflation, which is the rate at which prices for a diversified set of goods and services rise, can also be translated as the decline of purchasing power over time. The rate at which purchasing power drops can be reflected in the average price increase of a basket of selected goods and services over time. Inflation can be contrasted with deflation, which occurs when prices decline and purchasing power increases.

While it is easy to measure the price changes of individual products over time, human needs extend beyond just one or two products. Individuals require a large and diversified set of products as well as a host of services for living a comfortable life. This includes commodities like grains, metal, and fuel, utilities like electricity and transportation, and services like healthcare, entertainment and labor.

2.1 The Commonly Used Inflation Metrics

Depending on the selected set of goods and services used, multiple types of baskets of goods and services are calculated and tracked as price indexes. The most widely used

price indexes in the US are the Consumer Price Index (CPI) and Personal Consumption Expenditure Price Index (PCE).

In order to understand the differences between the most commonly used inflation metrics we need to understand each of them.

Personal Consumption Expenditures (PCE)
Let's first dig into Personal Consumption Expenditures (PCE), which is a measure of the spending on goods and services by people in the US and is managed by the Bureau of Economic Analysis (BEA), which cites that the PCE accounts for about two-thirds of domestic spending and is a significant driver of Gross Domestic Product (GDP).

The PCE Price Index measures the prices consumers pay for goods and services and changes in those prices. It is considered a gauge of inflation in the US economy. The PCE Price Index is calculated using PCE data. It may indicate whether prices are inflating or deflating and how consumer spending behavior changes in response. The Price Index provides two figures:

- The first is derived from all spending categories for the PCE
- The second excludes data for food and energy and is known as the Core PCE Price Index

The BEA reports the total value of Personal Consumption Expenditures collectively every month. Like most economic breakdowns, PCE data is categorized to include the following:

- Durable Goods: Motor vehicles and parts, furnishings and durable household equipment, recreational goods and vehicles, and other durable goods
- Nondurable Goods: Food and beverages purchased for off-premises consumption, clothing and footwear, gasoline and other energy goods, and other nondurable goods
- Services: Housing and utilities, healthcare, transportation services, recreation services, food services and accommodations, financial services and insurance, and other services

According to the BEA, the majority of PCE increases (valued by market prices, including sales tax) come from household purchases of new goods and services from private businesses. It also includes household purchases of new goods and services from the government.

The PCE also includes spending on behalf of households by third parties, such as employer-paid health insurance and medical care financed through government programs, life insurance expenses, and pension plan expenses.

The PCE derives its data from multiple sources. The primary ones include the US Census Bureau's monthly retail trade report and the Service Annual Survey (SAS). It also uses data from the Bureau of Labor Statistics, particularly the Consumer Expenditure Survey which is used more prominently in the CPI.

The weights, or the importance assigned to various items in the PCE, change over time as consumers adjust their spending habits. This is one key difference between the PCE and the CPI (Consumer Price Index). The CPI uses fixed weights, which means it gauges inflation for a set basket of goods and services over time. In contrast, the PCE's basket of goods and services is flexible, allowing it to more accurately capture changing consumption patterns.

While the PCE has a broader scope than many other measures, it does exclude certain expenditures. Notably, it doesn't account for home purchases (though it does consider rental expenses and the "imputed" rent that homeowners would pay to rent their homes).

The PCE is a chained index, so it's calculated using a complex formula that compares prices over two periods. The idea behind chaining is to frequently update expenditure weights in the index, making it more responsive to changes in consumer spending patterns.

In addition, prior PCE figures are subject to revision every year. That can result in different measurements over extended periods. Some observers feel that this reflects the inability to value personal consumption expenditures accurately.

Consumer Price Index (CPI)
The Consumer Price Index (CPI) is a measure used to estimate the average change over time in the prices paid by urban consumers for a market basket of consumer goods and services. It is one of the most widely recognized price measures for consumer goods in the US.

The most commonly used metric within the CPI is the Consumer Price Index - All Urban Consumers, a category that covers 93% of the US population. That index is called CPI-U and is often referred to as headline inflation.

A subset covering 29% of the US population, known as CPI-W, tracks price changes for urban wage earners and clerical workers. It is used to determine the cost of living adjustment for recipients of Social Security and other federal benefits.

There is also a chained CPI (C-CPI-U), which seeks to adjust for the effect of substitution between product categories as consumers opt for alternatives to goods and services with the fastest rising prices.

The headline CPI is based on the prices of about 94,000 goods and services collected monthly, with two-thirds collected by survey workers across 75 urban areas and from 23,000 retailers and service providers. Prices for some product categories, notably gasoline, new vehicle purchases and other motor fuels, come from outside data providers.

Housing, which accounts for more than 42% of the overall CPI, uses rental price survey data from 6,000 rental housing units to estimate housing rents as well as the value of shelter for homeowners.

The BLS groups the CPI price data by 211 product and service categories and adjusts each category's relative weight in the index every year, based on the past 2 years rolling averages of consumer spending patterns. Each item in the basket is assigned a weight that represents its importance in the spending habits of the representative consumers. This weight is largely based on reported consumer spending patterns and is the result of an annual consumer-based survey.

In addition to this, BLS adjusts the CPI for quality changes in goods and services to ensure the index reflects only pure price movements.

Certain items are not included in the CPI. For example, it excludes investment items, property taxes and mortgage, interest, and loan repayments. These items, though crucial, are not everyday consumption items.

In a nutshell, the key difference between the CPI and PCE is that the CPI represents a basket of goods and services that a consumer would buy without making substitution changes when prices change. The PCE, meanwhile, encompasses a broader range of goods and services than the CPI, from a broader range of buyers. It tries to track what is actually purchased and represents how consumers change their buying patterns when relative prices change. This leads to smoother price changes in the PCE and typically lower levels of reported inflation, at least as experienced by consumers. To compare the two, please read Truflation's Index Methodology.

2.2 How Existing Tools Measure Housing and Shelter Index

Delving deeper into the composition of these key inflation measures, it's crucial to review the housing / shelter index, whose calculation is a particularly contentious topic. Given the broad definitions of housing / shelter, it is important to understand these first before digging into the specifics. The indexes for housing / shelter in the inflation measurement tools of CPI and PCE index are generally consistent: in both indexes housing / shelter represents a service that a housing unit provides its occupants. The indexes consist of 4 components that include: owners' equivalent rent (OER), rent of primary residence (rent), lodging away from home (hotels, motels, Airbnb), and tenants and household insurance. For the purposes of this paper, we will only focus on OER and rent.

The BLS considers the shelter service that a housing unit provides to its occupants is a relevant consumption item for the CPI. Thus, rent is seen as representing the biggest part of the shelter cost.

For the owner-occupied unit, meanwhile, the BLS calculates the implicit rent that an owner-occupant would have to pay if they were renting their homes without furnishings or utilities. As such, the owned housing units themselves are not priced within the CPI index, since they are considered capital (or investment) goods. This makes them distinct from the shelter service they provide and therefore not a consumption good.

Spending to purchase and improve houses and other owned housing units is treated as investment, and not consumption, within the CPI. Interest costs such as mortgage interest, property taxes, real estate fees, maintenance, and all improvement costs are part of the cost of the capital, and as such are also not treated as consumption items.

These non-consumption costs of owned housing are considered to be "out of scope" for the CPI' cost of living framework.

The data source used by the CPI program to determine the weights of its index, which includes housing, is derived from the Consumer Expenditure (CE) Survey that asks households to report the share of their budget which goes towards housing and other categories of goods and services. The weighting contributions of each category to both the PCE and CPI are listed below in Table 1.0. Housing (as we have defined them for this document, i.e. rent and OER), account for 29.2% of the BLS CPI index and 20% of the PCE price index.

Table 1.0: Comparison of the Household Relative Importance by Category

Source: Bureau Labor And Statistics And Bureau Economic Analysis

Comparison of the Household Relative Importance by Category	CPI – U	PCE		CPI – U	PCE
Food And Beverages	15.1%	17.0%	Medical Care	15.1%	17.0%
Food At Home	15.1%	17.0%	Transportation	15.1%	17.0%
Food Away From Home	15.1%	17.0%	Motor Vehicles	15.1%	17.0%
Alcoholic Beverages	15.1%	17.0%	Gasoline	15.1%	17.0%
Housing	15.1%	17.0%	Other Transportation	15.1%	17.0%
Rented	15.1%	17.0%	Education & Communication	15.1%	17.0%
Owners Equivalent Rent	15.1%	17.0%	Recreation	15.1%	17.0%
Other Housing	15.1%	17.0%	Tobacco	15.1%	17.0%
Apparel	15.1%	17.0%	Other Goods & Services	15.1%	17.0%

Source: Bureau Labor and Statistics and Bureau Economic Analysis

The above table illustrates the important differences between the PCE and CPI-U in terms of the relative importance of housing, which is due in part to the difference in scope – CPI contains a large component of owner-equivalent rent, which by definition is an imputed value and not a real direct expenditure.

The BLS's Housing Survey collects about 8,000 rental housing unit quotes each month from across the United States. The housing sample of 96,000 interviews per year is

derived from 6 sampling panels, with each housing unit being sampled twice a year. The rental price information is collected through personal visits or by phone.

This same data is also used by the PCE index. However, given the definitional differences and the other data sets that the PCE uses, such as NIPA data, the weighting contributions differ.

Considering there are roughly 132 million households in the US and 35% of US households rent (46.2 million) it would appear that using a sample of 8,000 rental units seems small to calculate such an important statistic.

Using the OER as a metric to bring owner-occupied housing and rental properties under the same umbrella also has many pitfalls. Firstly, finding rental housing that is comparable to an owner-occupied unit is difficult. Predominantly, renter-occupied neighborhoods are often geographically separate from owner-occupied ones (a city center versus a suburb). Even in the same neighborhood, the former could be multi-family buildings, while the latter are often single-family homes, for example. This, coupled with the difficulty of finding comparable quality housing, adds a significant complexity to the BLS measurement that puts the consistency and validity of the numbers into question. In addition, methodologies for measuring owned property prices are not foolproof, as it is not an easy task.

The problem with using this metric is that, firstly, it considers rent and housing costs trends to be one and the same. The starting point for calculating the OER are the responses from the Consumer Expenditure Survey, which asks what a homeowner would receive if they were to rent their home today and adjusts the price changes based on imputed weighting factors like the area, size, single vs multi-family households, etc. factors like size or location vary depending on the sample used from month to month, causing an artificial price change that does not reflect the cost of owned housing. Indeed, the only difference is that for homeowners, this figure strips out utilities, while the utility costs of rental properties are also included if they are part of the rent paid by the tenant.

Using this method, the BLS intends to measure the cost of the consumption value of a home and discards the consumption of services like mortgages, property services through property taxes, building materials, and the labor costs of household maintenance or upgrades. This method, however, has its flaws, since there are likely to

be a significant number of homeowners who find themselves at different stages of their property development, while the utilization of those services by some people will be lower than for property renters.

The BLS does take some measures to keep its sample representative, however. It adjusts for the quality of the properties it observes based on age, neighborhood improvements and physical renovations to the home, and it also replaces one-sixth of the sample each year.

3. How Pennsylvania State University ACY improves the Rent Component of Inflation

As previously discussed, the Bureau of Labor Statistics (BLS) calculates rental costs for the Consumer Price Index (CPI) shelter index (and thus in turn the Personal Consumption Expenditures (PCE) Price Index Housing Services) by periodically surveying existing renters. Consequently, this index primarily reflects rent adjustments for ongoing tenancies and overlooks changes due to new tenants.

For example, take two identical rental units in a location where rent grows by 10% annually for four years, then decreases by 10% in the fifth year. In Unit A, a new tenant moves in every year on January 1, but surveys in the third and fifth years aren't completed. Thus, the BLS only records rent growth once from July of the first year to January of the second year, when back-to-back tenants complete the survey. The inflation rate is reported as zero percent for the period between January and July when surveys are completed, with no further data recorded.

In contrast, Unit B houses a long-term tenant who consistently completes surveys. Her annual lease renews every February 1, leading to her reporting no rent inflation from July to January, but a moderate increase (5%) from January to July due to modest rent hikes. This scenario, mirroring BLS's sampling method, underrepresents new tenants in Unit A while overrepresenting the continuous tenant in Unit B. Moreover, the sample often includes stagnant rent but neglects significant rent variations.

In their analysis of the shelter component, Verbrugge and Poole (2010) examine the distinctions and discrepancies between these two indices. For example, the BLS surveys six groups of households every six months on a rotating schedule. The BLS index is thus a monthly update using data from a different group. This methodology

allows the BLS to capture data regularly, a feature it shares with the Repeat Rent Index (RRI) introduced by Ambrose, Coulson and Yoshida (2015). However, the BLS and RRI differ notably in how they reflect market conditions. The RRI, for instance, incorporates rents from new lease agreements to immediately mirror current market dynamics. This timely reflection might lead the RRI to anticipate changes faster than the BLS index, which can be delayed depending on when leases are renewed.

Moreover, Verbrugge (2008) notes that the BLS approach tends to smooth out fluctuations in the rental index because it averages out rates from new and renewed leases and calculates growth rates semiannually from the same housing units. Thus, this method tends to understate the true volatility of rental prices.

This methodology introduces various biases in estimating rental costs. Firstly, the BLS index is likely to underreport rent growth during economic expansions and overstate it during downturns, as it mainly reflects rent renewals for existing tenants. Additionally, the underrepresentation of new leases becomes more pronounced during recessions with increased tenant turnover, leading to the BLS index showing minimal depreciation in recent economic contractions.

Secondly, as noted above, it smooths out data by averaging rents each month and calculates the half-year average growth rate.

Thirdly, the BLS rent index trails behind current rent measures, causing delays in reflecting market conditions. If leases are yearly, then only a twelfth of the BLS sample mirrors current market situations, with some data nearly a year old. Hence, the BLS index incorporates market data gradually, lagging current rent measures by roughly a year.

The Repeat Rent Index (RRI) and the Net Rent Index (NRI)
To address these issues, Ambrose et. al. (2015b) suggested a new rental index, the Repeat Rent Index (RRI), based on recurring unit-specific rental contracts. The RRI, a quality-adjusted rent index, gauges the marginal rent for new lease agreements with new tenants.

The RRI avoids survey omission issues, as it relies on rent payments to landlords. It displayed significant rent declines during the Great Recession, showing more fluctuation than the BLS index, and demonstrated Granger causality with it. Ambrose et al. (2015b)

verified that these discrepancies aren't due to sample differences. However, the RRI's utility for post-Great Recession analysis is limited as it concluded in 2010.

To extend the RRI's timeline, Ambrose et al. (2023) introduced a novel approach to calculate inflation in housing service prices, termed the Net Rent Index (NRI). The NRI is based on the Moody's/RCA Commercial Property Price Index (CPPI) for apartments, a quality-adjusted, repeat sale index. The NRI is derived by multiplying the CPPI's monthly figures with the average monthly multifamily capitalization rate. It represents a consistent monthly index of net rental income from both new and ongoing leases.

The CPPI, a monthly repeat sale index starting in December 2000, is grounded on comprehensive commercial real estate transactions tracked by Real Capital Analytics, and thus encompasses deals from domestic and international institutional and private investors, but excludes non-standard and non-"arm's length" transactions.

Covering 20 states and 34 metro areas, the CPPI requires a minimum transaction value of over $2.5 million (2010 constant value) and doesn't adjust for regular capital expenditures. The properties in the RCA sample resemble those in the RRI from Ambrose et al. (2015b), typically being larger complexes. Publicly available and regularly updated, the CPPI is essential for creating current measures of housing rental prices.

The NRI is created by combining the CPPI with average capitalization rates for apartments, and thus reflects a quality-adjusted average of net rents for all tenants and represents net operating incomes for apartment investors. Net Rental Income is calculated by deducting property-level operating expenses from gross rental income. The NRI's strength lies in its basis in "arm's length" market transactions, its reflection of cash flows from all leases, its consistency in rent type (net rent), and its monthly updates available at www.sites.psu.edu/inflation.

3.1 Estimated NOI is transformed to Match the Repeat Rent Index for the Training Period

The concept of housing inflation encompasses the economic idea of Owners' Equivalent Rent (OER), which signifies the hypothetical rent a homeowner forgoes by not leasing their property. This represents an opportunity cost, as the homeowner has the potential to earn rental income or opt for renting a dwelling themselves. When the housing

market is balanced, the opportunity cost of home ownership is on par with the marginal rent that a new tenant would pay.

Specifically, this opportunity cost accounts for the cost of capital, anticipated net depreciation of the property's value, and operational expenses, including property taxes and maintenance. Therefore, a measure of marginal gross rent is appropriate for this aspect.

While the Repeat Rent Index (RRI) is ideally suited for this calculation, its data ceased in 2010. Consequently, Ambrose et al. (2023) established the Marginal Rent Index, which aligns the average value and variability of the Net Rent Index (NRI) with the historical data of the RRI.

3.2 Vacancy Adjusted Effective Marginal Rent Measure, Instead of Observed New Lease Rents

A unique advantage of employing the Net Rent Index (NRI) as an indicator of marginal rent is that it incorporates the effect of changing vacancy rates. The NRI is designed to track the net income landlords receive from leased properties. Since vacancy rates vary throughout economic cycles, the NRI inherently captures shifts in both the net rent prices and vacancy rates. Landlords typically accept vacancy rates to change without immediately adjusting the rent for a new lease (a type of nominal rigidity). Landlords adjust new rents only when the vacancy rate significantly deviates from the normal level (aka. the natural rate of vacancy). The NRI removes this nominal rigidity by incorporating vacancy rates into the index. In other words, the NRI represents the counterfactual rental rate that will keep the vacancy rate constant over time.

Nevertheless, the influence of vacancy rates on the NRI is relatively minimal for a couple of reasons. Firstly, no immediate or delayed correlation exists between NRI figures and vacancy rates, indicating that the primary influence of vacancy rates on the NRI is on the fluctuation of its growth rates rather than its levels.

Secondly, the span of occupancy rates (the inverse of vacancy rates) during the observed period was relatively narrow, oscillating between 88.9% and 93.2%. To verify the limited impact of vacancy rates, we devised the Vacancy-Adjusted Net Rent Index, which is the NRI adjusted for occupancy levels.

This adjusted index exhibits slightly reduced volatility compared to the original NRI. Moreover, the high degree of congruence between the quarter-to-quarter shifts in the NRI and the Vacancy-Adjusted NRI indicates that the two metrics are virtually interchangeable over time. Consequently, the effect of vacancy rates on the Net Rent Index is negligible.

## 3.3 Historically 7 Month Lead > 12 Month Lead in the Recent Cycle

To validate the NRI and MRI as a measure of the rental market, Ambrose, Coulson, and Yoshida (2023) discuss the pairwise correlation between percentage changes from a year ago in alternative rent indexes during 33 quarters between 2002:Q1 – 2010:Q1. They note that the NRI reflects the average net rent for both new and existing tenants.

In contrast, the original RRI presented in Ambrose, Coulson, and Yoshida (2015) and the PCE rent reflect gross rents for new tenants and existing tenants, respectively. They note that the NRI is highly correlated with both the RRI (correlation is 0.858) and the 5-quarter lead PCE rent (the correlation is 0.884). The correlation between the RRI and the 5-quarter lead PCE Rent is even larger (0.950). However, the contemporaneous PCE Rent is not highly correlated with other indexes.

By examining these correlation measures, it is clear that the BLS rent index lags the contemporaneous market rent by approximately one year because of its sampling and index construction method. To confirm the consistency between the various rent measures, Figure 1 depicts the quarterly NRI, the 5-quarter lead PCE Rent, and the original RRI. The results clearly indicate that the NRI, the RRI, and the lead PCE rent reflect the common dynamics of rental housing markets. The key difference between these three indexes is volatility. The PCE rent series is significantly less volatile than the NRI or RRI.

Using the NRI, Ambrose, Coulson, and Yoshida (2023) construct the Marginal Rent Index (MRI) by matching the mean and standard deviation of the quarterly RRI growth rates. In doing so, they create the MRI to have the same properties as the original RRI.

Chart 1.0: Comparison of Net Rent Index (NRI), Repeat Rent Index (RRI) and PCE Rent

Comparison of Net Rent Index (NRI), Repeat Rent Index (RRI) and PCE Rent — Percentage change from a year ago

Comparison of Net Rent Index (NRI), Repeat Rent Index (RRI) and PCE Rent — Index Level
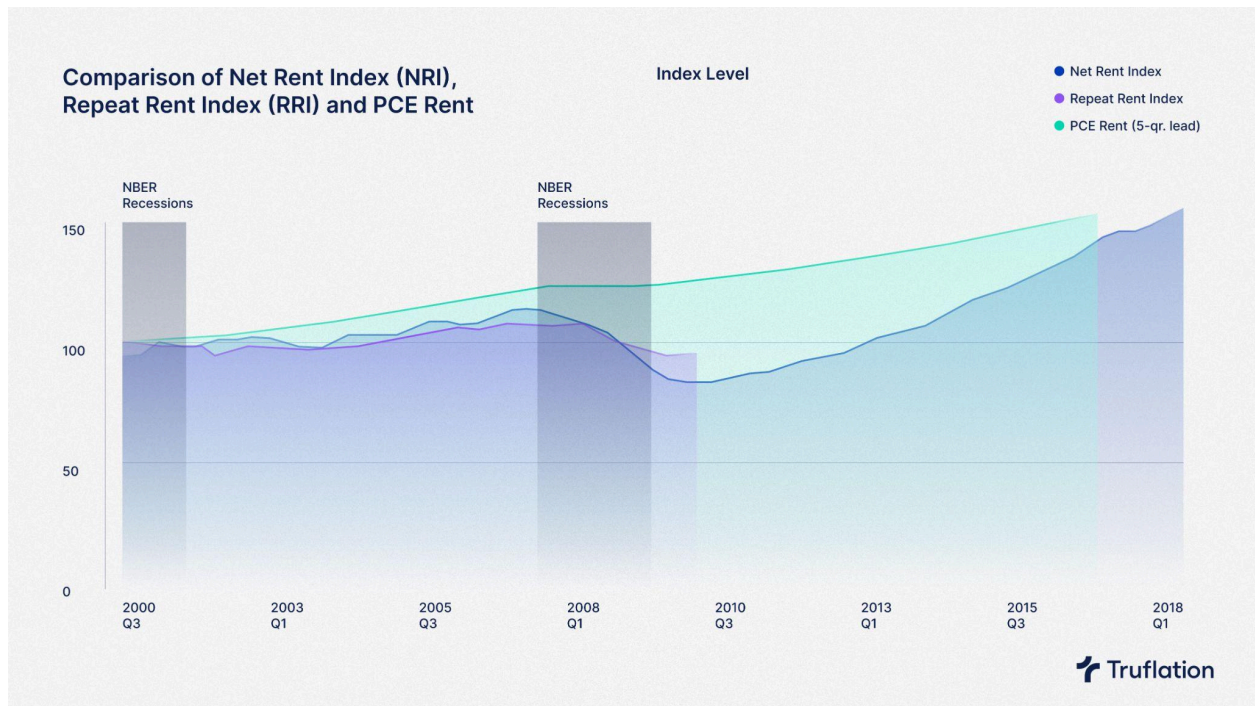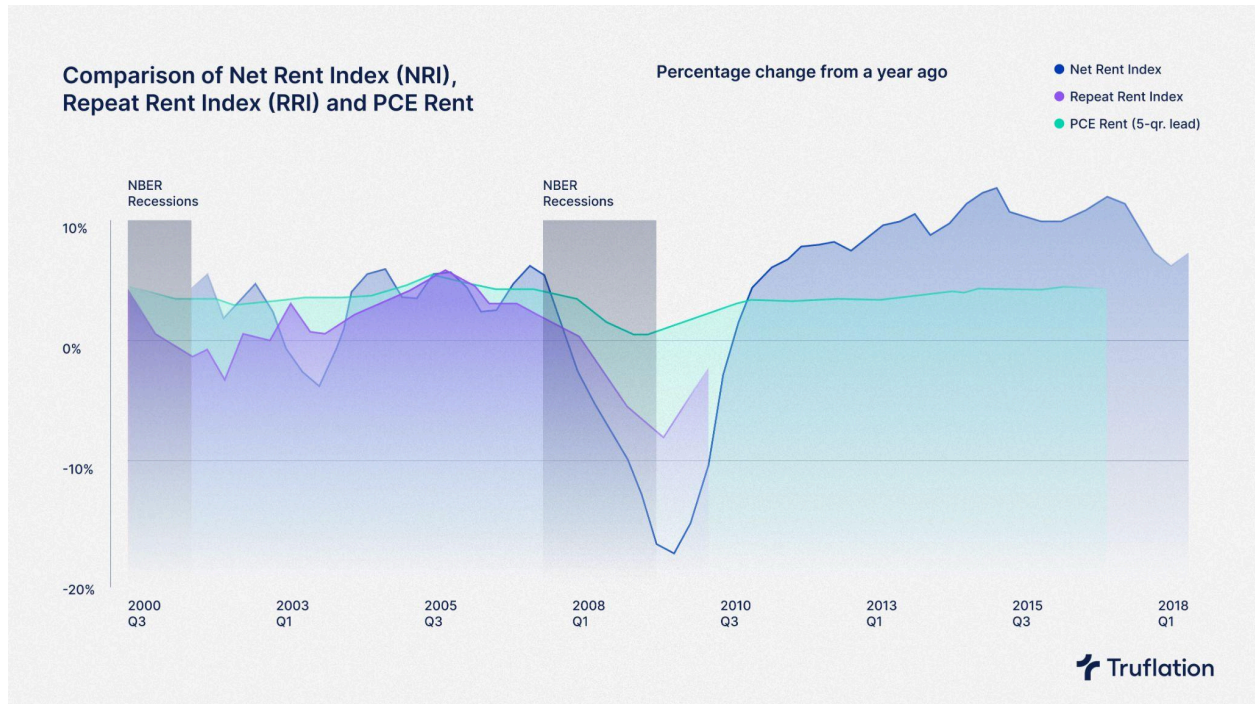
Source: Pennsylvania State University

4. How Truflation makes Housing Measurement more Comprehensive

Truflation believes that to measure the changes in the pricing of housing it is important to measure not only the cost of the consumption value of a home but also to include the consumption of services like mortgages, property services through property tax, building materials and the labor costs of household maintenance or improvements.   This does include capital expenditure on services provided for the homeowner. When it comes to the rental, Truflation also ensures that both new rental prices and rental renewals prices are included. The objective of Truflation is to ensure that we measure the price changes from a consumer cost of living perspective.

To determine the measurement, the first stage is to define the housing category which is broken down into three parts:

- Owned property which includes mortgage interest and charges, property taxes, maintenance, repairs, insurance and other expenses
- Rented property – the rental charge for the unit, including any extra charges such as garage / parking facilities, storage units, insurance
- Other lodgings, which includes hotels, motels, etc.

The data used by Truflation to determine weights for its index, which includes housing, is derived from multiple sources. This includes a household establishment survey to understand the household's budget allocations towards housing and other categories. This is combined with a validation process using nationally reported expenditure data, as well as Truflation's own Personal Inflation Calculator that captures more than 50,000 responses every month.

The weighting contributions of each category are updated every year based on the previous year's spending behavior. The current weightings for Housing, as Truflation defines it, stands at 23.2%. The first area is to validate the relative importance within the Housing category itself.

Table 2.0: Relative Importance of the Truflation Housing Category to the Average US Household
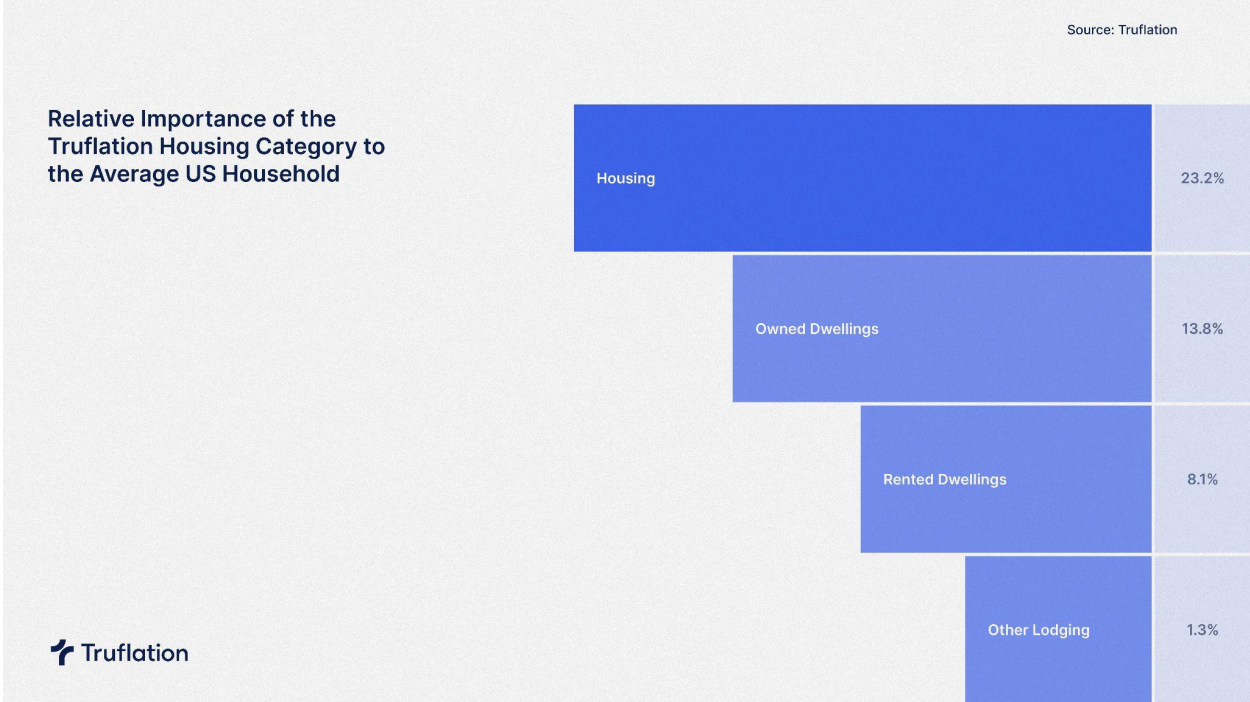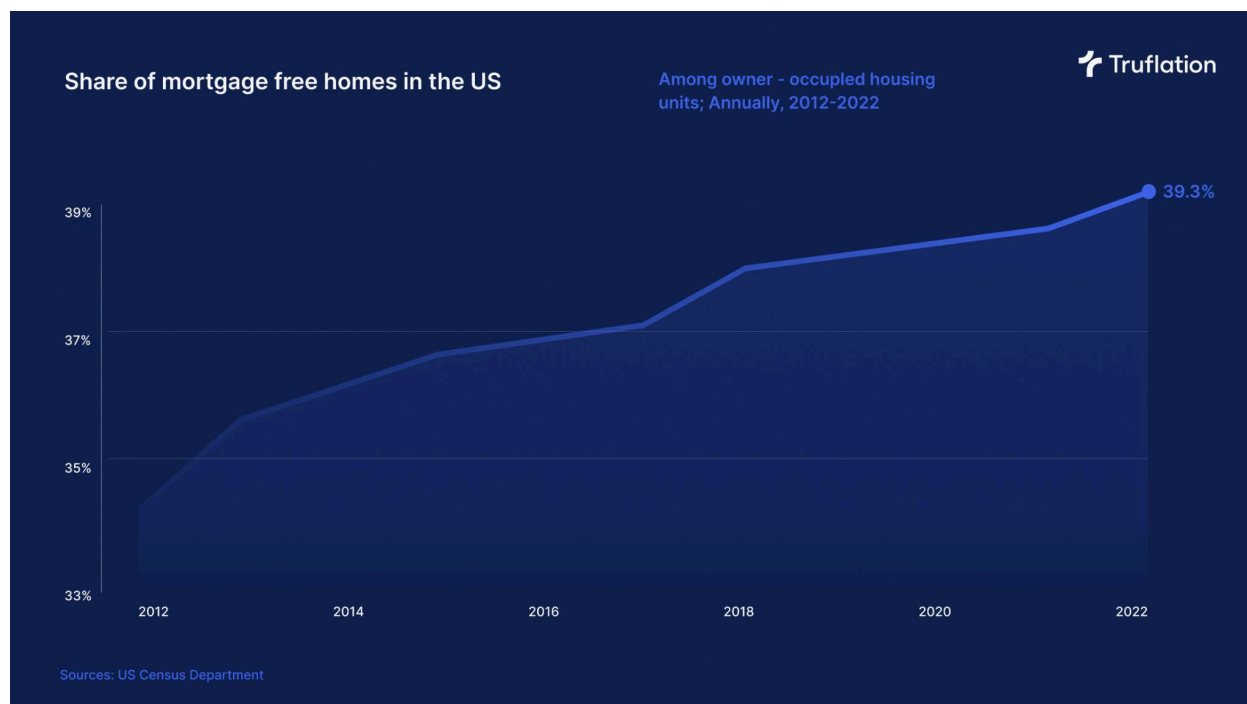

Source: Truflation

To validate the relative importance, firstly it is important to look at US homeownership which according to the US Census department is at 65.7% and amongst the owner occupied housing 39.3% of US homes are mortgage free. There is a larger share of homes in America that are without mortgages now compared to anytime since 2005, according to the latest census data.

Applying the 65.7% home ownership rate to the current total number of US households of 131.8M at the end of 2023, it does represent 86.25M households in the US that are owned. In chart 2.0, you can see the share of mortgage free US homes has jumped from 34.3% to 39.3% in the past decade, which translates into 33.9M homeowners are mortgage free. Many free and clear homeowners are baby boomers who have refinanced their mortgages when rates were lower, according to Bloomberg and no surprise that these individuals are not worrying about the high mortgage rates that are present today.

Chart 2.0: Share of mortgage free housing units in the US

Share of mortgage free homes in the US

Among owner - occupled housing units; Annually, 2012-2022

Truflation

39.3%

Sources: US Census Department

Source: US Census Department

This means that the remaining homeowners own a mortgage and with mortgage interest rates rising substantially over the past three years, homebuyers are finding it more difficult to buy a home as outlined by Urban Institute. Those that would have purchased a home with a mortgage, their payments have risen significantly relative to what they would have paid in a lower interest rate environment.

Urban Institute used the Mortgage Disclosure Act data, to calculate the cost burden for each loan starting with the monthly mortgage payment (using loan amount, interest rate and loan characteristics at closing) and then adding 2.6% of homes value for real estate taxes, homeowners insurance and utilities (this is the median estimate of homeowners from the 2021 American Housing Survey. With this data they determined that the typical homebuyer spends more than 30% of their monthly income on housing. In 2022, 44.7% of new purchase borrowers spent between 30% and 50% of their incomes on housing costs.   A further 5.8% of borrowers overall spend more than 50% of their income on housing costs.

Chart 3.0: The Share of Cost-Burdened Borrowers Increased in 2022, All Borrowers
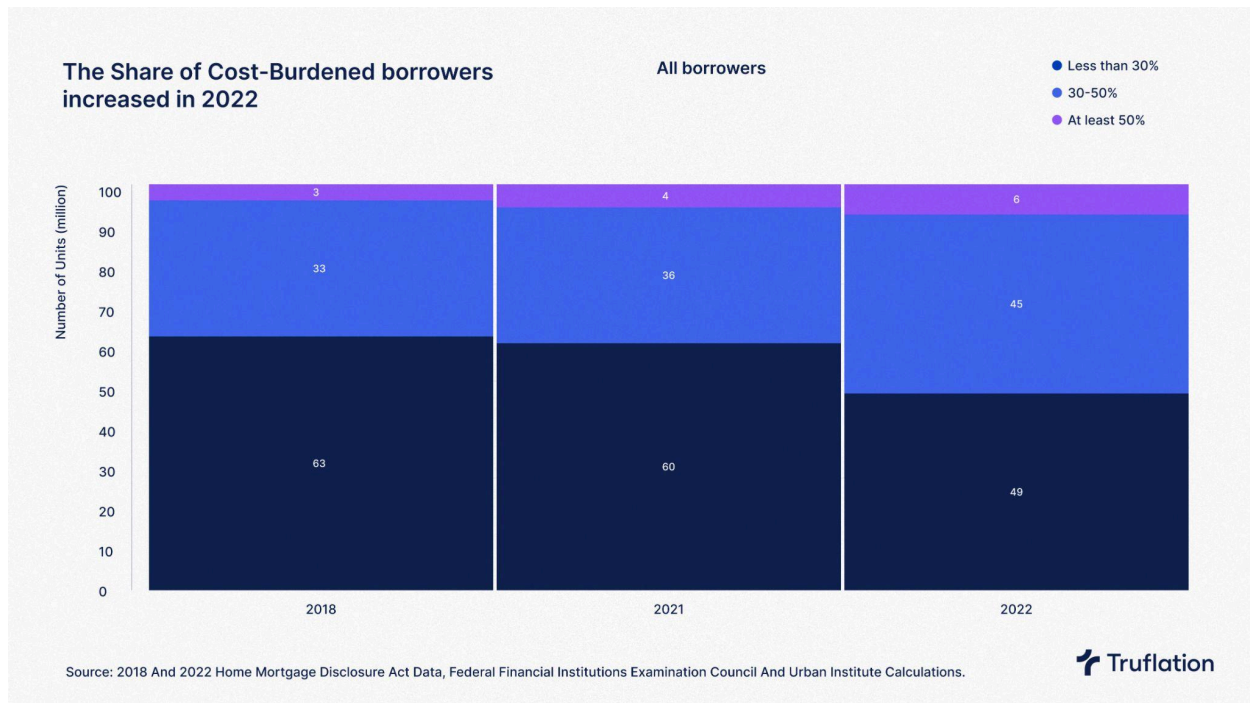
Source: 2018 and 2022 Home Mortgage Disclosure Act data, Federal Financial Institutions Examination Council and Urban Institute calculations.

The dual income households would reduce this burden of over 30% downwards especially given that there are 41M dual income households in the US. To what extent is hard to determine given the data from AHS or the Mortgage Disclosure Act Data doesn't differentiate between single and dual mortgages. Thus making an assumption that dual income households reduce the impact of the burden from a range of 20% to 25%, it would then suggest that the relative importance ranges from 12.1% to 15.2% which is very much in line with the Truflation estimate of 13.8%.

Looking at the national view of the impact of owned property prices in the US you can see the similarities and levels of what Truflation reports as the owned dwelling inflation trends are with some of the market data.

Chart 4.0: Owned Dwellings Inflation
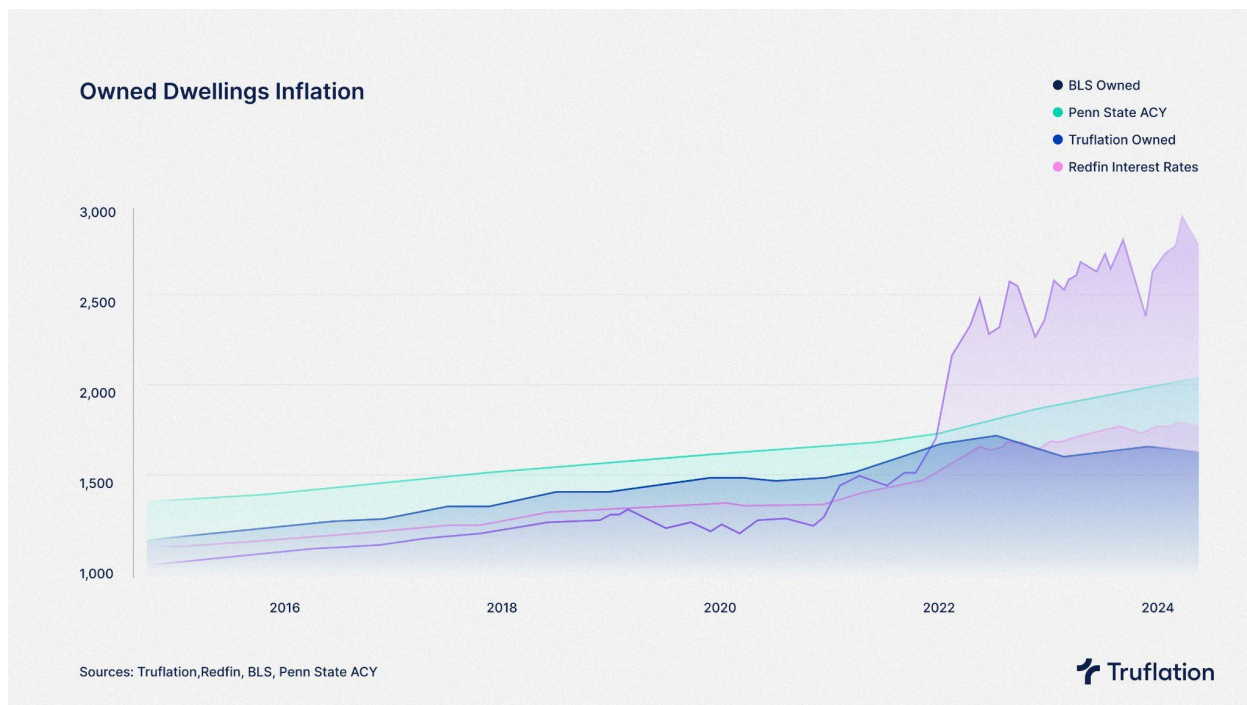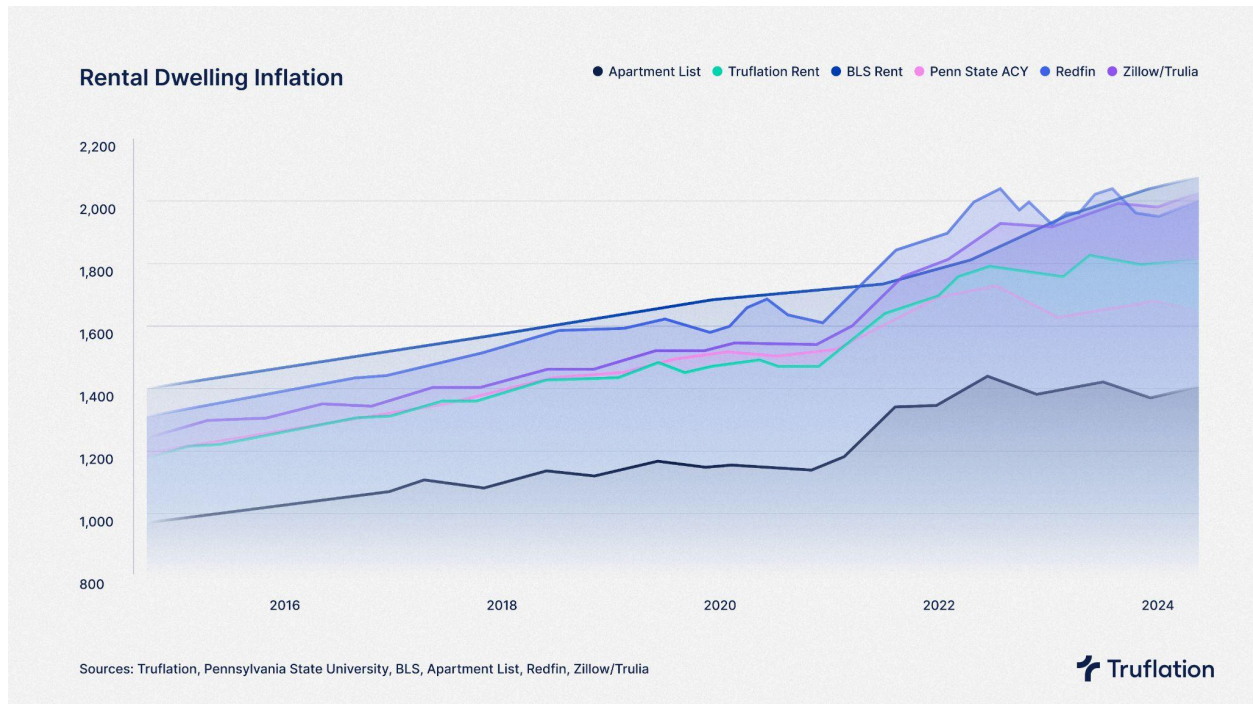

Source: Truflation, Redfin, Bureau of Labor and Statistics, and PennsylvaniaState University

Now turning to the rental market, which accounts for 34.3% of all households in the US, which translates to 52.4M homes that are rented. A popular standard for budgeting rent is to follow the 30% rule, where you spend a maximum of 30% of your monthly income on your rent. When the government found that people who spent over 30% of their income on housing, they were considered to be cost burdened. So are the increases in rental prices driven up the cost burden?

According to the Harvard Joint Center for Housing Studies, who have examined the 2022 Census data, there are 22.4M renters that are now paying more than 30% of their income on rent and utilities. This record high number of cost burdened renters in 2022 came from a record high rent growth at the end of 2021 and early 2022 which was driven by a surge in rental demand where the number of new inventory coming onto the market was insufficient. As a result there is no surprise that this drove vacancy rates down and pushed up rents and made it hard to find affordable housing. Since 2022, looking at the data we are seeing some slower rate of growth in the rent with some markets experiencing an actual decline but overall rents are in fact still growing.

Chart 5.0: Rental Dwelling Inflation

Rental Dwelling Inflation

Legend: Apartment List ● Truflation Rent ● BLS Rent ● Penn State ACY ● Redfin ● Zillow/Trulia

Sources: Truflation, Pennsylvania State University, BLS, Apartment List, Redfin, Zillow/Trulia

Truflation

Source: Truflation, Pennsylvania State University, Bureau of Labor and Statistics, Apartment List, Redfin, Zillow and Trulia

Given the Harvard Joint Center for Housing Studies figures include rent and utilities, we need to take the impact of utilities out of the equation as this is reported separately for Truflation. The percentage contribution of utilities varies significantly by household size, geographical location, etc with an average rule of thumb of utilities representing 15% to 20%. If we use the average / popular standard of the rental burden of 30%, deduct the 15% to 20% from this amount to remove the impact of utilities which Truflation measures independently, you derive a number that ranges from 8.2% to 8.7%. Truflation data brings us into the lower end of this range at 8.2%.

Data Sources & Calculations

In order to calculate the price shifts of the owned dwellings, Truflation believes there is a need to apply a mixed approach that combines census level data and a mathematical calculation, in particular for the mortgage rate impact. This is of particular importance given that the US has added 1.1 million new owners of occupied housing in 2023.

In order to measure housing, Truflation believes it is important to include the cost of the consumption value of a home and the cost of the consumption of services like

mortgages, property services through property taxes, building materials, and the labor costs of household maintenance or upgrades.

In order to measure this effectively, Truflation collects data from multiple sources including the New York Federal Reserve, Zillow, Trulia, Redfin, CoreLogic, Pennsylvania State University, Freddie Mac, National Association of Realtors, the US Census Bureau and Numbeo. The data for owned dwellings covers property value changes, mortgage property tax and property maintenance.

The price data on property repairs, maintenance, insurance costs, and property taxes are directly taken from multiple data sources that are combined to create an index. However, for mortgage interest and charges, Truflation creates an additional calculation to represent the impact of mortgage costs.

The calculation that determines mortgage interest and charges is based on:
- Average weighted monthly property value between new and existing homes.
- Average weighted down payment percentage between first time buyers (accounting for 32% of all buyers, who make an average down payment of 8%) and repeat buyers (accounting for 68% of all buyers, who make an average down payment of 19%) according to the National Association of Realtors.
- Given that 90% of the homeowners choose a 30-year fixed mortgage according to Freddie Mac, Truflation assumed this for all mortgages.
- Truflation takes the average monthly 30-Year fixed mortgage rate.
- The newly issued mortgages are added and weighted to all the existing mortgages and then are used to create the monthly price changes.

Using this approach allows us not only to include the impact of property prices but also the impact of the latest interest rates on mortgages.

Looking at the rental market, Truflation collects data from multiple sources that covers both new rental agreements as well as renewals of existing agreements. These data sources combined provide Truflation with more than 4 million transactions that are derived from Pennsylvania State University ACY, Zillow, Trulia, Redfin, Apartment List, Numbeo, Core Logic to name a few.

When Truflation calculates rental prices it is important to look at the split between rental renewals and new lease agreements. As new apartments surged in the market in 2023, and based on [RentCafé](#) 60.2% of the renters decided to stay put as opposed to 62.7% in 2022. Based on this Truflation applies a weighting to the rental data:
- Renewals accounts for 60% of all rental agreements
- New rental agreements accounts for 40% of all rental agreements

This methodology of incorporating both new rental agreements and rental renewals and weighting their data accordingly provides Truflation with a more balanced view of price changes over time.

5. Application Examples of Alternative Investment Metrics

In this section we provide a few example applications that demonstrate the economic significance of the differences between the original and modified inflation measures.

Our first application considers the impact of the modification to CPI on the Social Security Administration's annual cost-of-living adjustments (COLAs). Social Security benefits are indexed to inflation to protect beneficiaries from the loss in purchasing power associated with rising prices. Thus, mis-measuring inflation can have a profound effect on the segment of the population most at risk of losing purchasing power (the elderly or those living on fixed incomes).

Our second application considers how the change in the PCE Price Index can impact calculations of the real Gross Domestic Product (GDP). Since economic growth and fluctuations are analyzed via real GDP, inaccurate estimates of real GDP can distort fundamental macroeconomic analysis.

5.1 Cost-Of-Living Adjustments

A variety of contracts and programs are linked to changes in the CPI. As a result, differences in measured inflation between the BLS CPI and modified CPI measures can have profound effects on these contracts and programs. For example, the CPI-W is used as the index for yearly COLAs for determining Social Security (OASDI) and Supplemental Security Income (SSI) benefits. COLA calculations are set in December each year based on the percentage change in the average CPI-W in the third quarter

over the previous year's third quarter average as defined by the [Social Security Administration](#).

To illustrate the effect that differences in the housing inflation measures can have on Social Security benefits, we consider the differential impact of switching the actual CPI with our modified CPI in calculating the annual COLAs. Chart 6 shows the actual annual COLAs reported by the Social Security Administration over the period from 2002 to 2015. Since the CPI-W reported declines from the previous years in 2008 and 2009 as well as in 2014, the actual COLAs report no adjustment for years 2009, 2010, and 2015. Chart 6 also reports the estimated COLA based on the modified CPI as well as the yearly differential (actual less modified). Since our modified CPI reports higher increases than the CPI-W, the modified COLA would have resulted in no adjustment in 2010. The differential is illustrated by the bars in Chart 6.1.

Over the period from 2003 to 2016, the COLAs based on the modified CPI would have been 0.3% per year higher than the actual COLAs. However, following the financial crisis, COLA adjustments using the modified CPI would have been 0.8% per year higher.

Table 3 reports the differences in accumulated benefits that would have accrued to beneficiaries under the actual and modified COLA calculations. For an individual in 2016 who had been a beneficiary for five years (starting in 2011), the modified COLA would have resulted in benefits that are 6.3% higher than the actual COLA while the benefits to an individual who had been a beneficiary for 10 years (starting in 2006) are 3.6% higher under the modified COLA calculation. Finally, benefits would have been 4.2% higher for an individual who had been a beneficiary starting in 2002 under the modified COLA calculation versus the actual COLAs.

To put these differences in perspective, for a 70-year old individual that retired in 2016, the modified COLA would result in a monthly benefit that is $178 greater than the actual benefit paid to that individual. In terms of hypothetical costs to the Social Security system, Table 4.1 shows that using the modified COLA to adjust benefits from 2003 to 2015 would have increased total benefit payments by approximately $35.3 billion (in constant 2016 dollars).

Chart 6: Annual Social Security Cost-of-Living Increases (COLAs): Actual versus Modified
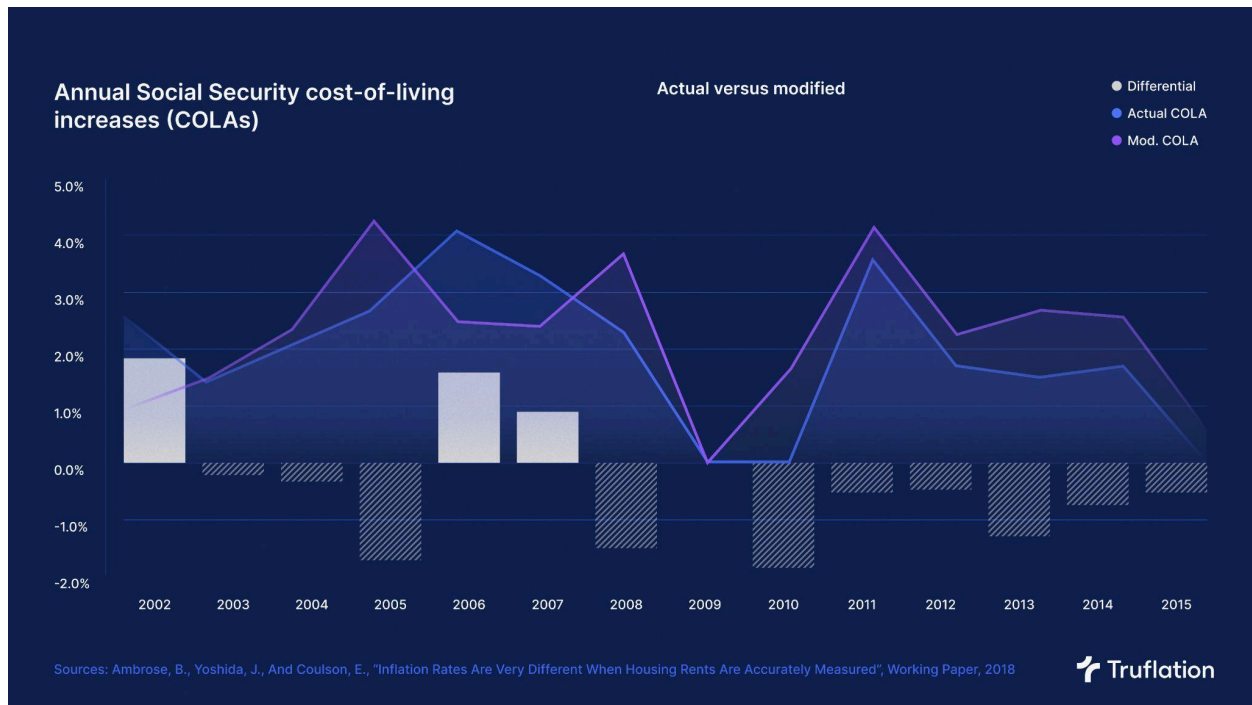
Source: Ambrose, B., Yoshida, J., and Coulson, E., "Inflation Rates Are Very Different When Housing Rents Are Accurately Measured", Working paper, 2018.

Table 3: Accumulative Benefit Increases from COLAs as of 2016 (in percent)

Accumulative benefit increases from COLAs as of 2016

Starting Year And Number Of Years In Beneficiary Status	Accumulated Modified	Cola Actual
2011 (5-Years)	36.8%	30.5%
2006 (10-Years)	20.0%	16.4%
2002 (14-Years)	12.9%	8.8%

Source: Ambrose, B., Yoshida, J., and Coulson, E., "Inflation Rates Are Very Different When Housing Rents Are Accurately Measured", Working paper, 2018.

Table 4.1: Year-over-Year Change to Average Monthly Benefits from COLA Adjustments

Year-over-year change to average monthly benefits from COLA adjustments

Year	Beneficiaries (millions)	Benefit Pay-ments (billion)	Modified COLA (billion) (A)	Actual COLA (billion)	Difference (A)-(B)	Cumulative Difference (billion in 2016)	Inflation Factor
2003	46.4	$453.8	$458.1	$465.6	-$7.5	-$7.7	2.27
2004	47	$470.8	$477.9	$477.4	$0.5	-$7.4	2.68
2005	47.7	$493.3	$504.9	$503.7	$1.3	-$6.3	3.39
2006	48.4	$520.7	$543.1	$534.8	$8.4	$2.1	3.23
2007	49.1	$546.2	$559.9	$568.6	-$8.7	-$6.8	2.85
2008	49.9	$585.0	$599.1	$604.3	-$5.2	-$12.4	3.84
2009	50.9	$615.4	$638.4	$629.6	$8.8	-$3.6	-0.36
2010	52.5	$675.5	$675.5	$675.5	$0.0	-$3.6	1.64
2011	54	$701.6	$713.3	$701.6	$11.7	$8.3	3.16
2012	55.4	$725.1	$755.5	$751.2	$4.3	$12.8	2.07
2013	56.8	$774.8	$792.4	$788.0	$4.4	$17.5	1.46
2014	58	$812.3	$834.3	$824.5	$9.8	$27.7	1.62
2015	59	$848.5	$870.5	$862.9	$7.5	$35.3	0.12

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Source: Ambrose, B., Yoshida, J., and Coulson, E., "Inflation Rates Are Very Different When Housing Rents Are Accurately Measured", Working paper, 2018.

5.2 Real Personal Consumption Expenditures and Gross Domestic Products

The modification of the PCE Price Index has a direct impact on the calculation of real PCE. The BEA calculates real PCE by deflating the nominal PCE by the PCE Price Index. In estimating the nominal PCE, BEA mainly uses the decennial Census of Housing, biennial American Housing Survey, Current Population Survey, and Residential Finance Survey.

However, the denominator is based on the CPI Housing Survey. Thus, an upward change to the price index has a negative effect on the real value of PCE. Furthermore, the modification to real PCE also affects real GDP because GDP is measured by adding final expenditures (i.e., using the final expenditure approach) in the US. This effect is large because PCE accounted for more than 68% of the US GDP in 2015.

To illustrate the impact of our price modification, we deflate the nominal PCE by our modified PCE price index and obtain the modified real PCE and GDP. Chart 7 compares

the original and modified real PCE. Growth rates from a year ago are almost identical until the Great Recession, but the decrease in real consumption during the recession is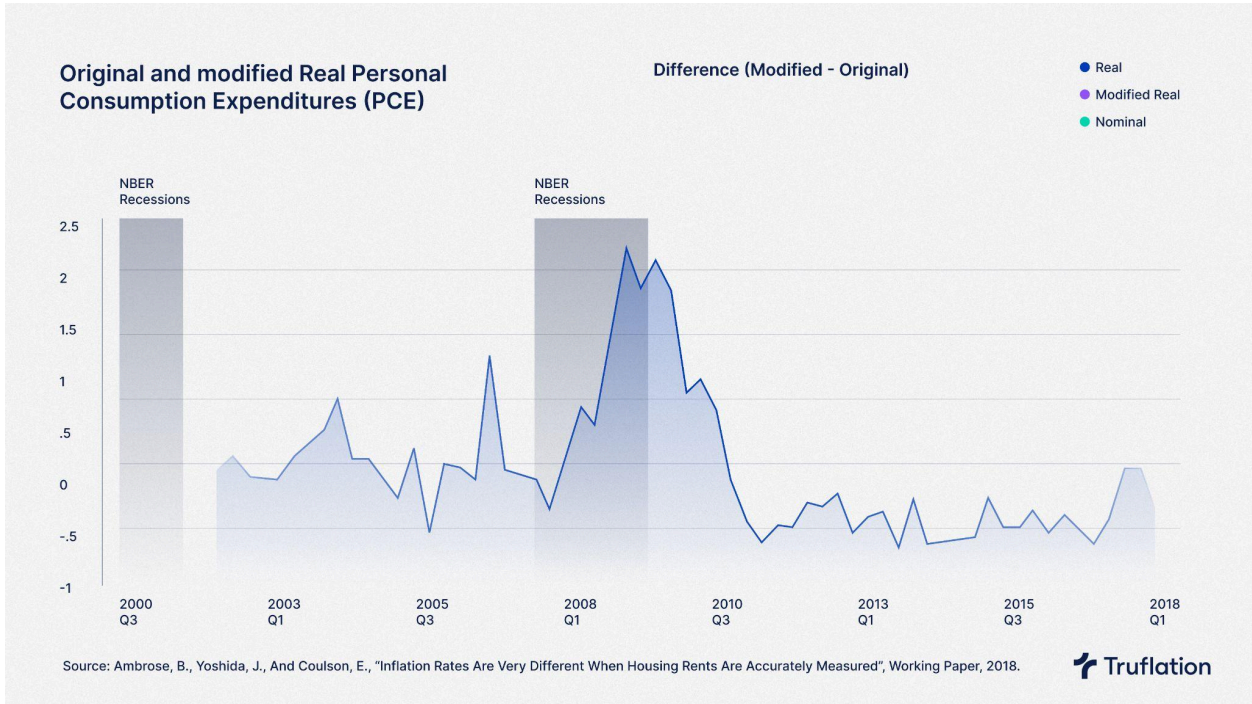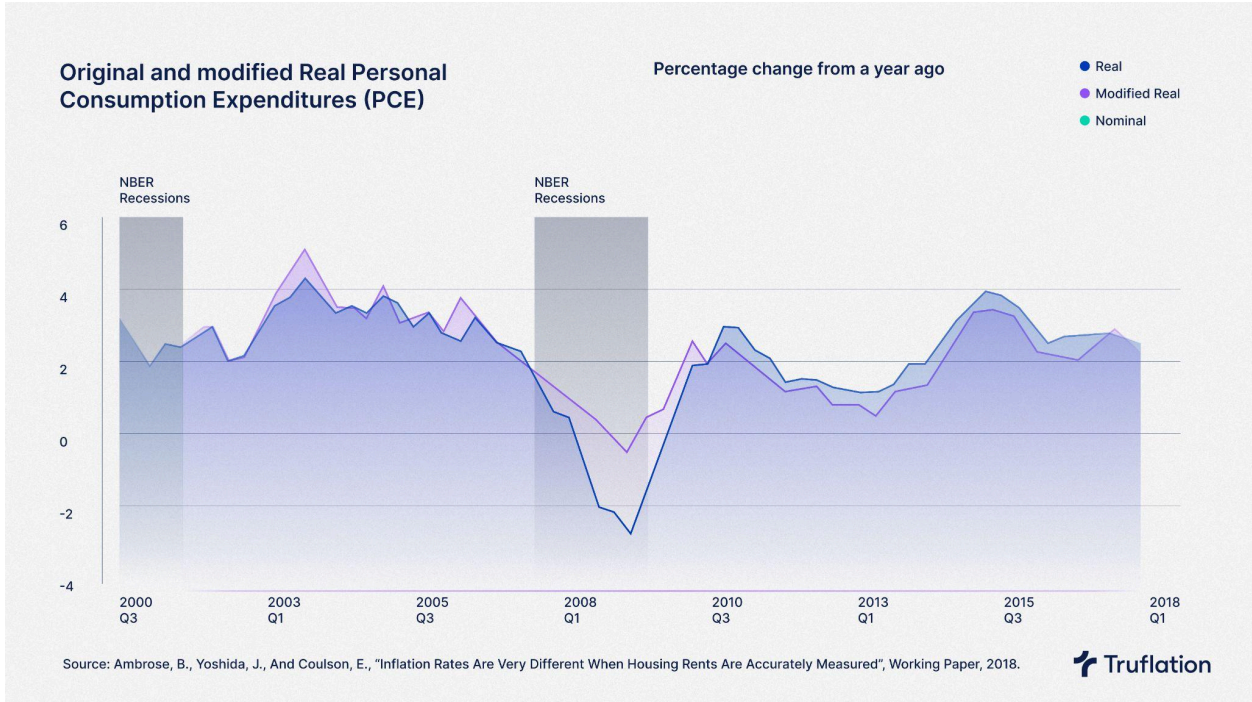 much more moderate based on the modified value. The largest quarterly decrease was 1.89% per annum in 2009:I for the modified value whereas it was 4.81% per annum for the original value in 2008:IV. In contrast, the modified real consumption growth is smaller in the current recovery period. The average growth rate after 2009:II is 2.06% per annum for the modified value whereas it is 2.37% per annum for the original value.

Chart 7.1 shows a qualitatively similar effect of the price modification on real GDP. The modified real GDP decreased by 5.12% per annum whereas the original real GDP decreased by 8.45% per annum in 2008:IV. Thus, any decrease in real GDP was more moderate during the Great Recession. In contrast, the average growth rate after 2009:II is 1.96% per annum for the modified value whereas it is 2.17% per annum for the original value.

Chart 7: Original and Modified Real Personal Consumption Expenditures (PCE)

Source: Ambrose, B., Yoshida, J., And Coulson, E., "Inflation Rates Are Very Different When Housing Rents Are Accurately Measured", Working Paper, 2018.

Original and modified Real Personal Consumption Expenditures (PCE) — Percentage change from a year ago

Legend: Real, Modified Real, Nominal

Source: Ambrose, B., Yoshida, J., And Coulson, E., "Inflation Rates Are Very Different When Housing Rents Are Accurately Measured", Working Paper, 2018.

Original and modified Real Personal Consumption Expenditures (PCE) — Difference (Modified – Original)

Legend: Real, Modified Real, Nominal

Source: Ambrose, B., Yoshida, J., And Coulson, E., "Inflation Rates Are Very Different When Housing Rents Are Accurately Measured", Working Paper, 2018.

Source: Ambrose, B., Yoshida, J., and Coulson, E., "Inflation Rates Are Very Different When Housing Rents Are Accurately Measured", Working paper, 2018.

Chart 7.1: Original and Modified Real Gross Domestic Product

Original and modified Real Gross Domestic Product

Percentage change from a year ago

- Real
- Modified Real
- Nominal

NBER Recessions

NBER Recessions

Source: Ambrose, B., Yoshida, J., And Coulson, E., "Inflation Rates Are Very Different When Housing Rents Are Accurately Measured", Working Paper, 2018.

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Original and modified Real Gross Domestic Product

Difference (Modified - Original)

- Real
- Modified Real
- Nominal

NBER Recessions

NBER Recessions

Source: Ambrose, B., Yoshida, J., And Coulson, E., "Inflation Rates Are Very Different When Housing Rents Are Accurately Measured", Working Paper, 2018.

Truflation

Source: Ambrose, B., Yoshida, J., and Coulson, E., "Inflation Rates Are Very Different When Housing Rents Are Accurately Measured", Working paper, 2018.

5.3 Other Applications

At the federal level, the government uses the CPI to adjust tax brackets. This ensures that entitlements keep pace with inflation and that taxpayers are not pushed into higher tax brackets due to inflation alone.

Businesses utilize the CPI for price-setting, wage negotiations, and lease agreements that have inflation-adjustment clauses. The CPI is also a fundamental metric for economic researchers and financial analysts, providing key insights into trends in consumer inflation and informing economic forecasting.

6. Conclusion

This research paper has rigorously examined the methodologies and shortcomings of the Personal Consumption Expenditure Price Index (PCE) and the Consumer Price Index (CPI) in calculating inflation in the shelter category, ultimately proposing an alternative metric that more accurately captures the true rate of inflation in this critical area.

Our collaborative efforts, drawing from the Pennsylvania State University ACY Inflation Index by Ambrose and Yoshida and the Truflation Index by Rust and Jelic, offer fresh perspectives on the measurement of shelter inflation in the United States. Given that shelter constitutes significant portions of both the CPI-U index (42.4%) and the PCE price index (32.9%), as well as 23.2% of Truflation's real-time US CPI index, ensuring precise and reflective metrics is paramount.

This paper highlighted the consistent increases in the shelter category reported by both the PCE and CPI indexes over recent years, contrasting with the more variable trends identified by Truflation's housing index and the Penn State ACY Marginal Rent Index (MRI). Notably, Truflation's housing index indicated a significant slowdown in growth over the past year, while the ACY MRI even reported negative year-over-year growth for much of 2023, underscoring discrepancies not captured by the CPI-U shelter index.

Through an in-depth analysis of the components and methodologies of the PCE, CPI, ACY-MRI, and Truflation indexes, we have illuminated the reasons behind these discrepancies and their implications for the overall inflation figure. The findings underscore the necessity for an improved housing metric that more accurately reflects the state of the US housing market.

In conclusion, our comprehensive examination sets the stage for ongoing discussions and developments in inflation measurement, advocating for methodologies that better represent real-world conditions. The alternative metrics proposed in this paper offer a pathway toward more reliable and relevant inflation measurement, particularly in the crucial shelter category, thereby enhancing economic policy decisions and public understanding of inflation dynamics.

Thank You

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