The Taylor Rule with an Alternative Housing Rent Index

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Abstract

The rent of shelter accounts for approximately a third of the Consumer Price Index (CPI). Using a new housing rent index (RRI) developed by Ambrose, Coulson, and Yoshida (2014), we modify the CPI and compute the Taylor rule for the period from 2000 to 2010. With this timely rent index, Taylor rule becomes more consistent with the Federal funds rate than the conventional calculations. However, the RRI-based Taylor rule still indicates that the Federal funds rate was too low during the housing boom between 2003 and 2006. In contrast, the Federal funds rate was too high during recessionary periods between 2001 and 2002 after the IT boom and between 2006 and 2009 after the housing boom.

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I. Introduction

What caused the Great Recession of 2007-2008? Answering this question is critically important to policy makers and market participants seeking to avoid similar crisis in the future. Unfortunately, nearly eight years after the start of the crisis we are still debating its underlying causes. For example, the conclusions reached in the majority and dissenting opinions of the Financial Crisis Inquiry Commission put forward numerous hypotheses and conjectures on the causes of the crisis such as poor mortgage underwriting and mortgage securitization, excessive capital availability and liquidity that resulted in a credit bubble, excessive leverage on the part of households and financial institutions, and government housing policies. A common theme underlying many of these possible causes is an assumption that low interest rates from approximately 2000 to 2005 were a significant causal factor in the housing boom of that period and that this in turn led to the bubble and crash in the housing market in 2007. These insights are based on comparisons of actual Federal Funds rates to interest rates implied by a prescriptive rule for monetary policy. One widely popular rule is the so-called Taylor rule that was first described in Taylor (1993). In fact, Taylor (2007) remarks that if this prescriptive rule had been followed, housing starts would have been far lower from 2003 to 2006, and in fact would have considerably smoothed out the housing boom and bust. Furthermore, Abel, Bernanke, and Croushore (2014) echo Taylor’s observation by noting that “In the 2000s, the Federal funds rate has mainly been lower than the level suggested by the Taylor rule” (p.571).

The Taylor Rule is an equation that links the Federal Funds rate to measures of inflation and output. Taylor (1993) originally developed the rule as a description of the Federal Reserve’s Federal Open Market Committee (FOMC) behavior during its largely successful attempts at stabilization during the Great Moderation of the 1980s and 1990s (Clarida, Gali, and Gertler (2000)). Because those years were regarded as successful implementation of monetary policy, the rule became as much prescriptive as descriptive and formed the basis for judging the appropriateness of monetary policy in the first decade of the new century. As such, many view the FOMC as setting interest rates too low in the wake of the crash of the tech bubble. However, the interest rate recommendation of the Taylor rule depends of course on the measurements of its inputs, which include some measure of output gap, or unemployment, and the rate of inflation. The greater the gap, or the lower the
rate of inflation, the lower is the Taylor rule recommendation for the Federal funds rate. Thus, if inflation or unemployment are incorrectly measured, then prescriptive views of interest rates based on the Taylor rule may not align with actual monetary policy pursued by the FOMC.

We argue that estimates of the consumer price index (CPI) rate of inflation, as calculated by the US Bureau of Labor Statistics (BLS) were too high throughout the decade 2000-2010, which led critics of the FOMC monetary policy to conclude that interest rates were too low. We make this argument because the BLS estimates of rental costs, which have a very large weight in the calculation of the CPI, exhibited rates of increase that are largely overstated during this time period. The reason for this upward bias is that they are based on repeated surveys of existing tenants. As explained in Ambrose, Coulson, and Yoshida (2014) the BLS rental index is not a contemporaneous view of the state of the housing market. Rather, it exhibits a certain amount of downward-stickiness. In contrast, Ambrose, Coulson, and Yoshida (2014) calculate a rental index based on repeated unit-specific observations of new rental contracts (the Repeat Rent Index, or RRI) that avoids this downward-stickiness bias. The RRI index displays a rate of increase that is substantially lower than that of the BLS both in the bubble period of 2000 to 2005 (as well as in the period from 2006 to 2010.) Ambrose, Coulson, and Yoshida (2014) interpreted this as measuring weakness in housing market demand that is unobserved when sitting tenants are surveyed.

We find that when the RRI replaces the BLS index in the calculation of core CPI, the interest rate policy that the FOMC pursued during the controversial 2000 to 2005 period was actually much closer to the Taylor rule as originally formulated. In fact, we show that interest rates were not too low but right on target during the crucial 2000 to 2005 period. Moreover, the increase in interest rates observed in 2005 is more precisely timed by our adjusted Taylor rule. Indeed, throughout the first decade of the 2000s, FOMC policy more closely adheres to the RRI adjusted rule than by a Taylor rule based on the BLS CPI. Given that our measure of rental inflation more closely follows contemporaneous movements in the housing market than the BLS index, we interpret the Taylor rule finding as suggesting the FOMC was aware of weakness in housing market fundamentals throughout the decade.

In the next section, we provide a brief overview of the Taylor rule and discuss the differences between the RRI and BLS rental indexes. Section III presents the results comparing the actual Federal funds rates with interest rates derived from five variations of the Taylor rule. Finally,
section IV concludes.

II. The Taylor Rule

Our analysis is based on the following basic formulation of the Taylor Rule as presented in Taylor (1993):

\[ i = \pi + 0.02 + 0.5y + 0.5(\pi - 0.02), \]  

(1)

where \( i \) denotes the nominal Federal funds rate, \( \pi \) denotes the rate of inflation over the previous four quarters, and \( y = (Y - \bar{Y}) / \bar{Y} \) denotes the percentage deviation of output from full-employment output. As indicated in equation (1), a primary component driving the nominal Federal funds rate is the \textit{ex post} rate of inflation (\( \pi \)). Unfortunately, accurately measuring the rate of inflation is a non-trivial matter. For example, housing comprises more than 30% of the BLS CPI and yet, it is very difficult to measure changes in the cost to housing – particularly for owner-occupied housing. As a result, the BLS bases its calculation of shelter in the CPI using an index based on rents. The rent index currently used is called the “Rent of Shelter” component and is mainly composed of owners’ equivalent rent and rent of primary residence. In 2012 these components comprised 71.4% and 20.7% of the rent index, respectively. The rent of primary residence index, which is also known as the BLS rent index, is calculated from the CPI Housing Survey. As of January 1999, the owners’ equivalent rent index is directly estimated from the rent of primary residences by re-weighting the renter sample to represent owner-occupied units. The correlation coefficient between these two components is 0.86 between 1999 and 2012. Thus, the rent of shelter is essentially driven by the rent data from the CPI Housing Survey.

In a recent paper, Ambrose, Coulson, and Yoshida (2014) develop a new rental index measure (referred to as the Repeat Rent Index or RRI) that is based on lease contracts that are signed by new tenants, which are more reflective of current market conditions than is the BLS survey of renters in the middle of leases. The RRI is calculated using residential lease transaction data obtained from Experian RentBureau for the period from January 1998 to December 2010.\(^2\)

\(^2\)RentBureau maintains a national database on tenant rental payment performance collected from property management companies. The data contains information on over 1.4 million lease contracts originated for 551,126 individual residential units in 2,934 multifamily properties (or complexes). On average, the database contains 2.7 lease contracts per individual apartment unit. Using the panel of apartment units contained in this data set, Ambrose, Coulson, and Yoshida (2014) construct a time-series of monthly rents paid by a succession of tenants for each apartment unit.
Figure 1 depicts the RRI and the rent of shelter in the CPI. Panel (a) depicts the index level and Panel (b) shows the year-over-year growth rate. As discussed in detail in Ambrose, Coulson, and Yoshida (2014), the RRI marks a sharp contrast with the CPI rent index. First, rents rose more slowly over the decade than would be inferred from the CPI index. In particular, Panel (a) shows that rents leveled off in 2006 and fell following the onset of the housing crisis in 2007. In contrast, the CPI rent index continued to increase until 2009. Second, the RRI is more volatile than the CPI rent index. Third, the CPI rent index lags the repeat rent index by approximately one year. This is most easily seen in Panel (b). The growth rate bottomed out in the third quarter of 2002 for RRI but in the fourth quarter of 2003 for CPI. The growth rate increased subsequently and peaked in the first quarter of 2006 for the RRI but in the first quarter of 2007 for the CPI. The last two differences are attributable to the differences in sampling methodology; the RRI is based only on new contracts with new tenants whereas the CPI rent index is based on the semi-annual rental growth from the existing renter survey.

We construct the RRI-based inflation (price) indexes for two types of CPI: headline CPI (all items) and core CPI (all items less food and energy). To replace the CPI rent index with the RRI, we use the relative importance of components for the period between 1997 and 2012 published by BLS. Table I shows the relative importance of the core CPI items, the rent of shelter, and the ratio of rent to the core items. The relative importance of rent is stable over time and is approximately 32% in all items and 41% in the core items. Although the BLS calculates owners’ equivalent rent by re-weighting the survey sample, the re-weighting scheme cannot be replicated in this study. Thus, we directly apply the RRI to the entire shelter component. However, the effect of this omission of re-weighting should not be large because, as noted previously, the owners’ equivalent rent is highly correlated with rent of primary residence.

Figure 2 depicts the RRI-based CPI for core items (Panel (a)) and all items (Panel (b)). The core RRI-based index exhibits marked differences from the original core price index. For example, the RRI-based core CPI was stable between 2001 and 2003, increased more rapidly in 2005, and decreased in 2008 and 2009 whereas core CPI steadily increased throughout the decade (see Figure

From the time-series of monthly rents, Ambrose, Coulson, and Yoshida (2014) created a weighted repeat rent index based on the weighted repeat transaction estimator developed by Bailey, Muth, and Nourse (1963), Case and Shiller (1989) and Calhoun (1996) and widely used for constructing constant-quality home price indexes (e.g., the Federal Housing Finance Agency (FHFA) and the S&P Case Shiller Home Price Indexes).

Ambrose, Coulson, and Yoshida (2014) show that RRI Granger-causes the BLS index.
The headline (or all item) based price indexes display a similar pattern except that we note a sharp increase and decrease in 2008 due to volatile energy prices (Figure 2b). Figure 3b shows the year-over-year changes in the RRI-based and BLS CPIs. Figure 3a indicates that the RRI-based core price index is substantially more volatile than the original BLS core CPI. In contrast, Figure 3b shows that the headline RRI-based and BLS price indexes track each other relatively closely but with the RRI-based index having significantly lower growth rates during the 2000-2001 recession and the 2007-2008 recession.

Finally, to parameterize the Taylor rule (equation (1)) we use the real gross domestic product (GDP) as a proxy for output and real potential GDP estimated by the Congressional Budget Office (CBO) for full-employment output. For the rate of inflation, we use (1) CPI, (2) core CPI, (3) RRI-based CPI, and (4) RRI-based core CPI. Since CPI is significantly influenced by energy prices, policymakers and researchers tend to prefer core CPI (e.g., Bernanke, 2015). Although the literature has explored various versions of the Taylor rule by using the forward-looking measure of inflation, alternative output gap measures, and alternative parameters, we use the most basic version (e.g., Poole, 2007; Taylor, 2007, 2010; Abel, Bernanke, and Croushore, 2014; Zimmermann, 2014).

III. Results

Figure 4 depicts the Federal funds rate and two variations of the Taylor rule. Taylor rules are based on core CPI and the RRI-based core CPI in Panel (a) and the headline CPI and the RRI-based CPI in Panel (b). Figure 5 depicts the difference between the Federal funds rate and Taylor rules to clarify whether the funds rate is relatively high or low. We obtain several key findings.

First, by using headline CPI and core CPI, we confirm the standard result that is reported in the existing studies. For example, Figure 4a clearly shows that the actual Federal Funds rates were substantially below rates prescribed by the Taylor rule during the period between 2001 and 4

We also investigated calculating the Taylor rule using the personal consumption expenditure (PCE) price index and the GDP deflator from the Federal Reserve Bank of St. Louis (FRD). The GDP deflator is almost identical to the GDP chain-type price index. Since the results are qualitatively the same we do not report them here, however, they are available upon request.

5 Other studies, such as Abel, Bernanke, and Croushore (2014), use the GDP deflator as the preferred output measure and also conclude that the Federal funds rate is lower than the level suggested by the Taylor rule. Comparisons of interest rates prescribed by the Taylor rule using the GDP deflator and the RRI-index are available upon request.
2005 when using Core CPI as the inflation measure. Similarly, Poole (2007) observed the same finding and noted that “there are sizable and persistent deviations of the funds rate from the values predicted by the formula.” Taylor (2007, 2010) further argues that “the deviation was larger than in any period since the unstable decade before the Great Modernization” and “the low interest rates added fuel to the housing boom, which in turn led to risk taking in housing finance and eventually a sharp increase in foreclosures and balance sheet deterioration at many financial institutions.”

Second, in a sharp contrast with the findings using the conventional Taylor rules, Figure 5 shows that the Taylor rule values based on the RRI-based CPI exhibit smaller differences from the Federal funds rate. In particular, the RRI-based core CPI (Figure 5a) gives remarkably smaller deviations. The mean difference between interest rates based on the RRI-based core CPI Taylor rule and the Federal funds rates is 0.30%, which is not statistically significant from zero (t-statistic is 1.29). In contrast, the mean difference between the Federal funds rates and the interest rates from the core-CPI Taylor rule is -1.45%, which is statistically different from zero at the 1% level (the t-statistic is -9.06) and indicates that the Federal Funds rates were significantly below the interest rates prescribed by the Taylor rule on average.

Third, and more importantly, the Federal funds rate was actually higher than the RRI-based core CPI Taylor rule between the fourth quarter of 2000 and the third quarter of 2002 and between the third quarter of 2006 and the fourth quarter of 2009. These are the critical recessionary periods following the dot-com boom and the housing boom, respectively, when the FOMC should have been following a monetary policy designed to stimulate the economy. Thus, the Taylor rule using the refined RRI based inflation measure suggests that the FOMC should have acted more quickly and boldly at the critical early stages of the recent recessions.

Fourth, Figure 4a shows that the Federal funds rate was lower than interest rates prescribed by the RRI-based core CPI Taylor rule between the second quarter of 2002 and the second quarter of 2006. This period corresponds to the housing boom. However, the degree of deviation is much smaller than the conventional result; the peak deviation between the Federal funds rate and the prescribed rate is approximately 2% using the RRI-based core CPI in contrast to over 4% when using the core CPI.

The last two findings are a consequence of stale information in the CPI rent index. To see this,
consider that in Figure [1] the CPI rent index lags the RRI by approximately one year. Thus, by relying on CPI, the FOMC’s decisions also seem to lag the peaks and troughs of the RRI-suggested rate by approximately one year.

IV. Conclusions

The idea of this paper is simple. The newly constructed Repeat Rent Index (RRI) shows a quite different picture of the housing market from what the CPI rent index indicates. Given that housing rent drives more than 30% of the consumer price index, the use of the alternative (and better in many respects) rent index would significantly change CPI. Moreover, since the CPI is a critical factor for monetary policy, the use of the RRI in the calculation of CPI would significantly alter monetary policy.

To demonstrate the importance of using a more timely measure of housing rent, we compare interest rates prescribed by a Taylor rule using the RRI-based CPI and the traditional BLS CPI over the period from 2000 to 2010, a period when the relevance of monetary policy is intensely debated. We show that the FOMC’s interest rate policy during the controversial 2000 to 2005 period was actually much closer to the RRI-based Taylor rule prescription than from the formula’s prescription when based on the conventional BLS CPI. Furthermore, since the BLS CPI lags the RRI by approximately one year, our RRI-based Taylor rule suggests that the FOMC should have acted earlier to lower interest rates in response to changes in the economic (inflationary) environment.
References

Abel, Andrew B., Ben Bernanke, and Dean Croushore, 2014, Macroeconomics (Prentice Hall) 8th edn.


<table>
<thead>
<tr>
<th>Year</th>
<th>All items (Headline CPI)</th>
<th>All items less food and energy (Core CPI)</th>
<th>Rent of shelter</th>
<th>Ratio of rent to core items ((b)/(a) \times 100)</th>
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<tr>
<td>1997</td>
<td>100.000</td>
<td>77.661</td>
<td>29.410</td>
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<td>1998</td>
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<td>29.912</td>
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<td>1999</td>
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<td>77.731</td>
<td>29.865</td>
<td>38.421</td>
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<td>29.885</td>
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<td>2003</td>
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<td>41.374</td>
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<td>100.000</td>
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<td>2006</td>
<td>100.000</td>
<td>77.401</td>
<td>32.407</td>
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<td>2007</td>
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<td>76.469</td>
<td>32.271</td>
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Table I: The Relative Importance of Components in the Consumer Price Indexes.

This table shows the relative importance of the core CPI items, rent, and the ratio of rent to the core items in the consumer price indexes. The data between 1997 and 2012 are obtained from the Bureau of Labor Statistics.
Figure 1: RRI and CPI Rent Index.

This figure depicts RRI (developed by Ambrose, Coulson, and Yoshida 2014) and the Rent of Shelter in CPI between 2000 and 2010. Panel (a) depicts the index level and Panel (b) depicts the year-over-year growth rate.
This figure depicts price indexes between 2000 and 2010. Panel (a) depicts the Core CPI excluding food and energy and the RRI-based core CPI. Panel (b) depicts the CPI for all items and the RRI-based CPI. In the RRI-based CPI, the rent index is replaced by the Repeat Rent Index developed by [Ambrose, Coulson, and Yoshida (2014)](https://doi.org/10.1111/j.1467-8296.2014.05385.x).
Figure 3: Year-Over-Year Change in Price Indexes.

This figure depicts the year-over-year growth rates of price indexes between 2000 and 2010. Panel (a) depicts the Core CPI excluding food and energy and the RRI-based core CPI. Panel (b) depicts the CPI for all items and the RRI-based CPI. In the RRI-based CPI, the rent index is replaced by the Repeat Rent Index developed by Ambrose, Coulson, and Yoshida (2014).
This figure depicts the Federal funds rate and variations of the Taylor rule. The Taylor rule is based on the core CPI (excluding food and energy), the GDP deflator, and the RRI-based core CPI in Panel (a), and the CPI, the GDP deflator, and the RRI-based CPI in Panel (b). The RRI-based indexes are based on the Repeat Rent Index developed by Ambrose, Coulson, and Yoshita (2014).
This figure depicts the difference between the Federal funds rate and the Taylor rule. A positive value indicates that the Federal funds rate is relatively high. The Taylor rule is based on the core CPI (excluding food and energy) and the RRI-based core CPI in Panel (a), and CPI and the RRI-based CPI in Panel (b). The difference based on the GDP deflator is also shown in both panels.

Figure 5: Difference Between the Federal Funds Rate and Taylor Rules.