Partially Disaggregated Household-level Debt Service Ratios: Construction and Validation

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Currently published data series on the United States household debt service ratio are constructed from aggregate household debt data provided by lenders and estimates of the average interest rate and loan terms of a range of credit products. The approach used to calculate those debt service ratios could be prone to missing changes in loan terms. Better measurement of this important indicator of financial health can help policymakers anticipate and react to crises in household finance. We develop and estimate debt service ratio measures based on individual-level debt payments data obtained from credit bureau data and published estimates of disposable personal income. Our results suggest that aggregate debt service ratios may have understated the payment requirements of households. To the extent possible with two very distinct data sources we examine the details on the composition of household debt service and identify some areas where required payments appear to have varied substantially from the assumptions used in the Board of Governors' aggregate calculation. We then use our technique to calculate both national and state-level debt ratios and break these debt service ratios into debt categories at the national, state level, and metro level. This approach should allow detailed forecasts of debt service ratios based on anticipated changes to interest rates and incomes, which could serve to evaluate the ability of households to cope with potential economic shocks. The ability to disaggregate these estimates into geographic regions or age groups could help to identify the severity of the effects on more exposed groups.

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Introduction

This paper develops debt service ratio measures based on individual-level minimum required debt payments data from a major credit bureau. The payments can be disaggregated geographically and by age; debt service ratios can be calculated for the groups where average disposable personal income is available. Currently published data series on household debt service are constructed from aggregate household debt data provided by banks and estimates of the average interest rate and loan terms applying to a range of credit products. That approach could be prone to missing changes in the terms of the loans that affect debt service. Our measure sums minimum required payments reported to credit bureaus available from the Equifax / Federal Reserve Bank of New York Consumer Credit Panel (CCP), so it should reflect any changes in terms or legal requirements. Our estimates are broadly similar to the published debt service ratio and an alternative calculated using Survey of Consumer Finance data, though we consistently find a higher ratio of debt service to income. Our results suggest that aggregate debt service ratios have generally reflected the payment requirements of US households, but the details on the composition of household debt service required payments have likely varied substantially from the assumptions used in the aggregate calculation.

An alternative approach in the existing literature develops fully individual-level debt service ratios, but in most countries, including the United States, the necessary data are only available infrequently. Using the CCP, our procedure can replicate the time patterns of the published national data, while also allowing the study of variation across states, metropolitan areas, and debt types. The primary constraint is the availability of disposable person income measures because the CCP has a large enough sample to estimate aggregate payments for detailed geographies. We describe the estimation techniques and then apply the approach to

national, state, and metro-level debt service ratios. We also break the debt service ratios in to debt categories at all three levels. This approach may enable further work to identify the impacts of household finance on other outcomes of interest, like consumption growth or employment decisions.

Finally, this approach may allow detailed forecasts of debt service ratio based on anticipated changes to interest rates and incomes that could serve to evaluate the ability of households to cope with potential shocks to the economy. The ability to disaggregate these estimates into geographic regions or age groups could help to identify the severity of the effects on more exposed groups.

2.0 Previous literature

The motivation for examining household debt service is simple. As Dynan, Johnson, and Pence (2003) note, "When a large share of household income is devoted to debt repayment, households have fewer funds available to purchase goods and services." In addition, households who are more financially constrained by debt payments may be more likely to default when confronted with a shock to their income and health. Dynan (2012a) shows how debt levels and debt service ratios alter the decisions of households, which has the potential to impact the broader economy during and after the financial crisis.

This mechanism can serve to propagate business cycle responses. Using aggregate data, Murphy (1998) documents that models of consumption benefit from the inclusion of lagged debt service measures. Mian and Sufi (2009) documents a strong connection between household indebtedness and the subsequent decline in spending across US counties. While Mian and Sufi (2009) are focused on leverage in the form of debt to income with a particular focus on mortgage

credit, different forms of debt come with distinct repayment periods and interest rates that may alter the consumption of households differently.

Drehman and Juselius (2012) argue that debt service ratios more accurately capture the burden imposed by debt compared to leverage measures like debt-to-GDP ratios, because debt service ratios can account for the changing interest rates and maturity structure of the debt. The same paper shows that the level of an estimated private debt service ratio "prior to economic downturns explains a significant fraction of subsequent output losses" and serves as a "very reliable early warning signal ahead of systemic banking crises" in developed nations. While their measure also includes business debt, they separate household and business debt for the United States and it is clear that household debt contributed substantially to the rising debt service levels prior to the 2008 financial crisis.

In the United States, the primary source for debt service information is the Federal Reserve Board of Governor's series which has been published since 1980. The current methodology is described in Dynan, Johnson, and Pence (2003). Conceptually, this series aims to report on the evolution of minimum principal and interest payments as a fraction of after tax income. The methodology for this series is based on using macro-economic information to generate average interest rates and maturities in order to back out an implied debt service estimate from aggregate data on bank credit. As Dynan, Johnson, and Pence (2003) demonstrate in their adjustments to the official measure, this process can lead to large revisions in the estimates when lenders change the terms of their lending options and households respond to ever evolving financial products. In addition, this approach allows only a very limited range of explanations for debt service trends to be explored and treats households as if the debt and income were evenly distributed.

In contrast, Faruqui (2008) explores the distribution of debt service across households in Canada and the United States. This approach demonstrates that more debt is held and serviced by the households most able to meet those obligations in terms of their income. While a fully disaggregated approach might bring important information to the published debt service ratios, this approach relies on household data which are only available in the United States once every three years. It would be preferable to have a more timely, higher frequency indicator of financial stress.

3.0   Data and definitions

The existing estimate of the aggregate debt service ratio in the United States is produced by the Federal Reserve Board of Governors (Board hereafter). It is derived from macro-level measures of debt balances, credit terms, loan maturity, and disposable personal income. Aggregate payments are estimated by type of credit based on the aggregate balances, average interest rates, and the distributions of maturity and terms of loans. The information on credit terms and the maturity of debt balances comes from a variety of sources, including the Survey of Consumer Finances, the Student Loan Marketing Association, and the Board's Consumer Credit (G.19) and Finance Companies (G.20) statistics. The debt service ratio is the sum of aggregate payment estimates divided by the nation's disposable personal income, which is taken from the National Income and Product Accounts. Because the necessary aggregate data are available for many years, the Board has data from 1980 through the third quarter of 2015.

The Board's debt service ratio has proven to be a useful measure, but it has limitations. Most prominently, it can be slow to respond to changes in financing conditions and instruments. This is in part because one of the key inputs to the series, the Survey of Consumer Finance, is only collected every three years. The Board's web page about its debt service ratio estimates

acknowledges the limitations of relying on aggregate measures rather than observed payments to estimate debt service ratio. It states, "The ideal data set for such a calculation would have the required payments on every loan held by every household in the United States" (Federal Reserve Board of Governors 2013).

The Equifax / Federal Reserve Bank of New York Consumer Credit Panel (CCP) data set brings us substantially closer to that ideal. It is a randomly selected 5 percent sample of credit reports from Equifax, one of the major credit reporting agencies in the US, and is reported at the individual level. We randomly select one-fifth of the individuals, giving us a 1 percent sample of credit reports. The dataset is still exceptionally large, with an average of 2.3 million records each quarter over the time span we cover, 2004Q1 to 2015Q2. Individuals' quarterly records are linked across time to form a panel. The data include information on the individuals' active debt with companies that report to credit agencies, which covers most debt. See Lee and van der Klaauw (2010) for more about these data.

The CCP data gives the individual's delinquency information, sum of balances, and sum of minimum required payments for each debt category. It also has geographic codes, age, bankruptcy status, and credit score. For payments and balances that are jointly held, we follow standard procedure with the CCP and assume the individual is responsible for half of the balance and payment.[1] Summing payments across individuals and weighting the results gives an estimate of required debt payments. The payments are broken out by debt type and provides more detail than is available in the published Board estimates. Debts are aggregated into several types: mortgage, credit cards, auto loans (bank-funded loans and loans from non-bank lenders), student loans, home equity loans (revolving lines of credit and installment loans), retail loans, consumer

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[1] The procedure for student loans is different because most student loans are co-signed. For student loans, we assume that the individual is responsible for all solely held and co-signed loans and half of other joint loans.

finance loans, and other debt. Because the data includes geographic detail down to the Census block, it is possible to estimate required debt payments for all the standard levels of geography from Census block to the nation.

The CCP provides the numerator of the debt service ratio, total minimum required payments. The denominator, disposable personal income, comes from the Bureau of Economic Analysis's (BEA) estimates of personal income and disposable personal income. The BEA does not provide quarterly estimates of disposable income for states. We proxy for a state's quarterly disposable personal income with:

$$DPI_{sq} = \frac{\frac{DPI_{Nq}}{PI_{Nq}}}{\frac{DPI_{Ny}}{PI_{Ny}}} \frac{DPI_{sy}}{PI_{sy}} PI_{sq}$$

where DPI is disposable personal income, PI is personal income, the N subscript indicates national measures, s indexes states, y indexes years, and q indexes quarters. Essentially, we are assuming that any seasonal variation in the ratio of disposable personal income and personal income is the same in all states.[2]

The debt service ratio for state s and debt category j in quarter q is:

$$DSR_{sjq} = \frac{100 \sum_{i \in s} p_{ijq}}{DPI_{sq}}$$

where p_{ijq} is the minimum required payment for debt category j of individual i in state s in quarter q. Because we are using a one percent random sample of credit reports the state estimate is 100 times the sample estimate. The national debt service ratio debt category j in quarter q is:

$$DSR_{jq} = \frac{100 \sum_{i} p_{ijq}}{DPI_{Nq}}.$$

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[2] We find little seasonality in our debt service ratios, which suggests that this is a reasonable assumption.

At both the state and national levels, the total debt service ratio is the sum of the debt service ratios of all the debt categories.

We also produce quarterly estimates for metropolitan statistical areas (MSAs). The CCP micro data makes it straightforward to get the sum of minimum required payments at the MSA-level. Unfortunately, disposable personal income is not available at the MSA-level, even annually. We will approximate an MSA's quarterly disposable personal income by assuming that the share of a state's disposable personal income in an MSA is the same as the share of the state's personal income that is in the MSA. The formula for quarterly MSA disposable personal income is then:

$$DPI_{mq} = \sum_{s \in m} \frac{\sum_{c \in m} PI_{cy}}{PI_{sy}} DPI_{sq}$$

where m subscripts MSA and c subscripts counties.

While the CCP provides timely information on minimum required debt payments, it is derived from administrative data and requires some data cleaning. To minimize the impact of outliers on the final tabulations, we use a two stage cleaning process. The first stage addresses the problems of undocumented missing value codes, the effect of defaults on debt payments, and extreme outliers. The second stage addresses outliers that remain after the first stage.

There are two main sources of unusually high payment values in the CCP. The first is that there are what appear to be undocumented missing value codes, such as 999999.[3] The second is that people who have an account that is 120 or more days late often have their minimum required payments increase to their full balances.[4] While these are their minimum

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[3] This includes 9999999, 999999, 99999, 9999, and (due to joint accounts) half of each of those values.
[4] While Lee and van der Klaauw (2010) recommend dropping cases that are in bankruptcy, after imputing payments that are severely delinquent we find little difference in trends when excluding bankruptcies. Averaging across quarters, excluding bankruptcies reduces the US debt service ratio 0.7 percentage points, about a 4.5 percent

required payments, in examining the data we found that few of these cases ever paid these full balance payments. Because these required payments are rarely paid and the intent of the debt service ratio is to capture how much of income is devoted to debt payments, we choose not to count the full value of the minimum required payments of severely delinquent cases. Therefore, we impute the minimum required payments for cases that have values that appear to be undocumented missing value codes or are severely delinquent.

There were other cases that had unrealistically large payments and undue influence on the tabulations where there was no clear explanation for the high values. To address these, we imputed and, in some cases, top coded payments for cases with normalized payments that were above a certain threshold. The threshold is defined within state as the 12-quarter moving average of the 99th percentile of the distribution of non-zero payments for the debt category.[5] Mortgage and home equity loan payments were normalized by dividing by the eight quarter moving average of the state's median home price to account for the wide disparity in home prices across states and adjust for inflation.[6] For similar reasons, the remaining payment categories were normalized by dividing by the eight quarter moving average of per capita income. By debt category, we impute payments for cases above this cutoff. We've experimented with more restrictive cutoffs and found that the 99th percentile was sufficient to address the effects of outliers.

The imputation process is done independently by debt type. We impute the ratio of payment over balance and then multiply this ratio by the individual's balance to get the imputed

reduction. Given that approximately 6 percent of person-quarters are in bankruptcy, this confirms that bankruptcies are not having an undue influence on the estimates.

[5] We use a backward looking moving average of the subject quarter and 11 prior quarters.

[6] The median home price used for the imputation comes from a combination of the quarterly median house price data from the Federal Housing Finance Agency (FHFA) from 2000Q1 to 2010Q2 and the quarterly FHFA home price index from 2000Q1 through 2013Q4. Through 2010Q2, we use the published home price. After that quarter, we impute home price as a function of the home price index, with separate imputations for each state. In years when both are available, median home price and the home price index are highly correlated (0.82).

payments. This allows the imputed payment to depend on the individual's current balance. The

imputation takes advantage of the panel nature of the data by first looking for a past valid

payment value for the same individual. If one is found, the ratio of payment over balance from

that period is assigned to the periods needing imputation.

For cases where no past valid payments are found, we use unweighted sequential hot

deck imputation to get the ratio of payment and balance from a similar case that has valid data.[7]

Hot deck imputation assigns the value of a donor case that is similar to the case that needs

imputed. The hot deck finds donors based on the following characteristics: debt balance for the

category being imputed, credit score, age, and quarter. The CCP provides additional data for

mortgages, home equity installment loans, and student loans that allows us to improve the

imputation of these installment loans by adding the date the loan was opened and the initial

balance to the characteristics determining the hot deck imputation.[8] Hot decking requires that the

characteristics are categorical variables, so we use a standard algorithm for defining histogram

bins to create bins for each of these characteristics. We use serpentine sorting, which alternates

between ascending and descending sorting in order of the variables being sorted on (Carlson,

Cox, and Bandeh 1995).[9] This ensures that sequential observations differ on as few dimensions

as possible. The donor case is the observation with valid data most closely preceding the case

that needs imputed.

There are a small number of cases that do not find an imputed value through this process

and we set their payment to missing. There are also some cases where the imputed value remains

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[7] Our serpentine sort and hot deck program was adapted from Carlson, Cox, and Bandeh (1995).
[8] In the few cases where these variables are missing, we use the same hot deck procedure used for the other debt categories.
[9] For example, if there are three variables, the first would be sorted ascending, the second would be sorted descending, and the third would be sorted ascending.

above the threshold we use to identify outliers. We top code these payments so that the normalized payment equals the threshold.

As shown in panel a of Table 1, 10.1 percent of person-quarter observations had at least one type of payment imputed from their own past payments and 3.7 percent had at least one payment imputed with the hot deck procedure. Bank card payments had the highest imputation rate (7.3 percent), followed by retail loan payments (3.1 percent). For the remaining debt categories, no more than 2 percent of observations were imputed due to having a missing value code or being severely delinquent. For each debt category, no more than half a percent of observations were treated as outliers (panel c of Table 1). Because the 99th percentile thresholds were defined based on non-zero payments, it is not surprising that less than 1 percent of each type of payments were treated as outliers.

The CCP provides timely microdata on the minimum required payments for a random sample of individuals with credit reports. By combining personal income data with tabulations of payments from the CCP, we produce estimates of debt service ratios that also provide detail for different types of debt. However, the data on payments in the CCP contain unrealistically high values for a small number of cases. If left unaddressed, these outliers would inflate our debt service ratio estimates. Therefore, we impute new values for people in default and other outliers and top code the cases that remain outliers after imputation.

4.0 Comparison to Board of Governors Debt Service Ratio

As the estimation approach indicates, there is room for substantive differences between a credit-panel based debt service ratio estimate and one based on aggregate calculations. In particular, the distribution of interest rates on the debt and the payment terms could evolve for either certain classes of customers or for products in a way that would be hard for the aggregate

approach to keep up with. Alternatively, the CCP may understate debt burden if the credit

reported to credit bureaus is not as complete as the debt reported by financial institutions as part

of their legal requirements. That said, the underlying patterns should conceptually be similar in

levels, particularly in the years close to 2003, when the Board's methodology had recently been

revised to better capture new finance conditions.

Figure 1 shows that the time pattern of the CCP debt service ratio is very close to the

Board debt service ratio, although the CCP debt service ratio is always between 3 to 4 percentage

points higher. The correlation between the two measures is very high at 0.98 over this period.

The Board debt service ratio has detailed information on the debt owed by households to banks,

but has to make more assumptions regarding the average interest rate and the terms associated

with the debt level. This result suggests a systematically higher level of payments has been

required of US households.

The Board debt service ratio has two published subcomponents: mortgage debt service

ratio and consumer debt service ratio, which by construction sum to the overall debt service

ratio. These two components can be compared with credit panel analogues to clarify where the

differences in the measures are coming from. Figure 2 repeats the comparison of the two

estimates for each published component. For the purposes of these comparisons home equity

loans are included with mortgages as the two categories are reported jointly in the Financial

Accounts of the United States, more widely known as the Flow of Funds data. In these two

comparisons, the time patterns are quite similar, with correlation coefficients of 0.99 for

mortgage debt service and 0.91 for other consumer debt. In both cases, the CCP shows higher

levels of debt service even while the time pattern is quite similar. On average the CCP mortgage

debt ratio is 1.4 percentage points above the Board's estimate, while the CCP estimate of consumer debt service as a fraction of income is 2.1 percentage points higher.

The gap could come from higher estimated balances, higher rates, or terms that require a larger payment. To investigate these possibilities, table 2 compares the balances and payments that are identified in both the CCP and the Flow of Funds data[10] that enter into the BOG DSR. Mortgage, auto, and student loan balances are all persistently higher in the Flow of Funds data, ranging from 10.4 percent higher for mortgage balances to just 2.1 percent higher for auto loans. This might result from the fact that reporting to credit bureaus is voluntary, if nearly universal. Interestingly, revolving debt, which we construct from bank cards, consumer finance loans, and retail debt in CCP, is on average 4.2 percent higher than the "revolving" credit reported in the Flow of Funds accounts. This may be due to some credit bureau reporting entities not reporting or under-reporting or due to inconsistent assignment of the debt categories to the Flow of Funds. There is no way to tell, but usefully, the correlations over time in the balances in the two data sources are high. Furthermore, it appears that the credit panel may understate the owed balances, even though it tends to show higher required payments.

It is not surprising that the CCP and BOG debt service ratios differ substantially on consumer debt. The payment requirements of consumer loans are particularly problematic to measure in aggregate. The Board measure has to make assumptions on the terms of both open- and closed-end loans. In the case of:

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[10] From the G.19 Consumer Credit statistical release we used Revolving consumer credit owned and securitized, not seasonally adjusted level; Student loans owned and securitized, not seasonally adjusted level; and Motor vehicle loans owned and securitized, not seasonally adjusted level (Board of Governors of the Federal Reserve System 2016a). From the Z.1 Flow of Funds Accounts of the United States statistical release we used Households and nonprofit organizations; home mortgages; liability(Board of Governors of the Federal Reserve System 2016b).

". . .revolving debt, the assumed required minimum payment is 2-1/2 percent of the balance per month. This estimate is based on the January 1999 Senior Loan Officer Opinion Survey, in which most banks indicated that required monthly minimum payments on credit cards ranged between 2 percent and 3 percent, a ratio that apparently had not changed substantially over the previous decade." (Federal Reserve Board of Governors 2013)

While this is a reasonable estimate for an estimate where no alternative data sources existed, it should not be surprising to learn that consumer experiences might have differed from this assumption. In the CCP, we cannot directly observe the terms of the loans, but we can observe required payments relative to balances. This should be similar to the required payment information obtained through the senior lending officer survey. In fact the median of the ratio of required bank card payment and balance in the CCP is very close to the assumed value of 2.5% in most years. As shown in Figure 3, the peak of the payment-weighted distribution of payments to balances is just a couple of tenths below 2.5%.[11] However, Figure 3 also reveals that the balance-weighted density is highly skewed, with a mean typically ranging from 3.5% to 4.1%. This difference in between the observed ratio and the assumption used to construct the BOG DSR could lead to a substantial difference in the estimate of revolving loan payments. Averaging across quarters, the sum of revolving loan payments from the CCP is $152 billion higher than the amount implied by the BOG DSR, though the two estimates are highly correlated (0.977).[12] Furthermore, required payments trend somewhat higher following the passage in 2009 of the CARD Act which may have influenced required payments, suggesting that this ratio has not been stable over time. The assumptions for other debt categories are also potentially problematic, although we have less ability to compare these categories with the BOG assumptions.

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[11] We use balance-weighted to align with the BoG calculation which multiplies the sum of balances by 2.5%. The unweighted densities are even more skewed toward 1, in part because some firms have specified minimum payment amounts and small balances are often collected in full.
[12] Each quarter's payments were derived from DSR by multiplying DSR by the Disposable Personal Income estimate.

Overall, these comparisons between the Board-published debt service ratio and our CCP estimates support the CCP being an accurate alternative source for debt service measures. It's higher reported values for debt service look viable in today's marketplace. If anything, the CCP may still be understating debt service if it is missing balances which are owed and subject to repayment, but not reported to credit bureaus.

Every three years, the Board publishes an alternative debt service ratio called aggregate payments-to-income (Bricker et al. 2014). This measure is based on individual-level data on debt payments and income from the Survey of Consumer Finances. This microdata-based estimate and the CCP debt service ratio are closer to each other than to the Board debt service ratio in three of the four years where both are available. Since 2004, aggregate payments-to-income has been 1.6 to 3.4 percentage points higher than the Board's debt service ratio and 0.6 to 2.1 percent lower than the CCP debt service ratio. While the Survey of Consumer Finances has the advantage of being reported as actual payments for each debt, it has far smaller sample size than the CCP and relies more on the memory of households. The fact that Survey of Consumer Finance also shows a higher level of debt service than the Board measure is also consistent with there being important heterogeneity in effective interest rates or the terms of repayment, as also implied by the CCP estimates.

5.0 National Patterns in CCP Debt Service Ratio

In addition to providing a broad characterization of debt service, estimating debt service ratios from the CCP allows other aspects to be studied. More detailed categories of debt are available in CCP than are published with the Board's debt service ratio. We use this to identify the underlying sources of debt that are driving the CCP debt service ratio estimates. In Figure 4 and Table 2, we show the CCP debt service ratio broken into major household borrowing

categories: mortgages, bank cards, auto loans (bank and other lenders), other consumer loans (notably, store cards, installment loans, other personal loans), home equity (revolving and fixed term), and student loans.

Outstanding mortgage balances were 73 percent of outstanding household debt in the second quarter of 2015 and peaked at 79 percent in the first quarter of 2008. Mortgages are also the largest category of debt service burden, but they represent a smaller portion of the debt burden because they have a longer duration and lower interest rates than most other categories of debt. Mortgage debt's share of the debt service ratio peaked at 46 percent in the second quarter of 2010 and declined to 42 percent in the second quarter of 2015. Since they are the dominant source of debt burden, the changes in mortgage debt service are responsible for much of the time pattern evident in the total debt service.

Other types of debt are important as well, despite the fact that they represent smaller shares of the aggregate debt statistics. Both bank card and auto loans each account for more than two percentage points of the debt service ratio in every quarter, representing 16 to 22 percent of the debt service burden. Auto loans' shorter duration implies a larger payment relative to size of the debt. The high usages rates of bank cards are enough to accumulate to a substantial debt burden even when the measured required payment is only the monthly minimum payment. While student loans have attracted a lot of media attention due to their growth, the debt service on student loans accounts for only 1.3 percent of disposable income.

Indexing the debt burdens to 2005 levels in each category (Figure 5) shows the effective growth of debt burdens over the credit expansion and the subsequent decline. Student loans are shown in a separate figure because they have a dramatically different trend. Non-mortgage debt burden of households peaked in the fourth quarter of 2007, primarily supported by rising debt

burdens in home equity and bank cards. Since that quarter, the debt burden from home equity loans has declined 59 percent, which is far larger than the decline in mortgage debt servicing. The decline in home equity payments is due to reductions in both balances and interest rates, as many of these loans have variable interest rates.

While home equity lines experienced the largest decline in debt service burdens, the reduction in debt service is certainly not limited to housing related debt. In fact, the bank card debt service ratio has declined 23 percent since the start of 2004, a larger percent decline than the mortgage debt service ratio over the same time. Auto lending is relatively strong and has seen a growing debt service ratio since the middle of 2012, though it remains 14 percent below its level at the start of 2004. This general decline is also evident in the "other consumer loans" category, so the largest categories of consumer debt service have all seen reductions in the debt burden of households.

The exception is student loans, which has been a small factor in household debt burdens, but has been growing rapidly. Figure 6 shows the time pattern of the rise of student loan debt burden. By the 2nd quarter of 2015, the student loan debt service ratio was almost three times as large as it was in 2004. While public attention has focused on the recent rise, the student loan debt service ratio has been rising steadily since 2004.

6.0 State Variation in Debt Service

Each state has fully independent and distinct estimates, but in terms of the overall debt service ratio over this period there are strong differences between states that did or did not experience a real estate boom. We use Dynan's (2012b) classification of states, but simplify the figure by including just four real estate boom states (Arizona [AZ], California [CA], Florida [FL], and Nevada [NV]) and four large, non-boom states (New York [NY], Illinois [IL], Ohio

[OH], and Texas [TX]). While the economic performance of the states vary along with degree and timing of house price appreciation, the common debt service patterns of the two groups are clearly evident in Figure 7. This, in part, reflects the large run-up in mortgage debt service in the boom states, where mortgages represent a larger fraction of the debt service than typical nationally. From the middle of 2005 to the beginning of 2008 – the period of the housing boom – total debt service ratios rose sharply in the boom states while remaining stable in the other states. It is worth noting that when our sample begins there had already been some significant price appreciation in the boom states and their debt-service levels are already elevated relative to the non-boom states (even when compared to a high real estate price state like New York). This figure illustrates that the housing boom was associated with a rise in the variation between states in debt service ratios. After the boom, the variation declined along with the aggregate debt service ratio and, in the full set of states, the variance of the total debt service ratio across states in the second quarter of 2015 (1.7) is below its value at the start of 2004 (2.2).

Mortgages serve as a key vehicle for the rise in debt service levels in boom states, with substantial increases in all four boom states from 2005 to 2008 and no significant rise in the other states. However, Figure 8 also shows that there is substantial variation in mortgage debt service ratios within the boom and non-boom states. For example, while overall debt service ratios remain higher in the boom states, in the middle of 2015 Illinois had a higher mortgage debt service ratio than Florida and stands roughly comparable to Nevada and Arizona. California continues to stand out as a high mortgage debt service state, likely reflecting its high cost. New York has lower mortgage debt burden despite areas of high cost real estate, perhaps due to its relatively low homeownership rate. Nonetheless, this figure shows that there are significantly less differences in mortgage debt burden between these states now than in 2005.

In their book and papers, Mian and Sufi show that the property boom spilled into non-housing expenditures that would likely be reflected in borrowing in other lending categories. Figure 9 shows that bank card debt burdens rose in the boom states until the middle of 2009, which is noticeably later than when the debt burdens for mortgages peaked in California and Florida. This suggests that consumers used bank cards to fund their initial shortfalls, but only a household level analysis could confirm that behavioral pattern. In addition, Figure 9 shows that important state differences in bank card debt service levels persist after the crisis. Most notably, New York and Florida stand out in having reliably higher debt service ratios. In the middle of 2015, all but one of these states had bank card debt service ratios below their 2004 levels, with New York the exception.

Auto loans (Figure 10) are one of the categories that recovered relatively early following the financial crisis. While the levels differ, the trends in auto debt service were similar in these states. All of the states saw a decline in the auto debt service ratio during the recession and a gradual increase since the start of 2012. These recent increases were not enough to counter the earlier decline and all eight states still have auto debt service ratios that are lower than they were in 2004.

Greenspan and Kennedy (2007) document significant draws on equity by homeowners, part of which occurred through home equity lines of credit. Figure 11 shows the time pattern of home equity loans, which include both lines of credit and term loans. It is worth noting that the debt service burdens associated with these loans are half that of the next smallest category, auto loans. This probably reflects the lower interest rates that typically are offered on these products and the fact that they are a less common form of debt. Interestingly, Ohio and Illinois – non-boom states – have home equity debt service trends in line with the boom states.

Finally, we turn to the one area of household credit that grew significantly over this period, student loans. Figure 12 shows the burden of student loans in the same set of states. Boom and non-boom states had very similar trends in student loan debt service ratios, though Ohio had a steeper increase than the others. The growth slowed following the recession, which is surprising given that the debt levels rose steadily throughout the period. This is a case where the terms of the loan are particularly important. Many student loans can be deferred while in school or during periods of unemployment and increasingly can be paid proportionate to the borrower's income. It is likely that one of the reasons student loan payments leveled off in the first two years of the recovery is that more debtors were in deferment or had reduced payments due to low income.

These initial estimates of state debt service levels by loan type suggest a significant amount of variation between states that could help to pin down estimates of the effects of borrowing and debt service levels on the outcomes of households in other variable of interest, including spending levels and employment patterns.

7.0 Metropolitan debt service ratios

The CCP also enables us to estimate aggregate payments for metropolitan areas (metros, for short). As noted in section 3.0, these can be used to estimate metropolitan DSRs if we assume that a metro's share of a state's disposable personal income is the same as the metro's share of the state's personal income.

For now we will focus on the DSRs of eight MSAs that demonstrate underlying trends: Chicago-Naperville-Elgin, IL-IN-WI; Cleveland-Elyria, OH; Las Vegas-Henderson-Paradise, NV; Los Angeles-Long Beach-Anaheim, CA; Miami-Fort Lauderdale-West Palm Beach, FL; Philadelphia-Camden-Wilmington, PA-NJ-DE-MD; Phoenix-Mesa-Scottsdale, AZ; and

Richmond, VA. While the economic performance of these regions varies along with degree and timing of house price appreciation, the differences between metros that had a housing boom and more stable metros are clearly evident in Figure 13. (The "sand MSAs" that experienced housing booms – Las Vegas, Los Angeles, Miami, and Phoenix – are shown with solid lines.) This, in part, reflects the large run-up in mortgage debt service in the boom regions, where mortgages represent a larger fraction of the debt service than typical nationally. From the middle of 2005 to the beginning of 2008 – the period of the housing boom – total debt service ratios rose sharply in the "sand MSAs" while remaining fairly stable in the others. In the first quarter of 2004, total DSRs in these eight MSAs ranged from 14.2 in Philadelphia to 17.3 in Phoenix. However, the housing boom was associated with a notable increase in the debt service ratios in the "sand MSAs" during the housing boom. In the fourth quarter of 2007, the total DSRs ranged from 15.8 in Chicago to 21.4 in Las Vegas. In the housing bust period, the debt service ratios of all eight MSAs fell, so that all areas are now below the Cleveland MSA debt service level at the start of 2004. In that sense all areas have seen a significant improvement in debt positions of households. Mortgage DSR had similar trends, as can be seen in Figure 14.

Metro DSRs highlight the amount of variation that exists in DSRs. For the remainder of this section, we restrict our attention to metros with at least 250,000 residents in 2010. In the 2nd quarter of 2015, total DSR ranges from 8.9 to 17.6 in these 185 metros, meaning that the maximum is almost double the minimum. The ratio of the maximum and minimum DSRs are even higher for the DSRs of specific debt categories. Mortgage DSR has the lowest ratio at 3.0 and other DSR has the highest ratio at 10.4.

The degree of heterogeneity varies across time, particularly for mortgage and home equity DSRs. Figure 16 shows the time series of two ratios of percentiles of the distribution of

the DSR across metros: 90th over 10th and 75th over 25th. An increase in the 90/10 ratio shows that the variation across metros has increased near the tails of the distribution while the 75/25 ratio measures the variation in the center of the distribution. The 75/25 ratio is quite stable for all of these DSRs, with changes over time of no more than 0.2. The 90/10 ratio show that there have been some changes to the degree of variation across metros over time. For example, the 90th percentile 2.1 times as large as the 10th percentile in when the ratio peaked (the 2nd quarter of 2008); this fell to 1.7 times by the second quarter of 2015. Variation increased the most for home equity, where the ratio peaked at 2.9 at the end of 2014, up from 1.7 at the start of 2004. Auto loan DSR has had the most stable ratios over this time. Total DSR has also had relatively stable dispersion over time, with a small increase in the 90/10 ratio during the housing boom years.

The metro-level debt service ratios follow the trends one would expect based on the state DSRs. As with states, metros most affected by the mid-2000's housing boom had larger increases in DSR than other metros. There is a great deal of heterogeneity across metros in DSR, with the maximum total debt service in a quarter ratio about double that of the minimum for the quarter. In future work we will study the determinants of metro-level DSR.

8.0 Discussion

The financial crisis showed that unchecked household debt burdens can extract large costs on society. The potential for a renewal in imprudent lending has led some commentators to suggest that there is another impending financial crisis. There is no definitive answer to these critics, but the declines in debt service levels across products and different parts of the US should offer reassurance. Of course, these declines are partially due to the unprecedented low interest rate structure. In order to have more confidence in the current debt service ratios, it would help to know how consumers are likely to fare when interest rates rise. In the subsequent version of this

paper we will explore how the debt service and interest rate structure interact. Given the established connection between debt service and consumption (Dynan 2012), these estimates could inform a "stress test" on the micro- and macroeconomic impacts of current and projected household debt service levels.

In this paper, we develop a new method for estimating debt service ratios which allows for timely, accurate, and partially disaggregated analysis of household borrowing. These new estimates consistently find a higher DSR than the official BOG DSR. These differences appear to be related to potential problems inherent in inferring required payments from aggregate data on debt balances. To the extent that some credit is not reported to the credit bureaus, the CCP may still tend to under-report debt service levels. Recognizing that all data sources on household finances have advantages and disadvantages, the CCP looks to be an informative new source for debt service information.

It is our intent to regularly update these figures for US states and metros. In addition, we intend to explore other population subgroups where disposable personal income can be estimated. This project should enable researchers to further explore issues of how debt service levels impact outcomes for households and the broader economy. The financial crisis showed the importance of household financial imbalances and the value of measuring and forecasting these imbalances. The post-crisis period also serves as a motivation for this analysis, because it remains unclear why households have deleveraged so dramatically. For much of the current expansion, consumer spending and housing investment have grown slower than in previous expansions, despite a sizable reduction in the debt service burdens of households. Further analysis of household debt dynamics may help to clarify these "headwinds" to growth.

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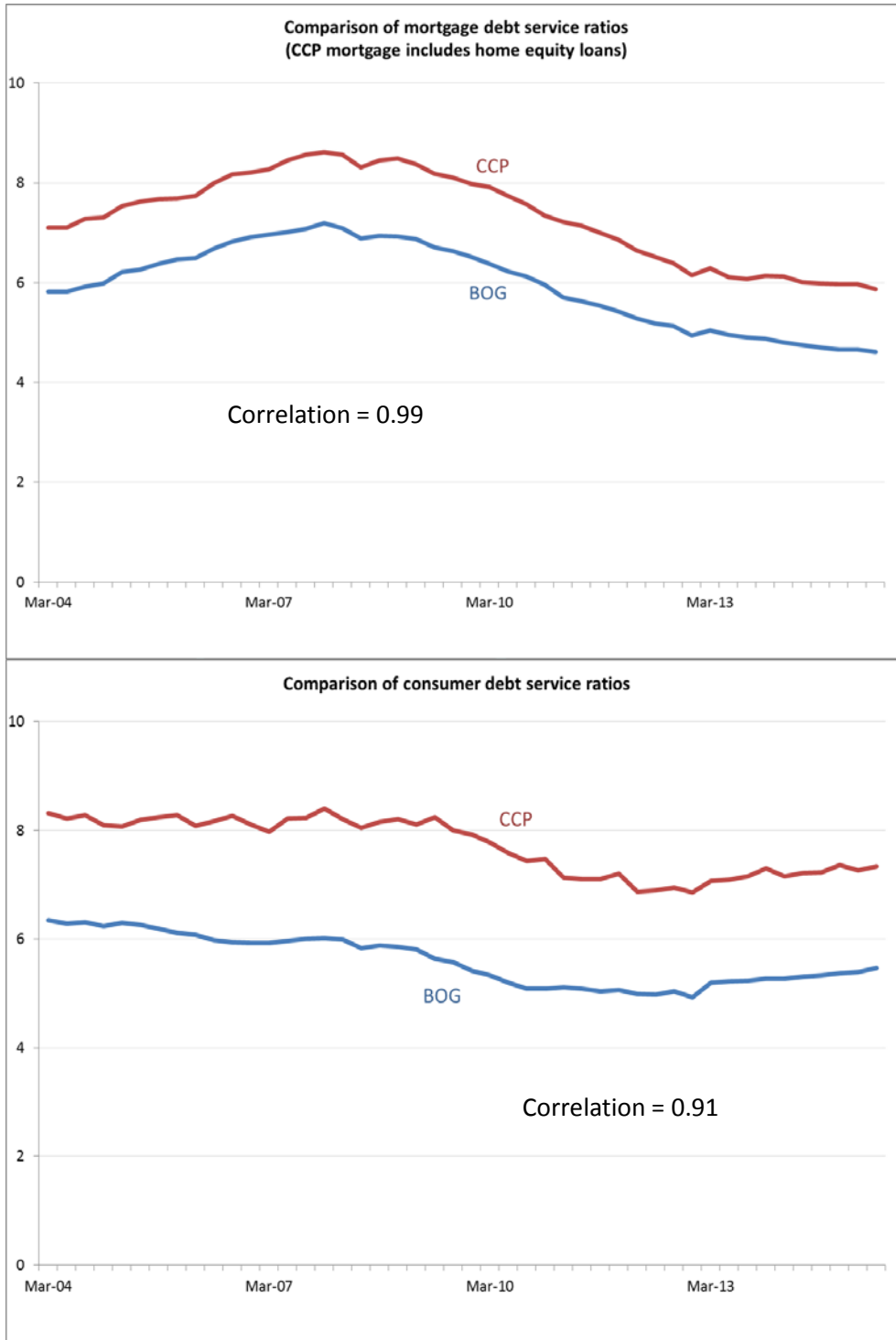
Figures

Figure 1: Comparison of US debt service ratio estimates
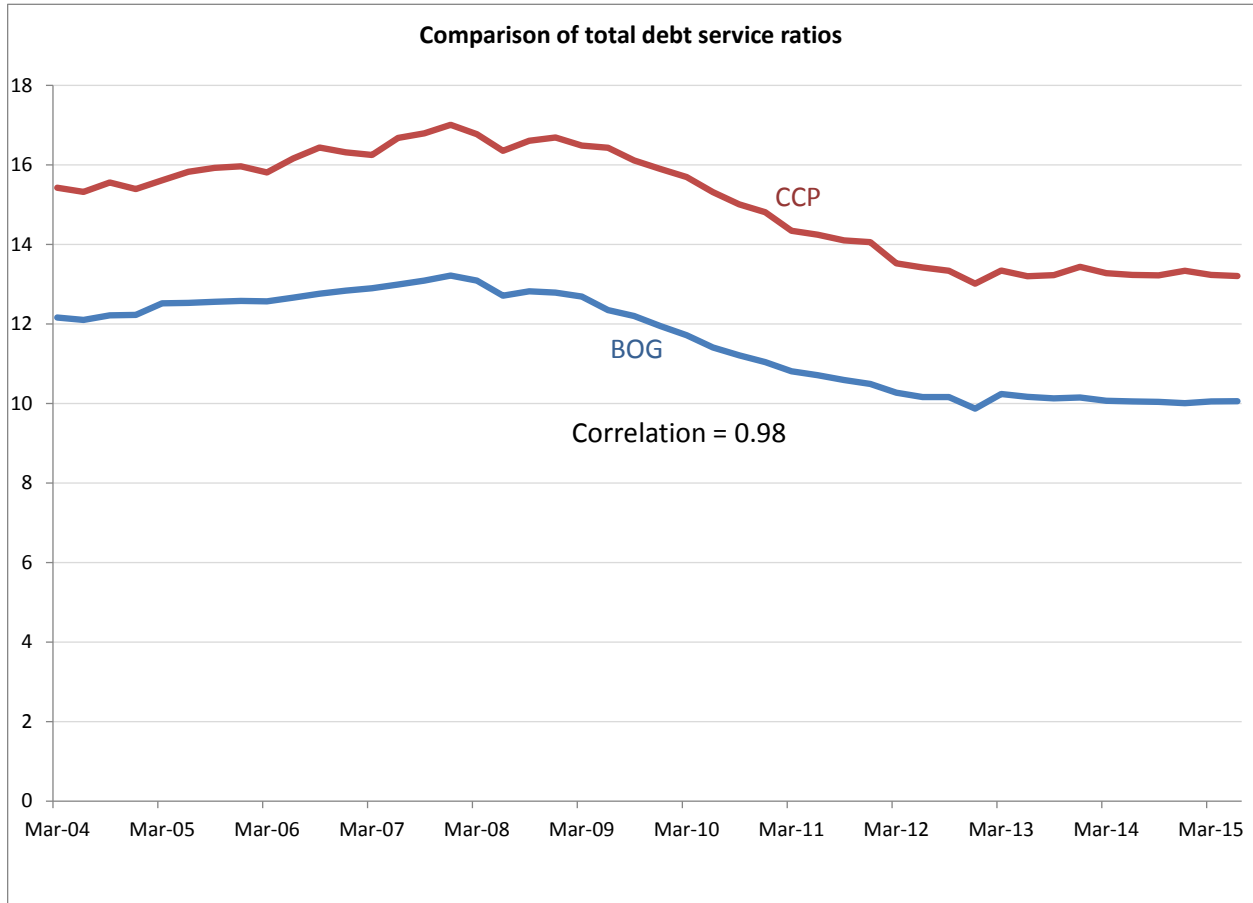
Source: Federal Reserve Board of Governors and the authors' calculations from the Federal Reserve Bank of New York Consumer Credit Panel / Equifax

Figure 2: Comparison of US debt service ratio components.

Comparison of mortgage debt service ratios
(CCP mortgage includes home equity loans)

CCP

BOG

Correlation = 0.99

Comparison of consumer debt service ratios

CCP

BOG

Correlation = 0.91

Source: Federal Reserve Board of Governors and the authors' calculations from the Federal Reserve Bank of New York Consumer Credit Panel / Equifax

Note: To increase comparability with the BOG DSR, the CCP mortgage DSR is the sum of mortgage and home equity DSRs.

Figure 3: Balance-weighted Density of Payment/Balance
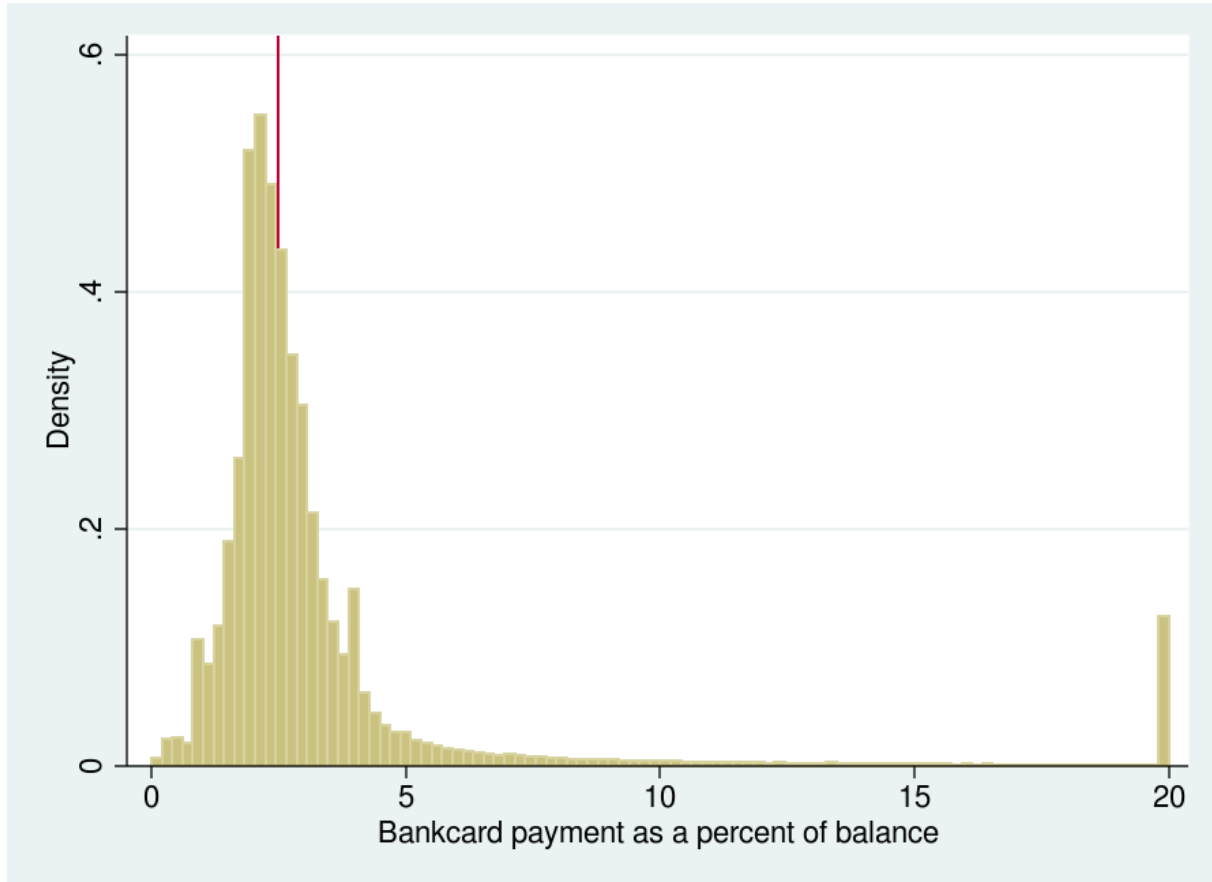
Source: The authors' calculations from the Federal Reserve Bank of New York Consumer Credit Panel / Equifax

Note: This is a histogram of individual-level ratios of payment/balance weighted by balance to show the distribution for balances rather than for individuals. While the percent can range as high as 100, here it is topcoded at 20 to increase readability of the graph.
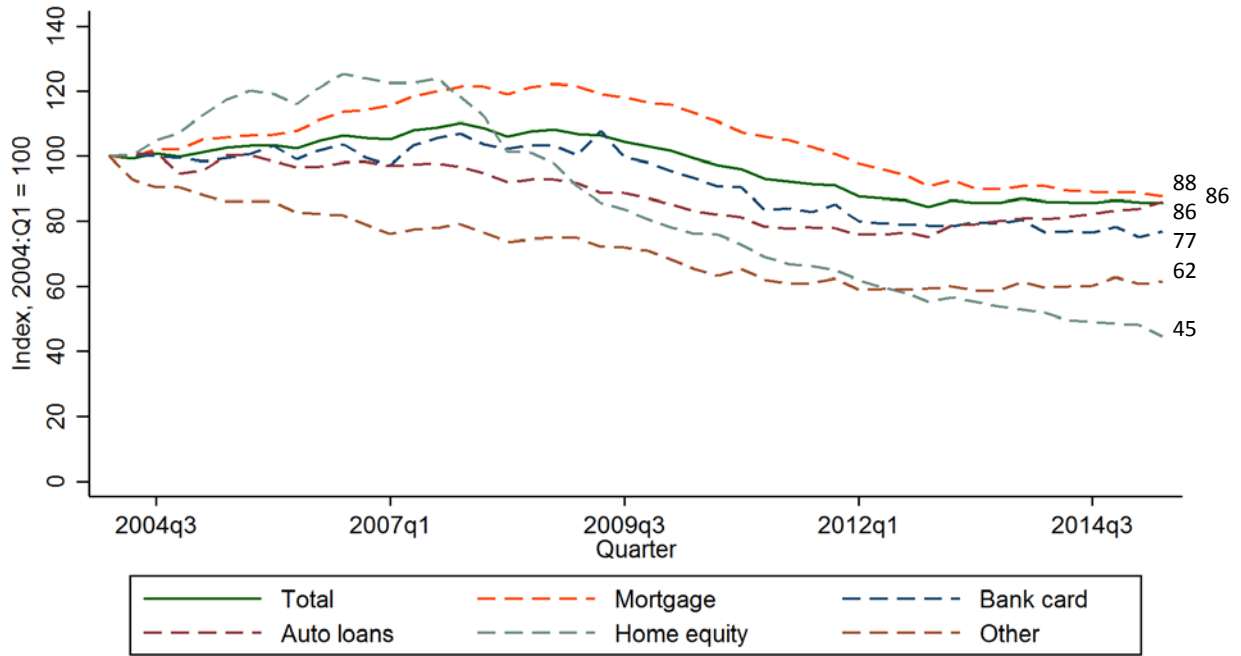
Figure 4: Composition of US Debt Service Ratio
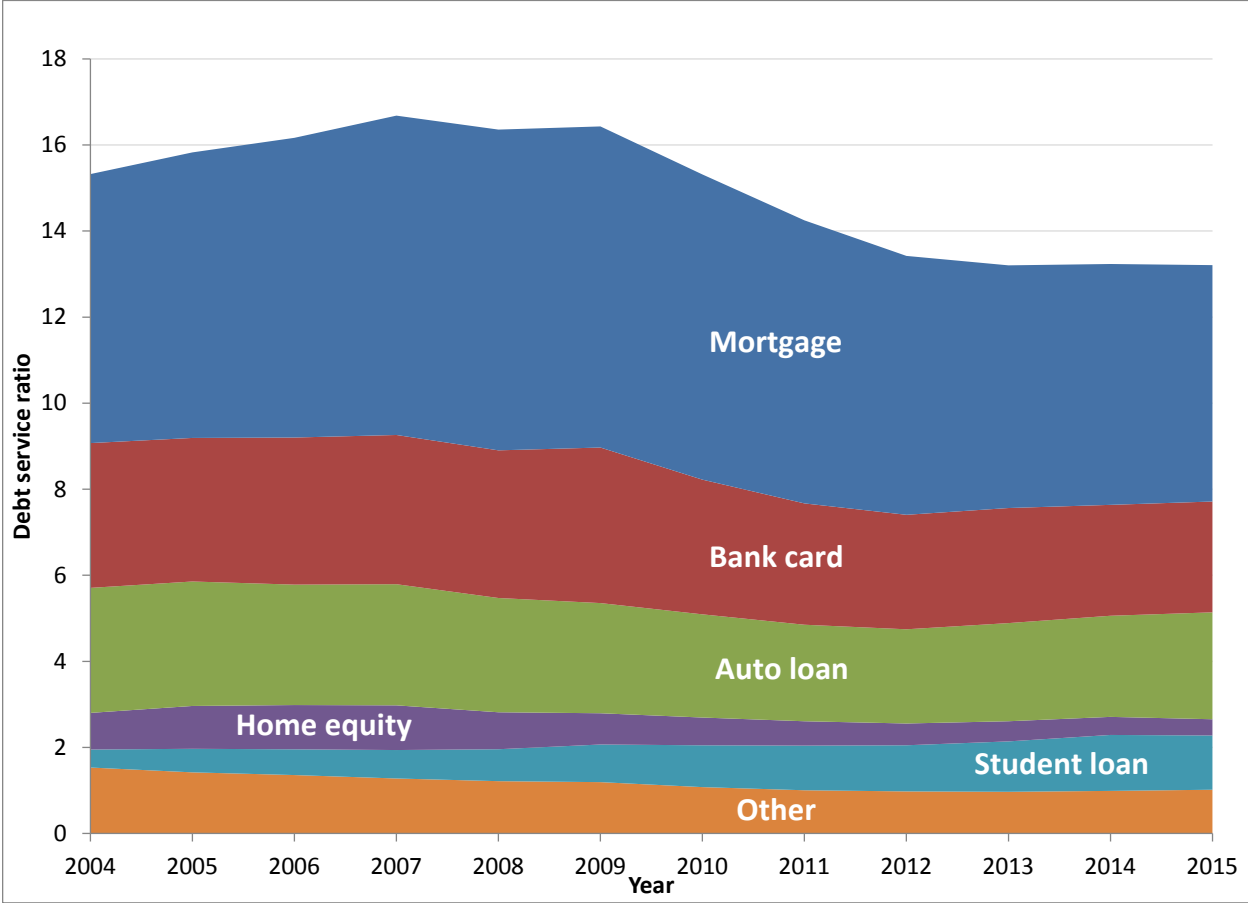
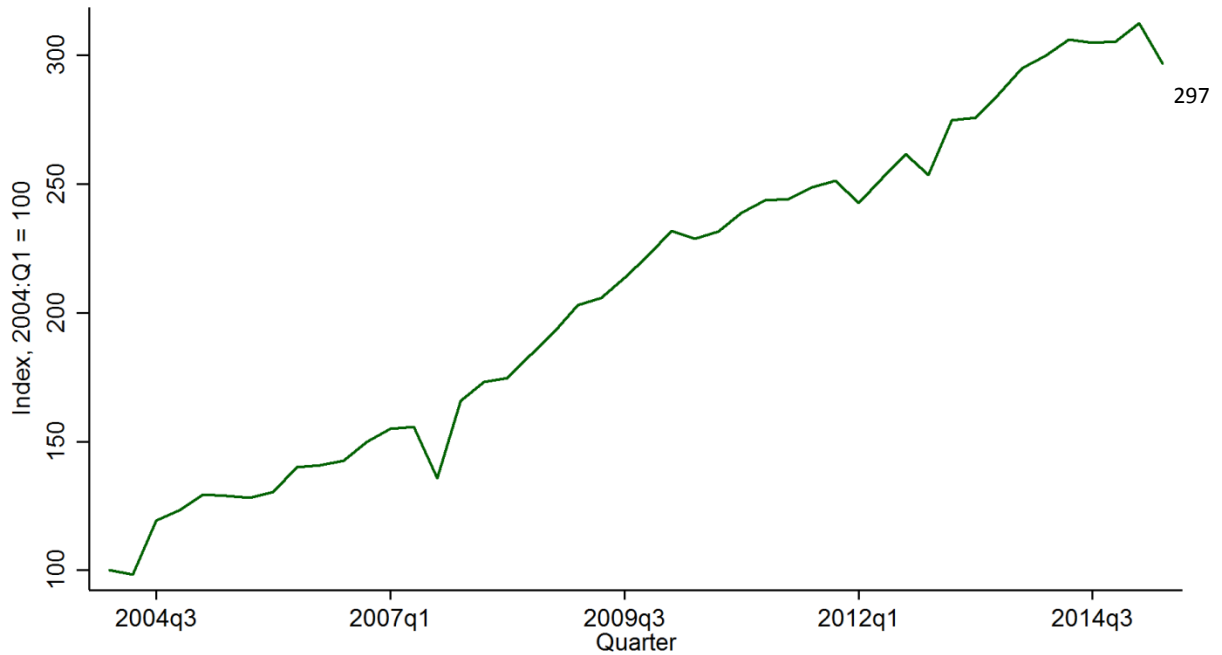Note: These are the 2nd quarter values of each year.

Source: The authors' calculations from the Federal Reserve Bank of New York Consumer Credit Panel / Equifax

Figure 5: Indexed US debt service ratios of key borrowing categories
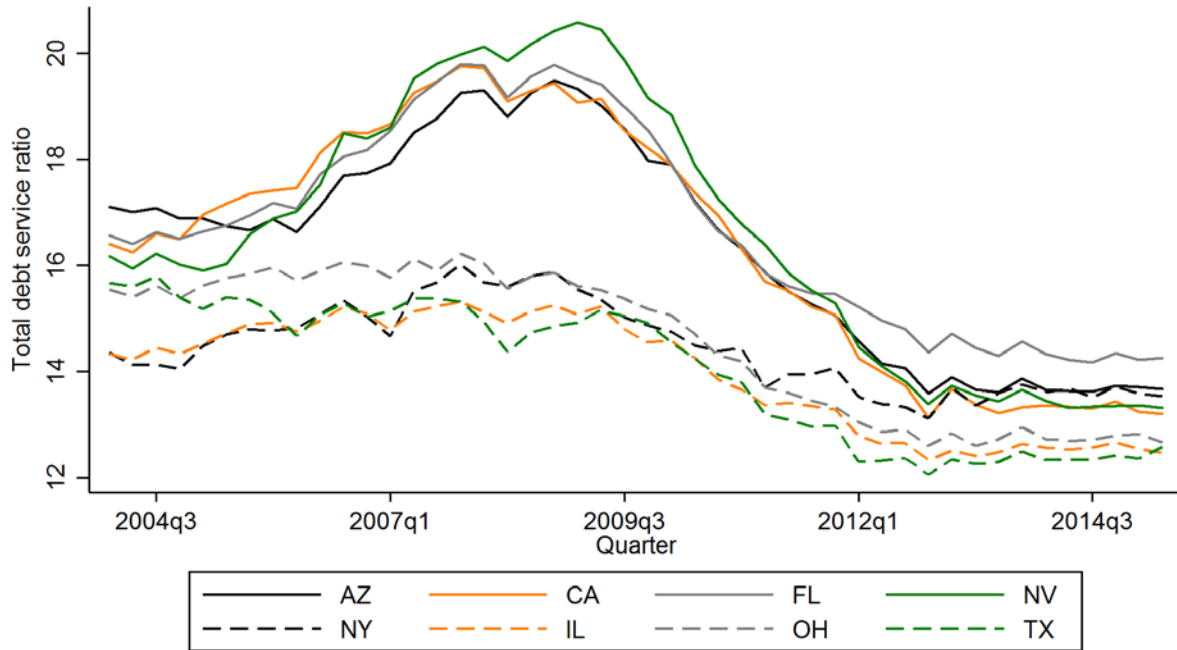

Source: The authors' calculations from the Federal Reserve Bank of New York Consumer Credit Panel / Equifax

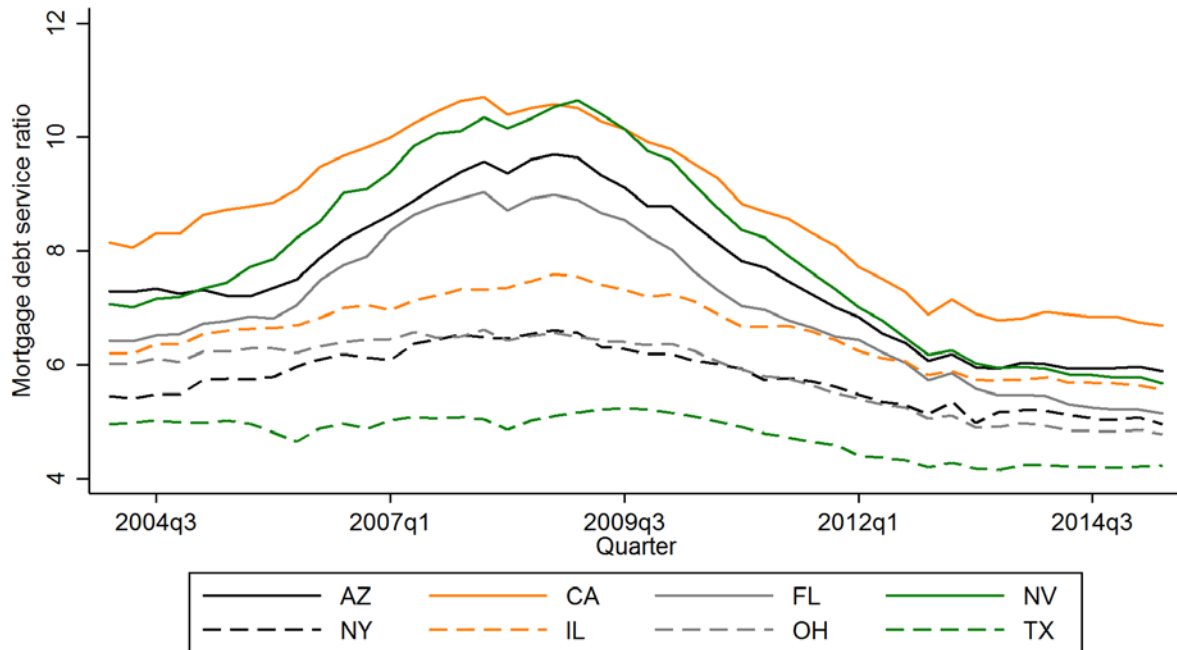**Figure 6: Indexed US student loan debt service ratio**

Source: The authors' calculations from the Federal Reserve Bank of New York Consumer Credit Panel / Equifax

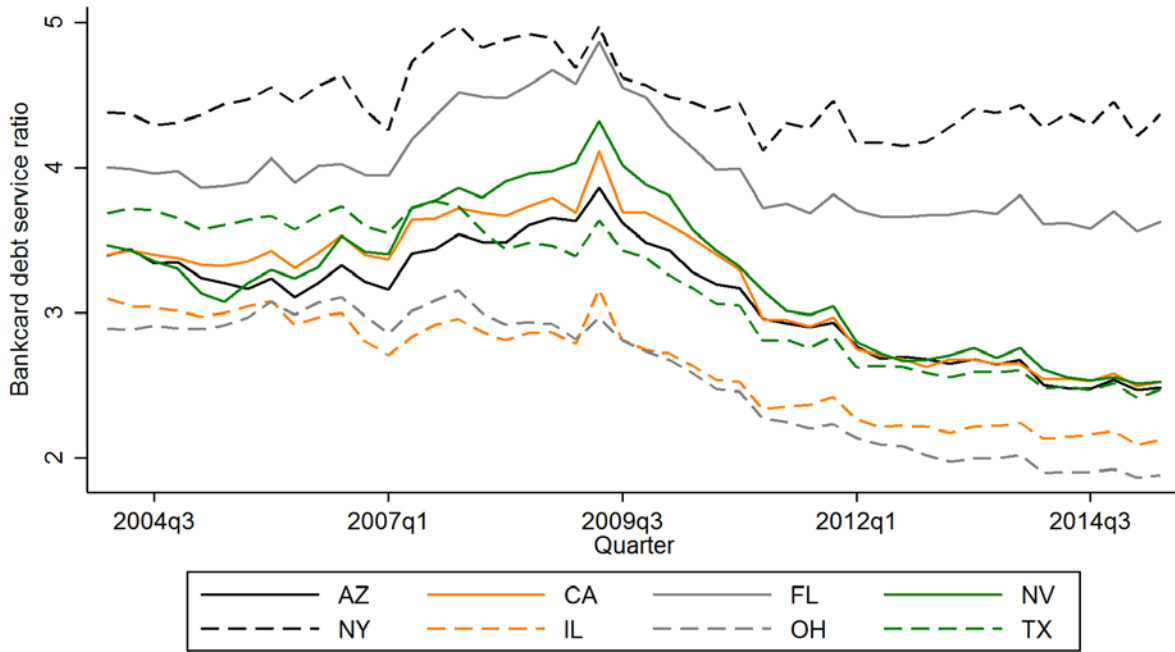**Figure 7: Variation in states total debt service ratios**

Source: The authors' calculations from the Federal Reserve Bank of New York Consumer Credit Panel / Equifax

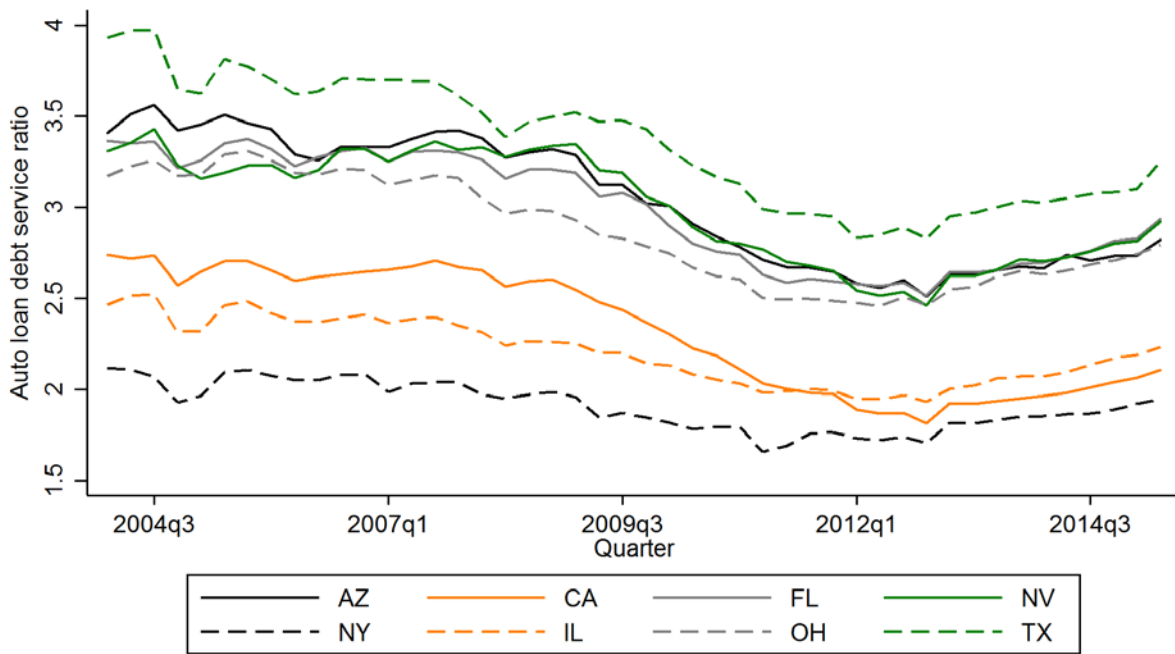**Figure 8: Variation in states mortgage debt service ratios**

Source: The authors' calculations from the Federal Reserve Bank of New York Consumer Credit Panel / Equifax

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Figure 9: Variation in states bank card debt service ratios

Source: The authors' calculations from the Federal Reserve Bank of New York Consumer Credit Panel / Equifax

Figure 10: Variation in states auto loan debt service ratios

Source: The authors' calculations from the Federal Reserve Bank of New York Consumer Credit Panel / Equifax

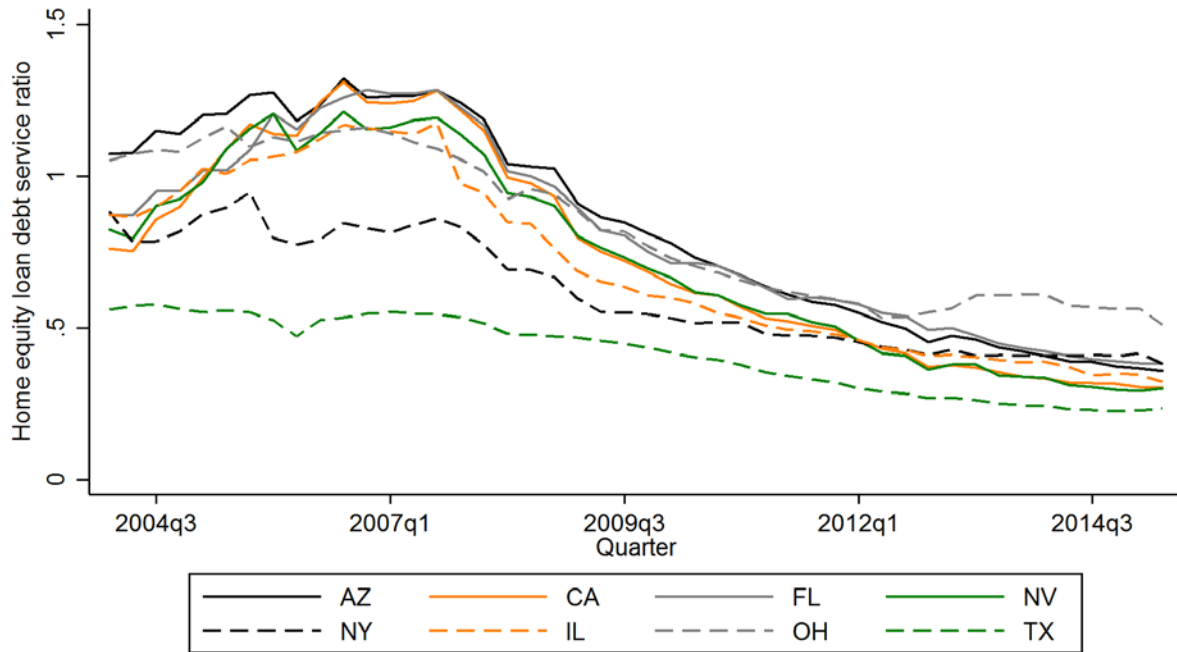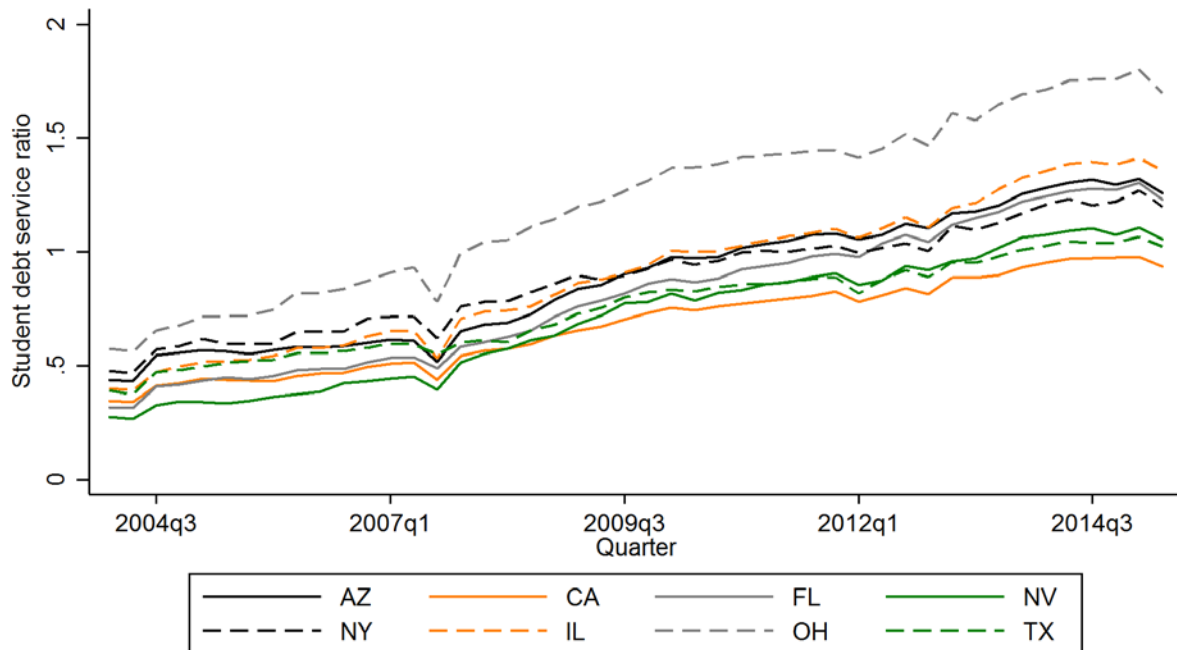**Figure 11: Variation in states home equity loan debt service ratios**

Source: The authors' calculations from the Federal Reserve Bank of New York Consumer Credit Panel / Equifax

Figure 12: Variation in states student loan debt service ratios

Source: The authors' calculations from the Federal Reserve Bank of New York Consumer Credit Panel / Equifax

Figure 13: MSA-level total debt service ratios

Source: The authors' calculations from the Federal Reserve Bank of New York Consumer Credit Panel / Equifax

Figure 14: MSA-level mortgage debt service ratios

Source: The authors' calculations from the Federal Reserve Bank of New York Consumer Credit Panel / Equifax

Figure 15: MSA-level bankcard debt service ratios
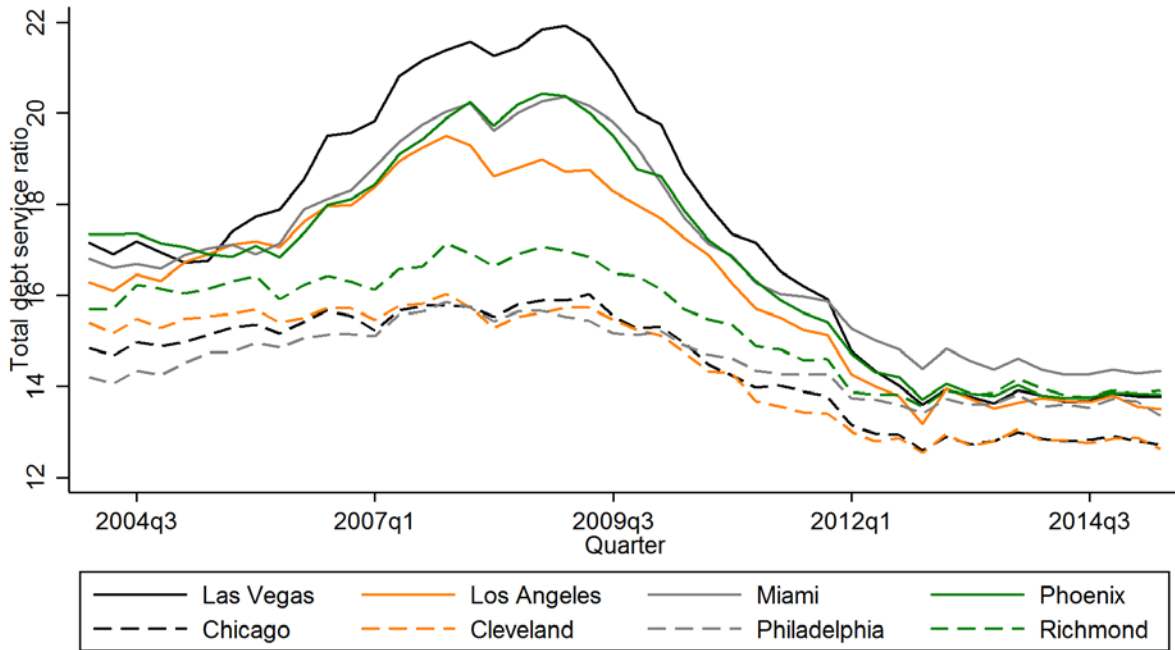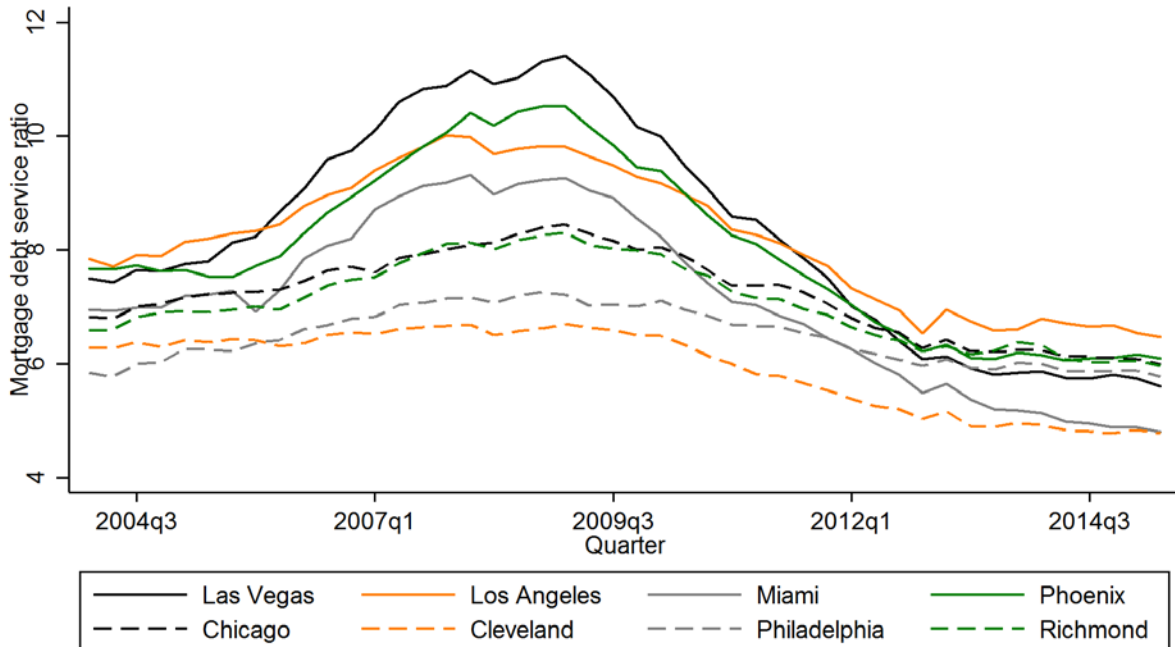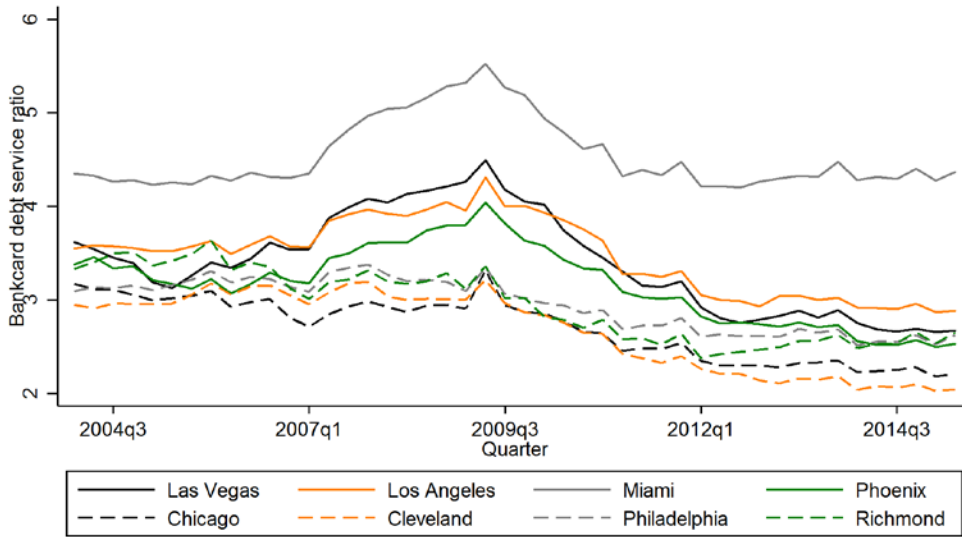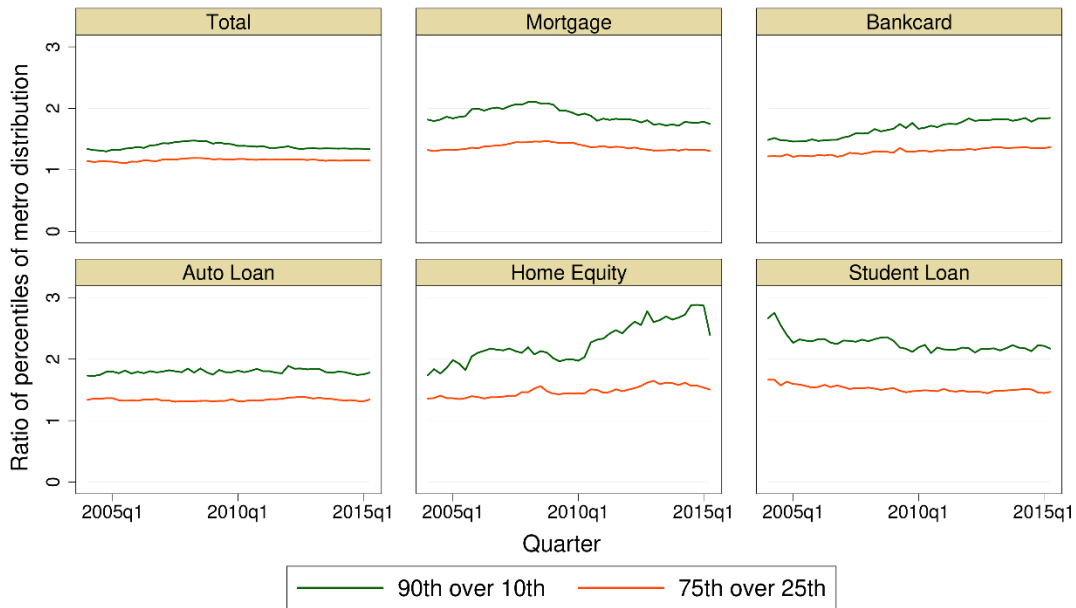

Source: The authors' calculations from the Federal Reserve Bank of New York Consumer Credit Panel / Equifax

Figure 16: MSA-level bankcard debt service ratios

Note: Based on data from the 185 CBSAs that had at least 250,000 residents in 2010.

Source: The authors' calculations from the Federal Reserve Bank of New York Consumer Credit Panel / Equifax

Tables

Table 1: Percent of person-quarters with payment imputed or topcoded

Reason for and method of imputation or topcoding	Payment type										
	Any	Auto finance	Auto bank	Bank card	Consumer	Mortgage	Home equity: Installment	Home equity: Revolving	Retail	Student loan	Other
a. Total											
Any imputation or topcoding	13.8	1.5	0.5	7.3	2.0	1.0	0.2	0.1	3.1	1.4	0.6
Imputed from own past value	10.1	1.2	0.3	5.2	1.4	0.8	0.1	0.1	1.9	1.2	0.3
Hot deck imputation	3.5	0.3	0.1	1.8	0.5	0.0	0.0	0.0	1.0	0.0	0.2
Hot deck for installment loans	0.2					0.1	0.0			0.1	
Topcoded	0.8	0.1	0.1	0.2	0.1	0.1	0.0	0.0	0.2	0.0	0.0
b. Due to missing value code or severe delinquency											
Any imputation or topcoding	12.4	1.4	0.4	6.8	1.9	0.7	0.2	0.1	2.9	1.3	0.6
Imputed from own past value	9.5	1.1	0.3	5.0	1.4	0.7	0.1	0.1	1.9	1.1	0.3
Hot deck imputation	3.3	0.2	0.1	1.8	0.5	0.0	0.0	0.0	1.0	0.0	0.2
Hot deck for installment loans	0.2					0.0	0.0			0.1	
Topcoded	0.2	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
c. Due to being an outlier											
Any imputation or topcoding	1.5	0.1	0.1	0.5	0.1	0.3	0.0	0.1	0.2	0.1	0.1
Imputed from own past value	0.7	0.0	0.0	0.2	0.0	0.2	0.0	0.0	0.1	0.1	0.0
Hot deck imputation	0.2	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hot deck for installment loans	0.0					0.0	0.0			0.0	
Topcoded	0.7	0.1	0.1	0.2	0.1	0.1	0.0	0.0	0.1	0.0	0.0

Source: The authors' calculations from the Federal Reserve Bank of New York Consumer Credit Panel / Equifax

Table 2: Summary stastistics for payments and balances from CCP and Flow of Funds data

Debt type	Correlation	Average difference	
		$ millions	Percent
Balances			
Mortgage	0.987	-976,405	-10.4
Revolving	0.843	40,120	4.2
Auto loans	0.947	-16,128	-2.1
Student loans	0.995	-67,866	-8.8
Payments			
Mortgage	0.977	151,955	23.2

Note: All statistics are calculated for all quarters from 2004Q1 to 2015Q2. CCP mortgage figures are the sum of mortgage and home equity. CCP revolving includes bankcard, consumer finance, and retail debt.

Source: The authors' calculations from the Federal Reserve Bank of New York Consumer Credit Panel / Equifax and the Federal Reserve Board of Governors Financial Accounts data.

Table 3: Debt service ratios by category for the US: 2004 to 2015

	Year											
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
a. Debt servce ratio												
Total	15.3	15.8	16.2	16.7	16.4	16.4	15.3	14.2	13.4	13.2	13.2	13.2
Debt type												
Mortgage	6.3	6.6	7.0	7.4	7.5	7.5	7.1	6.6	6.0	5.6	5.6	5.5
Bank cards	3.4	3.3	3.4	3.5	3.4	3.6	3.1	2.8	2.7	2.7	2.6	2.6
Auto loans	2.9	2.9	2.8	2.8	2.7	2.6	2.4	2.2	2.2	2.3	2.3	2.5
Home equity	0.9	1.0	1.0	1.0	0.9	0.7	0.6	0.6	0.5	0.5	0.4	0.4
Student loans	0.4	0.5	0.6	0.7	0.7	0.9	1.0	1.0	1.1	1.2	1.3	1.3
Other	1.5	1.4	1.4	1.3	1.2	1.2	1.1	1.0	1.0	1.0	1.0	1.0
b. Percent of total debt service												
Debt type												
Mortgage	40.8	41.9	43.1	44.5	45.6	45.4	46.3	46.2	44.8	42.7	42.3	41.6
Bank cards	22.0	21.1	21.1	20.8	21.0	22.0	20.4	19.8	19.8	20.3	19.5	19.5
Auto loans	19.0	18.3	17.3	16.9	16.2	15.6	15.7	15.7	16.3	17.3	17.8	18.8
Home equity	5.6	6.3	6.4	6.2	5.3	4.4	4.2	4.0	3.8	3.5	3.2	2.9
Student loans	2.7	3.5	3.7	4.0	4.5	5.3	6.3	7.3	8.0	8.9	9.8	9.5
Other	10.0	9.0	8.4	7.7	7.4	7.3	7.0	7.1	7.3	7.3	7.5	7.7

Note: These are the 2nd quarter values of each year.

Source: The authors' calculations from the Federal Reserve Bank of New York Consumer Credit Panel / Equifax

Table 4: Metropolitan debt service ratio summary statistics: 2nd Quarter of 2015

| | | | | | Quartile | | |
Debt service ratio	Mean	Std. dev.	Median	Min.	1st	3rd	Max.
Total	13.5	1.5	13.5	8.9	12.5	14.5	17.6
Mortgage	5.6	1.2	5.5	2.8	4.8	6.3	8.4
Auto loan	2.6	0.6	2.6	1.2	2.2	2.9	4.7
Bankcard	2.3	0.6	2.2	1.2	1.9	2.6	4.6
Student loan	1.4	0.4	1.5	0.5	1.2	1.7	3.1
Home equity	0.5	0.2	0.4	0.2	0.3	0.5	1.3
Other	1.1	0.5	1.0	0.3	0.8	1.3	3.4

Note: Based on data from the 185 CBSAs that had at least 250,000 residents in 2010.

Source: The authors' calculations from the Federal Reserve Bank of New York Consumer Credit Panel / Equifax