A Better CPI – Adjusting for Technological Change and Increased Housing Consumption

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Abstract

This article looks at modifying the currently reported CPI by the government to produce a "better" CPI. Comparisons are based on each alternative's ability to produce time series projections in line with measures reflecting consumer behavior. Suggested changes include restricting attention to goods with little change in the consumer experience over time as well as accounting for changes in the housing stock over time. The top performing CPI alternatives produce long run tends in income growth and poverty level reductions that indicate both have been understated by the official CPI.

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Each month the Bureau of Labor Statistics (BLS) produces and publishes the U.S. Consumer Price Index (CPI). Beyond its importance as a gauge of overall economic health, many government programs, contracts and investments are tied to its value (e.g. social security checks, treasury inflation protected securities and labor contracts with cost of living allowances). Given the CPI's widespread impact, it naturally garners intense public and academic interest.[1] While early works examine how it should be produced (Norton (1910)), recent work focuses on improving the calculations that go into it (Fixler, Fortuna, Greenlees and Lane (1999), Lebow and Rudd (2003), Diewart, Nakamura and Nakamura (2009), David, Stephen, and Kenneth (2006), Erickson and Pakes (2011), Diewert, Ambrose, Coulson and Yoshida (2015), Fox and de Haan (2016)). Others have explored ways for improving the CPI via the use of finer data to account for time varying prices and the variety of goods offered (Broda and Weinstein (2006), Ivancic, Diewart and Fox (2011) and Nakamura, Nakamura and Nakamura (2011) and Handbury and Weinstein (2015)). These papers will likely help the BLS and related agencies produce a more accurate CPI measure going forward. This paper instead looks at the problem of producing a better historical CPI and ways to compare alternative measures. Of course, restricting attention to alterations that can retroactively update the existing CPI time series limits the degree to which changes will deviate from the official CPI. Other proposals in the literature have a far more dramatic impact than those proposed here. However, the suggestions presented here do offer something else - a route towards potentially producing a more accurate index that academics and policy makers can use with the exiting historical time series data.

In terms of the CPI, what does "better" mean? No price index can represent every individual's circumstance. At best, it can provide insight into the economic conditions faced by a representative

[1] For example, a search through *USA Today*'s web pages for the CPI immediately brings up a report in its value with the same date as the announcement. A typical article can be found at http://www.usatoday.com/story/money/2017/02/15/consumer-prices-inflation-gas-food/97937182/. The *USA Today* is the number one paper in the US based on total circulation.

agent of some sort. As such, the CPI should tell us how much it costs in period $t+x$ to purchase a bundle of goods that leaves the agent's utility unchanged relative to the bundle purchased in period t. To carry out the calculation researchers often assume the agent has a constant elasticity of substitution (CES) utility function (see Feenstra (1995), Broda and Weinstein (2006), Broda and Weinstein (2010), Nakamura, Nakamura and Nakamura (2011) and Handbury and Weinstein (2015)). This paradigm makes it possible to calculate how broad changes in the consumption bundle (increased variety, improved chances of surviving a disease, etc.) should be handled and what data should be collected to do so. Since this paper takes the existing data as given, it uses a more empirical set of tests to distinguish between the accuracy of various measures. Since the CPI should reflect consumer perceptions, this paper compares CPI alternatives by looking at how well changes in each CPI's value forecast consumer behaviors that changes in real incomes and interest rates might affect. Towards that end, this paper proposes a set of tests using household debt, default and consumption data.

There are two primary changes to the CPI's calculation examined here. One involves housing costs. Overall, housing accounts for about a third of the CPI making it the largest single component. Its size makes accurately estimating its cost particularly important. A second alteration focuses on the cost of goods whose consumption value is relatively time invariant. Currently the BLS adds new items by assuming that they have little or no impact on inflation (Broda and Weinstein (2010) and Feldstein (2017)) even though they may enhance the consumption experience (i.e. reduce inflation). For some items this is not an issue. In this group, technological advancements may impact their production, but the delivered product is essentially unchanged. As will be shown, under certain conditions this set of goods can be used to generate an upper bound on the inflation rate.

When the BLS estimates the cost of a consumption good it does so for a single item. Consider the consumption of shirts. For most people the shirt itself is the unit of purchase, not the amount of material in it. The BLS treats housing in a manner similar to shirts. It attributes a cost of housing by the

unit. For example, it tracks the cost of a 4-bedroom, 3.5-bath house over time. One 4-bedroom, 3.5-bath house in an area is treated the same as any other. However, casual observation of real estate marketing material indicates that consumers place considerable value on the size of their residence as well as its configuration. That makes a significant difference in how an index measures housing costs. The average size has grown larger over time. According to the Census Bureau, average home size increased by 14% between 1986 and 2015, from 1,510 to 1,722 square feet. This adjustment alone reduces the annual housing inflation rate by about 0.7%. Since housing costs constitute about 40% of the CPI this yields a significant change to the overall index. Our tests indicate that adjusting for square feet improves the inflation measures ability to forecast consumer reactions. From March of 2001 onward, another option is to use the ACY repeat rent index to estimate housing costs. That index controls for changes in housing attributes over time by examining multiple observations on the same unit. So long as the repeatedly observed unit remains essentially unchanged (for example, does not grow in size via an addition) the ACY index should measure the change in rental costs for a given set of attributes. Later tests will show the ACY index does help produce a better CPI than using the existing Census Bureau's estimate corrected for changes in housing size.

While technology is always improving, casual introspection indicates its pace has picked up over time.[2] Moreover, day-to-day experience indicates that the focus of these changes has shifted somewhat. For example, in the 1950's many technological innovations allowed firms to produce goods faster with fewer inputs. But the consumption experience associated with the goods being produced did not differ that much. Cars, for example, changed style but overall functionality remained relatively unchanged. Recently, however, technological innovations have fundamentally altered the consumption experience for many goods and services. Cars now have sophisticated entertainment, telephone and anti-collision

[2] There have also been some more formal estimates of the rate of change Basu, Fernald and Shapiro (2001).

systems built in. As a result, a $40,000 car today may yield a much better consumer experience than a $40,000 car from a few years ago, even when prices are inflation adjusted. While the BLS does adjust about 7% of the items in the index for such technological changes, changes in the other 93% are not similarly accounted for.[3]

One way to avoid the issue of having to hedonically adjust prices is to focus on those goods that have seen little change in their consumption experience over time. While no single list will be universally agreed upon, there are a number of items that seem to be good candidates. For example, while the types of foods people eat changes over time the experience from a particular item probably has not. A banana in 1989 and in 2017 likely produces the same consumption value. That is not to say the production of bananas has not changed. Modern crop production techniques and transportation grids have undoubtedly allowed for the production of more bananas at lower cost. But to the consumer, the experience of eating one has probably remained about the same. [4] Other items, like haircuts, also seem to have undergone limited technological changes in consumption value. This paper constructs a basket of such goods and services with minimal technological changes accounting for nearly 40% of the overall index. It then calculates the inflation rate for this basket as a baseline. Under the right theoretical conditions, this can help reveal biases in the official CPI attributable to ignoring technology's impact on the consumer experience across other goods and services. While the overall CPI has grown by 2.57% per year from January 1988 to March 2018, an index composed of only products whose consumer

[3] See https://www.bls.gov/cpi/quality-adjustment/home.htm for the current list. Table 2 displays the weights over time. The 7% figure includes all items on the list other than housing. While the BLS includes housing on its list of hedonically adjusted items, the adjustment is limited. Based on Ambrose, Coulson and Yoshida (2015) there is reason to believe that it does not capture changing values due to changes in the housing stock over time. The main text discusses this issue in detail.

[4] While each food item itself has remained relatively unchanged over time, as Broda and Weinstein (2006) point out the available variety has increased. This is of value to consumers and accounting for it reduces the rate of CPI growth. The calculations in this paper ignore this avenue of utility gain to consumers. There is no claim in this article that the proposed indices are the most accurate possible and taking into account the value of variety to consumers would no doubt improve them. This correction is, however, beyond the scope of this paper where the goal is to rely on historic readily available public data to improve the CPI's accuracy.

experience has been relatively unaffected by technological progress grew at just 2.52% over this same period. While that may initially seem like a small difference, over 30 years it adds up.

In terms of consumption items that have been particularly impacted by technological progress without adjustment by the BLS, medical costs stand out. From 1988 to 2017 they grew from 5.8% to 8.7% of the index. Over the same period, medical treatments became far more effective. But, the BLS does not adjust medical costs to fully reflect the fact that current treatments deliver a better product than at any time in the past (Eggleston, Shah, Smith, Berndt and Newhouse (2011)). Now consider a version of the CPI that drops medical costs and adjusts housing costs by the ACY index when available and by square footage when it is not. That index has an annual growth rate of just 2.36% per annum. Apparently, a great deal of the CPI's growth over time has come from just medical and housing costs.

While it is easy to propose alternative CPIs, how does one determine if they are indeed superior? Any alteration of the CPI can be criticized. To provide a more objective measure, this paper suggests comparing indices based on the degree to which they are associated with consumer behavior. While consumer behavior covers a wide range of activities, given the limited time series data available, it is important to focus on those activities that are likely to respond quickly to shifting economic conditions. This paper looks at three: (1) consumer debt levels; (2) charge off rates on consumer loans; and (3) aggregate per capita consumption.

Basic economic theory indicates that consumers should react to a perceived increase in their real wages by increasing their consumption levels. Part of that will likely include the purchase of "big ticket" items that require financing. Since different versions of the CPI produce different real wage values, this makes it possible to compare indices. Presumably an index that better reflects the experience of the average consumer will yield a better link between real wages and consumer borrowing decisions. Like wages, consumers also react to their perception of real interest rates. If

consumers experience a rise in real interest rates they are less likely to borrow money and should cut back on their debt. At the same time, some families will react to a drop in real wages or a real rate increase by defaulting on their loans which should lead to an increase in consumer non-residential loan default rates.[5] Naturally, different CPIs yield different real economic values for both real wages and consumer interest rates. A "better" CPI should produce a superior link to consumer behavior if it more closely reflects of the average person's consumption experience. Overall, several variants of the CPI developed here better describe the consumer spending, borrowing, and default decisions than does the official version produced by the BLS.

Whenever academics suggest changes to the CPI's calculation, a frequent question is the degree to which the adjustments impact our understanding of real wages over time. A verbatim search for web pages updated in 2016 with the exact phrase "real wage growth" in the US yields over 63,000 entries. Given the political and policy importance of this topic, this wide interest is not surprising. Many of the articles in the popular press report that real household income has either declined or stagnated since 1999. This conclusion is largely due to the 2007 peak (prior to the financial crisis) being slightly below the 1999 level. In contrast, the CPI variants that outperform the official measure in forecasting luxury good consumption and default rates also have impact estimated real wage growth. Using the set of goods whose consumption value has been relatively unchanged over time along with housing cost adjusted for size in tandem with the ACY index, the real median household income in 2007 was 1.2% above its 1999 level. Using the index that includes all goods along with housing costs calculated on a square-foot-cost basis in tandem with the ACY, real wages were up 0.3%. The long term trends show even stronger real median (and real mean) wage growth than the official numbers indicate. Using the

[5] Residential loans are excluded here. They are secured by the underlying property and typically come with a fixed interest rate. Default is thus more likely to be associated with changing real estate values than short run changes in real wages or interest rates.

official index, it is estimated that median household income grew by 9.1% between 1988 and 2017. Alternatively, suppose one uses the index composed of goods with relatively low changes in consumption value along with housing costs that are calculated on a per square foot basis with the ACY index when available. In that case, one finds that median household real income growth over the same period has been 14.5%. Non-smoking households have seen an even larger jump of 16.7%. These figures indicate that since 1988, real household income has grown almost twice as much as the official figures indicate.

Calculation of the poverty level is also affected by the estimated rate of inflation. Based on the official CPI the poverty rate was 13.0% in 1988 and by 2017 it had fallen to 12.3%. At the same time, under the CPI containing all goods with housing measured on a per square foot basis and the ACY index when available, the 2017 poverty rate is 1.1% lower than in 1988. Using the index of goods that have seen limited changes in their consumption experience plus housing costs measured on a per square foot basis, the poverty rate drops by 1.3% from 1988 to 2017.[6] For non-smoking households the reductions are even larger, 1.3% in the former case and 1.6% in the latter. These differences paint a somewhat more encouraging picture regarding anti-poverty efforts over time than the BLS figures would indicate.

Those familiar with the extant literature discussing adjustments to the CPI's calculation will note that many suggest the official CPI overestimates the true inflation rate by as much as a half to a full percent a year (Broda and Weinstein (2006), Broda and Weinstein (2010)). Clearly, the changes suggested here generate changes that, in comparison, are very modest. That is primarily due to this paper's focus on adjustments that can be used to update the historical record. If one is free to collect better data, then the literature indicates that future calculations will yield far lower inflation numbers.

[6] Data updates are limited by Census bureau releases that are collected by IPUMS. As of March 2019, the most recent data only allows for the recalculation of poverty rates through 2016.

Nothing in this paper contradicts that. Ideally, it would be better if the BLS adopted many of the changes others have suggested. In the meantime, the changes suggested here may prove useful.

The paper's organization follows. Section I shows how an index of items whose consumer experience has been relatively unaffected by technological progress can act as an upper bound to the actual CPI. Section II discusses how housing costs are currently accounted for in the CPI and the issues with that arising from changes in residential size over time and possible improvements to the calculations. Section III discusses tobacco's impact on the CPI and the conditions under which it should be dropped when constructing an index. Section IV covers the list of items included and excluded from the list of items with minimal changes in consumption value over time. Section V discusses luxury goods and default rate tests and uses them to compare CPI alternatives. Section VI goes over how trends in average wages and the poverty level change under the alternative CPI indices proposed in this paper. Section VIII contains the paper's concluding remarks.

I. A Technology Free Index as an Upper Bound for the CPI

Adjusting the CPI for the addition of new products and changes in the characteristics of existing products is clearly quite difficult and will always be subject to controversy. (Just how much is a slightly faster cell phone processor worth?) However, there is a category of products in which there seems to have been little or no innovation in terms of either the list of items for sale or their attributes. For expositional purposes, call these items "technology free." This section lays out conditions for a technology free CPI to form an upper bound on the true CPI. Later on, the paper will test whether this variant of the index actually does a better job of reflecting consumer behavior.

A CPI composed of just technology free products can provide an upper bound on the inflation rate if the processes needed to produce the basket have not seen their costs rise relative to technology

affected products. As an example, suppose the consumption basket contains only chickens and cell phones. Each period, consumers spend 60% of their income on chickens and 40% on cell phones. While prices never change, technology does. Over time innovations improve the consumption value of cell phones but not chickens. Here, the technology free CPI would contain just chickens and show a zero inflation rate over time. Cell phones, however, are effectively becoming less and less expensive per utility unit delivered. Thus, the true CPI (the income level needed to keep the consumer at a constant utility level) declines year-over-year. The zero inflation rate is overestimating the true inflation rate.

More generally, consider a consumer that allocates between technology free (bundle 1) and technology impacted (bundle 2) goods. In period *t* assume the consumption weights are $W_t = \left(w_{1t}, w_{2t}\right)$. Now, consider a future period *t*+1 and that the price vector has gone from P_t to P_{t+1}. Over this time the characteristics of the two consumption bundles have morphed from $H_t = \left(h_{1t}, h_{2t}\right)$ to $H_{t+1} = \left(h_{1t+1}, h_{2t+1}\right)$. In line with the assumptions regarding goods and technological change, assume $h_{1t}=h_{1t+1}$. To simplify some of the expressions that follow, if the characteristic set for the technology free goods does not change, the *t* subscript will be suppressed.

Assuming technological progress makes a consumption item more desirable, each unit of the technology impacted goods produces higher utility with characteristic set h_{2t+1} than with h_{2t}. In standard preference notation, $U\left(x_{1t}\left(h_1\right), x_{2t}\left(h_{2t}\right)\right) \precsim U\left(x_{1t}\left(h_1\right), x_{2t}\left(h_{2t+1}\right)\right)$ where $x_{it}(h_{jt})$ represents a bundle of goods *x* with characteristics *h*. The critical assumption needed for goods in the technology free CPI to form an upper bound on inflation is that production technology does not deteriorate over time. Formally, assume that if in period *t*+1 the consumer devotes w_{1t} to the purchase of technology free goods at a cost of c_{1t+1} then it will be possible to purchase at least $x_{2t}(h_{2t})$ units of the technology impacted goods in period *t*+1. By construction, this leaves the consumer at least weakly better off if his income has increased from period *t* to *t*+1 by c_{1t+1}/c_{1t}. To see this let $p_{2t}(h_{2t})$ equal the cost of a unit of

bundle 2 in period *t* with hedonic characteristics h_{2t}. The assumption needed here is that $x_{2t}(h_{2t})\,p_{2t}(h_{2t})/c_{1t} \geq x_{2t+1}(h_{2t})\,p_{2t+1}(h_{2t})/c_{1t+1}$. To help fix ideas, return to the example where the consumer purchases just chickens and cell phones. Imagine that, in 2002, ten chickens cost as much as one cell phone. Then the assumption states that, in 2017, a cell phone based on 2002 era technology can be produced and sold for no more than ten chickens if consumer demand (given the availability and cost of 2017 era technology cell phones) warrants. This discussion can be formally summarized in the following proposition:

Proposition 1: Assume a consumer spends a total of C_t in period t. Of that the consumer spends c_{1t} on goods in bundle 1 and c_{2t} on bundle 2 in period t. Further assume the characteristics of this bundle h_{1t} do not change over time so that $h_{1t}=h_{1t+1}$. In contrast, assume the characteristics of the goods in bundle 2 do change over time and that these changes are viewed as desirable by the consumer so that $U(x_{1t}(h_1), x_{2t}(h_{2t})) \precsim U(x_{1t}(h_1), x_{2t}(h_{2t+1}))$. *Further assume that the relative cost of bundle 2 holding its characteristics constant does not increase faster than the cost of purchasing bundle 1, implying $x_{2t}(h_{2t})p_{2t}(h_{2t}) \geq c_{1t+1}x_{2t}(h_{2t})p_{2t+1}(h_{2t})/c_{1t}$. Then a consumer spending $c_{1t+1}C_t/c_{1t}$ is at least weakly better off.*

Proof: Assume the consumer has C_t to spend in period *t* and $c_{1t+1}C_t/c_{1t}$ in period *t*+1. In period *t* the consumer buys $x_{1t}(h_1)$ units of the technology free bundle at a cost of $c_{1t}= x_{1t}(h_1)p_{1t}(h_1)$ and $x_{2t}(h_{2t})$ units of the technology impacted bundle for a total cost of $c_{2t}= x_{2t}(h_{2t})p_{2t}(h_{2t})$. In period *t*+1 by assumption the consumer has $c_{1t+1}C_t/c_{1t}$ available to spend. Suppose the consumer again buys $x_{1t}(h_1)$ units of the technology free good at a cost of $c_{1t+1}= x_{1t}(h_1)p_{1t+1}(h_1)$ in period *t*+1. This yields total spending on the technologically impacted bundle of

$$
\begin{aligned}
c_{2t+1} &= C_{t+1} - c_{1t+1} \\
&= c_{1t+1}\left[\frac{C_t - c_{1t}}{c_{1t}}\right] \\
&= \frac{c_{1t+1}}{c_{1t}} c_{2t}.
\end{aligned} \tag{1}
$$

By assumption the relative price increase in the technology free bundle is at least as great as in the technologically impacted bundle, holding the technology level fixed. This implies

$$
\frac{p_{1t+1}}{p_{1t}} \geq \frac{p_{2t+1}}{p_2} \Rightarrow \frac{p_{1t+1}p_2}{p_{1t}p_{2t+1}} \geq 1. \tag{2}
$$

Based on equation (2) and the period t+1 price of technologically impacted bundle with the period t technology, the consumer can purchase $x_{2t+1}(h_{2t})$ units equal to

$$
\begin{aligned}
x_{2t+1}\left(h_{2t}\right) &= \frac{c_{1t+1}}{c_{1t}} \frac{c_{2t}}{p_{2t+1}} \\
&= \frac{p_{1t+1}x_{1t}}{p_{1t}x_{1t}} \frac{p_{2t}x_{2t}}{p_{2t+1}} \\
&= \frac{p_{1t+1}}{p_{1t}} \frac{p_{2t}x_{2t}}{p_{2t+1}} \\
&\geq x_{2t}\left(h_{2t}\right).
\end{aligned} \tag{3}
$$

The first equality comes from the last line of (1) along with the cost per unit of bundle 2. The second line follows from the relative cost of purchasing x_{1t} units of bundle 1 in periods t and t+1. Finally, the inequality follows from (2). By assumption the consumer's utility is increasing the total consumption of a bundle. In period t+1 the consumer can duplicate the amount of bundle 1 purchased and purchase at least as much of bundle 2 with the period t technology as was purchased in period t. Thus the consumer is at least weakly better off. QED

While the proposition lays out the case for using a technology free bundle to estimate an upper bound on inflation, this still leaves the issue of determining what should be in it. There will likely never

be unanimity regarding what items to include. Even something as seemingly impervious as food is subject to technological change. Swine have been bred over time to produce leaner and leaner cuts of meat. Nevertheless, assuming pork has not seen its consumption value per unit altered over time will, at worst, overestimate its inflation rate. However, this still leaves a technology free index that includes pork as an overestimate of the true inflation rate. The goal need not be to produce a list of items that are truly technology free. To bound the current index, one only needs a list that is minimally impacted by technological advances relative to the overall consumption bundle. Interested readers can find a discussion of alternative consumer price indices and details regarding how the BLS creates the official CPI in the appendix.

II. Real Estate

Housing is a major part of the CPI. Overall, it accounts for just under a third of the index. It is also listed by the BLS as an item in the consumption bundle subject to hedonic adjustment. While technically true, the adjustments are quite limited and do not seek to account for the utility per unit delivered over time. In recent decades, insulation has improved and amenities, like high-speed internet connections and Wi-Fi, have become ubiquitous.[7] Such changes are not part of the hedonic adjustments made by the BLS. More importantly, there is no adjustment for residential square feet.

When it comes to the housing stock, the BLS uses rental cost data to estimate a rental equivalent value to owner occupied housing. For each owner occupied house, the BLS finds a group of nearby rental units with the same number of bedrooms, baths, and similar construction vintage. The average rent is then imputed as the cost of housing to the home's owner. This hedonic correction seems

[7] Better insulation not only reduces household energy costs (which the BLS measures) it also reduces interior drafts (which the BLS does not measure) which increases a home's utility dividend.

designed to make sure rental and owner occupied costs are treated in a similar manner in any one year rather than to correct for changes in the consumption value of the current housing stock.

Even if one thinks that other elements of the housing stock have improved by negligible amounts over time, the number of square feet per household has increased significantly over the last few decades. In effect, the BLS measures the inflation rate of a house as a single unit. However, real estate ads, standard appraisal methods and even common sense all imply that people do not just purchase a residence. They also purchase square feet of living space.[8] This is, naturally, reflected in prices. A 2,500 square foot home will sell for less than a 3,500 square foot unit in the same neighborhood.

If home size did not change much over time, then adjusting for it would not make much difference. But, over the years, homes have continued to get larger and larger. Table 3 displays the average and median values from the American Home Survey (AHS). This has been conducted on either an annual or biannual basis by the US Census from 1986 to 2015.[9] In 1986 the average household lived in a 1510 square foot home, while the median one lived in a 1300 square foot home. By 2015 those figures had grown to 1722 and 1500 respectively. Overall, that amounts to a nearly 14% increase in the mean size and slightly over 15% increase in the median. On a per year basis, that comes to an annual growth rate of 0.5% in the mean and median square feet per housing unit.

Consider an example where a family starts out in a 2,500 square foot 4-bedroom, 3-bath house built in 2005 with a rental equivalent of $1,000 per month. From there, the family moves into a 3,500 square foot house with the same characteristic vector at a cost of $1,100 per month. This would enter

[8] The website Zillow.com is a popular real estate pricing portal. If you type in your area code you will see listed homes for sale with data presented in the following order: price, bedrooms, baths and square feet.
[9] In 2015 the Census department changed the way it reported data from the survey to the public. That year it stopped providing the underlying data on a house-by-house basis. Instead buckets were created covering size ranges and the number of homes in each bucket is reported. That makes calculating the mean home size impossible by third parties since the largest homes are in a bucket with just a lower bound.

into the CPI as a 10% increase in the cost of housing. However, people do not just move into a residence. They also purchase square feet of space. In this example, the family's cost per square foot has actually gone down from 40.0¢ to 31.4¢. This results in a decline of 21.4%, as opposed to the CPI entered increase of 10%. Over time, the change in the cost per square foot of housing consumption per household has been conflated by the BLS index with the square feet consumed by them.

The impact of changing home sizes on the real estate cost index in the CPI has not been insignificant. From January 1988 to March 2018 the BLS housing cost index increased 121%. If the index is adjusted by square feet, then the increase in housing costs over the same period is only 104%. In comparison, over this same period the reported CPI exhibited a 116% increase. This implies that, over the past few decades, housing costs have driven up the CPI relative to other items, but only because it has been calculated on a per unit and not a per square foot basis. If instead it is entered into the calculation on a per square foot basis, then it has actually been an ameliorating force.

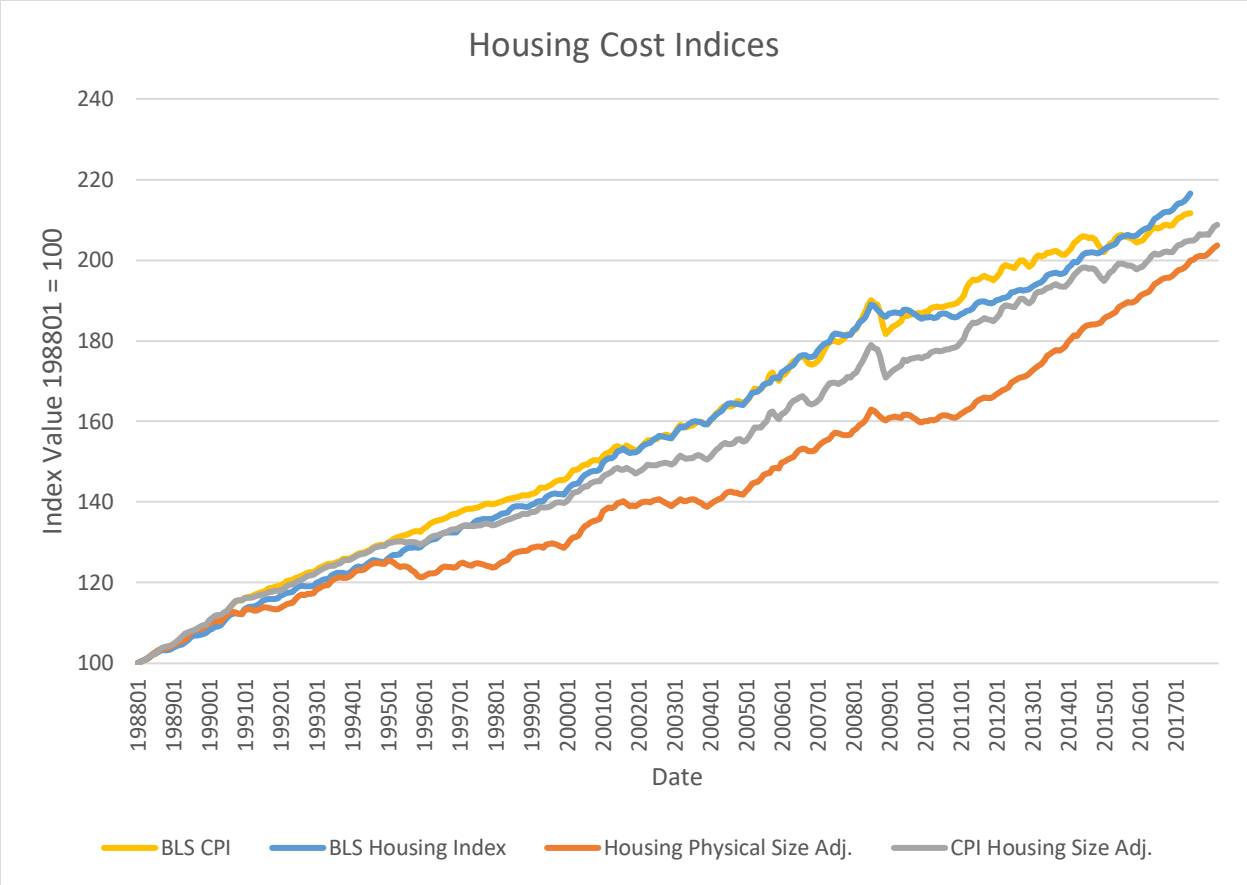

Figure 1: Housing costs over time under various size adjustments. Housing Physical Size Adjusted is the BLS Housing Index with housing costs adjusted by residential size. The CPI Housing Size Adj. index is the CPI with housing costs adjusted by residential size.

Figure 1 displays the impact of adjusting housing costs based on residential size over time from 1988 to June 2017. There are no jumps in the lines from periodic square foot adjustment since the data series has been smoothed with a three year running average.[10]

A. Housing Anomalies under the Current CPI

Following the BLS method of measuring housing as a unit of consumption yields some anomalous patterns over time. In the consumer survey used to estimate the 2001 CPI, mean household income was $66,863. A typical family spent 39.980% ($26,732) of this on housing. By 2009, household

[10] In June of any year the smoother weighs the current survey value by 12/36 and the two out years by 12/36. Each month one is subtracted from the lagging index and added to the next index in line. Thus in July the weights would be 11/36, 12/36,12/36 and 1/36 where the final weight would be for the survey figure two years hence.

nominal mean incomes had risen to $78,538 and the fraction of the income devoted to housing was 43.421%, implying total housing expenditures of $34,102. In 2001, the housing cost index stood at 149.83. That index represents the cost of a constant unit of housing. It implies the mean household in 2001 purchased 178.42 (26732 divided by 149.83) housing units. In 2009 the housing index had risen to 186.69 implying consumers purchased 182.67 housing units. At the same time, real mean incomes fell from $90,642 (in 2015 dollars) to $87,857. Now consider what happened to relative prices. The housing cost index went up by 24.6% while the CPI only increased by 20.6%.

Taken together, the above figures imply several things: (1) relative to other goods and services, the cost of housing went up during this time, (2) total housing units consumed went up and (3) real family incomes based on the BLS CPI were down. This is an odd confluence of facts. It implies that, as family incomes went down and housing became relatively more expensive, families decided to buy more housing. These are the properties associated with a Giffen good. Obviously, this does not conclusively prove that housing is a Giffen good. The classic textbook model assumes consumers can switch costlessly across goods and services. In real life, changing residences is very costly and it may take time for consumers to adjust their total expenditures in response to an income or price shock. However, in this case, the shocks were 8 years old. That is a long time even relative to a family's typical housing tenure. Census data analyzed by Green (2014) indicates the average American moves every 5 years. Chalabi (2015) produces similar results, finding that individuals can expect to move an average of 11.3 times in their lifetime, with 11% moving in any one year.

While the BLS figures may imply that housing is a Giffen good, a plausible alternative is that consumers are not purchasing just a residence but total square feet as well. From 2001 to 2009 the average residence went from 1,742 square feet to 1,849 square feet. On a per square foot basis the housing cost index went from 8.60¢ to 10.10¢ - an increase of 17.4%. As noted earlier, by comparison

the overall CPI over this period was up only 20.6%. Under this interpretation of the data, consumers spent a larger fraction of their income on housing, over a period where the BLS data indicates their real income declined, because the cost per square foot of housing dropped relative to many other goods and services.

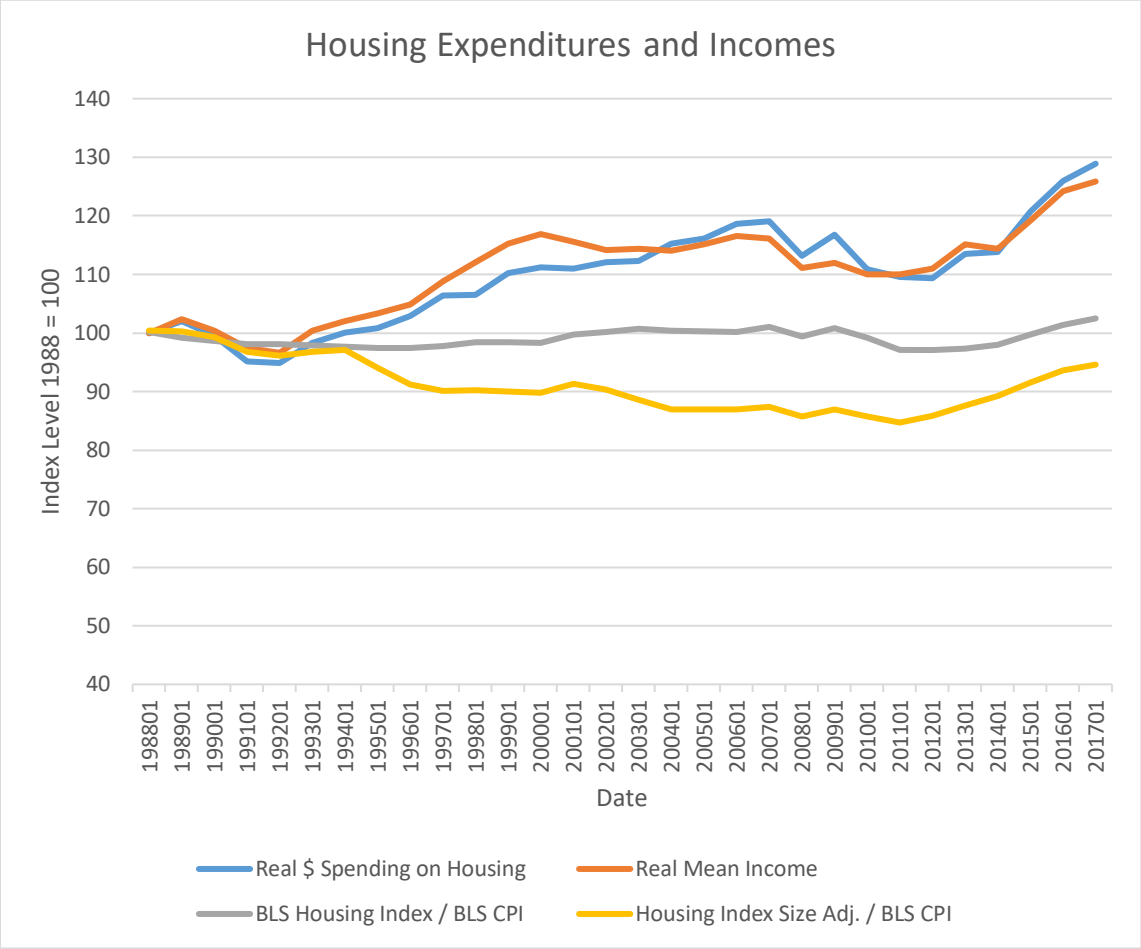

Figure 2: Housing costs and income over time. Real $ Spending on Housing and Real Mean Income are calculated use the BLS' CPI. The ratios are the BLS's Housing Cost index divided by the BLS CPI and the same housing cost index adjusted for the change in housing size over time again divided by the BLS CPI.

As seen in Figure 2 over the last several decades the price per square foot of housing has dropped over time relative to other goods and services (with some relative increase in the past few years). At the same time, consumers have increased the amount they spend on housing. Cost of living estimates that ignore the square feet of housing that consumers buy over time conflates changes in the total level of housing services purchased with changes in the cost of each unit of service.

B. The Ambrose, Coulson and Yoshida (ACY) Repeat Rent Index

Ambrose, Coulson and Yoshida (2015) (ACY) develop a rental cost index that can be used as a substitute for the one produced by the BLS. The advantage of the ACY index is that it attempts to produce a constant quality rental rate. In real estate, repeat sales indices refer to housing price indices based on repeated sales of the same unit.[11] The ACY index uses a similar methodology but applies it to repeated rental rate observations. Using repeated observations on the same unit helps reduce the impact of long-term changes in the housing stock of observed prices. In this case, each unit acts as its own control.

The Pennsylvania State University publishes an updated version of the ACY index each month going back to March 2001. An alternative to size adjusting the BLS housing cost index is to switch to the ACY index once it becomes available. The graph below illustrates the impact the ACY index has on the CPI relative to just adjusting by size.

[11] The S&P CoreLogic Case-Shiller home price indices are based on repeat sales (S&P Dow Jones Indices, 2019) as are the ones issued by Federal Housing Finance Agency (Calhoun, 1996).

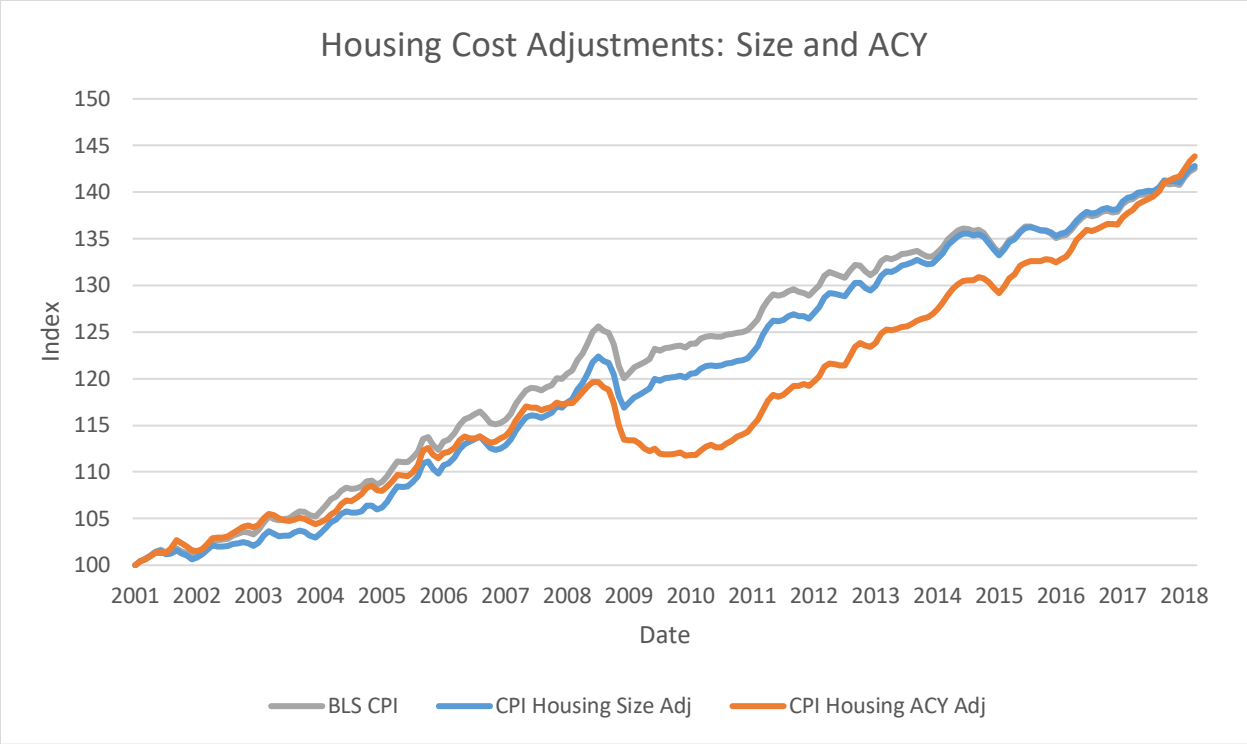

Figure 3: The blue line in the graph displays the CPI when housing costs are adjusted for the change in residential size from 2001 to 2018. The orange line repeats that exercise but instead uses the ACY index once it becomes available in 200103.

The ACY index produces a substantially larger decline in the cost of living due to financial crisis relative to adjusting housing costs by the available AHS survey data. From August 2008 to January 2010 the official CPI fell 1.09%, adjusted for residential size it was down 1.12% and with the ACY it fell 6.11%. The dramatic difference in the CPI depending on whether adjustments are made using the AHS or the ACY arises, at least in part, to the frequency at which the data is collected. [12] The AHS is only collected every other year and even then the final values are subject to considerable measurement error due to limits on the survey's size. In contrast, the ACY is based on data that makes monthly updates possible. Later sections will compare the impact of substituting out the AHS size adjustment for the ACY index to see if resulting CPI better explains consumer behavior. Overall, it appears to.

[12] The reason the CPI adjusted for size converges with the BLS CPI in Figure 3 but not in Figure 2 is due to the relative starting date of each. Returning to Table 3 one can see that according to the AHS, the average size of a dwelling has dropped in recent years and is now at about the same value as in 2000.

III. Tobacco

Tobacco consumption presents an interesting challenge to calculating the CPI. While it is a small fraction of total consumption, declining rather steadily from 1.287% in 1987 to just 0.665% in 2016, its costs have increased dramatically more than the CPI itself. As a result of litigation and taxes, the tobacco cost's index value has gone from 123.3 in June 1987 to 1,029.1 in June of 2017. An increase of 735%. Yes, tobacco products make up a small fraction of the overall consumption bundle. However, its dramatic cost increase causes it to have an outsized impact on the index. Dropping this one item reduces the CPI's overall growth by about 1.3% from 1988 to 2017. Furthermore, unlike many other items, people either do or do not smoke meaning the cost has a significant impact on some and not others.

As tobacco plays such a unique role in the CPI, some consideration should be given to whether or not the product should be included in the CPI calculation. Unlike most of the more consequential items in the BLS consumption basket, tobacco is an item that has a zero weight in many family budgets. Housing, food and the like are things every family has to spend money on - not tobacco. As of 2015, 15.1% of the US population smokes.[13] Even if that means 25% of American households have at least one smoker, since a household can have multiple members, it also means a CPI that includes tobacco costs will overstate inflation for 75% of the population. Also, most of the increase is due to excise fees of one type or another. Had the government decided to raise the same amount of money via an income tax, then there would have been little recorded tobacco price inflation. According to the United States

[13] Figure drawn from https://en.wikipedia.org/wiki/Prevalence_of_tobacco_consumption. That page also includes statistics for a number of other countries.

Department of Agriculture (USDA), the wholesale price of tobacco leaf was $1.573 in 1987 and $2.018 in 2016.[14] That corresponds to an increase of just 28% over a period when the CPI more than doubled.

At the same time there are clearly reasons to keep tobacco in the CPI's calculation. If 25% of households do use tobacco, then the weight in their consumption bundle should be tripled from what it is now. Removing tobacco from the CPI further understates its impact on these families. In many cases the CPI is used to estimate the inflation's impact on an "average" family. The source of the price change does not matter in this case.

Rather than come down one way or the other here, the discussion that follows allows for cases where tobacco is and is not included in the CPI's calculation. Depending on the context, people can then pick the version they think is most appropriate.

IV. Items with Minimal Changes in Consumption Value over Time

Calculating a CPI based upon items that have seen a minimal impact on their consumption experience from technological innovation requires deciding what to include. Any list is bound to be controversial and this study does not pretend to have a perfect rule. The final set the study produced can be found in Table 4. In 2016, the list contained nearly 40% of the CPI and, with housing, it accounts for over 70% of the index.

Here technology free refers to an item whose consumption value has not changed over time. That is separate from whether production has seen technological improvements. For example, personal care products like toothpaste have produced a fairly similar consumer experience since the late 1980's. But, the packaging has changed and, likely, the speed and efficiency with which tubes are filled has changed as well. In this case, consumption gains come through reduced prices. If new techniques allow

[14] See the 1987 and 2017 USDA annual crop values summary.

toothpaste to be produced 10% cheaper, then presumably competition will force the price down 10%. That will be fully reflected in any CPI calculation. In contrast, vehicles have been left off of the list for the opposite reason. A new and optional electronic traction control system may raise the cost of a car by 2%. If the consumer pays for the new system, the price of the car has actually fallen when the value of the new traction control system is properly accounted for. Yet, the CPI calculation would show a 2% inflation rate for automotive costs.

A. Constructing the Index and Matching Weights to Prices

In order to calculate the tech-free and other indices developed here, BLS price and consumption data going back to 1987 has to be matched year-by-year. While many of the price series go back much further, others have more recent starting dates. Handling these issues required making a number of judgement calls.

When it comes to producing a matching time series from the BLS data, a significant hurdle arises from the way it aggregated goods and services into primary, secondary and other categories and sub-categories before and after 1997. A particularly difficult problem involves pets and pet supplies. Prior to 1997 the primary category “toys, hobbies, other entertainment” contained (among many other sub-categories) “pet expense.” At the same time the primary category “entertainment” had a sub-category “entertainment services” and it had a sub-category “photographer fees, film processing, pet and veterinary service, and other.” Starting in December 1997 the BLS regrouped these into a new category “recreation.” It contained many sub-categories including “pets, pet products, and services.” That sub-category itself contained the sub-categories “pets and pet products” and “pet services including veterinary.” To maintain a constant set of categories, many were hand-matched across years to ensure consistency. (The list is in the Appendix, Section X.) However, in two cases “pets, pet products and services” and “education and communication” this was limited by the availability of matching price data.

Together they amount to about 7.5% of the CPI. Excepting these two categories, hand matching allowed for pasting between the pre and post 1997 data.

Since none of the indices created here include “pets, pet products and services” or “education and communication” before 1997, in what follows if an index based on all goods and services is constructed it should be understood to exclude these two categories until 1997.

B. A Comparison of the Tech Free Indices and the Official CPI

After having matched the BLS data through time, various indices were constructed to include the group making up the tech-free and technology impacted variants. Figure 4 compares a number of these indices against each other and the official CPI.

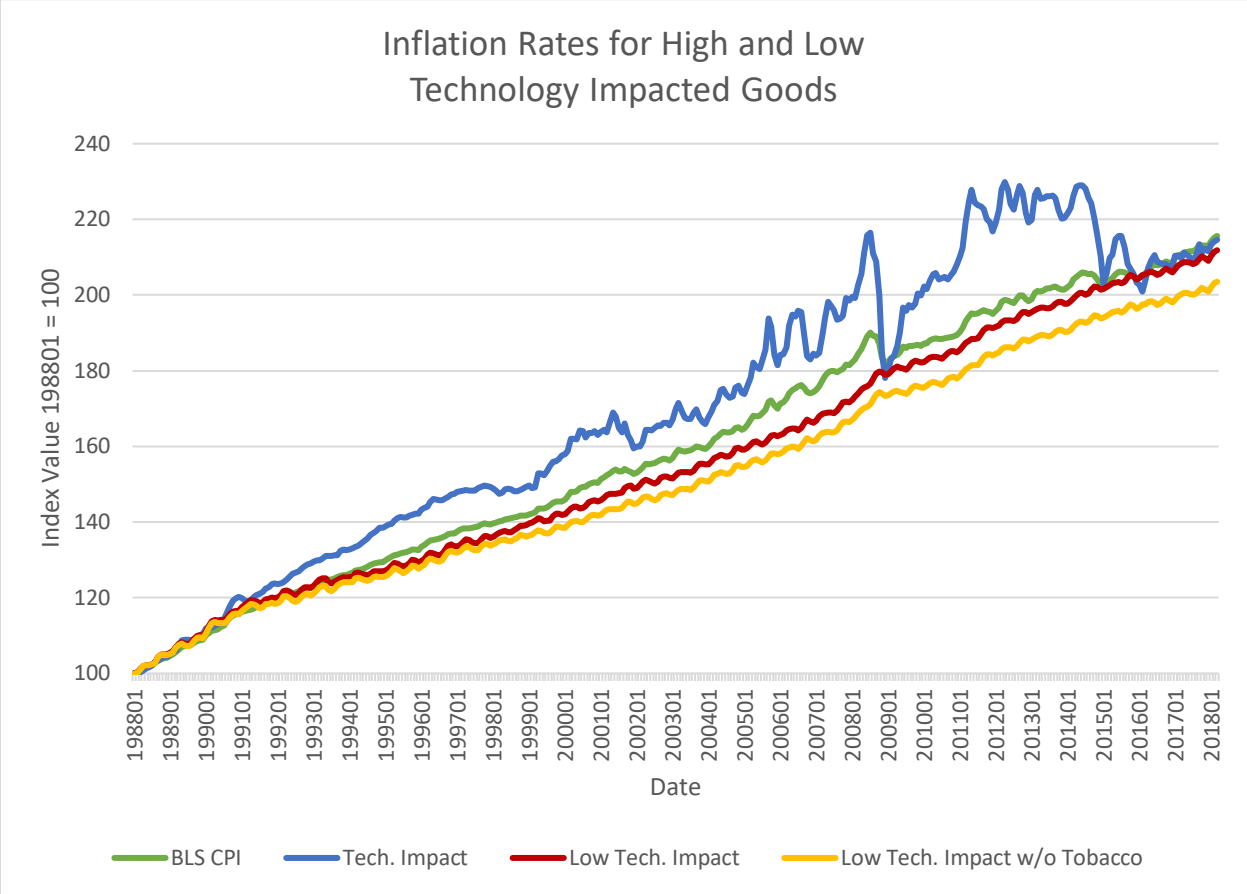

Figure 4: Price Growth in Low versus High Technology Impacted Goods and Services. BLS CPI is the official CPI. Tech Impacted are goods that have seen the consumption experience change over time due to

technological improvements. The Low Tech. impact indices are the set of goods that have had their consumption experience relatively unaltered over time. The w/o Tobacco indicates the index excludes tobacco.

The BLS CPI line in Figure 4 represents the BLS index with all items included and without any adjustments beyond what the BLS incorporates. The Low Tech Impact line represents the CPI based on the list of technology free goods including tobacco. The Low Tech impact w/o Tobacco line is the same index with tobacco excluded. The CPI based on goods with a consumer experience that was judged to be impacted by technological change is represented by the Tech Impacted line. Both the technology free and technology impacted lists exclude real estate. All the indices are normalized to 100 as of January 1988.

From January 1988 through March 2018 the technology impacted index increased at a cumulative average annual rate of 2.66%. In contrast, the technology free index increased at a rate of 2.52%. The difference of 0.14% per year may seem small, but it does add up. More importantly, the difference in the intervening years has been quite large, and the overall difference is large enough to alter the interpretation of some long-term price series.

To a large degree, the technology-impacted index's relatively large rise is driven by medical care. In 1987 medical services composed 3.049% of the consumption basket and had an index value of 129.9 in June of that year. By June 2017 it was 8.549% of the index and its index level had increased to 474.36. That is a 265.17% increase or 4.57% per year. These numbers are far larger than the overall rate of increase in the CPI and its impact has been growing over time. If medical care is removed from the technology-impacted index, it actually increases by far less than the technology free index.[15] The technology-impacted index minus medical care only grew at an annualized rate of 1.79% from January 1988 to March 2018.

[15] As noted earlier several papers have indicated that the lack of hedonic adjustment for advances in medical care has been particularly problematic, Eggleston, et al. (2011). Section IV.D contains a fuller discussion.

C. Adding Hedonically Adjusted Items to the Low Tech Impact List

The BLS prices the items in Table 2 based on a list of consumption characteristics in order to remove the impact of technological changes. If this has been successful, the resulting price index should reflect a constant consumption value. They should thus fit the criteria for inclusion in the list of items that have seen relatively little change in consumption value due to technological changes over time. (See Section I.) Adding them to the list of items in the low technological impact group does change its progression over time. Previously it grew at an average annual rate of 2.51% per year. Adding in the items from Table 2 reduces it to 2.22%. Over the sample period, this reduces the overall growth in the index from 103% to 94%.

D. Medical Care Costs and Adjustments

While the BLS tries to adjust price levels for a few commodities (see Table 2), medical care is not one of them. Now consider how cancer care has changed over time. Lee et al. (2016) estimate treatment costs and the number of people stricken from 1998 to 2012. Their estimates cover three-year periods, starting in 1998-2000 and ending in 2010-2012. All figures in their tables are reported in 2014 dollars. Based on their estimates, the cost in 2014 dollars of a cancer case went from $6,898 in the 1998-2000 period to $8,168 in the 2010-2012 period - an increase of 18% in real dollar terms. However, according to the National Cancer Institute the three-year survival rate went from 68.9% to 73.0% over the same period of time.[16] How much is a 4.1% increased chance of survival worth? It is certainly not invaluable. Nevertheless, since medical expenses are not hedonically adjusted such changes are not accounted for in the CPI's calculation.

[16] See the National Cancer Institute's web page at https://surveillance.cancer.gov/statistics/types/survival.html and the link titled "Relative Survival by Year of Diagnosis."

One might object that trying to adjust for technological improvements that extend life is extremely difficult. However, problems arise in other cases as well. Consider prosthetic legs: a study in 1994 by Williams estimates that the average permanent below-knee prosthesis cost $10,000 while an above knee one cost $19,000. Technology has now led to prosthetic variations with substantially different levels of functionality.[17] Quoting from McGimpsey and Bradford (2010):

> For $5,000 to $7,000, a patient can get a serviceable below-the-knee prosthesis that allows the user to stand and walk on level ground. By contrast, a $10,000 device will allow the person to become a "community walker," able to go up and down stairs and to traverse uneven terrain.
>
> A prosthetic leg in the $12,000 to $15,000 price range will facilitate running and functioning at a level nearly indistinguishable from someone with two legs.
>
> Devices priced at $15,000 or more may contain polycentric mechanical knees, swing-phase control, stance control and other advanced mechanical or hydraulic systems.
>
> Computer-assisted devices start in the $20,000 to $30,000 range. These take readings in milliseconds, adjusting for degree and speed of swing. Above-the-knee amputees can walk with a C-Leg without having to think about every step they take.

Based on the BLS's medical price index, spending $19,000 on medical care in 1993 was equivalent to spending $29,727 in 2009. (These dates were selected since Williams (1994) presumably used pricing data from 1993 while McGimpsey and Bradford (2010) presumably used data from 2009.) However, in 2009 for $29,727 you were able to buy a computer-assisted prosthetic that made it possible to "walk . . . without having to think about every step." No amount of money could purchase that in 1993. Even here, where life and death are not on the line, it seems clear that prices need to be adjusted for technological improvement if medical care is going to be properly accounted for in the CPI.

As medical care is not hedonically adjusted the time series includes some anomalous periods that are similar to what was noted earlier for real estate. In 2000 real mean family income (in 2015

[17] Then as McGimpsey and Bradford (2010) indicate the replacement rate on prosthesis remains about once every four years.

dollars) was $91,702. In 2013 it was $90,335 in real 2015 dollars and $87,671 in nominal dollars. In nominal dollars, it went from $65,773 in 2000 to $87,671 in 2013.[18] Over this same time period, the fraction of income devoted to medical care went from 5.768% to 7.163%, implying total nominal spending per household rose from $3,794 to $6,280. Simultaneously, the medical cost index went from 255.5 to 420.7. In percentage terms, the cost of a unit of medical care rose 65% while the CPI rose only 36%. Converting nominal dollars spent to units purchased implies that the average family bought 88.69 units of medical care in 2000 and 89.16 units in 2013. As with real estate, this implies (1) real incomes were down over this period, (2) the cost of a unit of medical care rose more than most other goods and (3) consumers increased the number of units they purchased. Once again, this is a pattern similar to what a Giffen good would produce. Defining the unit of housing consumption as a square foot seemingly creates units that are closer to ones with a constant consumption value over time. However, there does not appear to be an obvious and simple adjustment that will do the same for a unit of medical care. Rather a more complex hedonic model, like the one BLS uses for televisions, is needed. (Prior research looking into this issue include Cutler, McClellan and Newhouse (1998), Cutler, McClellan, Newhouse and Remler (1998) and Eggleston et al. (2011).) Since the BLS does not standardize a unit of medical care so that one unit brings a constant level of utility over time and because attempting to do so is far beyond this paper's scope, the calculations that follow will include cases where medical spending is dropped from the index.

E. CPI Adjusted for Housing Size and Dropping Medical Care

Section I argued that a price index formed with just items that have seen minimal changes in their consumption value provides an upper bound on the true CPI. However, an alternative that includes far more items can be produced if one assumes that the BLS has properly adjusted for the consumption

[18] Median income data from the St. Louis Federal Reserve's FRED database coded MEHOINUSA646N. This series represents the "Median Household Income in the United States, Current Dollars, Annual, Not Seasonally Adjusted."

value of all technological changes, excepting medicine, and calculates housing costs on a per square foot basis. This leads to an index that includes housing costs per square foot basis but excludes medical expenses due to the problematic nature of adjusting them for technological changes. These changes alone yield a CPI that has not risen as much as either the low technology impacted index or the official CPI.

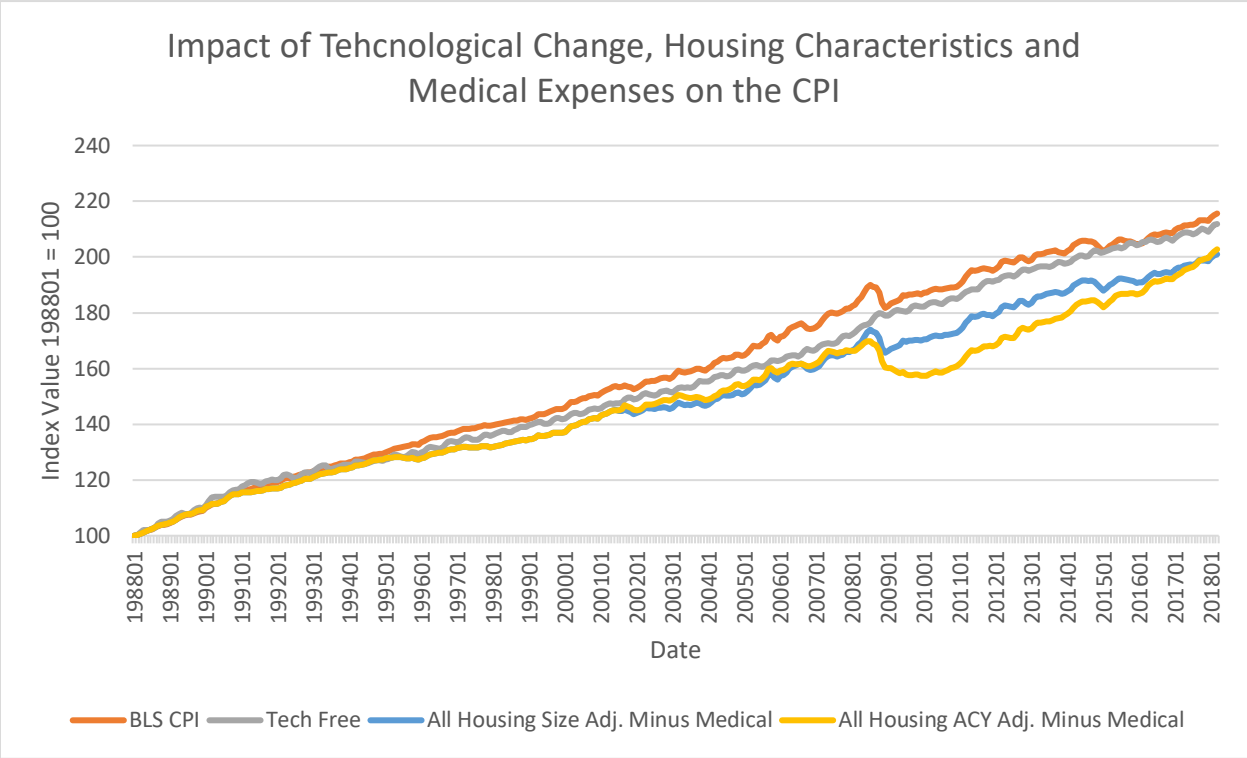

Figure 5: All Housing Size Adj. Minus Medical is the all Items index exclusive of medical costs and with housing costs adjusted for physical size. All Housing ACY Adj. Minus Medical uses the ACY index in place of a size adjustment starting in March 2001 when the ACY index becomes available.

From January 1988 to March 2018, the official CPI grew 2.57% per year and the Tech Free index grew 2.51%. By comparison, the all item index minus medical expenses and with housing adjusted for physical size grew only 2.33% per year, or 2.36% if the ACY index is used once it becomes available.

Medical and housing expenses make up a significant fraction of the CPI and have seen their consumption characteristics change over time. Yet, neither is accounted for in the official index. Without the appropriate adjustments, these items are likely to overstate the cost of purchasing a basket of goods with a constant level of utility over time. Adjusting for housing to measure its cost per square foot or

with the ACY index is relatively straightforward. Innovations in medical care are significantly more difficult. One potential solution is to use an index that considers the changes in housing consumption over time while dropping medical costs as shown by the blue line in Figure 5.

V. Comparing CPIs: Which is "Best?"

It is easy to create a variety of CPIs that indicate inflation has been lower than the official rate. Of course, by changing the categories that are included or their calculation it is possible to reverse that conclusion. This raises the question of how to decide the "best" model among the options. Naturally, one solution is theoretical. It is possible to set up a representative consumer model and then ask which CPI best captures that agent's experience (Fixler, et al. (1999), Lebow and Rudd (2003), Diewart, et al. (2009), David et al. (2006), Erickson and Pakes (2011), Diewert et al. (2016)). Rather than going that route, this paper asks if aggregate consumer behavior better reflects one CPI methodology or another. "Best" is then defined purely by the empirical results.

All of the tests in this section all follow the same functional form. Let t represent a quarter. The dependent variable y_t is the year-over-year change from quarter $t-4$ to t. There are two primary independent variables that vary with the CPI being tested. One is the change in the real interest rate (s_t) and the other is the percentage change household income (h_t), both of which are calculated from quarter $t-1$ to t. The other control variables are U_t the change in the unemployment rate from quarter $t-1$ to t; G_t the percentage change in the nominal GDP per capita from period $t-1$ to t; C_t the inflation rate from $t-4$ to t based on the CPI being tested and quarterly fixed effects (Q_t). This leads to the following regression equation.

$$y_t = \beta_0 + \sum_{i=0}^{3} \beta_{i+1} s_t + \beta_{i+4} h_{t-i} + \beta_9 U_t + \beta_{10} G_t + \beta_{11} U_t + \beta_{12} Q_2 + \beta_{13} Q_3 + \beta_{14} Q_4. \quad (4)$$

While consumers employ a variety of loan types, two that seem likely to influence their near-term behavior are those on 24-month personal loans and credit cards. (While the former covers 1988 to date, the latter series begins in November 1994). Both are reported on a quarterly basis. The real rates in (4) are constructed by calculating a quarterly inflation rate based on each alternative CPI measure and subtracting that number from the consumer loan rate. The other independent variable for these tests is per capita income, which is reported quarterly by the U.S Bureau of Economic Analysis and the unemployment rate from the BLS.[19] These two macro variables may impact consumer perception about their future prospects and thus may play a role separately from the inflation rate in borrowing, default and consumption decisions.

Due to the overlapping nature of the data, the *p*-values need to be adjusted to account for the non-zero off-diagonal terms in the variance-covariance matrix. In the tables that follow this is accomplished via *R*'s Sandwich package using its heteroskedastic, auto-correlated consistent estimator (vcovHAC function). The other test statistic displayed in the tables is the Davidson-MacKinnon *J*-test for non-nested models. The reported *J*-tests indicate if an alternative CPI provides statistically significant information above and beyond the BLS CPI in a regression. The values are calculated using *R*'s base package with --values based on the Sandwich package's HAC estimator.

A. Changes in Consumer Debt Levels

When real incomes rise, consumers purchase additional goods and services with their newfound wealth. Some of that additional consumption should anticipate higher future income, leading to an increased demand for credit to obtain "big ticket" items. Conversely, if consumers see real interest rates rise, that should discourage indebtedness. These changes should correspond to consumer perceptions.

[19] U.S. Bureau of Economic Analysis, Personal income per capita [A792RC0Q052SBEA], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/A792RC0Q052SBEA.

The set of CPI alternatives are tested against consumer debt per household. Its construction starts with monthly seasonally adjusted data on outstanding total consumer credit owned and securitized.[20] This number is then divided by the total number of US households. Since the latter series is annual, it was weighted by month and then divided into the consumer credit numbers. The weighting scheme started with consumer credit outstanding in January of year *X*. This was then divided by the year *X*-1 households and February was divided by households weighted 1/12 for year *X* and 11/12 for year *X*-1. Et cetera. To match other databases only quarterly values were retained. The results from the consumer indebtedness tests are in Table 5.

In Table 5 Panel A interest rates are based on the 24 month personal loan rate. While all of the alternative CPI measures based on the tech free set of goods produce a higher R^2 then the official CPI, only the tech free versions that also use the ACY index generate a statistically significant *J*-values . However, in Panel B where the real interest rate is based on the credit card rate, Not only do most of the tech free good based alternatives yield a higher R^2 statistic but so do those based on all goods if the ACY index is used to adjusted for housing costs. Furthermore, all of the indices with higher R^2 values also yield *p*-values for the *J*-test that are significant at the 1% level. Overall, in Panel B the CPI that generates the best fit is the one based on the set of tech free goods with the addition of housing adjusted for size and then the ACY index when it becomes available. Also note that credit card rates seem to better fit consumer borrowing behavior than does the 24-month personal loan rate (in that the former tests yield substantially higher R^2 statistics than the latter).

[20]Board of Governors of the Federal Reserve System (US), Total Consumer Credit Owned and Securitized, Outstanding [TOTALSL], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/TOTALSL.

B. Consumer Default Rates and Real Interest Rates

Consumer loan defaults are another area where short-term changes can have immediate consequences. When consumers perceive a rise in real interest rates, their incentive to default should increase. Consumer loan charge off data for these tests come from the Federal Reserve's Charge-Off and Delinquency Rates on Loans and Leases at Commercial Banks database. It provides quarterly data on overall consumer loan default rates on both an unadjusted and seasonally adjusted basis.

Table 6 summarizes a number of regression results.[21] A cell includes a * if the CPI variant produced at least one regression coefficient for the income or interest variables that was statistically significant at the 5% level. For the alternative CPI measures a cell contains a † if it produces a higher regression R^2 than the BLS CPI. The results indicate that over half of the tests using alternative indices that include the ACY index produce a superior fit to the charge off rate data (no matter the category) than the BLS index does. This is generally true whether the interest rate is based on either the personal loan or credit card rate, but holds almost universally for the indices based on the set of all goods. A *J* indicates the *J*-statistic yields a *p*-value below 5% and a *j* a *p*-value below 10%. The indices based on the set of all goods along with the ACY index yield significant *J*-statistics if the interest rate derives from the personal loan rate. Focusing on the regressions that use the credit card rate as the basis of the real interest rate, for the most part the indices based on the tech free goods with the ACY index generate *p*-values that are below 5%. An examination of the appendix Table 11 and Table 12 indicate that similarly to the results on consumer debt levels, the credit card rate seems to more closely correlate with consumer behavior than does the personal loan rate. For the most part, the former again produces

[21] Due to the number of possible permutations and combinations, the complete tables are quite long. However, readers interested in seeing all of the parameter estimates and *p*-values can find them in the appendix Table 11 and Table 12.

higher R^2 statistics than does the latter. This applies even when the dependent variable is the personal loan charge off rate.

Finally, cells in Table 6 include a + if the index includes housing and if replacing the size adjustment with the ACY further improves the fit. For the most part, this swap does seem to improve the model's ability to fit the consumer default data. Any index based on the set of all goods generates a higher R^2 statistic with the ACY index than without it. The same holds true for the indices based on the tech free set of goods when the personal loan rate is used for the interest rate.

C. Per Capita Consumption Tests

As consumers perceive changes in real incomes and interest rates, they are likely to adjust their overall level of consumption. When people experience a real wage increase, the cost of consumption (work) declines and one expects aggregate consumption levels to increase. Now, suppose real borrowing rates increase. If increased consumption requires additional debt that should suppress aggregate consumption. The results from these tests are in Table 7.

When interest rates are based on the 24-month personal loan rate, the BLS CPI yields highest R^2 statistic. For the *J*-tests, only the tech free good based indices with the ACY adjustment produce *p*-values below 10%. However, when the credit card rate is used instead, the tech free index and nearly all of the indices that use the ACY index yield higher R^2 statistics than does the BLS CPI. Furthermore, nearly all of the tech free indices and all those that use the ACY index yield statistically significant *J*-statistics. The overall results indicate that the tech free based indices with the ACY housing cost adjustment provide the fit to the consumption data. Also note, that the R^2 statistics are uniformly higher when the credit card rate is used as the real interest rate instead of the 24-month personal loan rate.

Most of the tables in this section seem to support the idea that relative to the 24-month personal loan rate, the credit card rate is viewed by households as the more important when making

their consumption decisions. At the very least, it is true that real interest rates based on the credit card rate overall produce higher R^2 statistics for the borrowing, default and consumption tests.

VI. The Impact of the CPI on Long Run Economic Trends

The CPI's role in the real economy can be profound because its reported value impacts numerous contractual and government payments. Examples include cost of living adjustments for wages and the coupon payments made on treasury inflation protected bonds. In more academic settings, it can impact the conclusions one draws from long term data that needs to be converted into real dollars. This section will examine what this implies for our understanding of how real wages and poverty levels have changed over time.

In what follows the analysis concentrates on how the official numbers change using either the all item index or the index of items seeing minimal technological impact both with and without tobacco costs. Given the prior results, these basic indices are also paired with and without housing costs. If the index does include housing, then housing costs are adjusted for physical size and, post March 2001, the ACY index. The reason for selecting these indices in particular is that they produce a higher R^2 than the official CPI when it comes to linking real incomes and real consumer loan rates with consumer debt levels and commercial bank charge offs. Since the majority of US households no longer include a smoker, the results are also shown for the indices that exclude tobacco costs.

A. Wage Growth over Time

There has been a wide-ranging debate regarding real wage stagnation since 1999. Using the BLS CPI and income data from the St. Louis Federal Reserve, real median family income reached $60,062 in 1999 (in 2017 dollars) and did not exceed that amount until 2016. Naturally, 17 years of limited wage growth produces a lot of speculation as to its cause. A web search turns up thousands of articles on the subject. Some examples can be found in Desilver (2014), Covert (2015) and Mishel (2015). Academics have

apparently been less interested in this issue. Several searches on EconLit, including “wage growth”, “wage stagnation” and “income growth”, produced nearly no results connected with attempts to explain wage trends over the past few decades. (In contrast there are numerous papers seeking to explain the measured slowdown in US productivity growth. See Syverson (2017) for a review of the literature.) However, any explanation of real wage growth has to start with a time series that is in real dollars. That requires deflating by a CPI measure of some sort and if inflation is overestimated then wage growth will be higher than the numbers indicate.

The graph below compares median household income over time under different CPI indices.

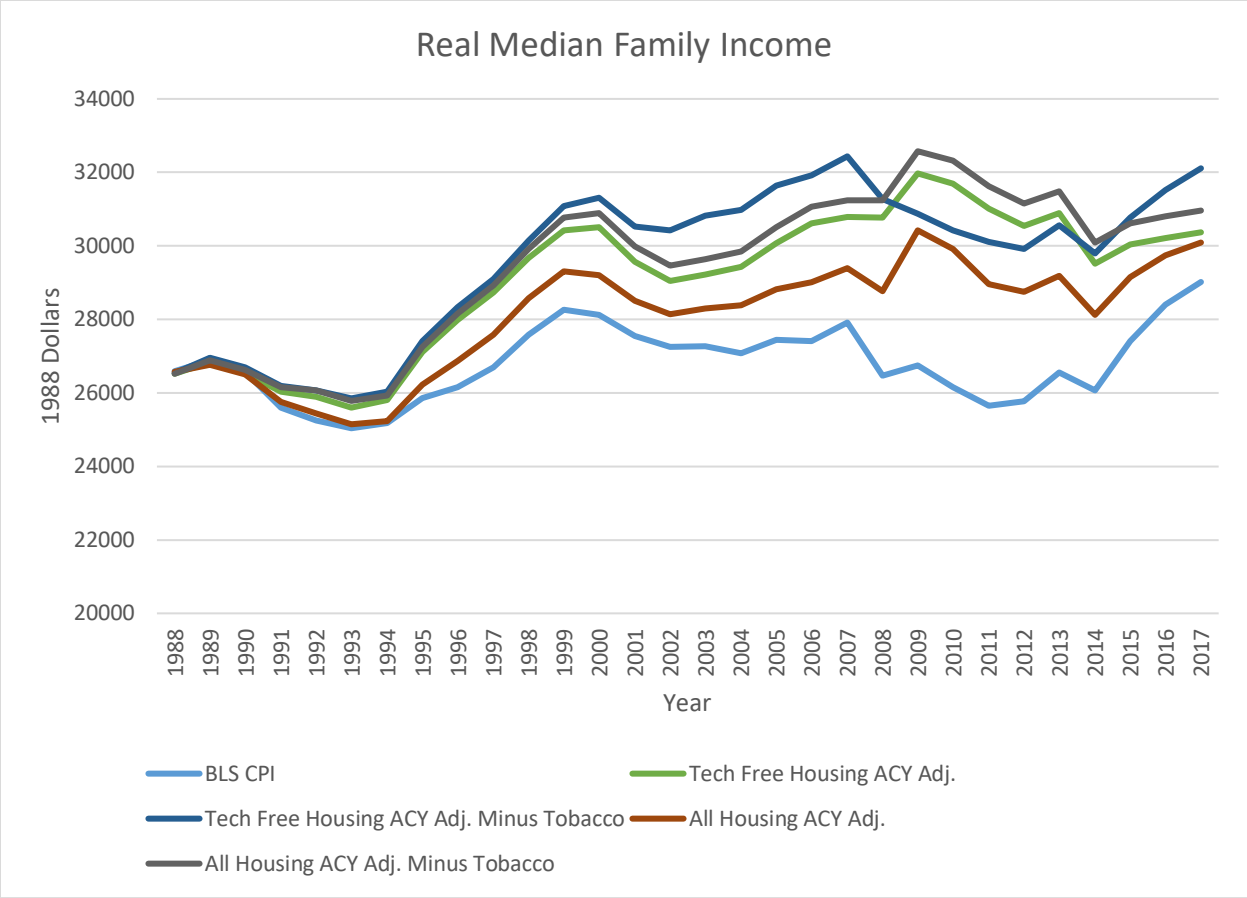

Figure 6: Real median family income based on various price indices. The BLS CPI is the official CPI issued by the BLS. The All Housing Size Adj. is an index of all items with the cost of housing adjusted for square feet. The Tech Free Housing Size Adj. is an index of items for which technological change has not significantly altered the consumption experience, along with housing costs adjusted for square feet. Minus Tobacco indicates the index excludes tobacco. Income data from https://fred.stlouisfed.org/series/MEHOINUSA672N.

The light blue line in Figure 6 represents the growth in real incomes based on the official CPI. This is the time series typically cited in discussions about wage stagnation. It locally peaks in 1999 at $28.264 (in 1988 dollars) and reaches its overall high in 2017 at $29,018. The obvious event is the financial crisis when it falls dramatically, only recovering to its previous peak in 2016. This has led to many mass-market articles about stagnant wage growth in the US. Based on the official CPI it does appear that real median wages have essentially stagnated since 1999. However, adjusting for inflation using one of the other indices, wage growth appears somewhat better. While all indicate that wages

have just fully recovered since their pre-recession peak, they do not show a 17-year failure in real wage growth either.

Given the 2007 recession, the claim that wages have been stagnant since 1999 is based on the 2007 peak of $27,911. Consider the dark red line, which includes everything in the official CPI and adjusts housing for physical size and the ACY index. Its 2007 peak is $29,402, which is 0.33% above its 1999 value of $29,305. However, using the Tech Free index with housing adjusted for physical size and the ACY index, the median household income reached $30,781 in 2007, which is 1.2% above the 1999 peak of $30,423. For non-smoking households, the increase was 0.60% when using the index of all items and 1.5% when using the tech-free based indices over the same period of time.

Moreover, in terms of the long-term trend, all of the adjusted indices show higher median household income growth than the BLS CPI does. From 1988 to 2017, the BLS CPI indicates median incomes have only grown 9.1%. By comparison, over the same period of time, the all goods index with housing size and ACY adjusted indicates median household incomes are up by 13.3% while, under the technology free index with housing size adjusted, total growth has been 14.5%. For non-smoking households, the total growth is 14.8% and 16.7% under the all goods and tech-free based indices respectively. That is roughly a third more than the value produced with the BLS CPI.

B. American Poverty Statistics

Related to the overall income data is the poverty rate. According to the Institute for Research on Poverty, the official poverty threshold was set at three times the cost of a minimum food diet in 1963. It has since been updated annually based upon the CPI.[22] The Census Bureau then compares this figure to

[22] See http://www.irp.wisc.edu/faqs/faq2.htm for additional details.

a family's total income. If a family falls below the line, all members of the household are defined as living in poverty.

The poverty rate has naturally attracted a lot of attention over time. While the press focuses on the official rate, recent academic studies have looked at how different definitions of inequality affect the estimated trends and rates.[23] The issue raised among academics is whether inequality should be measured with income (as the Census Bureau does) or with consumption. There are a number of data issues involving each and they are beyond the scope of this study. Here the analysis just assumes that the Census Bureau's measure is accurate but for the poverty threshold's level, which can be adjusted via one of the versions of the CPI constructed here. To create estimates of the poverty rate based on alternative CPIs, data was drawn from the IPUMS=CPS data extraction web page (Flood, King, Ruggles and Warren (2017)). This facility provides Census microdata by individual to the public.

As many commentators have noted, the official poverty rate has not seen a downward trend over time. It was 13% in 1988 and 12.3% in 2017. While it does not remain stable, it seems to drift within a bound of about 3%. Over this period of time it reached a minimum value of 11.3% and a maximum of 15.1%. However, that is based on the official CPI, which, as argued earlier, overstates inflation and thus understates real incomes. In this case, it overstates the poverty rate threshold.

When comparing the poverty rates over time note that the data for calculating alternative CPI estimates only goes back to 1988 and all of the indices start at the same initial value. For the earlier years, that means any CPI adjustments can only have a limited impact since any differences need time to build up. For example, if one index grows at 2% per year and another at 1.94%, in the first year the poverty threshold will only differ between them by 0.06%. Over time however, that 0.06% will add up

[23] Recent papers have focused on consumption inequality as opposed to wage inequality, e.g. Attanasio and Pistaferri (2014), Aguiar and Bils (2015) and Attanasio and Pistaferri (2016).

and towards the end of the series there will be a more significant difference. With that in mind, Figure 7 displays the poverty rates from 1988 to 2017 based on the All and Tech Free indices with housing adjusted for size and the ACY index with and without tobacco's inclusion.

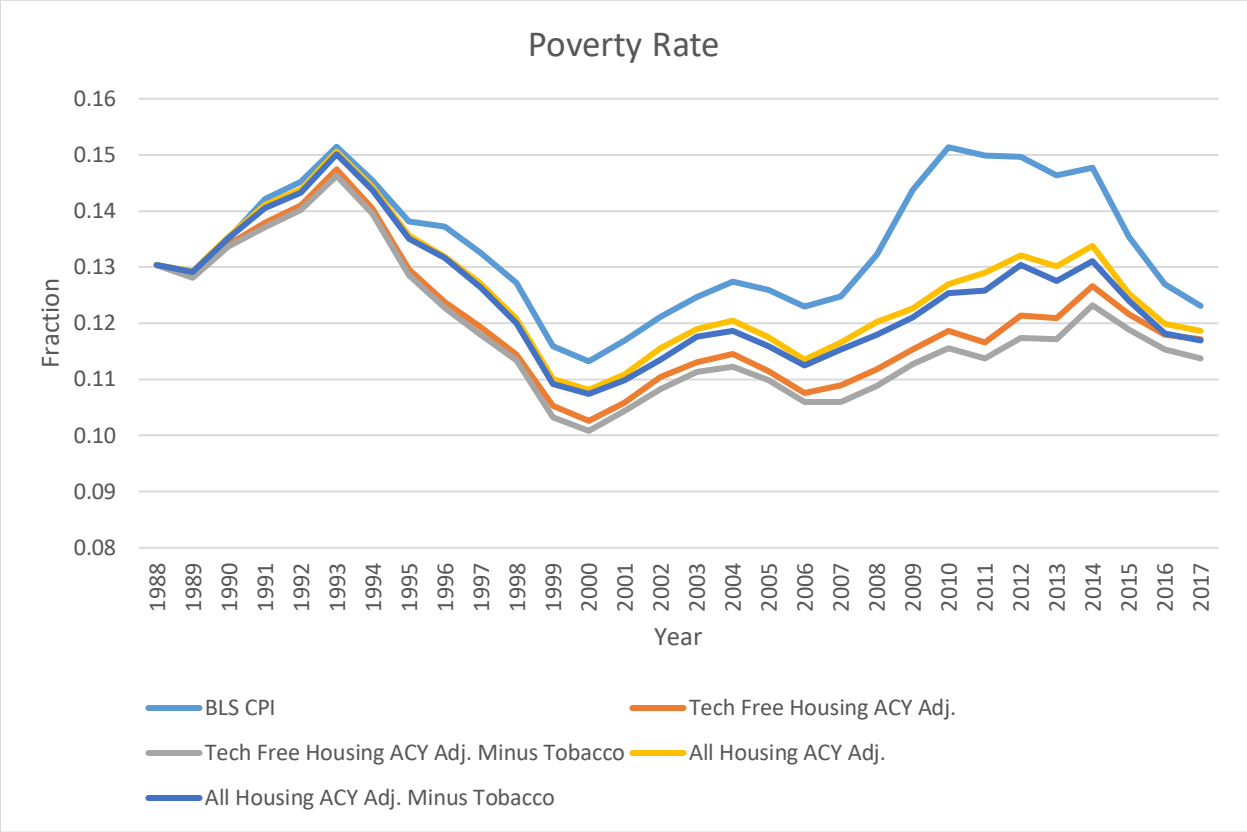

Figure 7: Poverty Rate with alternative indices. The BLS CPI is the official CPI issued by the BLS. The All Housing ACY Adj. is an index of all items with the cost of housing adjusted for square feet until March 2001, after which the ACY index is used. The Tech Free Housing Size Adj. is an index of items for which technological change has not significantly altered the consumption experience, along with housing costs adjusted for square feet until March 2001 and the ACY index thereafter. Minus Tobacco indicates the index excludes tobacco.

While the official poverty rate has remained fairly steady over time, when the threshold is calculated via one of the adjusted measures, a modestly different story emerges. While the general up and down patterns remain, the overall trend is negative. The official poverty rate peaked in 1993 at 15.1% only to return to that level in 2010. When the All goods index is adjusted for housing size and ACY index the poverty rate also peaks at 15.1% in 1993. It next peaks at 13.4% in 2014, a 1.7% improvement.

For non-smoking households, the 2014 peak was even lower: 13.1%. Using instead the index based on goods with little change in their consumption experience due to technological advancements and adjusting housing rates for size, the 1993 peak was 14.7% (14.6% if tobacco is excluded). In 2014 it reaches 12.7% (12.3% without tobacco). In 2017 the rate under the tech-free index with housing size adjusted was just 11.7% and, if you exclude tobacco, 11.4%.

Given the relatively short time frames involved and the small values poverty rates deal with, these are economically significant differences. Even a 1% cut to the peak poverty rate is a reduction in poverty of over 6%. The exact figure will depend on the base one uses. Using a 15% base, the peak rate yields a reduction of 1/15 = 6.67%. From this perspective, the tech-free with housing size adjusted index value of 11.7% falling 0.6% below the official rate indicates that progress against poverty has been at least somewhat more successful than typically reported.

Another way to look at the data is to start in the year 2000, when the official poverty rate hit a low of 11.3%. That same year, using the CPI adjusted for housing size and the ACY, the poverty rate was 10.8%. (For non-smoking households it was 10.6%.) Based on these figures, the financial crisis increased the official poverty rate by 3.8% from 2000 to 2010 (the poverty rate's peak), but only by 1.9% using a CPI with housing costs size and ACY adjusted. For non-smoking households, the poverty increased by just 1.6%. If the tech free index with housing size adjusted is used, then the 2000 poverty rate comes in at 10.3% (or 10.1% excluding tobacco). In 2010, it reaches 11.9% (or 11.6% without tobacco), an increase of 1.6% (1.5%). This is an even more modest change from that using the indices based on All Goods and, of course, from the official rate.

Overall, one way to measure progress against the poverty rate is to start with the longest time interval available. In 1988, all of the CPI measures are identical by construction and thus they all produce the same poverty rate of 13%. By 2017 the official rate showed an improvement of 0.7%. In contrast, the

rate, using the CPI with housing adjusted for physical size and the ACY index, is 1.2% lower and for non-smoking households, is 1.3% lower. Using the tech-free equivalents, the reductions are 1.3% and 1.7% if tobacco is excluded. It is clear from the graphs that, when the CPI is adjusted to account for the long-term changes in housing characteristics, there appears to be a general negative trend in the poverty rate. Nevertheless, given that poverty rates are a slow moving process and the year-to-year variation, it is not clear at this point if the current trends will turn into an overall long run decline.

VII. Robustness Tests

While many of the tests discussed earlier indicate that alternatives to the official CPI offer a better fit in regressions on changes in consumer behavior, it is possible that one or two years of data is responsible for all of the results. If removing a few quarters of data flip the results in favor of the BLS's version of the CPI, then perhaps the official CPI is a generally superior measure. To test for this, all of the regressions in Table 5, Table 6 and Table 7 were run on subsets of the data. In each case, the process begins by repeating the regression in the corresponding table for an alternative index. Next, Cook's distance measure is calculated to find the four or eight most influential data points. These are then dropped from the data. Finally, the tests are rerun using the new smaller dataset. This drops the four or eight observations that have the highest impact on the regression involving the alternative index. In general, these will not correspond to the most influential observations in the BLS CPI regression. Overall, if an alternative index outperforms the BLS CPI on the full index, these smaller datasets should indicate if this is due to just one or two years of data.

Results from the robustness tests are in Table 8, Table 9 and Table 10. Each displays the resulting difference in the R^2 statistic between the alternative CPI and the BLS version. A positive entry indicates the alternative generates the higher value. The columns labeled *J*-test indicate the resulting *p*-value for that test.

The household debt tests in Table 8 indicate that in general the alternative indices continue to produce a better fit to the data than does the BLS CPI. Also, the *J* tests remain significant, especially in the cases where real interest rates are based on the credit card rate. Table 9 repeats the tests using consumer loan charge off rates. Here many alternative CPI measures produce both a higher R^2 than the BLS CPI and generate a statistically significant *J*-statistics. Finally, Table 10 displays the results from the robustness tests on per capita consumption. Again, a large number of the indices continue to provide a better fit to the data than does the BSL CPI.

One item to note is that in a few cases the most influential observations were those that seemed to reduce an alternative index's fit relative to the BLS CPI. Looking through Table 8, Table 9 and Table 10 some rows indicate that removing the eight rather than four observations with the greatest impact on the alternative index's results, actually increases the alternative's R^2 statistic relative to the BLS CPI and reduces the *p*-value of it *J*-test statistic.

VIII. Conclusion

The CPI is one of the most closely followed statistics put out by the federal government. Markets are said to rise and fall based on the reported figure. Numerous contracts are adjusted by its value. While measuring the overall cost of goods and services may seem like a simple task, in practice it is not. Beyond the physical task of collecting the data there is the issue of what the data imply.

In principle, the CPI is supposed to measure the cost of a basket of goods that yields the consumer a constant utility level over time. If technology remained unchanged over time, the CPI calculation would be difficult enough as price changes induce consumers to change their consumption patterns. However, technology does change and that adds a layer of complexity. The BLS tries to account for technological change by hedonically adjusting prices for about 7% of the items in the index. However, that leaves

quite a few items that have seemingly had their consumption value altered by technological advancements over the years without any corresponding adjustment in how their prices enter the CPI.

Another issue impacting the CPI concerns the BLS's treatment of housing costs. The agency treats housing as a unit. That is to say a family consumes "a house." That leads to some anomalous time series patterns in housing consumption. Casual observation suggests instead that people consume housing on a per square foot basis. Making this one adjustment profoundly impacts the CPI because housing is nearly 40% of the index. It also eliminates some anomalous data patterns in which a decline in real incomes with an accompanied increase in home prices results in greater housing consumption; the marker of a Giffen good. Further improvements can be seen if the ACY repeat rent index is used after its starting date of March 2001. That index controls not only for residential size, but other unobserved characteristics as well.

One way to avoid having to adjust the CPI for the impact of technological change on the consumption experience is to create an index of items where such changes have been minimal. This paper shows that such an index provides an upper bound on the true CPI if technological changes do not increase production costs. Whether one uses an index based on all goods or just those that have seen little technological change to the consumer experience, once housing is adjusted for size, the overall index the new CPI grows at a much slower rate than the official version. This also changes the calculation of median income growth and the poverty rate, and the inferences one might draw about their time series properties.

Given the number of possible CPI variants, one way to winnow down which ones are best in a particular case is to look at how they fit consumer data. Presumably, if an index better reflects a consumer's perception of inflation, then it will also better fit that consumer's economic reactions. This was tested using household borrowing levels, consumer loan charge off rates and consumption per household.

When consumers perceive a change in their real wages or real interest rates we expect them to react in the financial markets by altering the amount they borrow and their propensity to default on existing loans. Tests based on household debt levels and charge off rates indicate that many of the alternative indices proposed here better fit the data than the BLS CPI. If housing is included in the index then using the ACY index when it becomes available and adjusting for the size of a typical residence prior to that, offers the best overall fit. The tests based on consumption per household indicate that if the real interest rate is based on the 24-month personal loan rate than the official CPI may be the best choice. However, if the credit card rate is used then quite a few alternatives do better, especially those that include the ACY index to account for housing costs.

A common question that arises when an alternative CPI is proposed is whether the new version is sufficiently different to make an economically meaningful difference. This paper offers two answers to that question. First, the alternative CPIs tested here do a better job of explaining when consumers will take on more debt and when they will default. Second, there is the economic difference in the time series they produce for real income growth and poverty levels. Under the official CPI it appears that median incomes have stagnated since about 2000. With any one of the CPI adjustments used in this paper, while real income growth has not been robust it has not been zero or negative either. Furthermore, relative to the conclusions one draws from the official CPI, there appears to be substantial median income growth over the decades. Similarly, under the official CPI one would likely conclude that public policy has failed to materially impact the poverty rate. Again, many of the versions of the CPI suggested in this paper alters that conclusion somewhat.

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X. Appendix

A. Index Construction over Time

In theory the CPI should measure the funds needed by a consumer to maintain a constant utility level over time. While theoretically simple, actually estimating the CPI is anything but. There is no obvious way to measure consumer utility. Even if that were possible, how would one compare individuals? Putting theory into practice thus involves making comprises.

One common compromise has been to treat a country's average household consumption bundle as the one selected by a representative agent and to use that when measuring the CPI. Since the goal here is to understand the current CPI's construction, its parts and their implications for the overall economy, nothing that follows will vary from that basic paradigm. Let $X_t = \left(x_{1t}, x_{2t}, \ldots, x_{nt}\right)'$ equal the vector of goods purchased by the representative consumer in period *t* and $P_t = \left(p_{1t}, p_{2t}, \ldots, p_{nt}\right)'$ equal the vector of prices. The cost of a bundle in period *t* then equals $C_t = P_t' X_t$ Based on the representative consumer's purchases, if the purchased bundle remains unchanged across two periods then inflation is defined to equal C_{t+1} / C_t. This ratio is taken to equal the additional amount the representative consumer needs from one period to the next to maintain a constant utility level.

The ratio C_{t+1} / C_t may accurately represent inflation for the representative consumer if the consumption bundle remains unchanged. But, of course, the aggregate bundle changes over time. Debates on how to handle time variation in consumption have a long history. Generally, they revolve around the systems named after Paasche and Laspeyres. The Laspeyres index uses the ratio period *t* bundle's cost over periods *t* and *t*+1 to measure the inflation rate, $P_{t+1}' X_t / P_t' X_t$. Paasche's version uses the relative cost of the period *t*+1 bundle over periods *t* and *t*+1, $P_{t+1}' X_{t+1} / P_t' X_{t+1}$.

If the representative consumer's consumption bundle remained unchanged over time the Laspeyres and Paasche indices would yield identical results. However, consumers respond to changes in

relative prices and other external factors leading them to change how much they spend for items across periods. In general, Laspeyres will overstate inflation unless consumer demand is completely price insensitive. Otherwise, a consumer with C_t dollars in period t will be better off in period t+1 than he was in period t using the cost C_{t+1} based on the period t consumption bundle. Conversely, the Paasche index underestimates inflation for the opposite reason. In this case, the amount needed to leave the consumer as well off in period t as in period t+1 is overestimated.

B. BLS Categories Over Time

The BLS creates categories and subcategories of various levels into which it groups consumption items. In 1997 they implemented a number of major changes to this system. For expositional purposes, pre-1997 refers to 1996 and earlier categorization regime while post-1997 refers to 1997 and later.

Prior to 1997 the file layout for the consumption weights had the following format:

Item Code	Expenditure Category	CPI-U	CPI-W
SE53	PUBLIC TRANSPORTATION	1.490	1.139
SE5301	AIRLINE FARE	0.967	0.608
SE5302	OTHER INTERCITY PUBLIC TRANSPORTATION	0.159	0.111
SE5303	INTRACITY PUBLIC TRANSPORTATION	0.353	0.411
SE5309	UNPRICED ITEMS	0.011	0.010

In this case the primary category is Public Transportation (SE53). The others are subcategories and are designated at such via the addition of two additional numbers to the Item Code.

Starting in 1997 the file layout and categorizations changed to a system that relied on indentations to signify category levels. This is an example:

```
Public transportation.................     1.125          .784
 Airline fare.........................      .731          .490
 Other intercity transportation........      .166          .096
 Intracity transportation..............      .222          .192
 Unsampled public transportation.......      .006          .006
```

Many expenditure categories had subcategories several level deep. While there were some pre-1997 the post-1997 era saw many more. Worse, some of these new tertiary and below categories were

primary or secondary categories pre-1997. Medical care is typical. Prior to 1997 nonprescription drugs constituted their own primary category:

Item Code	Expenditure Category	CPI-U	CPI-W
SE55	NONPRESC DRUGS,MED SUPPLS	0.393	0.342
SE5502	INT & RESP OVER-THE-COUNTER ITEM	0.254	0.256
SE5503	NONPRSCRPT MED EQUIP, SUPP	0.139	0.086

Post-1997 that changed and nonprescription drugs became a subcategory of medical care. The BLS then demoted the nonprescription drug subcategories to sub-subcategories of medical care.

```
Medical care..................................... 6.390          5.355
  Nonprescription drugs and medical supplies.....  .372           .305
   Internal and respiratory over-the-counter drugs....  .259      .218
   Nonprescription medical equipment and supplies.....  .113     .088
```

The all item index was created from the BLS primary level categories and their index levels based on the post-1997 groupings. However, due to the changes in the way goods and services were grouped in 1997 some categories had to be hand matched. To do this some of the pre-1997 groupings needed to be redone to match the post-1997 classification system. The list below describes the post-1997 categories for which this was necessary: housing, apparel, medical care, recreation, transportation, education and other goods. This is not an extensive list of the primary categories that were started in 1997 or each primary category's subcategories. It is just a list of the adaptations needed to create indices for the post-1997 categories in the years prior to 1997.

Housing costs: This category underwent a dramatic change in its grouping starting in 1997. The pre-1997 categories "rent-renter occupied," "homeowners' costs," "maintenance and repair services," "fuel oil and other household fuel commodities", "gas (piped) and electricity," "other utilities and public services," "textile house furnishings," "furniture and bedding," "major household appliances", "other house furnishings,", "housekeeping supplies," "housekeeping services" and "tenants' insurance" were all moved into the post-1997 category "housing."

Apparel costs: The pre-1997 categories included “men’s apparel”, “boys’ apparel,” “woman’s apparel”, “girls’ apparel”, “footwear,” “infants’ and toddlers’ apparel”, “sewing materials, notions and luggage,” “jewelry and watches” and “apparel services” were all merged into “apparel” starting in 1997. Also the separate “men’s apparel” and “boys’ apparel” were merged into a single “men’s and boys’ apparel” category. Similarly for women and girls.

Medical care: The pre-1997 categories included “prescription drugs,” “nonprescription drugs,” “professional medical services,” “hospital and related services,” and “health insurance.” Post-1997 these were all merged into “medical care.” The “medical care” category was also split into “medical care commodities” and “medical care services.” The former then contained as sub groups the prescription and nonprescription categories. The “medical care services” subcategory then contained as sub-sub-categories the rest of the pre-1997 categories.

Recreation: The pre-1997 categories that became the recreation category were “TV and sound equipment,” “reading materials,” “sporting goods, equipment,” “toys, hobbies, other entertainment” and “entertainment services.” These were merged into “recreation” along with “pets, pet products and services.”

Transportation: Pre-1997 the BLS had primary categories for “new vehicles,” “used cars,” “motor fuel, motor oil, coolant,” “automobile parts and equipment,” “automobile maintenance and repair,” “automobile insurance,” “automobile finance charges,” “vehicle rental, registration, other” and “public transportation.” Starting in 1997 these were all grouped under “transportation.” It was then given a subcategory called “private transportation” that included among its subcategories one for “new and used motor vehicles.” That in turn was split into “new vehicles

Education and communication: The pre-1997 classifications included “school books and supplies,” “tuition, other school fees” and “information processing equipment.” These were merged into education and communication which was given subcategories of “education” and “communication.”

Table 1: Consumer Expenditure Survey Years

Years in which the U.S. Bureau of Labor Statistics conducted a consumer expenditure survey. Year introduced represents the January of the year in which that survey is first used for the weights determining the representative consumer's consumption bundle. The terminal year is the December of that year, the last month the survey data was used for the representative consumer's consumption bundle. The only exception is the 1919 Year Introduced. The BLS did not provide a record for the month it was introduced, just the year. Source: U.S. Bureau of Labor Statistics.

Expenditure Reference Period	Year Introduced	Terminal Year
1917-1919	1919	1924
Avg. 1917-1919 and 1934-1936	1925	1929
1934-1936	1930	1949
1947-1949	1950	1952
1950	1953	1963
1960-1961	1964	1977
1972-1973	1978	1986
1982-1984	1987	1997
1993-1995	1998	2001
1999-2000	2002	2003
2001-2002	2004	2005
2003-2004	2006	2007
2005-2006	2008	2009
2007-2008	2010	2011
2009-2010	2012	2013
2011-2012	2014	2015
2013-2014	2016	2017
2015-2016	2017	

Table 2: Consumption Categories Subject to Hedonic Adjustment by the BLS

Each column represents a broad consumer consumption category as defined by the BLS. The values under a category equals its surveyed fraction of the consumer's total spending. The "Total" column sums up the weights to give the total fraction of the consumption bundle subject to hedonic adjustment.

Year	Apparel	Major Appliances	Televisions	Other Video Equipment	Photographic Equipment and Supplies	Total
1987	5.772	0.372	0.233	0.153	0.134	6.664
1988	5.79	0.369	0.22	0.141	0.136	6.656
1989	5.573	0.348	0.207	0.128	0.134	6.39
1990	5.512	0.327	0.188	0.109	0.128	6.264
1991	5.535	0.311	0.181	0.1	0.126	6.253
1992	5.44	0.303	0.173	0.094	0.125	6.135
1993	5.333	0.3	0.166	0.09	0.123	6.012
1994	5.097	0.302	0.159	0.082	0.116	5.756
1995	4.967	0.293	0.148	0.0765	0.114	5.5985
1996	4.786	0.284	0.137	0.071	0.112	5.39
1997	4.944	0.217	0.215	0.087	0.108	5.571
1998	4.831	0.21	0.201	0.075	0.103	5.42
1999	4.684	0.205	0.182	0.062	0.1	5.233
2000	4.453	0.194	0.157	0.049	0.094	4.947
2001	4.399	0.194	0.138	0.04	0.09	4.861
2002	4.22	0.19	0.131	0.046	0.101	4.688
2003	3.975	0.176	0.156	0.051	0.101	4.459
2004	3.841	0.165	0.132	0.043	0.091	4.272
2005	3.786	0.192	0.164	0.047	0.092	4.281
2006	3.726	0.193	0.124	0.04	0.08	4.163
2007	3.731	0.219	0.167	0.035	0.077	4.229
2008	3.691	0.223	0.135	0.03	0.072	4.151
2009	3.695	0.176	0.201	0.032	0.07	4.174
2010	3.601	0.165	0.16	0.028	0.062	4.016
2011	3.562	0.161	0.178	0.028	0.055	3.984
2012	3.564	0.165	0.144	0.025	0.05	3.948
2013	3.437	0.159	0.161	0.03	0.059	3.846
2014	3.343	0.147	0.133	0.029	0.058	3.71
2015	3.101	0.06	0.132	0.026	0.038	3.357
2016	3.034	0.055	0.097	0.024	0.039	3.249

Table 3: American Housing Survey Residential Square Footage

The data is taken from American Housing Survey (AHS). This survey has been conducted on an annual or biannual basis from 1986 to 2015. The mean for 2015 comes from a Freedom of Information Request and has likely been rounded to the nearest whole number by the BLS. Bold text indicates a year where the survey was not conducted. In these cases the average and median are the average values from the prior and subsequent survey year. The values in this table are used in this study to convert the reported real estate index from cost per housing unit to cost per square foot of housing. The 2015 median is taken from the AHS summary table. The underlying data is not available with which to calculate the mean. Instead, only the number of homes within preset ranges is provided. Sample size equals the number of housing units with reported square footage.

Year	Mean	Median	Sample size
1986	1510.13	1300	25146
1987	1558.28	1350	42830
1988	1640.58	1450	30453
1989	1569.54	1375	44457
1990	1531.46	1350	33077
1991	1593.75	1400	44585
1992	1654.65	1450	26559
1993	1647.60	1450	23439
1994	1533.43	1400	25139
1995	1623.39	1400	44632
1996	1630.05	1440	28194
1997	1832.73	1620	28722
1998	1643.22	1500	46509
1999	1766.25	1450	42127
2000	**1754.06**	**1425**	
2001	1741.86	1400	42380
2002	1691.74	1400	48086
2003	1791.76	1400	48860
2004	1873.19	1500	45075
2005	1818.83	1450	45653
2006	**1826.80**	**1461**	
2007	1834.76	1472	42451
2008	1841.85	1486	
2009	1848.95	1500	47981
2010	**1844.96**	**1475**	
2011	1840.98	1450	134709
2012	**1811.46**	**1475**	
2013	1781.94	1500	61282
2014	**1751.97**	**1500**	
2015	1722.00	1500	54082

Table 4: Goods and Services Included in the Technology Free Index

List of items used to create the index of goods and services that have seen relatively little change in consumption value due to technological change. Rent of Shelter (housing) is separated since it will be adjusted by mean dwelling size when included in an index. The column years refer to the year in which the Consumer Survey was conducted and the CPI-U Weight reported by the BLS.

Item	1988	2016
Food	16.171	13.698
Window and floor coverings and other linens		0.252
Furniture and bedding	1.260	0.755
Other household equipment and furnishings		0.452
Tools, hardware, outdoor equipment and supplies		0.675
Housekeeping supplies	1.190	0.861
Apparel and upkeep	6.353	3.034
Pets and pet products	0.358	0.955
Sporting goods	0.475	0.431
Recreational reading materials	0.686	0.153
Other recreational goods		0.366
Educational books and supplies	0.229	0.166
Alcoholic beverages	1.545	0.952
Tobacco and smoking products	1.349	0.665
Personal care products	0.659	0.700
Miscellaneous personal goods		0.186
Water and sewer and trash collection services		1.172
Household operations		0.856
Nursing homes and adult day services		0.194
Care of invalids and elderly at home		0.077
Motor vehicle maintenance and repair	1.526	1.165
Motor vehicle insurance	2.248	2.494
Motor vehicle fees		0.529
Public transportation	1.440	1.086
Other recreation services		1.824
Tuition, other school fees, and childcare	2.094	3.044
Postage and delivery services		0.136
Personal care services	0.567	0.610
Miscellaneous personal services	1.179	1.018
Total of Technology Free Weights	**39.329**	**38.506**
Rent of shelter	27.031	33.309
Total of Technology Free and Rent of Shelter	**66.36**	**71.815**

Table 5: CPI tests based on consumer debt per household.

Year-over-year percentage change in consumer debt per household (times 100) regressed against real interest rate and real income measures. Interest rate and income measures are quarter-over-quarter. Columns labeled Int*A* and Inc*A* represent the interest and income measure lagged *A* quarters. Every regression includes a constant, and for the period over which the change in consumer debt is measured the inflation rate, change in the unemployment rate, percentage change in GDP and quarterly fixed effects (quarter 1 omitted) as controls. Nominal rates use the 24-month personal loan rate from 1988Q1 to 2018Q1 or the credit card rate from 1994Q4 to 2018Q1. Real rates are a loan rate minus a CPI variant. All year-over-year changes are calculated on a quarter-by-quarter basis (resulting in overlapping time periods). Regressions run the percentage change in consumer debt levels against the change in the real interest rate and the percentage change in real income per capita (using the corresponding inflation rate) from the prior quarters. In all cases the *p*-values are adjusted using *R*'s vcovHAC function. Key: * = significant at the 10% level, ** significant at the 5% level, *** = significant at the 1% level. Red text indicates the adjusted R^2 for the alternative index is higher than for the BLS CPI.

Index	Int1	Int2	Int3	Int4	Inc1	Inc2	Inc3	Inc4	[J-Stat]/R^2
				Panel A: 24 Month Personal Loan Rate					
BLS CPI	8.781	91.781	126.655	31.596	-52.296	-48.957	26.638	76.485	NA
	(0.887)	(0.242)	(0.102)	(0.614)	(0.213)	(0.304)	(0.268)	(0.035)**	0.189
All Housing Size Adj.	62.042	145.99	167.256	37.86	-37.825	-19.374	42.781	83.081	[0.191]
	(0.461)	(0.208)	(0.105)	(0.526)	(0.420)	(0.724)	(0.249)	(0.043)**	0.182
All Housing Size Adj. Minus	56.77	140.93	162.108	37.144	-36.436	-19.946	41.54	81.379	[0.348]
Med.	(0.468)	(0.184)	(0.085)*	(0.487)	(0.427)	(0.710)	(0.278)	(0.045)**	0.179
All Housing Size Adj. Minus	64.278	149.916	172.111	43.256	-37.442	-19.699	41.297	80.765	[0.168]
Tobacco	(0.457)	(0.209)	(0.107)	(0.495)	(0.424)	(0.716)	(0.266)	(0.050)*	0.180
All Housing Size Adj. Minus	58.586	144.236	166.371	42.433	-35.895	-20.325	39.937	78.892	[0.359]
Med. & Tobacco	(0.466)	(0.188)	(0.088)*	(0.454)	(0.433)	(0.701)	(0.296)	(0.052)*	0.178
Tech Free	154.523	225.225	214.329	88.961	-50.518	-18.024	48.703	87.115	[0.03]**
	(0.390)	(0.414)	(0.465)	(0.663)	(0.205)	(0.718)	(0.189)	(0.031)**	0.197
Tech Free Housing Size Adj.	390.336	477.374	462.585	290.704	-47.016	-6.269	58.515	87.844	[0.181]
	(0.096)*	(0.132)	(0.145)	(0.191)	(0.272)	(0.899)	(0.167)	(0.066)*	0.232
Tech Free Housing Size Adj.	401.967	493.101	485.658	309.259	-46.633	-6.58	57.264	84.642	[0.144]
Minus Tobacco	(0.091)*	(0.127)	(0.137)	(0.188)	(0.275)	(0.892)	(0.171)	(0.074)*	0.233
Tech Free Plus Hedonic	391.534	493.387	450.791	259.214	-50.811	-10.12	62.147	97.038	[0.155]
Housing Size Adj.	(0.088)*	(0.125)	(0.160)	(0.215)	(0.256)	(0.848)	(0.145)	(0.048)**	0.248
Tech Free Plus Hedonic	403.924	511.169	471.794	275.36	-50.6	-10.803	60.67	94.102	[0.136]
House Size Adj. Minus Tobac	(0.083)*	(0.118)	(0.152)	(0.211)	(0.255)	(0.834)	(0.150)	(0.054)*	0.247
All Housing ACY Adj.	110.458	224.08	249.218	132.323	-25.205	0.103	36.63	47.436	[0.156]
	(0.168)	(0.047)**	(0.018)**	(0.117)	(0.560)	(0.998)	(0.320)	(0.204)	0.183
All Housing ACY Adj. Minus	102.371	211.765	235.623	124.693	-23.288	-0.069	36.27	46.006	[0.166]
Med.	(0.175)	(0.045)**	(0.018)**	(0.114)	(0.580)	(0.999)	(0.337)	(0.212)	0.181
All Housing ACY Adj. Minus	112.271	226.167	251.555	135.728	-24.54	0.365	35.88	45.383	[0.124]
Tobacco	(0.172)	(0.050)*	(0.019)**	(0.114)	(0.572)	(0.994)	(0.331)	(0.241)	0.183
All Housing ACY Adj. Minus	103.94	213.37	237.406	128.012	-22.443	0.259	35.455	43.76	[0.125]
Med. & Tobacco	(0.180)	(0.049)**	(0.019)**	(0.111)	(0.596)	(0.996)	(0.349)	(0.252)	0.181
Tech Free Housing ACY Adj.	483.668	521.945	535.973	458.523	-31.693	17.635	61.314	50.774	[0.068]*
	(0.020)**	(0.024)**	(0.044)**	(0.065)*	(0.296)	(0.614)	(0.032)**	(0.073)*	0.276
Tech Free Housing ACY Adj.	477.136	527.678	546.937	454.712	-32.44	15.674	60.784	50.543	[0.055]*
Minus Tobacco	(0.021)**	(0.025)**	(0.040)**	(0.063)*	(0.301)	(0.666)	(0.032)**	(0.073)*	0.279
Tech Free Plus Hedonic	493.991	547.108	549.074	450.889	-35.296	16.262	61.22	55.248	[0.084]*
Housing ACY Adj.	(0.015)**	(0.026)**	(0.050)*	(0.071)*	(0.210)	(0.640)	(0.035)**	(0.068)*	0.282
Tech Free Plus Hedonic	491.126	553.739	559.397	449.768	-36.01	14.376	60.531	54.92	[0.07]*
House ACY Adj. Minus Tobac	(0.016)**	(0.026)**	(0.046)**	(0.069)*	(0.213)	(0.690)	(0.035)**	(0.069)*	0.285

Panel B: Credit Card Rate

BLS CPI	-78.321	-35.874	-24.576	-44.024	-48.835	-56.58	44.997	96.647	NA
	(0.110)	(0.447)	(0.692)	(0.551)	(0.359)	(0.364)	(0.218)	(0.047)**	0.311
All Housing Size Adj.	-68.71	-31.864	-31.086	-52.519	-43.712	-56.033	40.555	94.918	[0.489]
	(0.145)	(0.499)	(0.616)	(0.449)	(0.406)	(0.365)	(0.258)	(0.040)**	0.289
All Housing Size Adj. Minus	-61.529	-18.771	-14.828	-44.018	-39.974	-53.772	38.666	93.393	[0.426]
Med.	(0.160)	(0.697)	(0.815)	(0.501)	(0.435)	(0.365)	(0.272)	(0.040)**	0.283
All Housing Size Adj. Minus	-69.515	-30.643	-28.817	-51.52	-41.537	-54.963	40.561	95.121	[0.427]
Tobacco	(0.139)	(0.488)	(0.611)	(0.447)	(0.423)	(0.368)	(0.255)	(0.037)**	0.285
All Housing Size Adj. Minus	-62.559	-17.967	-12.923	-42.819	-37.775	-52.891	38.415	93.357	[0.383]
Med. & Tobacco	(0.151)	(0.690)	(0.824)	(0.504)	(0.454)	(0.367)	(0.272)	(0.037)**	0.279
Tech Free	-153.655	-178.561	-206.292	-142.8	-50.909	-43.621	25.323	68.146	[0.016]**
	(0.148)	(0.238)	(0.270)	(0.271)	(0.211)	(0.350)	(0.563)	(0.130)	0.306
Tech Free Housing Size Adj.	-233.284	-229.894	-291.736	-70.038	-42.928	-52.104	-16.244	32.682	[0.004]***
	(0.018)**	(0.109)	(0.132)	(0.671)	(0.167)	(0.258)	(0.694)	(0.209)	0.434
Tech Free Housing Size Adj.	-230.024	-212.827	-274.321	-60.349	-39.39	-49.381	-14.199	34.715	[0.005]***
Minus Tobacco	(0.029)**	(0.151)	(0.158)	(0.705)	(0.205)	(0.273)	(0.732)	(0.212)	0.420
Tech Free Plus Hedonic	-206.026	-212.008	-275.639	-66.123	-43.513	-51.367	-9.537	38.285	[0.008]***
Housing Size Adj.	(0.039)**	(0.169)	(0.143)	(0.686)	(0.181)	(0.273)	(0.819)	(0.151)	0.406
Tech Free Plus Hedonic	-200.763	-197.49	-261.82	-57.457	-40.485	-48.918	-7.598	40.082	[0.011]**
House Size Adj. Minus Tobac	(0.055)*	(0.214)	(0.167)	(0.717)	(0.214)	(0.285)	(0.855)	(0.163)	0.394
All Housing ACY Adj.	17.876	97.06	132.377	126.85	-11.991	-15.545	22.834	47.896	[0.034]**
	(0.776)	(0.192)	(0.140)	(0.242)	(0.695)	(0.630)	(0.499)	(0.178)	0.364
All Housing ACY Adj. Minus	16.103	92.933	126.955	118.926	-8.219	-14.312	21.7	46.785	[0.036]**
Med.	(0.789)	(0.198)	(0.140)	(0.245)	(0.787)	(0.645)	(0.517)	(0.187)	0.362
All Housing ACY Adj. Minus	15.128	94.101	130.054	125.316	-10.386	-15.48	22.62	47.884	[0.042]**
Tobacco	(0.809)	(0.196)	(0.136)	(0.248)	(0.731)	(0.637)	(0.503)	(0.185)	0.358
All Housing ACY Adj. Minus	13.402	89.859	124.431	117.487	-6.484	-14.205	21.374	46.585	[0.043]**
Med. & Tobacco	(0.823)	(0.200)	(0.134)	(0.250)	(0.828)	(0.653)	(0.523)	(0.197)	0.356
Tech Free Housing ACY Adj.	52.87	173.622	176.062	315.343	11.302	42.096	40.795	57.656	[0.001]***
	(0.612)	(0.175)	(0.280)	(0.035)**	(0.638)	(0.167)	(0.061)*	(0.031)**	0.546
Tech Free Housing ACY Adj.	49.002	173.999	184.283	308.287	12.737	39.236	40.528	58.648	[0.001]***
Minus Tobacco	(0.640)	(0.171)	(0.250)	(0.042)**	(0.602)	(0.200)	(0.072)*	(0.027)**	0.537
Tech Free Plus Hedonic	60.488	161.465	165.316	328.748	9.498	37.549	37.556	57.68	[0.001]***
Housing ACY Adj.	(0.569)	(0.228)	(0.284)	(0.023)**	(0.707)	(0.215)	(0.093)*	(0.042)**	0.534
Tech Free Plus Hedonic	58.124	162.41	174.207	324.71	11.043	35.165	37.274	58.576	[0.002]***
House ACY Adj. Minus Tobac	(0.588)	(0.226)	(0.255)	(0.028)**	(0.666)	(0.251)	(0.108)	(0.038)**	0.526

Table 6: CPI tests using the charge off rate for non-residential consumer loans

Year-over-year changes in consumer loan charge off rates on a quarter-by-quarter basis were calculated. These values were then regressed against quarter-over-quarter changes in real interest rate and income measures. Columns labeled Int*A* and Inc*A* represent the interest and income measure lagged *A* quarters. Every regression includes a constant and for the year over which the change in a charge off rate was calculated the corresponding inflation rate, change in the unemployment rate, the percentage change in GDP and quarterly fixed effects (quarter 1 omitted) as controls. Nominal rates use the 24-month personal loan rate from 1988Q1 to 2018Q1 or the credit card rate from 1994Q4 to 2018Q1. Real rates are a loan rate minus a CPI variant. All year-over-year changes are calculated on a quarter-by-quarter basis (resulting in overlapping time periods). Regressions run the percentage change in charge off rates against the change in the real interest rate and the percentage change in real income per capita (using the corresponding inflation rate) from the prior quarters. In all cases the *p*-values are adjusted using *R*'s vcovHAC function. Key: An * indicates the inflation measure yielded a *p*-value less than 0.05 on at least one real interest rate or real income parameter. A † the alternative inflation measure produced a higher R^2 than the BLS CPI. A *J* indicates a *J*-test statistic below 0.05 and a *j* indicates a *J*-test statistic below 0.10. Rows for the ACY housing cost adjustment receive a + sign if the R^2 in the regression exceeds the R^2 for the corresponding index based only on the size adjustment. Tables with the actual parameter estimates can be found in appendix Table 11 and Table 12.

		Seasonally Adjusted			Unadjusted		
		Consumer loans	Credit card loans	Other consumer loans	Consumer loans	Credit card loans	Other consumer loans
BLS CPI	Personal	*	*	*	*		*
	Credit Card	*			*		
All Housing Size Adj.	Personal	*†	*†	*J	*†	*†	*J
	Credit Card	*	†			†	
All Housing Size Adj. Minus Med.	Personal	*†j	*†	*J	*†	*†	*J
	Credit Card	*					
All Housing Size Adj. Minus Tobacco	Personal	*†	*†j	*J	*†j	*†j	*J
	Credit Card	*†	†			†	
All Housing Size Adj. Minus Med. & Tobacco	Personal		*†	*J	*†	*†	*J
	Credit Card	*	†			†	
Tech Free	Personal		J	†		J	
	Credit Card	j	J	†	j	J	†
Tech Free Housing Size Adj.	Personal		J	†		J	†
	Credit Card		j	†			†
Tech Free Housing Size Adj. Minus Tobacco	Personal		J	†		J	†
	Credit Card	j	j	†		j	†
Tech Free Plus Hedonic Housing Size Adj.	Personal		J	†		J	†
	Credit Card		j	†		j	†
Tech Free Plus Hedonic Housing Size Adj. Minus Tobacco	Personal		J	†		J	*†
	Credit Card	j	j	†	j	j	†

All Housing ACY Adj.	Personal	*†ɹ+	*†j+	*†ɹ+	*†ɹ+	*†j+	*†ɹ+
	Credit Card	*†	†+	*†+	*†+	†+	*+
All Housing ACY Adj. Minus Med.	Personal	*†ɹ+	*†j+	*†ɹ+	*†ɹ+	*†j+	*†ɹ+
	Credit Card	*†	†+	*†+	*+	†+	*†+
All Housing ACY Adj. Minus Tobacco	Personal	*†ɹ+	*†j+	*†ɹ+	*†ɹ+	*†j+	*†ɹ+
	Credit Card	*†	†+	*†+	*†+	†+	*†+
All Housing ACY Adj. Minus Med. & Tobacco	Personal	*†ɹ+	*†j+	*†ɹ+	*†ɹ+	*†j+	*†ɹ+
	Credit Card	*†	†+	*†+	*+	†+	†j+
Tech Free Housing ACY Adj.	Personal	†ɹ+	ɹ	*†j	ɹ+	ɹ+	*†j+
	Credit Card	ɹ	ɹ+	†j+	ɹ	ɹ	†j+
Tech Free Housing ACY Adj. Minus Tobacco	Personal	†ɹ+	ɹ	*†j	†ɹ+	ɹ+	*†j+
	Credit Card	ɹ	ɹ+	†j+	ɹ	ɹ	†j+
Tech Free Plus Hedonic Housing ACY Adj.	Personal	†ɹ+	ɹ	*†j	†ɹ+	ɹ+	*†j+
	Credit Card	ɹ	ɹ+	†j+	ɹ	ɹ	†j+
Tech Free Plus Hedonic Housing ACY Adj. Minus Tobacco	Personal	†ɹ+	ɹ	*†j	†ɹ+	ɹ+	*†j+
	Credit Card	ɹ	ɹ+	†j+	ɹ	ɹ	†j+

Table 7: CPI tests based on per capita consumption.

Year-over-year percentage change in consumption per capita is regressed against real interest rate and real income measures. Interest rate and income measures are quarter-over-quarter. Columns labeled Int*A* and Inc*A* represent the interest and income measure lagged *A* quarters. Every regression includes a constant and for the year over which the change in per capita consumption was calculated the corresponding inflation rate, change in the unemployment rate, the percentage change in GDP and quarterly fixed effects (quarter 1 omitted) as controls. Nominal rates use the 24-month personal loan rate from 1988Q1 to 2018Q1 or the credit card rate from 1994Q4 to 2018Q1. Real rates are a loan rate minus a CPI variant. All year-over-year changes are calculated on a quarter-by-quarter basis (resulting in overlapping time periods). Regressions run the percentage change in consumer debt levels against the change in the real interest rate and the percentage change in real income per capita (using the corresponding inflation rate) from the prior quarters. In all cases the *p*-values are adjusted using *R*'s vcovHAC function. Key: * = significant at the 10% level, ** significant at the 5% level, *** = significant at the 1% level. Red text indicates the adjusted R^2 for the alternative index is higher than for the BLS CPI.

Panel A: 24 Month Personal Loan Rate									
Index	Int1	Int2	Int3	Int4	Inc1	Inc2	Inc3	Inc4	[J-Stat]/R^2
BLS CPI	-0.258	-0.358	-0.452	-0.352	0.164	0.091	0.147	0.231	NA
	(0.015)**	(0.010)**	(00000)***	(00000)***	(0.038)**	(0.351)	(0.071)*	(0.009)***	0.876
All Housing Size Adj.	-0.234	-0.315	-0.404	-0.309	0.193	0.117	0.148	0.224	[0.724]
	(0.036)**	(0.024)**	(0.001)***	(00000)***	(0.023)**	(0.235)	(0.071)*	(0.003)***	0.871
All Housing Size Adj. Minus	-0.211	-0.282	-0.365	-0.275	0.19	0.123	0.151	0.222	[0.554]
Med.	(0.048)**	(0.042)**	(0.004)***	(00000)***	(0.026)**	(0.207)	(0.068)*	(0.002)***	0.869
All Housing Size Adj. Minus	-0.229	-0.321	-0.408	-0.318	0.191	0.121	0.153	0.229	[0.645]
Tobacco	(0.034)**	(0.022)**	(0.001)***	(00000)***	(0.023)**	(0.223)	(0.059)*	(0.002)***	0.870
All Housing Size Adj. Minus	-0.205	-0.287	-0.369	-0.283	0.188	0.127	0.156	0.228	[0.483]
Med. & Tobacco	(0.046)**	(0.040)**	(0.004)***	(00000)***	(0.026)**	(0.196)	(0.056)*	(0.002)***	0.869
Tech Free	-0.787	-0.938	-0.992	-0.808	0.200	0.110	0.156	0.259	[0.003]***
	(0.014)**	(0.018)**	(0.012)**	(0.002)***	(0.012)**	(0.252)	(0.119)	(0.004)***	0.867
Tech Free Housing Size Adj.	-0.711	-0.614	-0.713	-0.552	0.244	0.144	0.123	0.205	[0.182]
	(0.031)**	(0.142)	(0.105)	(0.080)*	(0.002)***	(0.209)	(0.216)	(0.007)***	0.864
Tech Free Housing Size Adj.	-0.698	-0.654	-0.729	-0.573	0.239	0.145	0.13	0.211	[0.185]
Minus Tobacco	(0.029)**	(0.126)	(0.099)*	(0.077)*	(0.003)***	(0.204)	(0.176)	(0.005)***	0.864
Tech Free Plus Hedonic	-0.656	-0.577	-0.748	-0.587	0.238	0.136	0.131	0.216	[0.142]
Housing Size Adj.	(0.035)**	(0.140)	(0.069)*	(0.039)**	(0.003)***	(0.243)	(0.166)	(0.008)***	0.863
Tech Free Plus Hedonic	-0.646	-0.611	-0.768	-0.611	0.233	0.137	0.138	0.221	[0.14]
Housing Size Adj. Minus Tobac.	(0.034)**	(0.126)	(0.066)*	(0.037)**	(0.004)***	(0.239)	(0.131)	(0.007)***	0.863
All Housing ACY Adj.	-0.174	-0.295	-0.314	-0.178	0.207	0.133	0.129	0.205	[0.141]
	(0.119)	(0.071)*	(0.037)**	(0.086)*	(0.021)**	(0.189)	(0.121)	(0.015)**	0.876
All Housing ACY Adj. Minus	-0.159	-0.268	-0.284	-0.149	0.204	0.136	0.132	0.202	[0.166]
Med.	(0.136)	(0.096)*	(0.063)*	(0.126)	(0.024)**	(0.175)	(0.117)	(0.015)**	0.875
All Housing ACY Adj. Minus	-0.170	-0.303	-0.318	-0.183	0.204	0.134	0.133	0.209	[0.179]
Tobacco	(0.112)	(0.063)*	(0.037)**	(0.078)*	(0.022)**	(0.187)	(0.106)	(0.011)**	0.875
All Housing ACY Adj. Minus	-0.154	-0.275	-0.288	-0.154	0.201	0.137	0.136	0.206	[0.211]
Med. & Tobacco	(0.129)	(0.088)*	(0.063)*	(0.116)	(0.025)**	(0.173)	(0.102)	(0.010)**	0.874
Tech Free Housing ACY Adj.	-0.482	-0.526	-0.072	0.11	0.248	0.189	0.155	0.204	[0.035]**
	(0.117)	(0.127)	(0.786)	(0.660)	(0.006)***	(0.090)*	(0.075)*	(0.007)***	0.869
Tech Free Housing ACY Adj.	-0.461	-0.558	-0.083	0.109	0.243	0.186	0.157	0.207	[0.039]**
Minus Tobacco	(0.103)	(0.108)	(0.756)	(0.657)	(0.007)***	(0.098)*	(0.067)*	(0.005)***	0.868
Tech Free Plus Hedonic	-0.473	-0.475	-0.144	0.030	0.250	0.184	0.153	0.204	[0.095]*
Housing ACY Adj.	(0.121)	(0.162)	(0.620)	(0.906)	(0.006)***	(0.116)	(0.076)*	(0.012)**	0.866
Tech Free Plus Hedonic	-0.455	-0.508	-0.152	0.031	0.245	0.181	0.156	0.206	[0.105]
Housing ACY Adj. Minus Tobac.	(0.114)	(0.139)	(0.602)	(0.904)	(0.007)***	(0.122)	(0.068)*	(0.010)**	0.865

Panel B: Credit Card Rate

BLS CPI	-0.267	-0.458	-0.670	-0.419	0.199	0.144	0.186	0.231	NA
	(0.038)**	(0.012)**	(0.000)***	(0.000)***	(0.020)**	(0.163)	(0.031)**	(0.011)**	0.891
All Housing Size Adj.	-0.270	-0.482	-0.694	-0.436	0.214	0.159	0.184	0.227	[0.454]
	(0.053)*	(0.004)***	(0.000)***	(0.000)***	(0.017)**	(0.112)	(0.016)**	(0.005)***	0.887
All Housing Size Adj. Minus	-0.24	-0.432	-0.629	-0.393	0.213	0.168	0.188	0.226	[0.256]
Med.	(0.071)*	(0.009)***	(0.000)***	(0.000)***	(0.019)**	(0.084)*	(0.011)**	(0.006)***	0.885
All Housing Size Adj. Minus	-0.257	-0.483	-0.696	-0.442	0.214	0.166	0.189	0.232	[0.339]
Tobacco	(0.055)*	(0.004)***	(0.000)***	(0.000)***	(0.016)**	(0.100)	(0.012)**	(0.005)***	0.886
All Housing Size Adj. Minus	-0.226	-0.431	-0.630	-0.398	0.213	0.174	0.194	0.230	[0.184]
Med. & Tobacco	(0.075)*	(0.011)**	(0.000)***	(0.000)***	(0.018)**	(0.075)*	(0.009)***	(0.005)***	0.885
Tech Free	-1.142	-1.231	-1.472	-1.089	0.243	0.189	0.233	0.319	[0.000]***
	(0.000)***	(0.001)***	(0.000)***	(0.000)***	(0.006)***	(0.065)*	(0.010)**	(0.000)***	0.903
Tech Free Housing Size Adj.	-1.108	-1.000	-1.221	-0.606	0.254	0.182	0.104	0.163	[0.011]**
	(0.001)***	(0.003)***	(0.000)***	(0.004)***	(0.001)***	(0.043)**	(0.265)	(0.062)*	0.888
Tech Free Housing Size Adj.	-1.042	-1.018	-1.218	-0.604	0.253	0.187	0.115	0.173	[0.028]**
Minus Tobacco	(0.001)***	(0.005)***	(0.001)***	(0.007)***	(0.001)***	(0.036)**	(0.195)	(0.049)**	0.886
Tech Free Plus Hedonic	-1.032	-0.95	-1.190	-0.655	0.262	0.191	0.122	0.172	[0.012]**
Housing Size Adj.	(0.000)***	(0.003)***	(0.000)***	(0.001)***	(0.001)***	(0.038)**	(0.173)	(0.057)*	0.886
Tech Free Plus Hedonic	-0.978	-0.962	-1.192	-0.668	0.260	0.195	0.134	0.181	[0.031]**
Housing Size Adj. Minus Tobac.	(0.000)***	(0.004)***	(0.000)***	(0.001)***	(0.001)***	(0.034)**	(0.116)	(0.047)**	0.885
All Housing ACY Adj.	-0.178	-0.406	-0.490	-0.161	0.244	0.191	0.150	0.185	[0.001]***
	(0.191)	(0.036)**	(0.004)***	(0.216)	(0.006)***	(0.024)**	(0.063)*	(0.016)**	0.897
All Housing ACY Adj. Minus	-0.162	-0.371	-0.450	-0.140	0.242	0.196	0.154	0.183	[0.004]***
Med.	(0.214)	(0.055)*	(0.008)***	(0.258)	(0.007)***	(0.020)**	(0.059)*	(0.017)**	0.896
All Housing ACY Adj. Minus	-0.170	-0.414	-0.497	-0.167	0.242	0.193	0.153	0.187	[0.005]***
Tobacco	(0.197)	(0.035)**	(0.003)***	(0.211)	(0.005)***	(0.024)**	(0.059)*	(0.014)**	0.896
All Housing ACY Adj. Minus	-0.153	-0.378	-0.455	-0.145	0.239	0.197	0.157	0.185	[0.018]**
Med. & Tobacco	(0.224)	(0.054)*	(0.007)***	(0.252)	(0.007)***	(0.020)**	(0.054)*	(0.015)**	0.894
Tech Free Housing ACY Adj.	-0.669	-0.801	-0.365	0.211	0.322	0.268	0.152	0.204	[0.000]***
	(0.063)*	(0.010)**	(0.214)	(0.419)	(0.000)***	(0.000)***	(0.057)*	(0.004)***	0.896
Tech Free Housing ACY Adj.	-0.599	-0.835	-0.361	0.226	0.322	0.264	0.151	0.202	[0.000]***
Minus Tobacco	(0.065)*	(0.010)**	(0.207)	(0.358)	(0.000)***	(0.000)***	(0.062)*	(0.004)***	0.894
Tech Free Plus Hedonic	-0.700	-0.775	-0.438	0.108	0.328	0.270	0.150	0.194	[0.000]***
Housing ACY Adj.	(0.038)**	(0.010)**	(0.159)	(0.691)	(0.000)***	(0.000)***	(0.059)*	(0.009)***	0.893
Tech Free Plus Hedonic	-0.638	-0.809	-0.430	0.123	0.327	0.267	0.151	0.193	[0.000]***
Housing ACY Adj. Minus Tobac.	(0.043)**	(0.011)**	(0.162)	(0.642)	(0.000)***	(0.000)***	(0.060)*	(0.010)**	0.891

Table 8: Robustness Tests -- Household Debt

The first step repeats the Table 5 regressions for each alternative index. Second, Cook's distance measure for the influence of each data point is calculated. Then either the 4 or 8 most influential data points for the regression with the alternative index are dropped. Third, the regressions for the BLS CPI and the alternative CPI are repeated on the now smaller dataset. The results below summarize the difference in the R^2 statistic between the alternate and the BLS CPI ($R^2_{Alt} - R^2_{BLS}$) is displayed in the columns labeled R^2 Diff. Similarly, columns labeled *J*-test report the *p*-value for the marginal information for the alternative relative to the BLS CPI. Key: *J*-test significance levels, *=10%, **=5% and ***=1%.

	Drop 4				Drop 8			
	Personal		Credit Card		Personal		Credit Card	
Index	R^2 Diff	*J*-test	R^2 Diff	*J*-test	R^2 Diff	*J*-test	R^2 Diff	*J*-test
All Housing Size Adj.	-0.001	0.355	0.000	0.514	-0.01	0.979	-0.003	0.666
All Housing Size Adj. Minus Med.	-0.004	0.610	0.000	0.696	-0.013	0.907	0.000	0.488
All Housing Size Adj. Minus Tobacco	-0.002	0.333	0.002	0.275	-0.013	0.857	-0.007	0.969
All Housing Size Adj. Minus Med. & Tobac.	-0.005	0.681	0.002	0.453	-0.016	0.818	-0.004	0.798
Tech Free	0.029	0.035**	0.015	0.021**	-0.023	0.023**	0.031	0.001***
Tech Free Housing Size Adj.	0.031	0.053*	0.034	0.006***	0.112	0.004***	0.111	0.001***
Tech Free Housing Size Adj. Minus Tobac.	0.077	0.012**	0.037	0.001***	0.093	0.007***	0.090	0.003***
Tech Free Plus Hedonic Housing Size Adj.	0.077	0.064*	0.042	0.064*	0.076	0.003***	0.082	0.003***
Tech Free + Hedonic House Size Adj. Minus Tobac	0.083	0.041**	0.046	0.012**	0.063	0.007***	0.088	0.007***
All Housing ACY Adj.	0.006	0.380	-0.004	0.462	0.074	0.057*	0.121	0.001***
All Housing ACY Adj. Minus Med.	0.003	0.428	-0.010	0.917	0.072	0.063*	0.092	0.004***
All Housing ACY Adj. Minus Tobac.	0.007	0.342	-0.001	0.074*	0.07*	0.069*	0.114	0.003***
All Housing ACY Adj. Minus Med. & Tobac.	0.003	0.385	-0.002	0.411	0.069	0.074*	0.113	0.004***
Tech Free Housing ACY Adj.	0.136	0.013**	0.168	0.003***	0.253	0.000***	0.235	0.000***
Tech Free Housing ACY Adj. Minus Tobac.	0.138	0.011**	0.172	0.003***	0.238	0.000***	0.164	0.000***
Tech Free Plus Hedonic Housing ACY Adj.	0.144	0.013**	0.134	0.008***	0.257	0.000***	0.216	0.000***
Tech Free Plus Hedonic House ACY Adj. Minus Tobac.	0.145	0.012*	0.135	0.008***	0.207	0.000***	0.145	0.000***

Table 9: Robustness Tests: Consumer Loan Charge off Rates – Seasonally Adjusted

The first step repeats the Table 11 regressions for each alternative index. Second, Cook's distance measure for the influence of each data point is calculated. Then either the 4 or 8 most influential data points for the regression with the alternative index are dropped. Third, the regressions for the BLS CPI and the alternative CPI are repeated on the now smaller dataset. The results below summarize the difference in the R^2 statistic between the alternate and the BLS CPI ($R^2_{Alt} - R^2_{BLS}$) is displayed in the columns labeled R^2 Diff. Similarly, columns labeled *J*-test report the *p*-value for the marginal information for the alternative relative to the BLS CPI. Key: *J*-test significance levels, *=10%, **=5% and ***=1%.

	Drop 4				Drop 8			
	Personal		Credit Card		Personal		Credit Card	
Index	R^2 Diff	*J*-test	R^2 Diff	*J*-test	R^2 Diff	*J*-test	R^2 Diff	*J*-test
	Panel A: Consumer Loan Defaults – Seasonally Adjusted							
All Housing Size Adj.	0.026	0.103	0.009	0.178	0.003	0.443	0.002	0.556
All Housing Size Adj. Minus Med.	0.023	0.153	0.006	0.325	-0.004	0.762	-0.005	0.849
All Housing Size Adj. Minus Tobacco	0.026	0.081*	0.010	0.132	0.007	0.288	0.004	0.449
All Housing Size Adj. Minus Med. & Tobac.	0.024	0.125	0.007	0.263	0.000	0.565	-0.003	0.750
Tech Free	0.018	0.025*0	0.012	0.028**	0.010	0.004***	0.002	0.105
Tech Free Housing Size Adj.	0.032	0.000***	0.029	0.000***	0.031	0.009***	-0.006	0.032**
Tech Free Housing Size Adj. Minus Tobac.	0.032	0.000***	0.030	0.000***	0.035	0.004***	0.032	0.002***
Tech Free Plus Hedonic Housing Size Adj.	0.038	0.000***	0.029	0.000***	0.030	0.011**	-0.016	0.052*
Tech Free + Hedonic House Size Adj. Minus Tobac	0.038	0.000***	0.030	0.000***	0.034	0.006***	-0.012	0.031**
All Housing ACY Adj.	0.040	0.006***	0.024	0.002***	0.013	0.101	-0.01	0.253
All Housing ACY Adj. Minus Med.	0.039	0.010**	0.021	0.005***	0.004	0.196	-0.014	0.326
All Housing ACY Adj. Minus Tobac.	0.040	0.005***	0.025	0.001***	0.003	0.142	-0.009	0.211
All Housing ACY Adj. Minus Med. & Tobac.	0.039	0.009***	0.022	0.004***	0.012	0.105	-0.013	0.278
Tech Free Housing ACY Adj.	0.030	0.001***	0.030	0.002***	-0.017	0.039**	-0.013	0.051*
Tech Free Housing ACY Adj. Minus Tobac.	0.031	0.000***	0.032	0.001***	-0.015	0.025**	-0.009	0.032**
Tech Free Plus Hedonic Housing ACY Adj.	0.037	0.001***	0.030	0.001***	-0.013	0.030**	-0.015	0.052*
Tech Free Plus Hedonic House ACY Adj. Minus Tobac.	0.034	0.000***	0.031	0.001***	-0.011	0.021**	-0.011	0.034**
	Panel B: Credit Card Defaults – Seasonally Adjusted							
All Housing Size Adj.	0.022	0.090*	0.033	0.099*	0.008	0.410	0.009	0.456
All Housing Size Adj. Minus Med.	0.021	0.119	0.030	0.135	0.002	0.638	0.009	0.450
All Housing Size Adj. Minus Tobacco	0.022	0.045**	0.035	0.069*	0.012	0.244	0.013	0.320
All Housing Size Adj. Minus Med. & Tobac.	0.026	0.051*	0.032	0.100	0.006	0.445	0.004	0.568
Tech Free	-0.001	0.032**	-0.002	0.092*	0.009	0.041**	0.051	0.018**

Tech Free Housing Size Adj.	0.021	0.003***	0.026	0.004***	0.045	0.008***	0.074	0.002***
Tech Free Housing Size Adj. Minus Tobac.	0.021	0.003***	0.027	0.002***	0.023	0.033**	0.084	0.003***
Tech Free Plus Hedonic Housing Size Adj.	0.022	0.001***	0.025	0.005***	0.047	0.007***	0.046	0.020**
Tech Free + Hedonic House Size Adj. Minus Tobac	0.022	0.001***	0.027	0.002***	0.036	0.029**	0.046	0.019**
All Housing ACY Adj.	0.053	0.011**	0.054	0.013**	0.028	0.077*	0.018	0.152
All Housing ACY Adj. Minus Med.	0.052	0.021**	0.052	0.025**	0.022	0.117	0.011	0.208
All Housing ACY Adj. Minus Tobac.	0.055	0.009***	0.056	0.011**	0.032	0.062*	0.022	0.125
All Housing ACY Adj. Minus Med. & Tobac.	0.054	0.018**	0.053	0.023**	0.025	0.096*	0.015	0.176
Tech Free Housing ACY Adj.	0.008	0.015**	0.025	0.001***	-0.018	0.131	0.009	0.042**
Tech Free Housing ACY Adj. Minus Tobac.	0.010	0.009***	0.028	0.001***	-0.016	0.112	0.013	0.033**
Tech Free Plus Hedonic Housing ACY Adj.	0.013	0.018**	0.011	0.018**	0.002	0.060*	0.013	0.045**
Tech Free Plus Hedonic House ACY Adj. Minus Tobac.	0.014	0.013**	0.022	0.001***	-0.012	0.095*	0.016	0.037**
Panel C: Other Consumer Loan Defaults – Seasonally Adjusted								
All Housing Size Adj.	0.005	0.001***	0.009	0.001***	0.000	0.247	0.001	0.036**
All Housing Size Adj. Minus Med.	0.007	0.003***	0.009	0.002***	0.002	0.159	0.002	0.031**
All Housing Size Adj. Minus Tobacco	0.004	0.001***	0.008	0.000***	-0.003	0.453	0.000	0.132
All Housing Size Adj. Minus Med. & Tobac.	0.006	0.002***	0.008	0.001***	-0.002	0.34	0.000	0.100
Tech Free	0.026	0.100	-0.011	0.143	0.087	0.094*	0.002	0.056*
Tech Free Housing Size Adj.	0.027	0.132	0.019	0.013**	0.121	0.092*	0.002	0.163
Tech Free Housing Size Adj. Minus Tobac.	0.045	0.164	0.025	0.011**	0.124	0.091*	0.032	0.049**
Tech Free Plus Hedonic Housing Size Adj.	0.034	0.138	0.020	0.004***	0.120	0.089*	-0.002	0.173
Tech Free + Hedonic House Size Adj. Minus Tobac	0.038	0.135	0.027	0.003***	0.113	0.069*	0.002	0.170
All Housing ACY Adj.	0.011	0.025**	0.042	0.001***	0.029	0.097*	-0.004	0.241
All Housing ACY Adj. Minus Med.	0.014	0.011**	0.041	0.002***	0.027	0.107	-0.008	0.272
All Housing ACY Adj. Minus Tobac.	0.018	0.007***	0.045	0.001***	0.032	0.083*	0.000	0.178
All Housing ACY Adj. Minus Med. & Tobac.	0.016	0.009***	0.043	0.002***	-0.013	0.128	-0.004	0.205
Tech Free Housing ACY Adj.	0.058	0.014**	0.047	0.002***	0.211	0.021**	0.015	0.073*
Tech Free Housing ACY Adj. Minus Tobac.	0.063	0.012**	0.052	0.001***	0.215	0.020**	0.019	0.063*
Tech Free Plus Hedonic Housing ACY Adj.	0.057	0.009***	0.052	0.001***	0.202	0.028**	0.016	0.070*
Tech Free Plus Hedonic House ACY Adj. Minus Tobac.	0.061	0.008***	0.056	0.001***	0.130	0.033**	0.021	0.061*

Table 10: Robustness Tests -- Per Capita Consumption

The first step repeats the Table 7 regressions for each alternative index. Second, Cook's distance measure for the influence of each data point is calculated. Then either the 4 or 8 most influential data points for the regression with the alternative index are dropped. Third, the regressions for the BLS CPI and the alternative CPI are repeated on the now smaller dataset. The results below summarize the difference in the R^2 statistic between the alternate and the BLS CPI ($R^2_{Alt} - R^2_{BLS}$) is displayed in the columns labeled R^2 Diff. Similarly, columns labeled *J*-test report the *p*-value for the marginal information for the alternative relative to the BLS CPI. Key: *J*-test significance levels, *=10%, **=5% and ***=1%.

	Drop 4				Drop 8			
	Personal		Credit Card		Personal		Credit Card	
Index	R^2 Diff	*J*-test	R^2 Diff	*J*-test	R^2 Diff	*J*-test	R^2 Diff	*J*-test
All Housing Size Adj.	0.009	0.056*	0.004	0.206	0.003	0.401	0.004	0.362
All Housing Size Adj. Minus Med.	0.009	0.045**	0.004	0.225	0.007	0.194	0.003	0.428
All Housing Size Adj. Minus Tobacco	0.011	0.021**	0.006	0.075*	0.011	0.030**	0.006	0.109
All Housing Size Adj. Minus Med. & Tobac.	0.012	0.012**	0.006	0.066*	0.011	0.029**	0.006	0.129
Tech Free	0.036	0.000***	0.055	0.000***	0.039	0.000***	0.046	0.000***
Tech Free Housing Size Adj.	0.017	0.000***	0.02	0.000***	0.002	0.023**	0.011	0.004***
Tech Free Housing Size Adj. Minus Tobac.	0.020	0.000***	0.037	0.000***	0.006	0.017**	0.013	0.003***
Tech Free Plus Hedonic Housing Size Adj.	0.019	0.000***	0.037	0.000***	0.002	0.024**	0.01	0.007***
Tech Free + Hedonic House Size Adj. Minus Tobac	0.023	0.000***	0.042	0.000***	0.007	0.015**	0.014	0.003***
All Housing ACY Adj.	-0.003	0.914	-0.01	0.457	-0.006	0.602	-0.004	0.477
All Housing ACY Adj. Minus Med.	-0.003	0.886	-0.01	0.485	-0.007	0.694	-0.006	0.552
All Housing ACY Adj. Minus Tobac.	-0.003	0.771	-0.009	0.638	-0.007	0.677	-0.006	0.631
All Housing ACY Adj. Minus Med. & Tobac.	-0.002	0.719	-0.009	0.688	-0.009	0.769	-0.007	0.694
Tech Free Housing ACY Adj.	0.01	0.004***	0.016	0.000***	-0.008	0.009***	0.004	0.011**
Tech Free Housing ACY Adj. Minus Tobac.	0.009	0.007***	0.016	0.000***	-0.01	0.022**	-0.012	0.033**
Tech Free Plus Hedonic Housing ACY Adj.	0.008	0.005***	0.014	0.001***	-0.01	0.021**	0.004	0.009***
Tech Free Plus Hedonic House ACY Adj. Minus Tobac.	0.007	0.010***	0.014	0.002***	-0.012	0.049**	0.001	0.016**

XI. Appendix

This appendix provides a detailed look at how the BLS constructs the CPI over time. It then examines the impact new products have on its accuracy, in particular why they lead to an overestimate of the actual inflation rate.

A. Survey Data: Pasting of Indices over Time

However one might consider measuring the CPI over short periods of time, in practice the Laspeyres method breaks down over long periods. In principle, it requires using the representative agent's consumption bundle from, say, 1950 to measure inflation in 2017. The Paasche index is similarly unusable over long periods of time. The 2017 consumption bundle contains numerous items that were simply unavailable in 1950. Furthermore, many of the adjustments one might consider are limited by data collection costs. There is no practical way to measure consumption across items on a continuous basis. Instead the BLS surveys consumers on a periodic basis. Since 1999 these surveys have been conducted every two years. Prior to then, they took place on a rather sporadic basis as shown in Table 1. Without any way to update the consumption bundle between surveys, the BLS has little choice but to calculate the CPI using Laspeyres' method. Once a survey does take place weights can be updated and the index calculated based upon them. While this may seem like a straightforward issue it is not.

The following example shows how the BLS turns the data it collects into the CPI. Consider a simple economy that initially has only three goods: chicken, haircuts and cars. The BLS then gathers data to set an initial index price for each item in the basket. For this example, set the initial price vector (chicken, haircuts, cars) to (20, 35, 250). The BLS also conducts a survey to estimate the fraction of the representative household's budget devoted to each as well. Assume they are (0.3, 0.5, 0.2). The next step is to calculate the number of "units" the consumer has purchased of each item. If this is the initial period, the index

will start at 100. Thus, for every $100 the consumer has $30 is spent on chicken, $50 on haircuts and $20 on cars. Given the price index of chicken, this means that for every $100 spent the $30 spent on chickens purchases 30/20 = 1.5 units of chicken. Similarly, the consumer buys 35/50 = 1.43 units of haircuts and 20/250 = 0.08 units of cars. Until the next consumer survey, the index will assume that the number of units consumed does not change.

Once the BLS has set the number of units consumed of each item it updates the index from month-to-month based on observed price changes. Continuing the example, during the following survey period the price vector becomes (20.11, 35.04, 251.49). In this case, the price of every item in the consumer's basket of goods has gone up. With these new prices, the old basket now costs 1.5×20.11+1.43×35.04+0.08×251.49 = 100.34 and the CPI will report this value as the CPI's new level. They will also state that the inflation rate for the month is 0.34%. This same updating procedure will continue until the next survey.

When the BLS conducts another survey it updates the consumption weights. However, at this point it also needs to set an initial index value. For the initial survey that choice is arbitrary and by convention 100 is generally used. If the survey is for the January 2016 index, then the value will also determine the inflation rate for December 2015, which was based on the prior consumption survey's data. At this point the initial value matters. The BLS's solution is to metaphorically paste the two indices together by adjusting the representative consumer's budget constraint. First, it calculates what the January 2016 index would be with the same consumption bundle it used to produce the December 2015 index. To continue the prior example, suppose that the January 2016 price vector is (21.16, 35.63, 261.74). The cost of the units purchased from the prior survey now comes to 1.5×21.16+1.43×35.63+0.08×261.74 = 103.58. This will now form the baseline budget used to determine the number of units purchased by the consumer going forward. If the new survey consumption weights are (0.36, 0.44, 0.2) then for every $103.58 spent the consumer devoted 0.36×103.58 = 37.29 on chicken. The same calculation yields spending of 45.57 and 20.72 on haircuts and cars respectively. Dividing the amount spent on each item by its index value produces the consumption unit vector (1.76, 1.28, 0.08) for each item.

This new consumption vector will then be used until the next survey takes place. The calculations are easy to verify since both the old vector of units purchased (1.5, 1.43, 0.08) and the new one (1.76, 1.28, 0.08) cost 103.58 in the January 2016 transition month.

The way the indices from the old and new surveys are pasted together must overstate inflation. Both the old and new consumption bundles have the exact same cost, yet the consumer picked the new one. By revealed preference, in the example, consumers are better off with 103.58 in January 2016 than they were with the CPI's index value in December 2015. This, of course, is just the standard critique of the Laspeyres index.

B. Adding a New Consumer Item

Debates surrounding the consumer price index often revolve around how to deal with changing consumption weights over time. Especially those consumption changes that are in response to changes in relative prices. However, changes in the available consumption bundle due to technological change can also have a profound impact on the estimated CPI's accuracy and has been the subject of extensive research (Fixler, Fortuna, Greenlees and Lane (1999), Lebow and Rudd (2003), David, Stephen, and Kenneth (2006) and Erickson and Pakes (2011)).

When a new item enters the consumption bundle, the BLS follows a procedure that is similar to the way it normally pastes the indices together from one consumer survey to the next. Returning to the prior example, suppose that the 2016 survey includes cell phones for the first time. There are now four items across which the consumer spends his income rather than three. To paste the two surveys together the BLS simply drops the new item into the list of items purchased. From there it calculates a number of units purchased for each item in the new consumption bundle so that the total cost equals the cost of purchasing the old one. Returning to the example, assume the December 2015 survey finds that the vector of consumption weights equals (chicken, haircuts, cars, cell phones) = (0.27, 0.33, 0.15, 0.25). As in the case where a new item was not added to the survey, the BLS first calculates the cost of purchasing the consumption bundle based on the old survey. In this case that is 103.58. Using the consumption weights based on the new survey implies that for every 103.58

in consumer spending 0.27×103.58 = 27.97 went to purchasing chicken. The overall vector of dollars spent per 103.58 can be calculated similarly and equals (27.97, 34.18, 15.54, 25.89). Dividing this by the vector of index prices (21.16, 35.75, 262.38, 50) implies the representative consumer is assumed to purchase (1.32, 0.96, 0.06, 0.52) units of the chicken, haircuts, cars and cell phones respectively.

In some ways, the addition of a new item to the consumption bundle is similar to the problem of dealing with time variation in the consumption bundle as it reacts to price changes. However, in terms of the long run impact on measured inflation, the creation of a consumer item will vary with the pace of technological change- something that simple introspection indicates has accelerated over time. The BLS handles this problem in some areas by adjusting prices based on a hedonic index. They do this for clothing, major appliances, televisions, other video equipment and photographic equipment.[24] Table 2 provides the weight of each of the hedonically adjusted categories by year and the sum of their weights. The important point to note is that the total weight in the consumption bundle of items the BLS hedonically adjusts has never amounted to more than 6.7% of the index and has now fallen to 3.2%. Furthermore, some large purchase items that have undergone significant technological change, such as cars, are not part of the list. There is thus considerable reason to think that the estimated impact of technological change on consumer welfare, as reflected in the CPI, is underestimated.

[24] As noted in the main text, the BLS also lists housing as another consumption category subject to hedonic adjustment. However, as also noted in the main text, the adjustment is quite limited. See also, Ambrose, Coulson and Yoshida (2015) for a discussion of this issue.

Table 11: Seasonally Adjusted Consumer Loan Charge off Rates Tests Regressed against Credit Card Real Interest Rates and Real Incomes

This table displays the results of regressing seasonally adjusted consumer loan charge off rates against a variety of real interest rate and real income measures. Nominal interest rates are based credit card rates from 1994Q4 to 2018Q1. Real rates are calculated by subtracting either the official CPI or one of the variants proposed in this paper from the prevailing credit card rate. Year-over-year changes were then calculated on a quarter-by-quarter basis (resulting in overlapping time periods). Next year-over-year changes in the charge off rates on a quarter-by-quarter basis were calculated. Regressions were then conducted using the change in the charge off rate against the change in the real interest rate and the percentage change in real incomes (using the corresponding inflation rate) from the prior quarter. (Example: The 2006Q2 change in the charge off rate is the difference in the charge off rate from 2005Q2 to 2006Q2. This would then have as its dependent variables the change in the real interest rate and the change in real incomes from 2005Q1 to 2006Q1.) In all cases the *p*-values are adjusted for the overlapping time periods. Key: * = significant at the 10% level, ** significant at the 5% level, *** = significant at the 1% level. Red text indicates the adjusted R^2 for the alternative index is higher than for the BLS CPI.

Index	Int1	Int2	Int3	Int4	Inc1	Inc2	Inc3	Inc4	[J-Stat]/R^2
				Panel A: Consumer Loan Defaults Seasonally Adjusted – Personal Loan Rate					
BLS CPI	34.381	28.203	34.406	22.504	-4.065	0.658	-11.991	-7.862	NA
	(0.016)**	(0.147)	(0.108)	(0.136)	(0.557)	(0.954)	(0.315)	(0.373)	0.448
All Housing Size Adj.	35.21	27.87	32.334	16.891	-3.888	2.372	-9.468	-5.343	[0.119]
	(0.015)**	(0.160)	(0.121)	(0.218)	(0.571)	(0.829)	(0.400)	(0.527)	0.464
All Housing Size Adj. Minus Med.	32.80	25.576	29.371	15.042	-4.329	2.144	-8.976	-5.249	[0.183]
	(0.016)**	(0.165)	(0.135)	(0.235)	(0.527)	(0.841)	(0.417)	(0.534)	0.463
All Housing Size Adj. Minus	35.644	28.819	33.362	17.755	-4.178	2.088	-9.600	-5.447	[0.084]*
Tobacco	(0.014)**	(0.148)	(0.113)	(0.198)	(0.547)	(0.850)	(0.393)	(0.515)	0.466
All Housing Size Adj. Minus Med.	33.210	26.549	30.428	15.893	-4.633	1.834	-9.095	-5.326	[0.143]
& Tobacco	(0.015)**	(0.152)	(0.125)	(0.211)	(0.503)	(0.864)	(0.410)	(0.524)	0.464
Tech Free	9.838	29.104	24.693	12.663	-1.042	-2.959	-8.536	-2.817	[0.247]
	(0.732)	(0.376)	(0.443)	(0.558)	(0.902)	(0.821)	(0.420)	(0.680)	0.419
Tech Free Housing Size Adj.	24.601	47.895	40.006	13.105	-0.929	-2.579	-9.401	-3.087	[0.308]
	(0.300)	(0.109)	(0.257)	(0.662)	(0.914)	(0.858)	(0.411)	(0.700)	0.428
Tech Free Housing Size Adj. Minus	26.091	52.049	43.461	17.394	-1.169	-2.773	-9.460	-2.919	[0.212]
Tobacco	(0.267)	(0.073)*	(0.220)	(0.579)	(0.891)	(0.847)	(0.408)	(0.711)	0.430
Tech Free Plus Hedonic Housing	23.002	48.989	41.428	16.691	-0.867	-2.701	-9.331	-2.81	[0.214]
Size Adj.	(0.314)	(0.099)*	(0.231)	(0.577)	(0.918)	(0.848)	(0.421)	(0.722)	0.430
Tech Free Plus Hedonic House Size	24.633	53.132	44.996	20.350	-1.04	-2.889	-9.439	-2.644	[0.135]
Adj. Minus Tobac	(0.277)	(0.067)*	(0.196)	(0.511)	(0.901)	(0.838)	(0.416)	(0.734)	0.433
All Housing ACY Adj.	32.339	23.125	24.671	13.142	-5.971	0.226	-8.446	-4.035	[0.014]**
	(0.008)***	(0.152)	(0.109)	(0.230)	(0.452)	(0.985)	(0.441)	(0.611)	0.488
All Housing ACY Adj. Minus Med.	30.298	21.425	22.761	11.576	-6.535	-0.041	-8.029	-3.860	[0.024]**
	(0.008)***	(0.156)	(0.123)	(0.248)	(0.414)	(0.997)	(0.458)	(0.625)	0.488
All Housing ACY Adj. Minus	32.766	24.289	25.829	13.934	-6.317	-0.029	-8.485	-4.078	[0.012]**
Tobacco	(0.007)***	(0.135)	(0.099)*	(0.208)	(0.430)	(0.998)	(0.438)	(0.603)	0.489
All Housing ACY Adj. Minus Med.	30.719	22.634	23.98	12.385	-6.908	-0.329	-8.061	-3.879	[0.022]**
& Tobacco	(0.007)***	(0.136)	(0.111)	(0.222)	(0.391)	(0.978)	(0.455)	(0.620)	0.490
Tech Free Housing ACY Adj.	21.369	23.468	3.931	19.896	-5.559	-7.984	-9.049	-1.358	[0.040]**
	(0.147)	(0.205)	(0.872)	(0.412)	(0.579)	(0.601)	(0.406)	(0.847)	0.449
Tech Free Housing ACY Adj. Minus	22.864	25.742	7.253	22.137	-5.773	-8.255	-9.107	-1.202	[0.026]**
Tobacco	(0.102)	(0.159)	(0.765)	(0.346)	(0.565)	(0.591)	(0.408)	(0.863)	0.451

Tech Free Plus Hedonic Housing	18.181	25.966	5.699	17.889	-5.258	-7.376	-8.938	-1.328	[0.030]**
ACY Adj.	(0.188)	(0.157)	(0.809)	(0.476)	(0.596)	(0.625)	(0.416)	(0.850)	0.450
Tech Free Plus Hedonic House ACY	20.200	28.230	8.850	20.161	-5.470	-7.580	-8.999	-1.194	[0.020]**
Adj. Minus Tobac	(0.124)	(0.118)	(0.707)	(0.409)	(0.582)	(0.618)	(0.417)	(0.864)	0.452
				Panel B: Consumer Loan Defaults Seasonally Adjusted – Credit Card Rate					
BLS CPI	47.321	50.715	57.658	36.168	-4.044	1.038	-13.572	-9.778	NA
	(0.037)**	(0.119)	(0.089)*	(0.091)*	(0.546)	(0.923)	(0.236)	(0.288)	0.491
All Housing Size Adj.	47.605	50.373	54.377	30.201	-3.902	2.304	-10.62	-6.831	[0.778]
	(0.044)**	(0.146)	(0.117)	(0.138)	(0.566)	(0.826)	(0.317)	(0.427)	0.489
All Housing Size Adj. Minus Med.	43.579	45.13	48.381	26.597	-4.563	1.842	-9.918	-6.441	[0.909]
	(0.046)**	(0.156)	(0.132)	(0.152)	(0.499)	(0.858)	(0.345)	(0.457)	0.485
All Housing Size Adj. Minus	48.104	51.576	55.387	31.107	-4.155	2.072	-10.619	-6.911	[0.556]
Tobacco	(0.044)**	(0.141)	(0.113)	(0.130)	(0.544)	(0.842)	(0.314)	(0.417)	0.492
All Housing Size Adj. Minus Med.	44.047	46.338	49.406	27.464	-4.817	1.594	-9.901	-6.490	[0.883]
& Tobacco	(0.045)**	(0.150)	(0.127)	(0.144)	(0.478)	(0.876)	(0.342)	(0.449)	0.487
Tech Free	34.764	72.537	66.195	36.106	-1.792	-2.461	-6.45	-1.112	[0.082]*
	(0.408)	(0.146)	(0.178)	(0.341)	(0.845)	(0.849)	(0.532)	(0.904)	0.447
Tech Free Housing Size Adj.	44.233	89.106	71.700	35.658	-0.968	-2.001	-9.153	-3.479	[0.133]
	(0.293)	(0.071)*	(0.214)	(0.522)	(0.916)	(0.882)	(0.404)	(0.679)	0.456
Tech Free Housing Size Adj. Minus	45.751	98.105	76.401	41.813	-1.248	-2.044	-8.816	-2.772	[0.082]*
Tobacco	(0.300)	(0.051)*	(0.201)	(0.483)	(0.891)	(0.878)	(0.408)	(0.734)	0.463
Tech Free Plus Hedonic Housing	42.040	85.241	72.663	42.703	-1.388	-2.708	-9.458	-2.997	[0.125]
Size Adj.	(0.309)	(0.083)*	(0.195)	(0.429)	(0.879)	(0.839)	(0.389)	(0.715)	0.457
Tech Free Plus Hedonic House Size	43.802	93.424	77.614	48.632	-1.626	-2.790	-9.213	-2.358	[0.081]*
Adj. Minus Tobac	(0.308)	(0.062)*	(0.181)	(0.398)	(0.858)	(0.833)	(0.394)	(0.765)	0.463
All Housing ACY Adj.	42.633	39.331	38.176	22.011	-8.090	-0.930	-9.233	-5.796	[0.163]
	(0.038)**	(0.162)	(0.152)	(0.241)	(0.399)	(0.941)	(0.392)	(0.516)	0.495
All Housing ACY Adj. Minus Med.	39.209	35.344	34.219	19.275	-8.921	-1.578	-8.780	-5.351	[0.210]
	(0.036)**	(0.169)	(0.165)	(0.254)	(0.357)	(0.900)	(0.412)	(0.548)	0.492
All Housing ACY Adj. Minus	43.046	40.738	39.353	22.988	-8.417	-1.204	-9.115	-5.780	[0.125]
Tobacco	(0.037)**	(0.151)	(0.143)	(0.226)	(0.382)	(0.924)	(0.394)	(0.512)	0.497
All Housing ACY Adj. Minus Med.	39.609	36.791	35.469	20.266	-9.261	-1.883	-8.656	-5.309	[0.17]
& Tobacco	(0.035)**	(0.156)	(0.154)	(0.237)	(0.341)	(0.881)	(0.415)	(0.545)	0.494

Tech Free Housing ACY Adj.	36.680	46.902	19.889	43.171	-8.449	-8.087	-9.015	-0.358	[0.032]**
	(0.337)	(0.144)	(0.658)	(0.355)	(0.457)	(0.604)	(0.406)	(0.964)	0.445
Tech Free Housing ACY Adj. Minus Tobacco	37.599	50.085	23.545	46.108	-8.676	-8.359	-8.860	0.089	[0.012]**
	(0.316)	(0.125)	(0.603)	(0.317)	(0.447)	(0.596)	(0.417)	(0.991)	0.449
Tech Free Plus Hedonic Housing ACY Adj.	35.493	51.578	23.711	45.542	-8.623	-7.671	-8.726	-0.303	[0.027]**
	(0.353)	(0.129)	(0.607)	(0.355)	(0.449)	(0.619)	(0.421)	(0.969)	0.447
Tech Free Plus Hedonic House ACY Adj. Minus Tobac	36.996	54.774	27.161	48.716	-8.841	-7.907	-8.600	0.101	[0.014]**
	(0.327)	(0.110)	(0.560)	(0.320)	(0.440)	(0.612)	(0.430)	(0.989)	0.452
Panel C: Credit Card Defaults Seasonally Adjusted – Personal Loan Rate									
BLS CPI	58.139	28.511	33.301	21.74	-6.501	3.122	-18.62	-19.35	NA
	(0.048)**	(0.470)	(0.485)	(0.477)	(0.627)	(0.885)	(0.373)	(0.215)	0.492
All Housing Size Adj.	60.239	29.538	32.049	14.470	-6.035	6.128	-14.896	-16.033	[0.141]
	(0.039)**	(0.455)	(0.492)	(0.604)	(0.640)	(0.763)	(0.447)	(0.273)	0.508
All Housing Size Adj. Minus Med.	56.841	26.797	28.115	12.193	-6.915	5.808	-14.15	-15.806	[0.176]
	(0.038)**	(0.474)	(0.526)	(0.640)	(0.589)	(0.769)	(0.463)	(0.277)	0.508
All Housing Size Adj. Minus Tobacco	61.709	31.388	33.797	15.916	-6.563	6.043	-14.919	-16.3	[0.09]*
	(0.038)**	(0.429)	(0.470)	(0.573)	(0.613)	(0.766)	(0.442)	(0.260)	0.510
All Housing Size Adj. Minus Med. & Tobacco	58.301	28.700	29.887	13.607	-7.474	5.704	-14.136	-16.043	[0.12]
	(0.037)**	(0.445)	(0.501)	(0.605)	(0.562)	(0.773)	(0.459)	(0.265)	0.510
Tech Free	2.504	43.529	46.200	26.692	-0.557	-4.423	-12.842	-11.732	[0.033]**
	(0.964)	(0.466)	(0.448)	(0.496)	(0.968)	(0.851)	(0.486)	(0.303)	0.473
Tech Free Housing Size Adj.	19.770	64.87	77.553	16.645	2.480	0.527	-14.806	-16.921	[0.015]**
	(0.644)	(0.217)	(0.220)	(0.767)	(0.861)	(0.983)	(0.458)	(0.246)	0.479
Tech Free Housing Size Adj. Minus Tobacco	23.518	71.768	82.535	23.547	2.005	0.494	-14.595	-16.62	[0.01]***
	(0.584)	(0.163)	(0.199)	(0.688)	(0.887)	(0.984)	(0.459)	(0.243)	0.481
Tech Free Plus Hedonic Housing Size Adj.	17.727	68.857	81.636	24.805	3.002	0.039	-15.09	-16.488	[0.006]***
	(0.671)	(0.192)	(0.192)	(0.648)	(0.826)	(0.999)	(0.456)	(0.244)	0.482
Tech Free Plus Hedonic House Size Adj. Minus Tobac	21.126	75.681	87.143	30.795	2.658	0.012	-14.964	-16.201	[0.003]***
	(0.616)	(0.145)	(0.171)	(0.584)	(0.844)	(10000)	(0.455)	(0.242)	0.484
All Housing ACY Adj.	58.183	25.761	23.148	19.994	-9.151	2.768	-13.364	-18.24	[0.074]*
	(0.040)**	(0.475)	(0.566)	(0.472)	(0.512)	(0.897)	(0.472)	(0.228)	0.521

All Housing ACY Adj. Minus Med.	55.016	23.340	20.264	17.385	-10.136	2.286	-12.795	-17.933	[0.095]*
	(0.040)**	(0.497)	(0.599)	(0.501)	(0.469)	(0.913)	(0.487)	(0.233)	0.521
All Housing ACY Adj. Minus Tobacco	59.396	27.826	24.856	21.234	-9.708	2.666	-13.241	-18.442	[0.062]*
	(0.038)**	(0.444)	(0.539)	(0.446)	(0.488)	(0.900)	(0.472)	(0.218)	0.523
All Housing ACY Adj. Minus Med. & Tobacco	56.250	25.478	22.043	18.633	-10.742	2.158	-12.646	-18.11	[0.082]*
	(0.038)**	(0.461)	(0.568)	(0.472)	(0.445)	(0.918)	(0.487)	(0.223)	0.523
Tech Free Housing ACY Adj.	28.045	28.600	17.767	59.247	-5.414	-7.816	-11.609	-15.173	[0.057]*
	(0.193)	(0.370)	(0.665)	(0.182)	(0.740)	(0.758)	(0.502)	(0.247)	0.484
Tech Free Housing ACY Adj. Minus Tobacco	31.604	32.511	21.083	62.15	-5.657	-8.185	-11.517	-15.018	[0.036]**
	(0.130)	(0.314)	(0.614)	(0.158)	(0.732)	(0.749)	(0.505)	(0.243)	0.486
Tech Free Plus Hedonic Housing ACY Adj.	21.548	34.574	24.986	54.060	-4.556	-6.717	-11.734	-15.289	[0.046]**
	(0.316)	(0.286)	(0.536)	(0.255)	(0.778)	(0.788)	(0.501)	(0.252)	0.484
Tech Free Plus Hedonic House ACY Adj. Minus Tobac	25.834	38.238	28.378	57.336	-4.878	-6.979	-11.658	-15.132	[0.03]**
	(0.230)	(0.240)	(0.490)	(0.227)	(0.765)	(0.781)	(0.503)	(0.249)	0.486
Panel D: Credit Card Defaults Seasonally Adjusted – Credit Card Rate									
BLS CPI	81.029	59.753	62.721	37.664	-9.678	3.776	-19.913	-23.136	NA
	(0.078)*	(0.352)	(0.373)	(0.356)	(0.514)	(0.870)	(0.347)	(0.159)	0.505
All Housing Size Adj.	83.334	63.328	62.799	33.39	-9.439	5.172	-16.800	-20.292	[0.683]
	(0.083)*	(0.351)	(0.387)	(0.387)	(0.510)	(0.811)	(0.395)	(0.172)	0.507
All Housing Size Adj. Minus Med.	77.189	56.265	54.586	29.01	-10.704	4.354	-15.893	-19.835	[0.864]
	(0.081)*	(0.372)	(0.420)	(0.416)	(0.451)	(0.837)	(0.418)	(0.179)	0.504
All Housing Size Adj. Minus Tobacco	85.225	65.724	64.413	34.978	-9.922	5.244	-16.547	-20.576	[0.471]
	(0.080)*	(0.336)	(0.376)	(0.372)	(0.490)	(0.808)	(0.395)	(0.163)	0.510
All Housing Size Adj. Minus Med. & Tobacco	79.057	58.662	56.196	30.539	-11.195	4.434	-15.594	-20.092	[0.665]
	(0.079)*	(0.356)	(0.407)	(0.398)	(0.432)	(0.833)	(0.419)	(0.170)	0.507
Tech Free	36.466	109.181	124.336	56.69	-3.417	-4.2	-9.623	-9.671	[0.016]**
	(0.675)	(0.268)	(0.177)	(0.367)	(0.828)	(0.865)	(0.586)	(0.499)	0.482
Tech Free Housing Size Adj.	55.466	128.664	140.891	43.566	2.714	-0.025	-16.545	-21.183	[0.084]*
	(0.505)	(0.170)	(0.150)	(0.637)	(0.860)	(0.999)	(0.426)	(0.170)	0.493

Tech Free Housing Size Adj. Minus Tobacco	61.090 (0.485)	143.886 (0.129)	149.503 (0.143)	52.988 (0.591)	2.248 (0.884)	0.33 (0.989)	-15.556 (0.442)	-19.859 (0.185)	[0.066]* 0.497
Tech Free Plus Hedonic Housing Size Adj.	52.837 (0.514)	122.888 (0.177)	143.970 (0.126)	59.333 (0.499)	2.324 (0.878)	-1.36 (0.956)	-17.483 (0.395)	-20.213 (0.171)	[0.068]* 0.495
Tech Free Plus Hedonic House Size Adj. Minus Tobac	58.116 (0.493)	136.951 (0.137)	153.466 (0.117)	68.769 (0.460)	1.903 (0.900)	-1.103 (0.964)	-16.636 (0.406)	-18.966 (0.184)	[0.054]* 0.499
All Housing ACY Adj.	80.023 (0.074)*	51.76 (0.384)	44.138 (0.468)	35.671 (0.366)	-16.108 (0.327)	0.858 (0.970)	-14.616 (0.437)	-23.753 (0.162)	[0.233] 0.516
All Housing ACY Adj. Minus Med.	74.509 (0.072)*	45.978 (0.405)	38.111 (0.501)	31.306 (0.384)	-17.545 (0.291)	-0.203 (0.993)	-13.940 (0.458)	-23.149 (0.169)	[0.284] 0.514
All Housing ACY Adj. Minus Tobacco	81.611 (0.070)*	54.302 (0.364)	45.778 (0.451)	37.255 (0.346)	-16.734 (0.311)	0.779 (0.973)	-14.215 (0.442)	-23.946 (0.154)	[0.184] 0.518
All Housing ACY Adj. Minus Med. & Tobacco	76.103 (0.068)*	48.581 (0.381)	39.848 (0.481)	32.904 (0.361)	-18.196 (0.276)	-0.296 (0.989)	-13.513 (0.464)	-23.324 (0.161)	[0.23] 0.516
Tech Free Housing ACY Adj.	67.052 (0.297)	72.915 (0.254)	51.927 (0.479)	98.076 (0.215)	-10.062 (0.587)	-7.638 (0.770)	-11.648 (0.502)	-15.286 (0.242)	[0.054]* 0.472
Tech Free Housing ACY Adj. Minus Tobacco	71.110 (0.259)	78.908 (0.229)	54.959 (0.461)	102.833 (0.187)	-10.524 (0.576)	-7.929 (0.765)	-11.334 (0.512)	-14.753 (0.252)	[0.037]** 0.476
Tech Free Plus Hedonic Housing ACY Adj.	64.075 (0.334)	81.222 (0.217)	64.448 (0.386)	101.723 (0.229)	-10.066 (0.585)	-6.803 (0.790)	-11.272 (0.511)	-15.22 (0.246)	[0.051]* 0.475
Tech Free Plus Hedonic House ACY Adj. Minus Tobac	68.716 (0.292)	87.272 (0.192)	67.690 (0.371)	107.316 (0.201)	-10.628 (0.570)	-7.111 (0.784)	-10.988 (0.519)	-14.657 (0.257)	[0.039]** 0.479
Panel E: Other Consumer Loan Defaults Seasonally Adjusted – Personal Loan Rate									
BLS CPI	6.034 (0.560)	13.706 (0.095)*	20.799 (0.003)***	5.938 (0.550)	-6.293 (0.278)	-4.018 (0.615)	-1.965 (0.728)	6.141 (0.188)	NA 0.167
All Housing Size Adj.	7.886 (0.458)	14.906 (0.066)*	21.076 (0.005)***	3.729 (0.705)	-5.718 (0.289)	-2.329 (0.757)	-0.412 (0.940)	7.564 (0.125)	[0.009]*** 0.166
All Housing Size Adj. Minus Med.	7.378 (0.465)	14.735 (0.054)*	20.429 (0.004)***	3.501 (0.712)	-5.772 (0.274)	-2.338 (0.749)	-0.202 (0.970)	7.453 (0.128)	[0.014]** 0.166

All Housing Size Adj. Minus Tobacco	7.892 (0.454)	15.259 (0.057)*	21.3 (0.004)***	4.185 (0.670)	-5.633 (0.293)	-2.352 (0.752)	-0.458 (0.932)	7.341 (0.125)	[0.008]*** 0.165
All Housing Size Adj. Minus Med. & Tobacco	7.337 (0.464)	15.03 (0.046)**	20.6 (0.003)***	3.95 (0.676)	-5.663 (0.279)	-2.369 (0.743)	-0.258 (0.961)	7.21 (0.128)	[0.026]** 0.164
Tech Free	14.807 (0.349)	15.628 (0.470)	18.61 (0.347)	7.856 (0.583)	-3.853 (0.453)	-2.548 (0.711)	-4.161 (0.481)	3.884 (0.223)	[0.430] 0.169
Tech Free Housing Size Adj.	24.526 (0.083)*	30.472 (0.120)	30.043 (0.202)	19.347 (0.341)	-3.071 (0.511)	-1.899 (0.780)	-3.562 (0.592)	5.55 (0.177)	[0.348] 0.187
Tech Free Housing Size Adj. Minus Tobacco	25.014 (0.069)*	32.447 (0.095)*	31.545 (0.183)	21.739 (0.295)	-2.861 (0.535)	-1.79 (0.788)	-3.528 (0.587)	5.382 (0.177)	[0.324] 0.191
Tech Free Plus Hedonic Housing Size Adj.	24.407 (0.083)*	31.415 (0.105)	26.997 (0.219)	15.255 (0.405)	-3.222 (0.488)	-2.272 (0.743)	-3.605 (0.588)	5.88 (0.155)	[0.370] 0.181
Tech Free Plus Hedonic House Size Adj. Minus Tobac	25.044 (0.069)*	33.466 (0.082)*	28.465 (0.198)	17.379 (0.354)	-3.005 (0.511)	-2.156 (0.750)	-3.598 (0.581)	5.708 (0.153)	[0.346] 0.184
All Housing ACY Adj.	13.872 (0.180)	25.122 (0.008)***	31.801 (0.002)***	15.892 (0.249)	-3.513 (0.433)	1.02 (0.873)	-0.912 (0.866)	3.22 (0.376)	[0.027]** 0.184
All Housing ACY Adj. Minus Med.	12.967 (0.192)	23.956 (0.008)***	30.077 (0.002)***	14.813 (0.262)	-3.532 (0.417)	0.999 (0.872)	-0.651 (0.903)	3.113 (0.394)	[0.031]** 0.183
All Housing ACY Adj. Minus Tobacco	13.783 (0.181)	25.275 (0.007)***	31.691 (0.001)***	16.141 (0.241)	-3.424 (0.439)	0.999 (0.875)	-0.895 (0.867)	3.009 (0.406)	[0.026]** 0.184
All Housing ACY Adj. Minus Med. & Tobacco	12.855 (0.194)	24.068 (0.006)***	29.926 (0.002)***	15.059 (0.253)	-3.415 (0.426)	0.986 (0.873)	-0.639 (0.903)	2.879 (0.430)	[0.032]** 0.183
Tech Free Housing ACY Adj.	42.655 (0.036)**	45.009 (0.073)*	49.872 (0.100)	51.602 (0.095)*	-2.23 (0.596)	1.726 (0.781)	-0.825 (0.897)	3.892 (0.248)	[0.075]* 0.255
Tech Free Housing ACY Adj. Minus Tobacco	41.279 (0.034)**	45.363 (0.065)*	49.941 (0.094)*	51.025 (0.088)*	-2.119 (0.614)	1.479 (0.811)	-0.872 (0.890)	3.884 (0.236)	[0.072]* 0.258
Tech Free Plus Hedonic Housing ACY Adj.	42.422 (0.049)**	47.189 (0.069)*	48.731 (0.117)	47.734 (0.122)	-2.105 (0.613)	2.003 (0.745)	-1.16 (0.859)	3.822 (0.277)	[0.092]* 0.244
Tech Free Plus Hedonic House ACY Adj. Minus Tobac	41.541 (0.045)**	47.485 (0.062)*	48.822 (0.111)	47.557 (0.114)	-2.001 (0.629)	1.811 (0.768)	-1.211 (0.851)	3.795 (0.269)	[0.087]* 0.248

Panel F: Other Consumer Loan Defaults Seasonally Adjusted – Credit Card Rate									
BLS CPI	6.171	18.37	20.093	2.757	-7.172	-6.889	-2.186	6.884	NA
	(0.640)	(0.154)	(0.131)	(0.870)	(0.366)	(0.466)	(0.755)	(0.290)	0.165
All Housing Size Adj.	5.842	16.613	16.651	-2.107	-6.26	-5.417	-0.532	8.575	[0.826]
	(0.673)	(0.202)	(0.242)	(0.902)	(0.406)	(0.564)	(0.938)	(0.181)	0.154
All Housing Size Adj. Minus Med.	5.524	16.305	16.535	-1.808	-6.271	-5.232	-0.229	8.567	[0.620]
	(0.671)	(0.167)	(0.193)	(0.909)	(0.392)	(0.568)	(0.973)	(0.172)	0.154
All Housing Size Adj. Minus Tobacco	5.643	16.957	16.984	-1.49	-6.042	-5.362	-0.574	8.349	[0.754]
	(0.683)	(0.191)	(0.229)	(0.931)	(0.420)	(0.565)	(0.932)	(0.181)	0.152
All Housing Size Adj. Minus Med. & Tobacco	5.281	16.576	16.81	-1.207	-6.029	-5.187	-0.291	8.317	[0.89]
	(0.684)	(0.158)	(0.181)	(0.939)	(0.407)	(0.569)	(0.965)	(0.172)	0.152
Tech Free	12.612	21.016	13.906	0.552	-4.104	-5.117	-6.758	1.889	[0.312]
	(0.515)	(0.367)	(0.520)	(0.975)	(0.478)	(0.478)	(0.321)	(0.734)	0.198
Tech Free Housing Size Adj.	6.609	22.992	-4.223	-3.734	-3.429	-5.64	-8.384	2.226	[0.119]
	(0.766)	(0.399)	(0.903)	(0.880)	(0.507)	(0.450)	(0.270)	(0.558)	0.259
Tech Free Housing Size Adj. Minus Tobacco	6.663	27.59	-2.873	-0.553	-3.096	-5.228	-8.127	2.249	[0.115]
	(0.764)	(0.325)	(0.935)	(0.983)	(0.543)	(0.473)	(0.273)	(0.554)	0.259
Tech Free Plus Hedonic Housing Size Adj.	6.058	20.459	-4.667	-3.379	-3.696	-6.094	-8.166	2.612	[0.134]
	(0.771)	(0.422)	(0.886)	(0.890)	(0.483)	(0.416)	(0.274)	(0.472)	0.253
Tech Free Plus Hedonic House Size Adj. Minus Tobac	6.527	24.557	-3.398	-0.542	-3.38	-5.717	-7.939	2.616	[0.129]
	(0.756)	(0.348)	(0.919)	(0.983)	(0.517)	(0.435)	(0.274)	(0.468)	0.253
All Housing ACY Adj.	13.910	30.808	34.274	16.152	-1.908	0.67	-1.888	2.418	[0.225]
	(0.319)	(0.009)***	(0.006)***	(0.381)	(0.747)	(0.928)	(0.775)	(0.538)	0.170
All Housing ACY Adj. Minus Med.	12.857	28.607	31.958	14.92	-2.029	0.694	-1.547	2.426	[0.245]
	(0.332)	(0.011)**	(0.007)***	(0.390)	(0.724)	(0.924)	(0.812)	(0.539)	0.168
All Housing ACY Adj. Minus Tobacco	13.64	30.795	34.102	16.528	-1.77	0.708	-1.825	2.206	[0.206]
	(0.328)	(0.008)***	(0.005)***	(0.371)	(0.762)	(0.924)	(0.781)	(0.573)	0.170
All Housing ACY Adj. Minus Med. & Tobacco	12.585	28.581	31.765	15.283	-1.854	0.748	-1.493	2.184	[0.225]
	(0.341)	(0.010)**	(0.006)***	(0.379)	(0.743)	(0.917)	(0.817)	(0.581)	0.168

Tech Free Housing ACY Adj.	35.933 (0.143)	54.099 (0.078)*	38.62 (0.253)	51.931 (0.110)	-0.198 (0.967)	4.042 (0.576)	-0.987 (0.900)	4.688 (0.150)	[0.057]* 0.274
Tech Free Housing ACY Adj. Minus Tobacco	35.214 (0.143)	54.612 (0.069)*	39.457 (0.237)	52.553 (0.100)	-0.09 (0.985)	3.8 (0.594)	-0.868 (0.911)	4.719 (0.144)	[0.051]* 0.279
Tech Free Plus Hedonic Housing ACY Adj.	34.922 (0.171)	54.094 (0.076)*	36.792 (0.282)	50.255 (0.127)	-0.385 (0.936)	3.894 (0.579)	-1.323 (0.865)	4.569 (0.172)	[0.069]* 0.267
Tech Free Plus Hedonic House ACY Adj. Minus Tobac	34.707 (0.166)	54.804 (0.068)*	37.64 (0.267)	51.302 (0.116)	-0.256 (0.957)	3.747 (0.589)	-1.211 (0.875)	4.569 (0.169)	[0.062]* 0.272

Table 12: Consumer Loan Charge off Rates Tests Regressed against Credit Card Real Interest Rates and Real Incomes

This table displays the results of regressing consumer loan charge off rates against a variety of real interest rate and real income measures. Nominal interest rates are based credit card rates from 1994Q4 to 2018Q1. Real rates are calculated by subtracting either the official CPI or one of the variants proposed in this paper from the prevailing credit card rate. Year-over-year changes were then calculated on a quarter-by-quarter basis (resulting in overlapping time periods). Next year-over-year changes in the charge off rates on a quarter-by-quarter basis were calculated. Regressions were then conducted using the change in the charge off rate against the change in the real interest rate and the percentage change in real incomes (using the corresponding inflation rate) from the prior quarter. (Example: The 2006Q2 change in the charge off rate is the difference in the charge off rate from 2005Q2 to 2006Q2. This would then have as its dependent variables the change in the real interest rate and the change in real incomes from 2005Q1 to 2006Q1.) In all cases the *p*-values are adjusted for the overlapping time periods. Key: * = significant at the 10% level, ** significant at the 5% level, *** = significant at the 1% level. Red text indicates the adjusted R^2 for the alternative index is higher than for the BLS CPI.

Panel A: Consumer Loan Defaults – Personal Loan Rate									
Index	Int1	Int2	Int3	Int4	Inc1	Inc2	Inc3	Inc4	[J-Stat]/R^2
BLS CPI	33.923	29.435	37.261	24.916	-4.041	0.279	-11.986	-8.071	NA
	(0.018)**	(0.142)	(0.083)*	(0.101)	(0.563)	(0.981)	(0.324)	(0.372)	0.445
All Housing Size Adj.	34.609	28.938	34.973	19.192	-3.864	1.997	-9.391	-5.496	[0.134]
	(0.017)**	(0.155)	(0.094)*	(0.163)	(0.579)	(0.859)	(0.411)	(0.525)	0.461
All Housing Size Adj. Minus Med.	32.214	26.616	31.898	17.245	-4.300	1.767	-8.903	-5.404	[0.204]
	(0.018)**	(0.160)	(0.105)	(0.173)	(0.534)	(0.872)	(0.429)	(0.532)	0.459
All Housing Size Adj. Minus	35.066	29.889	35.96	20.043	-4.148	1.699	-9.528	-5.602	[0.095]*
Tobacco	(0.016)**	(0.144)	(0.088)*	(0.146)	(0.556)	(0.880)	(0.404)	(0.514)	0.462
All Housing Size Adj. Minus Med.	32.645	27.589	32.915	18.083	-4.597	1.444	-9.027	-5.484	[0.158]
& Tobacco	(0.017)**	(0.148)	(0.098)*	(0.154)	(0.511)	(0.895)	(0.422)	(0.522)	0.460
Tech Free	8.941	29.046	26.173	12.277	-0.885	-3.609	-8.641	-2.473	[0.209]
	(0.759)	(0.377)	(0.410)	(0.570)	(0.917)	(0.788)	(0.417)	(0.717)	0.415
Tech Free Housing Size Adj.	23.419	46.982	41.809	14.067	-1.080	-3.170	-9.287	-2.903	[0.31]
	(0.314)	(0.112)	(0.226)	(0.642)	(0.902)	(0.828)	(0.419)	(0.721)	0.423
Tech Free Housing Size Adj. Minus	25.071	51.190	45.255	18.409	-1.307	-3.395	-9.355	-2.730	[0.21]
Tobacco	(0.274)	(0.076)*	(0.191)	(0.559)	(0.881)	(0.817)	(0.415)	(0.732)	0.426
Tech Free Plus Hedonic Housing	21.94	48.195	43.135	17.45	-0.993	-3.296	-9.230	-2.618	[0.214]
Size Adj.	(0.325)	(0.102)	(0.204)	(0.562)	(0.908)	(0.819)	(0.428)	(0.744)	0.426
Tech Free Plus Hedonic House Size	23.69	52.388	46.717	21.157	-1.154	-3.511	-9.346	-2.448	[0.132]
Adj. Minus Tobac	(0.285)	(0.070)*	(0.173)	(0.498)	(0.893)	(0.807)	(0.423)	(0.756)	0.428
All Housing ACY Adj.	31.849	24.104	27.373	15.032	-6.000	-0.146	-8.244	-4.017	[0.014]**
	(0.009)***	(0.141)	(0.071)*	(0.165)	(0.455)	(0.991)	(0.454)	(0.617)	0.484
All Housing ACY Adj. Minus Med.	29.82	22.414	25.358	13.396	-6.567	-0.413	-7.817	-3.842	[0.024]**
	(0.009)***	(0.143)	(0.082)*	(0.176)	(0.416)	(0.973)	(0.472)	(0.631)	0.484
All Housing ACY Adj. Minus	32.313	25.278	28.483	15.803	-6.346	-0.422	-8.288	-4.060	[0.012]**
Tobacco	(0.008)***	(0.125)	(0.066)*	(0.149)	(0.432)	(0.973)	(0.451)	(0.609)	0.486
All Housing ACY Adj. Minus Med.	30.276	23.633	26.532	14.185	-6.942	-0.723	-7.854	-3.861	[0.022]**
& Tobacco	(0.008)***	(0.126)	(0.074)*	(0.158)	(0.393)	(0.953)	(0.470)	(0.625)	0.486
Tech Free Housing ACY Adj.	21.517	23.072	5.440	18.616	-5.580	-8.771	-9.08	-1.049	[0.043]**
	(0.115)	(0.193)	(0.819)	(0.435)	(0.586)	(0.575)	(0.406)	(0.882)	0.445
Tech Free Housing ACY Adj. Minus	23.15	25.489	8.662	21.089	-5.801	-9.068	-9.138	-0.893	[0.029]**
Tobacco	(0.069)*	(0.147)	(0.714)	(0.357)	(0.573)	(0.565)	(0.408)	(0.898)	0.447

Tech Free Plus Hedonic Housing	18.139	25.570	7.206	16.705	-5.283	-8.193	-8.946	-0.998	[0.033]**
ACY Adj.	(0.155)	(0.150)	(0.756)	(0.502)	(0.604)	(0.597)	(0.415)	(0.888)	0.446
Tech Free Plus Hedonic House ACY	20.278	27.969	10.286	19.172	-5.500	-8.422	-9.007	-0.865	[0.023]**
Adj. Minus Tobac	(0.088)*	(0.111)	(0.657)	(0.427)	(0.590)	(0.589)	(0.417)	(0.902)	0.448
				Panel B: Consumer Loan Defaults – Credit Card Rate					
BLS CPI	46.74	52.322	61.685	39.839	-3.927	0.664	-13.738	-10.203	NA
	(0.044)**	(0.120)	(0.073)*	(0.068)*	(0.565)	(0.952)	(0.239)	(0.268)	0.490
All Housing Size Adj.	46.911	51.749	58.091	33.63	-3.778	2.000	-10.654	-7.151	[0.869]
	(0.052)*	(0.147)	(0.098)*	(0.102)	(0.585)	(0.852)	(0.326)	(0.409)	0.487
All Housing Size Adj. Minus Med.	42.911	46.415	51.853	29.804	-4.437	1.539	-9.952	-6.754	[0.793]
	(0.054)*	(0.157)	(0.111)	(0.113)	(0.518)	(0.884)	(0.355)	(0.439)	0.482
All Housing Size Adj. Minus	47.450	52.915	59.037	34.512	-4.039	1.749	-10.662	-7.229	[0.625]
Tobacco	(0.051)*	(0.142)	(0.095)*	(0.097)*	(0.561)	(0.869)	(0.321)	(0.399)	0.490
All Housing Size Adj. Minus Med.	43.418	47.589	52.818	30.648	-4.700	1.273	-9.942	-6.802	[0.981]
& Tobacco	(0.053)*	(0.152)	(0.107)	(0.106)	(0.496)	(0.903)	(0.350)	(0.430)	0.485
Tech Free	34.658	72.104	68.806	35.904	-1.641	-3.155	-6.591	-0.726	[0.090]*
	(0.409)	(0.145)	(0.156)	(0.356)	(0.860)	(0.812)	(0.521)	(0.937)	0.443
Tech Free Housing Size Adj.	43.825	87.675	74.297	36.786	-1.017	-2.681	-9.051	-3.232	[0.158]
	(0.298)	(0.076)*	(0.196)	(0.522)	(0.913)	(0.843)	(0.405)	(0.701)	0.451
Tech Free Housing Size Adj. Minus	45.772	96.372	78.999	43.019	-1.286	-2.768	-8.738	-2.525	[0.103]
Tobacco	(0.300)	(0.056)*	(0.184)	(0.485)	(0.890)	(0.837)	(0.412)	(0.757)	0.458
Tech Free Plus Hedonic Housing	41.850	84.052	75.268	43.659	-1.425	-3.394	-9.36	-2.745	[0.146]
Size Adj.	(0.311)	(0.086)*	(0.177)	(0.433)	(0.878)	(0.801)	(0.393)	(0.738)	0.452
Tech Free Plus Hedonic House Size	43.929	92.011	80.267	49.636	-1.653	-3.513	-9.135	-2.104	[0.099]*
Adj. Minus Tobac	(0.306)	(0.065)*	(0.164)	(0.402)	(0.860)	(0.794)	(0.397)	(0.790)	0.458
All Housing ACY Adj.	42.147	40.758	41.887	24.877	-7.97	-1.19	-9.017	-5.87	[0.171]
	(0.044)**	(0.150)	(0.112)	(0.181)	(0.410)	(0.927)	(0.406)	(0.513)	0.491
All Housing ACY Adj. Minus Med.	38.737	36.705	37.685	21.952	-8.813	-1.848	-8.548	-5.413	[0.222]
	(0.042)**	(0.157)	(0.122)	(0.190)	(0.366)	(0.886)	(0.428)	(0.545)	0.489
All Housing ACY Adj. Minus	42.619	42.133	42.972	25.802	-8.317	-1.502	-8.908	-5.841	[0.130]
Tobacco	(0.042)**	(0.140)	(0.106)	(0.171)	(0.391)	(0.908)	(0.407)	(0.509)	0.493
All Housing ACY Adj. Minus Med.	39.193	38.126	38.852	22.896	-9.174	-2.192	-8.433	-5.358	[0.177]
& Tobacco	(0.040)**	(0.145)	(0.115)	(0.178)	(0.348)	(0.865)	(0.430)	(0.543)	0.491
Tech Free Housing ACY Adj.	37.904	45.585	22.365	41.645	-8.41	-9.085	-8.976	-0.122	[0.044]**

	(0.307)	(0.151)	(0.622)	(0.386)	(0.471)	(0.570)	(0.410)	(0.988)	0.440
Tech Free Housing ACY Adj. Minus Tobacco	39.086 (0.282)	48.822 (0.132)	25.876 (0.572)	44.853 (0.342)	-8.643 (0.462)	-9.379 (0.561)	-8.845 (0.419)	0.323 (0.968)	[0.018]** 0.444
Tech Free Plus Hedonic Housing ACY Adj.	36.677 (0.325)	50.177 (0.135)	26.449 (0.569)	44.034 (0.385)	-8.59 (0.463)	-8.704 (0.582)	-8.667 (0.423)	-0.029 (0.997)	[0.037]** 0.442
Tech Free Plus Hedonic House ACY Adj. Minus Tobac	38.401 (0.297)	53.424 (0.115)	29.799 (0.527)	47.448 (0.346)	-8.819 (0.454)	-8.962 (0.574)	-8.561 (0.431)	0.376 (0.961)	[0.021]** 0.446
Panel C: Credit Card Defaults – Personal Loan Rate									
BLS CPI	56.124 (0.054)*	27.116 (0.501)	36.463 (0.434)	26.08 (0.373)	-5.243 (0.694)	2.674 (0.904)	-19.089 (0.369)	-19.625 (0.214)	NA 0.489
All Housing Size Adj.	58.138 (0.044)**	28.029 (0.487)	34.920 (0.442)	18.688 (0.482)	-4.828 (0.707)	5.591 (0.789)	-15.323 (0.441)	-16.264 (0.270)	[0.151] 0.505
All Housing Size Adj. Minus Med.	54.744 (0.044)**	25.247 (0.508)	30.700 (0.476)	16.211 (0.513)	-5.688 (0.654)	5.288 (0.794)	-14.574 (0.457)	-16.085 (0.273)	[0.190] 0.505
All Housing Size Adj. Minus Tobacco	59.548 (0.043)**	29.934 (0.461)	36.662 (0.422)	20.114 (0.455)	-5.307 (0.681)	5.471 (0.793)	-15.364 (0.435)	-16.549 (0.257)	[0.098]* 0.507
All Housing Size Adj. Minus Med. & Tobacco	56.138 (0.042)**	27.196 (0.479)	32.461 (0.454)	17.601 (0.483)	-6.197 (0.628)	5.147 (0.799)	-14.578 (0.452)	-16.340 (0.260)	[0.132] 0.507
Tech Free	3.424 (0.950)	40.536 (0.494)	46.985 (0.430)	24.837 (0.512)	0.777 (0.955)	-5.355 (0.828)	-13.847 (0.457)	-11.256 (0.311)	[0.034]** 0.469
Tech Free Housing Size Adj.	21.344 (0.610)	60.313 (0.239)	75.627 (0.206)	16.854 (0.755)	3.625 (0.797)	-0.883 (0.973)	-15.560 (0.445)	-16.429 (0.253)	[0.021]** 0.475
Tech Free Housing Size Adj. Minus Tobacco	24.988 (0.549)	67.533 (0.179)	80.843 (0.186)	23.850 (0.672)	3.240 (0.818)	-0.932 (0.971)	-15.376 (0.444)	-16.140 (0.250)	[0.013]** 0.477
Tech Free Plus Hedonic Housing Size Adj.	19.450 (0.633)	64.236 (0.214)	79.833 (0.180)	24.644 (0.638)	4.152 (0.761)	-1.384 (0.957)	-15.882 (0.440)	-15.944 (0.253)	[0.009]*** 0.477
Tech Free Plus Hedonic House Size Adj. Minus Tobac	22.775 (0.579)	71.34 (0.162)	85.563 (0.160)	30.768 (0.572)	3.889 (0.775)	-1.429 (0.955)	-15.783 (0.438)	-15.667 (0.250)	[0.004]*** 0.480
All Housing ACY Adj.	55.958 (0.044)**	24.298 (0.503)	26.489 (0.492)	23.783 (0.369)	-7.920 (0.567)	2.199 (0.920)	-13.781 (0.464)	-18.231 (0.224)	[0.074]* 0.518

All Housing ACY Adj. Minus Med.	52.804	21.854	23.293	20.990	-8.893	1.729	-13.201	-17.958	[0.095]*
	(0.045)**	(0.526)	(0.527)	(0.394)	(0.522)	(0.936)	(0.479)	(0.227)	0.518
All Housing ACY Adj. Minus Tobacco	57.113	26.431	28.154	24.952	-8.424	2.057	-13.676	-18.442	[0.062]*
	(0.042)**	(0.471)	(0.468)	(0.349)	(0.545)	(0.925)	(0.463)	(0.213)	0.520
All Housing ACY Adj. Minus Med. & Tobacco	53.973	24.051	25.027	22.163	-9.444	1.557	-13.071	-18.143	[0.082]*
	(0.042)**	(0.489)	(0.499)	(0.370)	(0.498)	(0.942)	(0.479)	(0.217)	0.520
Tech Free Housing ACY Adj.	28.715	26.077	17.861	57.156	-3.973	-9.142	-12.637	-14.558	[0.074]*
	(0.155)	(0.408)	(0.652)	(0.182)	(0.812)	(0.731)	(0.474)	(0.257)	0.480
Tech Free Housing ACY Adj. Minus Tobacco	31.888	30.267	21.152	60.130	-4.151	-9.543	-12.568	-14.395	[0.047]**
	(0.102)	(0.346)	(0.603)	(0.160)	(0.806)	(0.721)	(0.476)	(0.254)	0.482
Tech Free Plus Hedonic Housing ACY Adj.	22.820	31.619	25.017	52.319	-3.118	-8.119	-12.805	-14.618	[0.061]*
	(0.250)	(0.322)	(0.518)	(0.256)	(0.850)	(0.757)	(0.470)	(0.263)	0.480
Tech Free Plus Hedonic House ACY Adj. Minus Tobac	26.730	35.554	28.405	55.657	-3.376	-8.415	-12.754	-14.453	[0.039]**
	(0.182)	(0.270)	(0.473)	(0.229)	(0.839)	(0.749)	(0.471)	(0.261)	0.483
Panel D: Credit Card Defaults – Credit Card Rate									
BLS CPI	79.117	58.405	66.608	43.342	-8.187	3.589	-20.645	-23.889	NA
	(0.091)*	(0.372)	(0.334)	(0.275)	(0.579)	(0.878)	(0.334)	(0.145)	0.503
All Housing Size Adj.	81.428	61.911	66.431	38.919	-8.029	4.963	-17.401	-20.943	[0.717]
	(0.095)*	(0.371)	(0.351)	(0.298)	(0.572)	(0.821)	(0.383)	(0.158)	0.504
All Housing Size Adj. Minus Med.	75.276	54.746	57.803	34.192	-9.271	4.175	-16.482	-20.536	[0.91]
	(0.094)*	(0.394)	(0.384)	(0.321)	(0.509)	(0.846)	(0.406)	(0.164)	0.501
All Housing Size Adj. Minus Tobacco	83.270	64.359	68.070	40.469	-8.464	4.996	-17.184	-21.242	[0.497]
	(0.092)*	(0.356)	(0.340)	(0.286)	(0.554)	(0.819)	(0.381)	(0.149)	0.507
All Housing Size Adj. Minus Med. & Tobacco	77.088	57.187	59.431	35.680	-9.713	4.211	-16.219	-20.807	[0.705]
	(0.090)*	(0.377)	(0.372)	(0.308)	(0.491)	(0.843)	(0.405)	(0.155)	0.504
Tech Free	41.497	106.208	124.284	53.186	-1.931	-5.256	-10.97	-9.403	[0.025]**
	(0.634)	(0.274)	(0.161)	(0.393)	(0.902)	(0.838)	(0.524)	(0.498)	0.477
Tech Free Housing Size Adj.	61.963	123.424	136.133	42.473	3.95	-1.702	-17.648	-21.011	[0.105]
	(0.468)	(0.193)	(0.157)	(0.652)	(0.800)	(0.946)	(0.401)	(0.166)	0.488

Tech Free Housing Size Adj. Minus Tobacco	68.120 (0.448)	138.724 (0.148)	144.717 (0.150)	51.722 (0.608)	3.584 (0.818)	-1.336 (0.957)	-16.679 (0.412)	-19.735 (0.179)	[0.085]* 0.492
Tech Free Plus Hedonic Housing Size Adj.	58.781 (0.479)	117.476 (0.202)	139.928 (0.132)	57.674 (0.521)	3.542 (0.817)	-3.062 (0.903)	-18.564 (0.370)	-19.973 (0.165)	[0.090]* 0.489
Tech Free Plus Hedonic House Size Adj. Minus Tobac	64.494 (0.458)	131.57 (0.158)	149.423 (0.123)	66.941 (0.483)	3.207 (0.834)	-2.803 (0.910)	-17.739 (0.377)	-18.760 (0.178)	[0.072]* 0.493
All Housing ACY Adj.	78.147 (0.084)*	50.725 (0.395)	48.286 (0.407)	40.589 (0.284)	-14.593 (0.371)	0.567 (0.981)	-15.168 (0.423)	-24.091 (0.151)	[0.226] 0.513
All Housing ACY Adj. Minus Med.	72.607 (0.082)*	44.817 (0.417)	41.779 (0.441)	35.876 (0.298)	-16.021 (0.331)	-0.484 (0.983)	-14.472 (0.444)	-23.517 (0.158)	[0.281] 0.511
All Housing ACY Adj. Minus Tobacco	79.684 (0.080)*	53.326 (0.375)	49.877 (0.393)	42.028 (0.270)	-15.165 (0.356)	0.435 (0.985)	-14.801 (0.426)	-24.277 (0.143)	[0.176] 0.515
All Housing ACY Adj. Minus Med. & Tobacco	74.141 (0.078)*	47.47 (0.394)	43.466 (0.424)	37.329 (0.282)	-16.617 (0.316)	-0.635 (0.978)	-14.08 (0.448)	-23.68 (0.149)	[0.226] 0.513
Tech Free Housing ACY Adj.	71.259 (0.263)	69.614 (0.269)	50.978 (0.474)	96.097 (0.225)	-8.474 (0.653)	-9.179 (0.736)	-12.79 (0.469)	-15.055 (0.237)	[0.052]* 0.468
Tech Free Housing ACY Adj. Minus Tobacco	74.768 (0.231)	75.853 (0.241)	53.989 (0.460)	100.676 (0.197)	-8.88 (0.643)	-9.476 (0.731)	-12.497 (0.477)	-14.52 (0.247)	[0.035]** 0.472
Tech Free Plus Hedonic Housing ACY Adj.	68.904 (0.296)	77.093 (0.234)	63.69 (0.380)	99.593 (0.241)	-8.461 (0.652)	-8.423 (0.752)	-12.47 (0.474)	-14.945 (0.241)	[0.052]* 0.471
Tech Free Plus Hedonic House ACY Adj. Minus Tobac	73.093 (0.261)	83.355 (0.207)	66.865 (0.368)	105.066 (0.213)	-8.969 (0.637)	-8.736 (0.746)	-12.218 (0.480)	-14.384 (0.252)	[0.038]** 0.475
Panel E: Other Consumer Loan Defaults – Personal Loan Rate									
BLS CPI	7.204 (0.507)	17.168 (0.051)*	22.428 (0.001)***	5.683 (0.562)	-6.529 (0.252)	-4.336 (0.583)	-1.688 (0.764)	6.465 (0.164)	NA 0.168
All Housing Size Adj.	8.964 (0.421)	18.235 (0.033)**	22.563 (0.002)***	3.490 (0.716)	-5.936 (0.263)	-2.618 (0.725)	-0.094 (0.986)	7.881 (0.106)	[0.008]*** 0.167
All Housing Size Adj. Minus Med.	8.403 (0.428)	17.951 (0.027)**	21.933 (0.002)***	3.286 (0.722)	-5.983 (0.249)	-2.611 (0.718)	0.123 (0.982)	7.776 (0.109)	[0.011]** 0.167

All Housing Size Adj. Minus Tobacco	9.014 (0.414)	18.612 (0.027)**	22.772 (0.002)***	3.995 (0.677)	-5.868 (0.266)	-2.643 (0.720)	-0.134 (0.980)	7.66 (0.105)	[0.007]*** 0.166
All Housing Size Adj. Minus Med. & Tobacco	8.407 (0.423)	18.270 (0.022)**	22.092 (0.001)***	3.782 (0.682)	-5.892 (0.254)	-2.641 (0.712)	0.074 (0.989)	7.536 (0.108)	[0.023]** 0.165
Tech Free	15.378 (0.327)	17.761 (0.406)	18.963 (0.331)	6.245 (0.662)	-4.204 (0.416)	-2.792 (0.678)	-3.733 (0.534)	4.330 (0.166)	[0.460] 0.167
Tech Free Housing Size Adj.	25.583 (0.070)*	34.022 (0.073)*	31.737 (0.178)	17.981 (0.371)	-3.406 (0.465)	-2.123 (0.750)	-3.125 (0.643)	6.098 (0.146)	[0.355] 0.186
Tech Free Housing Size Adj. Minus Tobacco	26.353 (0.057)*	36.256 (0.056)*	33.169 (0.161)	20.654 (0.314)	-3.245 (0.481)	-2.028 (0.756)	-3.076 (0.640)	5.948 (0.143)	[0.326] 0.190
Tech Free Plus Hedonic Housing Size Adj.	25.427 (0.069)*	34.907 (0.064)*	28.925 (0.190)	14.141 (0.440)	-3.590 (0.438)	-2.453 (0.717)	-3.156 (0.641)	6.426 (0.127)	[0.373] 0.181
Tech Free Plus Hedonic House Size Adj. Minus Tobac	26.313 (0.057)*	37.214 (0.048)**	30.354 (0.171)	16.478 (0.379)	-3.419 (0.453)	-2.348 (0.723)	-3.134 (0.636)	6.270 (0.124)	[0.345] 0.184
All Housing ACY Adj.	14.885 (0.167)	28.321 (0.003)***	32.743 (0.001)***	15.028 (0.254)	-3.637 (0.415)	0.825 (0.896)	-0.574 (0.916)	3.582 (0.343)	[0.026]** 0.184
All Housing ACY Adj. Minus Med.	13.931 (0.178)	27.041 (0.003)***	31.068 (0.001)***	14.011 (0.266)	-3.65 (0.402)	0.835 (0.892)	-0.302 (0.955)	3.474 (0.360)	[0.030]** 0.183
All Housing ACY Adj. Minus Tobacco	14.845 (0.166)	28.485 (0.002)***	32.626 (0.001)***	15.353 (0.243)	-3.573 (0.418)	0.803 (0.898)	-0.55 (0.918)	3.371 (0.369)	[0.025]** 0.184
All Housing ACY Adj. Minus Med. & Tobacco	13.870 (0.177)	27.167 (0.002)***	30.913 (0.001)***	14.330 (0.255)	-3.558 (0.408)	0.82 (0.892)	-0.282 (0.957)	3.241 (0.391)	[0.029]** 0.183
Tech Free Housing ACY Adj.	42.821 (0.036)**	47.545 (0.057)*	50.452 (0.090)*	49.634 (0.103)	-2.704 (0.511)	1.495 (0.807)	-0.377 (0.955)	4.383 (0.225)	[0.079]* 0.248
Tech Free Housing ACY Adj. Minus Tobacco	41.850 (0.032)**	48.066 (0.051)*	50.518 (0.084)*	49.498 (0.092)*	-2.642 (0.519)	1.247 (0.838)	-0.399 (0.951)	4.376 (0.214)	[0.073]* 0.252
Tech Free Plus Hedonic Housing ACY Adj.	42.473 (0.049)**	49.731 (0.054)*	49.480 (0.108)	45.737 (0.133)	-2.604 (0.524)	1.821 (0.765)	-0.703 (0.917)	4.323 (0.250)	[0.096]* 0.239
Tech Free Plus Hedonic House ACY Adj. Minus Tobac	41.966 (0.043)**	50.213 (0.048)**	49.572 (0.102)	45.935 (0.122)	-2.547 (0.531)	1.633 (0.787)	-0.729 (0.913)	4.296 (0.242)	[0.089]* 0.243

Panel F: Other Consumer Loan Defaults– Credit Card Rate									
BLS CPI	7.201	22.758	22.517	2.616	-7.34	-7.66	-2.036	7.389	NA
	(0.594)	(0.086)*	(0.081)*	(0.873)	(0.337)	(0.415)	(0.774)	(0.246)	0.172
All Housing Size Adj.	6.783	20.805	18.855	-2.433	-6.400	-6.166	-0.363	9.115	[0.988]
	(0.635)	(0.122)	(0.169)	(0.884)	(0.378)	(0.509)	(0.958)	(0.145)	0.160
All Housing Size Adj. Minus Med.	6.385	20.290	18.722	-2.090	-6.407	-5.963	-0.055	9.126	[0.782]
	(0.635)	(0.100)	(0.127)	(0.892)	(0.363)	(0.513)	(0.993)	(0.136)	0.160
All Housing Size Adj. Minus Tobacco	6.628	21.132	19.130	-1.810	-6.210	-6.124	-0.398	8.909	[0.683]
	(0.642)	(0.113)	(0.159)	(0.914)	(0.390)	(0.509)	(0.953)	(0.144)	0.158
All Housing Size Adj. Minus Med. & Tobacco	6.186	20.549	18.946	-1.483	-6.193	-5.93	-0.11	8.898	[0.834]
	(0.645)	(0.092)*	(0.118)	(0.924)	(0.377)	(0.513)	(0.987)	(0.134)	0.158
Tech Free	12.425	23.113	15.241	-0.700	-4.548	-5.472	-6.24	2.448	[0.325]
	(0.518)	(0.320)	(0.484)	(0.968)	(0.421)	(0.442)	(0.363)	(0.663)	0.198
Tech Free Housing Size Adj.	6.142	26.521	-0.574	-5.476	-3.743	-6.025	-7.805	2.945	[0.128]
	(0.781)	(0.323)	(0.987)	(0.823)	(0.455)	(0.416)	(0.305)	(0.451)	0.258
Tech Free Housing Size Adj. Minus Tobacco	6.459	31.276	0.741	-2.113	-3.467	-5.646	-7.536	3.012	[0.124]
	(0.770)	(0.259)	(0.984)	(0.934)	(0.481)	(0.435)	(0.309)	(0.439)	0.259
Tech Free Plus Hedonic Housing Size Adj.	5.795	23.904	-0.898	-4.717	-4.038	-6.448	-7.586	3.354	[0.146]
	(0.778)	(0.342)	(0.978)	(0.846)	(0.429)	(0.385)	(0.310)	(0.370)	0.252
Tech Free Plus Hedonic House Size Adj. Minus Tobac	6.476	28.177	0.397	-1.743	-3.774	-6.102	-7.346	3.398	[0.141]
	(0.755)	(0.276)	(0.991)	(0.945)	(0.455)	(0.401)	(0.312)	(0.360)	0.252
All Housing ACY Adj.	14.711	34.768	35.742	15.041	-1.885	0.100	-1.631	3.011	[0.231]
	(0.305)	(0.004)***	(0.004)***	(0.393)	(0.744)	(0.989)	(0.808)	(0.451)	0.174
All Housing ACY Adj. Minus Med.	13.582	32.359	33.455	13.922	-2.007	0.147	-1.284	3.03	[0.25]
	(0.318)	(0.005)***	(0.004)***	(0.399)	(0.721)	(0.984)	(0.846)	(0.450)	0.172
All Housing ACY Adj. Minus Tobacco	14.492	34.717	35.524	15.469	-1.790	0.120	-1.562	2.817	[0.212]
	(0.311)	(0.004)***	(0.003)***	(0.381)	(0.754)	(0.987)	(0.814)	(0.479)	0.175
All Housing ACY Adj. Minus Med. & Tobacco	13.362	32.302	33.226	14.337	-1.876	0.183	-1.223	2.807	[0.23]
	(0.324)	(0.004)***	(0.003)***	(0.387)	(0.735)	(0.980)	(0.852)	(0.485)	0.173

Tech Free Housing ACY Adj.	34.393 (0.159)	56.267 (0.067)*	40.535 (0.235)	49.117 (0.126)	-0.776 (0.866)	3.554 (0.620)	-0.444 (0.957)	5.301 (0.109)	[0.062]* 0.264
Tech Free Housing ACY Adj. Minus Tobacco	34.209 (0.152)	56.866 (0.060)*	41.361 (0.220)	50.294 (0.110)	-0.716 (0.876)	3.299 (0.642)	-0.321 (0.969)	5.352 (0.102)	[0.054]* 0.270
Tech Free Plus Hedonic Housing ACY Adj.	33.352 (0.190)	56.270 (0.066)*	38.907 (0.261)	47.473 (0.145)	-0.978 (0.832)	3.429 (0.621)	-0.769 (0.926)	5.209 (0.126)	[0.075]* 0.258
Tech Free Plus Hedonic House ACY Adj. Minus Tobac	33.567 (0.178)	57.109 (0.058)*	39.773 (0.247)	48.975 (0.129)	-0.902 (0.844)	3.270 (0.634)	-0.647 (0.936)	5.229 (0.122)	[0.066]* 0.263

Table 13: Robustness Tests: Consumer Loan Charge off Rates

The first step repeats the Table 12 regressions for each alternative index. Second, Cook's distance measure for the influence of each data point is calculated. Then either the 4 or 8 most influential data points for the regression with the alternative index are dropped. Third, the regressions for the BLS CPI and the alternative CPI are repeated on the now smaller dataset. The results below summarize the difference in the R^2 statistic between the alternate and the BLS CPI ($R^2_{Alt} - R^2_{BLS}$) is displayed in the columns labeled R^2 Diff. Similarly, columns labeled *J*-test report the *p*-value for the marginal information for the alternative relative to the BLS CPI. Key: *J*-test significance levels, *=10%, **=5% and ***=1%.

	Drop 4				Drop 8			
	Personal		Credit Card		Personal		Credit Card	
Index	R^2 Diff	*J*-test	R^2 Diff	*J*-test	R^2 Diff	*J*-test	R^2 Diff	*J*-test
				Panel A: Consumer Loan Defaults				
All Housing Size Adj.	0.025	0.114	0.008	0.205	0.001	0.508	0.000	0.634
All Housing Size Adj. Minus Med.	0.022	0.167	0.004	0.37	-0.006	0.846	-0.007	0.942
All Housing Size Adj. Minus Tobacco	0.026	0.089*	0.009	0.153	0.005	0.337	0.003	0.516
All Housing Size Adj. Minus Med. & Tobac.	0.023	0.135	0.005	0.302	-0.002	0.637	-0.005	0.835
Tech Free	0.017	0.022**	0.01	0.028**	0.021	0.017**	-0.004	0.110
Tech Free Housing Size Adj.	0.029	0.000***	0.025	0.000***	0.008	0.017**	0.021	0.008***
Tech Free Housing Size Adj. Minus Tobac.	0.029	0.000***	0.026	0.000***	0.011	0.009***	0.028	0.003***
Tech Free Plus Hedonic Housing Size Adj.	0.035	0.000***	0.025	0.000***	0.026	0.012**	-0.004	0.038**
Tech Free + Hedonic House Size Adj. Minus Tobac	0.036	0.000***	0.026	0.000***	0.030	0.007***	-0.018	0.038**
All Housing ACY Adj.	0.038	0.008***	0.025	0.004***	-0.004	0.208	-0.018	0.186
All Housing ACY Adj. Minus Med.	0.037	0.013**	0.022	0.009***	0.007	0.153	-0.022	0.244
All Housing ACY Adj. Minus Tobac.	0.039	0.006***	0.026	0.003***	-0.001	0.162	-0.016	0.157
All Housing ACY Adj. Minus Med. & Tobac.	0.037	0.012**	0.023	0.007***	-0.005	0.207	-0.020	0.208
Tech Free Housing ACY Adj.	0.031	0.001***	0.028	0.004***	-0.019	0.054*	-0.016	0.071*
Tech Free Housing ACY Adj. Minus Tobac.	0.032	0.001***	0.03	0.002***	-0.017	0.037**	-0.012	0.048**
Tech Free Plus Hedonic Housing ACY Adj.	0.033	0.001***	0.025	0.003***	-0.016	0.041*	-0.018	0.069*
Tech Free Plus Hedonic House ACY Adj. Minus Tobac.	0.034	0.000***	0.028	0.002***	-0.014	0.03**	-0.014	0.050*
				Panel B: Credit Card Defaults				
All Housing Size Adj.	0.021	0.143	0.025	0.128	0.007	0.430	0.008	0.468
All Housing Size Adj. Minus Med.	0.019	0.185	0.021	0.173	0.001	0.674	0.000	0.716
All Housing Size Adj. Minus Tobacco	0.023	0.094*	0.026	0.094*	0.011	0.255	0.013	0.325
All Housing Size Adj. Minus Med. & Tobac.	0.022	0.126	0.022	0.129	0.006	0.473	0.004	0.577
Tech Free	0.000	0.032**	-0.004	0.111	0.000	0.022**	0.047	0.025**

Tech Free Housing Size Adj.	0.019	0.002***	0.033	0.001***	0.043	0.010**	0.048	0.005***
Tech Free Housing Size Adj. Minus Tobac.	0.02	0.003***	0.034	0.001***	0.022	0.038**	0.047	0.005***
Tech Free Plus Hedonic Housing Size Adj.	0.023	0.001***	0.028	0.002***	0.045	0.009***	0.026	0.019**
Tech Free + Hedonic House Size Adj. Minus Tobac	0.021	0.002***	0.030	0.001***	0.043	0.009***	0.027	0.014**
All Housing ACY Adj.	0.052	0.012**	0.053	0.014**	0.027	0.080*	0.016	0.163
All Housing ACY Adj. Minus Med.	0.050	0.022**	0.050	0.027**	0.02	0.121	0.009	0.222
All Housing ACY Adj. Minus Tobac.	0.054	0.010**	0.054	0.012**	0.03	0.063*	0.020	0.134
All Housing ACY Adj. Minus Med. & Tobac.	0.052	0.019*	0.051	0.024**	0.024	0.098*	0.013	0.187
Tech Free Housing ACY Adj.	0.009	0.015**	0.025	0.001***	-0.018	0.124	0.018	0.036**
Tech Free Housing ACY Adj. Minus Tobac.	0.011	0.009***	0.033	0.001***	-0.016	0.099*	0.012	0.035**
Tech Free Plus Hedonic Housing ACY Adj.	0.009	0.014**	0.022	0.003***	-0.003	0.076*	0.019	0.041**
Tech Free Plus Hedonic House ACY Adj. Minus Tobac.	0.011	0.009***	0.024	0.003***	-0.013	0.090*	0.022	0.033**
Panel C: Other Consumer Loan Defaults								
All Housing Size Adj.	0.002	0.001***	0.005	0.000***	0.000	0.297	-0.001	0.082*
All Housing Size Adj. Minus Med.	0.005	0.002***	0.006	0.002***	0.002	0.195	0.000	0.039**
All Housing Size Adj. Minus Tobacco	0.000	0.001***	0.004	0.000***	-0.004	0.508	-0.003	0.351
All Housing Size Adj. Minus Med. & Tobac.	0.003	0.002***	0.004	0.001***	-0.002	0.381	-0.002	0.214
Tech Free	-0.005	0.303	0.002	0.133	0.086	0.091*	-0.003	0.057*
Tech Free Housing Size Adj.	0.044	0.158	0.030	0.015**	0.117	0.092*	-0.029	0.200
Tech Free Housing Size Adj. Minus Tobac.	0.049	0.154	0.036	0.013**	0.105	0.077*	0.013	0.086*
Tech Free Plus Hedonic Housing Size Adj.	0.038	0.128	0.004	0.008***	0.115	0.091*	-0.033	0.227
Tech Free + Hedonic House Size Adj. Minus Tobac	0.041	0.125	0.009	0.006***	0.105	0.072*	-0.028	0.205
All Housing ACY Adj.	-0.010	0.033**	0.023	0.002***	-0.004	0.133	0.000	0.181
All Housing ACY Adj. Minus Med.	-0.011	0.035**	0.023	0.003***	-0.008	0.143	-0.004	0.202
All Housing ACY Adj. Minus Tobac.	0.017	0.006***	0.025	0.001***	-0.002	0.108	0.003	0.135
All Housing ACY Adj. Minus Med. & Tobac.	0.015	0.008***	0.025	0.001***	-0.017	0.133	-0.001	0.152
Tech Free Housing ACY Adj.	0.104	0.028**	0.051	0.002***	0.201	0.022**	0.019	0.077*
Tech Free Housing ACY Adj. Minus Tobac.	0.109	0.025**	0.035	0.013**	0.205	0.021**	0.023	0.069*
Tech Free Plus Hedonic Housing ACY Adj.	0.097	0.026**	0.056	0.001***	0.192	0.029**	0.02	0.075*
Tech Free Plus Hedonic House ACY Adj. Minus Tobac.	0.103	0.024**	0.061	0.001***	0.196	0.027**	0.025	0.067*