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Abstract

Growth in household debt-to-income ratios can be attributed to nominal debt changes or mechanical "Fisher effects" from interest income and expenses, real income growth, and inflation. With microdata covering the universe of Norwegian households for more than 20 years, we decompose the importance of these channels for how debt-to-income ratios evolve over time and respond to monetary policy shocks. On average, debt changes outsize Fisher effects, and they are due to households who move. But among highly leveraged households, Fisher effects dominate. After interest rate hikes, debt changes and Fisher effects pull in opposite directions. The former dominate so that debt-to-income ratios fall. This pattern holds across sub-groups, even among highly indebted households. Hence, changes in borrowing and repayment dominate mechanical effects via nominal income growth in the transmission of monetary policy shocks to debt-to-income ratios.

JEL: E21, E52, D14, G51
Keywords: Household Debt, Monetary Policy

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1 Introduction

Historical studies find that run-ups in household debt are associated with deeper macroeconomic recessions and financial crises (Jordà, Schularick, and Taylor, 2013, 2015b, 2016; Mian and Sufi, 2018). Recent experiences fit into this pattern, as the macroeconomic consequences of the 2008 financial crisis were more severe in geographical areas where household debt had increased more before the crisis began (Glick and Lansing, 2010; Mian, Rao, and Sufi, 2013; Martin and Philippon, 2017). These findings have, in turn, shaped policy discussions over the last decade, where a particularly central and controversial question has been whether monetary policy should "lean against the wind" by raising the interest rate when household indebtedness accelerates (Gelain, Lansing, and Natvik, 2017; Svensson, 2017; Gourio, Kashyap, and Sim, 2018).

The rationale for policies to stabilize debt rests on pecuniary or aggregate demand externalities. Suppose the economy enters a recession where asset prices fall or unemployment increases. In such a scenario, highly indebted households may respond by (i) selling assets or (ii) cutting consumption. In case (i), indebted households deepen the recession because their sales contribute to lower prices which worsens the situation for households whose borrowing constraints depend on asset prices (pecuniary externality). In case (ii), indebted households deepen the recession because their initial response reduces aggregate demand (aggregate demand externality). In either case, households do not internalize these effects, and there could therefore be a role for policy to dampen debt accumulation. Farhi and Werning (2016) and Korinek and Simsek (2016) show how these mechanisms motivate macroprudential tools, such as debt-to-income or loan-to-value caps. However, if the available macroprudential tools are imperfect, the central bank might be called upon to use its interest rate policy to prevent debt from building up (Caballero and Simsek, 2020).

The question then becomes: how will interest rate changes affect household indebtedness? One conjecture is that tighter monetary policy motivates households to borrow less, consistent with textbook intertemporal substitution effects. But on the other hand, higher interest rates are likely to reduce debtors' labor income growth and raise their interest costs. The latter will pull household indebtedness up, particularly among those who are liquidity-constrained due to high debt levels and therefore also are a main source of concern regarding financial stability. Unfortunately, precise documentation of these opposing forces is missing. Hence, even the sign of how monetary policy affects household indebtedness is an unsettled empirical question.

We provide micro-level evidence on the relative importance of the channels mentioned above across different households and estimate how monetary policy shocks transmit to household indebtedness. To this end, we utilize administrative records covering the universe of Norwegian households for 22 years (1994 to 2015). These data allow us to dissect the dynamics of each household's debt-to-income ratio and estimate how it is affected by monetary policy shocks. Importantly for interpreting our results, this is a setting where nearly all debt consists of mortgage loans with adjustable interest rates. Hence, direct effects from interest rate changes to debtor cash flows will be rather immediate.

Our point of departure is the households' debt-to-income ratio, DTI_t. As a matter of accounting, changes in this ratio are either due to movement in the numerator, i.e. increased or reduced nominal debt, or the denominator, i.e. nominal disposable household income growth:

$$\Delta DTI_t = \underbrace{\frac{B_t - B_{t-1}}{Y_{t-1}}}_{\text{Nominal debt change}} \underbrace{- DTI_t \frac{Y_t - Y_{t-1}}{Y_{t-1}}}_{\text{“Fisher effects”}} \tag{1}$$

where B_t is nominal debt and Y_t is nominal income. We refer to the first term as nominal debt change, capturing how much a household increases or cuts its debt over the year. Nominal income growth can in turn be decomposed into real income growth, inflation, and net interest income, which is the difference between interest income and interest expenses. We term the total impact of these forces *"Fisher effects"*, referring to Irving Fisher's emphasis on how adjustments in prices, interest rates, and real income propagated problems of high indebtedness during the Great Depression (Fisher, 1933).

Our first contribution is to quantify the role of nominal debt changes and Fisher effects in accounting for how household indebtedness has evolved in the microdata over time. The average debt-to-income ratio increased from 118 to 216% over our sample period, which reflects that positive nominal debt changes outsized the moderating Fisher effects. Among the Fisher variables, real income growth was the most important factor and in some years even made debt-to-income ratios fall despite positive nominal debt changes.

While the aggregate analysis points to nominal debt changes as the dominant force, a closer look within distributions shows that Fisher effects are important. In particular, the relative importance of nominal debt changes and Fisher effects varies considerably across households with different initial debt levels. Among the 60 percent of households with the lowest debt-to-income ratios, Fisher effects are close to irrelevant. But among households in the top 20 percent of the debt-to-income distribution, Fisher effects outsize nominal debt changes, driving down the debt-to-income ratios of the most heavily indebted households. The variation across the debt-to-income distribution partly reflects the mechanical logic of equation (1), as Fisher effects are weighted by indebtedness. It also reflects that households with high debt tend to have relatively high real income growth.

Fisher effects will be particularly important for debt-to-income movements if households tend to follow given amortization schedules. Therefore, we distinguish between households who move to a new home and those who stay, under the conjecture that households are likely to readjust the terms of their mortgage contracts when they get a new house.[1] The data are consistent with this conjecture. Among movers, high nominal debt growth almost entirely drives debt dynamics. Among stayers, Fisher effects are approximately of the same magnitude as nominal debt changes. Taken together, our micro evidence implies that the Fisher effects we observe in aggregate stem

[1] Bernstein and Koudijs (2021) find that empirically, amortization schedules have a strong effect on household saving, indicating that these schedules bind households' debt repayment.

from households that do not move (the majority of households) and who have high debt-to-income ratios.

Our second contribution is to directly estimate how monetary policy shocks affect households' debt-to-income ratios through nominal debt changes and Fisher effects. We use the Norwegian monetary policy shock series recently constructed with a narrative approach by Holm, Paul, and Tischbirek (2021). In line with the conventional logic that higher interest rates motivate saving, i.e. intertemporal substitution, we find that on average across households, nominal debt changes fall after interest rate hikes. Fisher effects pull in the opposite direction, but their responses are weaker than those of nominal debt changes. Hence, tighter monetary policy on average reduces debt-to-income moderately in the short run.

The above pattern holds not just on average but remains surprisingly stable across different household groups. It holds among households who are highly indebted and therefore have a high weight on Fisher effects in their accounting identity (1). It holds among households with high labor income risk who therefore are the most likely to have their earnings respond to monetary policy. It holds among households with low liquidity. It also holds among households who have recently moved and thus are unlikely to buy a new house in the coming years. The latter is striking because we would expect their repayment to be particularly connected to preset amortization plans, as suggested by our historical decomposition and the evidence in Bernstein and Koudijs (2021). Hence, our estimates indicate that even among those households where our historical decomposition suggests the strongest mechanical effects from nominal income growth, the impact of monetary policy on indebtedness is dominated by the choice of how much more to borrow or repay.

The upshot of our results is that while nominal income growth matters for the historical evolution of debt-to-income ratios over time, the transmission of monetary policy shocks to household indebtedness is still driven by household behavior rather than Fisher effects in our sample. As financial stability risk arguably concerns tail events, we find it notable that this conclusion holds not just for the average household but also among debtors who are likely to be most at risk, namely the households with high debt-to-income ratios, limited liquid reserves, or high income risk.

Our estimates are informative for evaluating leaning-against-the-wind policies in economic models. Gelain et al. (2017) and Svensson (2017) argue that it makes little sense for monetary policy to target household indebtedness if debt dynamics are tied to predetermined amortization plans, as monetary policy mainly affects debt-to-income ratios through Fisher effects. Our evidence indicates that this logic might not be important in practice. Long-term debt contracts could limit the influence of monetary policy on household debt, but nominal debt changes do respond to monetary policy. As nominal income responses to monetary policy are delayed and relatively small in our sample, these nominal debt responses determine how debt-to-income ratios respond to monetary policy shocks.

A related literature uses structural models to assess how details of household mortgage contracts interact with monetary policy more generally (Beraja, Fuster, Hurst, and Vavra, 2018; Wong, 2019; Berger, Milbradt, Tourre, and Vavra, 2021; Guren, Krishnamurthy, and McQuade, 2021; Kinnerud, 2021; Eichenbaum, Rebelo, and Wong, 2022). Moreover, the elasticity of asset demand, including debt, to interest rate changes can play a key role in understanding how long-run trends in inequality or demographics affect equilibrium interest rates (see, e.g., Auclert and Rognlie, 2018, Straub, 2018, Auclert, Malmberg, Martenet, and Rognlie, 2020, and Mian, Straub, and Sufi, 2021). Our study provides micro-level estimates to inform such quantitative analyses of how monetary policy affects household debt-to-income ratios in an environment with adjustable interest rate mortgages.

Existing evidence on household debt dynamics primarily stems from macro data. Mason and Jayadev (2014) propose and apply a similar decomposition framework as we use.[2] They show that much of the historical variation (from 1929 to 2011) in the aggregate US household debt-to-income ratio is explained by Fisher effects. A set of papers have used time-series techniques to estimate how household debt responds to monetary policy shocks (Jordà, Schularick, and Taylor, 2015a; Bauer and Granziera, 2017; Robstad, 2018). Their evidence is mixed. Overall it seems that interest hikes moderately reduce household debt, while results on the macro-level response of debt-to-income are ambiguous.[3] Unlike this literature, our contribution is to use microdata which allows us to decompose debt and income components for different households.

Finally, our study fits into a growing set of papers that illuminates the transmission of monetary policy using microdata on households allowing researchers to gauge distributional and not just aggregate effects.[4] Within this literature, our paper is the first to focus on how monetary policy affects indebtedness.

Section 2 presents our data and relevant aspects of the institutional setting. Section 3 gives a historical decomposition of debt-to-income movements. Section 4 reports responses to monetary policy shocks. Section 5 concludes.

[2]As discussed in Section 2, we use a slightly different decomposition than Mason and Jayadev (2014) so as to ensure that the direct cash-flow effects of interest rate changes are included in Fisher effects only. Our results are not qualitatively altered by applying their decomposition framework instead, but then results are somewhat harder to interpret since cash flow effects of interest rates are present in both Fisher effects and the term for nominal debt changes.

[3]A related study focusing on financial crises rather than household debt is the historical investigation of Schularick, Ter Steege, and Ward (2021). They estimate that monetary policy has limited effects on financial crisis risk.

[4]Some recent prominent examples include Broer, Kramer, and Mitman (2021), Coglianese, Olsson, and Patterson (2021), Holm et al. (2021), Amberg, Jansson, Klein, and Picco (2022), Cantore, Ferroni, Mumtaz, and Theophilopoulou (2022), Faia, Kudlyak, Shabilina, and Wiczer (2022), Andersen, Johannesen, Jorgensen, and Peydro (2023), and Hubert and Savignac (2023).

2 Data

We here describe our data, how we decompose debt-to-income ratios, and some key aspects of the institutional setting.

The data. We utilize data from Norwegian administrative registries. Because Norway taxes wealth and income, tax registry data provide a detailed annual account of household income and balance sheets over time. For our purposes, one should note that debt and income are third-party reported by financial intermediaries and employers. These data, thus, are of particularly high quality. All assets and liabilities are reported at the end of the year, on December 31st. This means that for each household (defined as either a married or cohabiting couple or a single individual) in the economy, we observe their annual income and their stock of debt at the beginning and end of each year. The sample period for our data is 1994 to 2015. For further details on the Norwegian registry data, see Fagereng, Holm, and Natvik (2021).

Decomposition. Our empirical analysis starts with the definition of a household h's debt-to-income ratio $DTI_{h,t} = \frac{B_{h,t}}{Y_{h,t}}$, where $B_{h,t}$ is end-of-period nominal debt and $Y_{h,t}$ is within-period nominal disposable household income. We use yearly data, so t indexes the calendar year. Note the timing convention where $DTI_{h,t}$ is the ratio of debt at the end of year t relative to income obtained during year t.

The change in household h's debt-to-income ratio can be re-written as follows

$$\begin{aligned}\frac{B_{h,t}}{Y_{h,t}} - \frac{B_{h,t-1}}{Y_{h,t-1}} &= \frac{B_{h,t}Y_{h,t-1} - B_{h,t-1}Y_{h,t} + B_{h,t}Y_{h,t} - B_{h,t}Y_{h,t}}{Y_{h,t}Y_{h,t-1}} \\ &= \frac{B_{h,t} - B_{h,t-1}}{Y_{h,t-1}} - \frac{B_{h,t}}{Y_{h,t}}\frac{Y_{h,t} - Y_{h,t-1}}{Y_{h,t-1}},\end{aligned}$$

which is the expression in equation (1). Furthermore, the components of nominal income growth can be attributed to "Fisher effects" from real income growth, inflation, and the difference between interest income and interest expenses as follows:

$$\frac{B_{h,t}}{Y_{h,t}}\frac{Y_{h,t} - Y_{h,t-1}}{Y_{h,t-1}} = \frac{B_{h,t}}{Y_{h,t}}\left(\frac{Y^{non-i}_{h,t} - Y^{non-i}_{h,t-1}}{Y_{h,t-1}} + \frac{Y^{i}_{h,t} - Y^{i}_{h,t-1}}{Y_{h,t-1}}\right) \tag{2}$$

$$\approx \frac{B_{h,t}}{Y_{h,t}}\left(\frac{Y^{non-i}_{h,t-1}}{Y_{h,t-1}}\left(g_{h,t} + \pi_t\right) + \frac{Y^{i-inc}_{h,t} - Y^{i-inc}_{h,t-1}}{Y_{h,t-1}} - \frac{Y^{i-exp}_{h,t} - Y^{i-exp}_{h,t-1}}{Y_{h,t-1}}\right). \tag{3}$$

The first line splits total nominal income growth into non-interest income, $Y^{non-i}_{h,t}$, and net interest income, $Y^{i}_{h,t}$. The second line in addition decomposes non-interest income growth into real income growth, $g_{h,t}$, and inflation, π_t, and splits net interest income into interest income, $Y^{i-inc}_{h,t}$, and interest expenses, $Y^{i-exp}_{h,t}$. The decomposition then holds only as an approximation because $\left(1+g_{h,t}\right)(1+\pi_t)-1 = g_{h,t}+\pi_t+g_{h,t}\pi_t$, whereas we ignore the term $g_{h,t}\pi_t$ in order to separate between real income growth and inflation.[5]

Definition of variables. We construct $DTI_{h,t}$ by dividing outstanding debt at the end of year t by disposable income received over the year t. Similarly, the debt-change term in equation (1), $\frac{B_{h,t}-B_{h,t-1}}{Y_{h,t-1}}$, is directly computed as debt at the end of year t minus debt at the end of $t-1$, divided by disposable income in year $t-1$. Debt includes all outstanding liabilities including mortgages, car loans, and credit card debt. Disposable income $Y_{h,t}$ is the sum of labor income, transfers, interest income, and dividends, minus taxes and interest expenses. Each of these income components is third-party reported to the tax authorities. Hence, we directly observe $Y^{non-i}_{h,t}$ and $Y^{i}_{h,t}$, where the latter is interest income minus interest expenses.

In the Fisher effects of equation (3), we compute $g_{h,t}$ as the growth rate of all non-interest income components net of taxes for every household h, adjusted for inflation in year t. The inflation rate, π_t, is measured as the growth rate of the national consumer price index.

In one exercise we will separate people by their likelihood of becoming unemployed. To that end, we compute the predicted job separation rate at the individual level using a probit regression with a dummy for receiving unemployment insurance in $t+1$ on a full set of industry dummies and a second-order polynomial in tenure in year t. Figure A.1 shows the distribution of predicted job separation rates. Our sample for computing the predicted unemployment probability is restricted to individuals in the working-age population (24-62 years) who currently hold a job.

Sample selection. We restrict our analysis to households with adult members aged 24 years or older. We drop observations with extremely high debt or income (top 0.5% of each distribution) which will arise when households experience extraordinary events, such as bonus payments or housing transactions where they buy a new house in one calendar year and sell their old house in the next year. We also drop observations with income or implied spending less than the social security minimum, a debt-to-income ratio above 10, extreme changes in debt-to-income (top/bottom 1%), and extreme values of implied interest rates or real income growth (top/bottom 5%).

[5] An alternative approach, used by Mason and Jayadev (2014) on aggregate US data, is to follow the sovereign debt literature (for instance Hall and Sargent, 2011) which considers the law-of-motion for public debt $b_t = d_t + \frac{1+r_t}{1+g_t+\pi_t} b_{t-1}$, where b is the debt-to-GDP ratio, r is the interest rate, g real GDP growth, and d_t is the primary deficit divided by GDP. Primary deficits differ from nominal debt changes ($B_t - B_{t-1}$) as they are net of interest expenses ($B_t - B_{t-1} - r_t B_{t-1}$). We use a slightly different decomposition, with nominal debt change rather than primary deficits, because we want the direct cash-flow effects of interest rate changes to enter only in Fisher effects so as to distinguish mechanical effects of interest expenses from households' new borrowing or repayment, and because the concept of primary deficits is more opaque for households than nations as the former tend to save (dissave) in many additional ways beyond repaying (accumulating) debt. Still, we have explored both ways to decompose the debt-to-income ratio. No results are substantively different if we proceed as in the sovereign debt literature.

Summary statistics. Table 1 presents summary statistics for our sample of Norwegian households from 1994–2015. Focusing first on the whole sample, the average debt-to-income ratio is 162%. During our sample period, the ratio increased, as seen from the positive average nominal debt change around 11% and the smaller average Fisher effects of about minus 7%.

		Debt-to-income Quintiles				
Variable	**All**	**1**	**2**	**3**	**4**	**5**
Age	52.81	67.31	55.76	51.23	46.35	42.18
Less than high school education	0.31	0.48	0.36	0.28	0.23	0.21
High school education	0.38	0.34	0.38	0.39	0.40	0.38
College education	0.31	0.18	0.26	0.32	0.38	0.41
Debt-to-income in %	161.51	8.11	36.82	109.58	221.58	434.68
Debt (USD 1,000)	72.99	3.42	16.82	51.36	105.78	189.04
Income (USD 1,000)	42.41	34.40	42.88	45.24	46.66	43.82
Change in debt-to-income	3.81	6.47	11.77	8.05	3.73	-11.94
Nominal debt change	10.78	6.64	12.45	11.45	12.17	11.95
Fisher effects	-6.97	-0.17	-0.68	-3.40	-8.44	-23.88
Interest rate r in %	5.12	5.14	4.76	5.24	5.20	5.21
Real income growth g in %	3.52	2.51	2.10	2.95	3.78	6.22
Inflation π in %	2.01	2.03	2.00	2.01	2.01	2.01
Predicted job separation rate in %	5.50	5.48	5.19	5.20	5.43	5.97
Observations	48,492,186	10,739,727	8,611,796	9,715,931	9,713,514	9,711,218

Notes: The table presents the means of each variable across all household-year observations and within debt-to-income quintiles. For debt and income, our variables denote averages within the household denoted in 2011 USD. Quintile 1 contains more observations since more than 20% of the population hold no debt in some years.

Table 1: Summary statistics, 1994–2015.

In our later analysis, we will stratify households by debt-to-income quintiles. Table 1 shows that these groups differ in several dimensions. First, highly indebted households tend to be younger and have more formal education. Their high debt-to-income ratio is due to high debt, not low income. As they are young and income tends to increase with age, the highly indebted households have high income relative to their age.[6] Second, the most indebted households face higher job separation risk, as predicted by the sector of employment and tenure in their current job. Third, the highly indebted households also tend to have higher real income growth $g_{i,t}$, which bodes well for their longer-run ability to service debt. This pattern reflects a correlation between (young) age and higher education (see, e.g., Blundell, Graber, and Mogstad, 2015). A consequence

[6]Consistent with this observation, Bartscher, Kuhn, Schularick, and Steins (2020) use U.S. data from 1950 to 2016 and find that debt-to-income has increased most for households between the 50th and 90th percentile of the income distribution.

of the high real income growth is that Fisher effects are large among highly indebted households.

Institutional setting. Around 80% of Norwegian households own a house in our sample period. Almost all debt (97%) in our sample consists of mortgage loans. The typical mortgage contract in Norway is a 25-year loan with an adjustable interest rate.[7] The debt contract is usually an annuity contract where the sum of debt repayment and interest costs is scheduled to be the same each month. For adjustable-rate contracts, interest rate adjustments happen within weeks following a change in the central bank's policy rate. When the interest rate changes, the schedule for monthly payments is also adjusted so that the sum of debt repayment and interest costs stays constant at a new level going forward.

In our sample period, monetary policy was formally conducted under a flexible inflation targeting regime since 2001 with an inflation target of 2.5%. De facto this regime was introduced somewhat earlier, while in the beginning of our period, Norges Bank targeted the exchange rate. Following the 2007-2008 global financial crisis, Norges Bank has emphasized financial stability as a separate concern in addition to inflation and output.[8]

3 Historical Decomposition of Debt-to-Income Movements

This section dissects the annual change in debt-to-income ratios over our sample period into nominal debt changes and Fisher effects based on equation (1), an accounting identity that holds exactly. We further decompose the Fisher effects into real income growth, inflation, and interest income and expenses using (3).

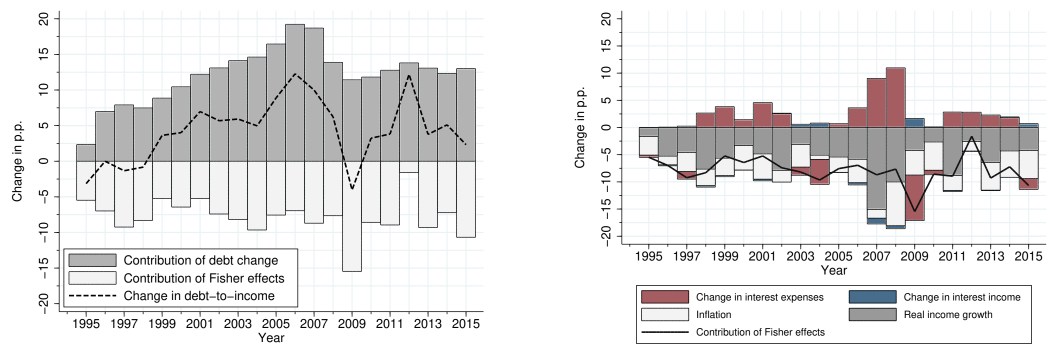
3.1 Decomposition of Population Averages

Figure 1 decomposes the average debt-to-income growth across all households in each year of our sample period. In panel (a), the dashed curve displays each year's debt-to-income change, the dark bars show the contributions from nominal debt changes, and the light grey bars show the contributions from Fisher effects. The bars together sum up to the debt-to-income line. We see that both nominal debt changes and Fisher effects have been important for debt-to-income growth. The two forces pull in opposite directions every year, and sometimes they almost cancel each other out. Still, nominal debt changes have clearly dominated in most years.

Panel (b) uses equation (3) to attribute each year's total Fisher effect to contributions from interest income and expenses, real income growth, and inflation. Because real income growth and inflation have been positive every year, they have always contributed to reducing debt-to-income growth and therefore consistently lie in the negative region of the plot. In contrast, the

[7] More than 90 percent of all household debt has adjustable interest rates (Holm et al., 2021).

[8] The financial stability target was formalized in 2019 when the formulation "counteract the build-up of financial imbalances" was included in the central bank's mandate.



(a) Historical decomposition of debt-to-income

(b) Historical decomposition of Fisher effects

Notes: Figure (a) plots the sample average of changes in debt-to-income, and the contributions from nominal debt changes and Fisher effects as defined in (1). Figure (b) decomposes the sample average Fisher effects into interest income, interest expenses, real non-interest income growth, and nominal non-interest growth due to inflation, based on equation (3).

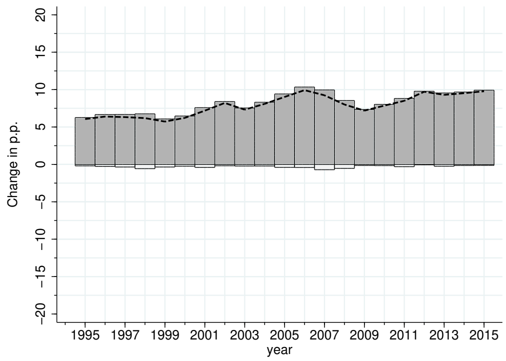
Figure 1: Historical decomposition of debt-to-income changes and Fisher effects.

contributions from interest income and expenses switch sign several times due to years with sharp interest hikes or cuts. We also see that the contributions from variation in interest expenses dwarf those from interest income, which are hardly visible in the figure. On average, the contributions from interest expenses have been on the upside, meaning they have tended to raise the debt-to-income ratio over time. The reason is that household debt grew in this period, so interest expenses increased too, even though the interest rate level fell over the period as a whole. The takeaway from panel (b) is that real non-interest income growth is the most important component behind the Fisher effects, followed by changes in interest expenses. In the years where Fisher effects were particularly forceful in pulling debt-to-income growth down, especially in 2009, it was because interest expenses fell and thus contributed in the same direction as real income growth.

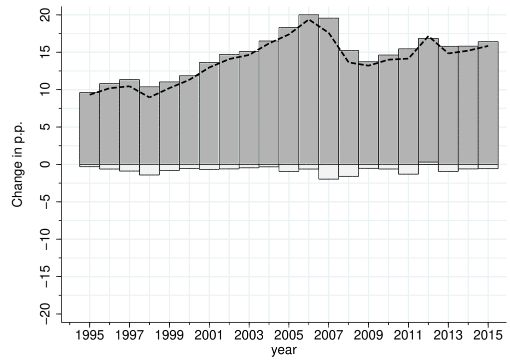
3.2 Decomposition along the Debt-to-Income Distribution

Fisher effects work through households' stock of debt, as equation (1) shows. Hence, these effects are more important for highly indebted households. Moreover, financial stability concerns regard this group in particular. Figure 2 therefore decomposes debt-to-income changes as in Figure 1(a), but now differentiates households by their debt-to-income quintile in year $t-1$.

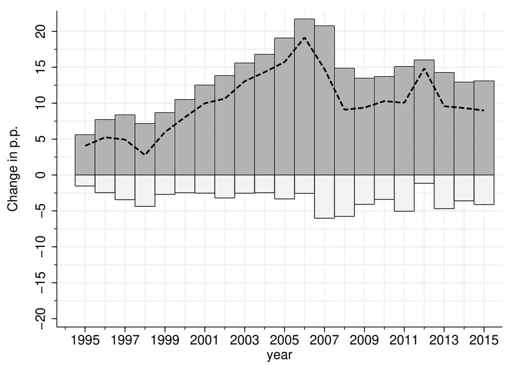
Panels (a), (b), and (c) in Figure 2 show that among the 60% least indebted households, the debt-to-income ratio has grown every year and nominal debt changes almost entirely account for this growth. Hence, the Fisher effects we previously observed in the aggregate stem from households who are relatively highly indebted. Panel (d) shows how the fourth debt-to-income quintile is a middle ground, where debt-to-income growth is moderate and influenced both by nominal debt changes and Fisher effects which pull in opposite directions. Panel (e) shows that



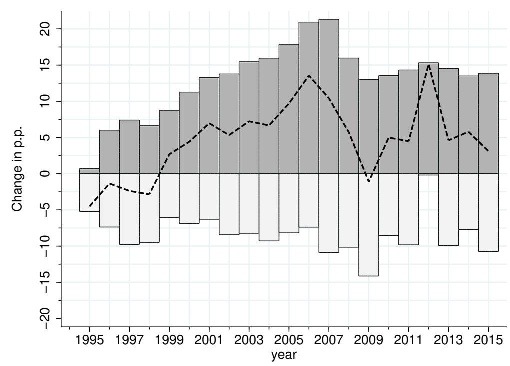
(a) Quintile 1



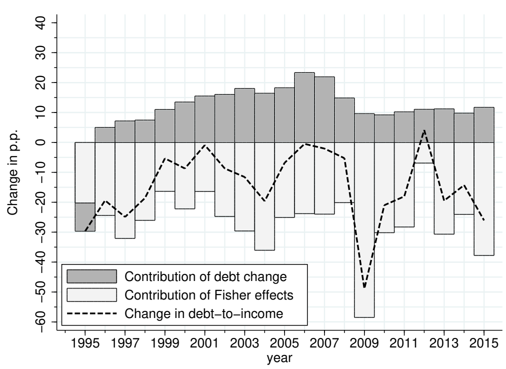
(b) Quintile 2



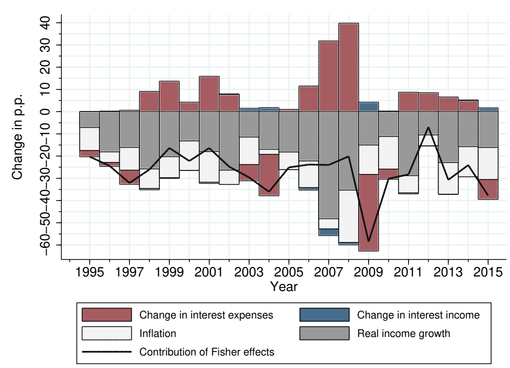
(c) Quintile 3



(d) Quintile 4



(e) Quintile 5



(f) Fisher effects in Quintile 5

Notes: Panel (a)-(e) decomposes the average debt-to-income change within each quintile of beginning-of-year debt-to-income ratios according to equation (1). Panel (f) decomposes the Fisher effects in quintile 5 according to equation (2).

Figure 2: Historical decomposition of debt-to-income changes by quintiles of debt-to-income ratios in $t-1$.

highly indebted households stand out. Their debt burden has fallen every year except one (2012). This has happened because Fisher effects, especially nominal income growth, have dominated small positive nominal debt changes.

Panel (f) dissects the Fisher effects in the top debt-to-income quintile. We see that the main driver is real income growth, which has been particularly high in this group as already shown in Table 1. Unsurprisingly, interest expenses have also been important in this group, but they are outsized by real income growth. In addition, we see that even though inflation was low over this period, averaging at 2%, it still played a non-negligible role in curtailing the debt-to-income ratio among the most indebted households.

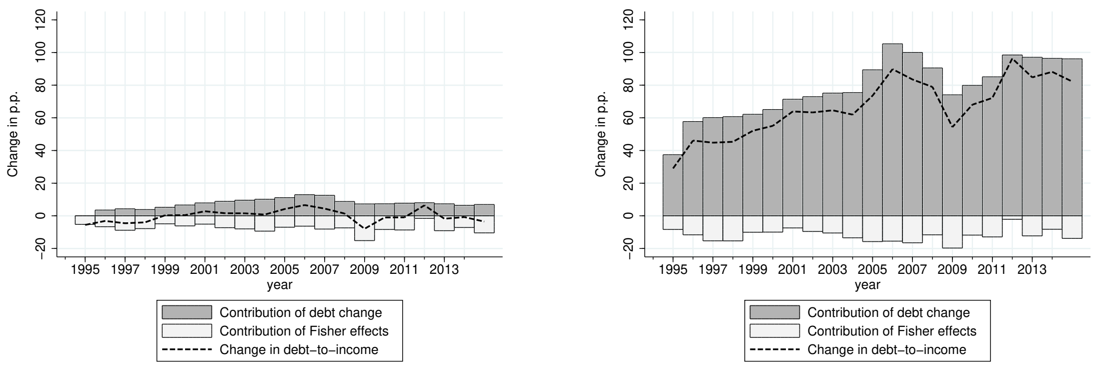
A takeaway from Figures 1 and 2 is that the average evolution of debt-to-income ratios masks heterogeneity across households with different debt levels. While Fisher effects are irrelevant for households with low debt burdens, they are large and dominant among the most indebted households. For policy aimed a preventing financial instability, this observation is important. The reason is that highly indebted households will likely be the first to struggle to repay their debt, thereby possibly inducing systemic strain if a large macroeconomic shock hits the economy. Our results show that Fisher effects, particularly real income growth, are key for the extent to which indebtedness builds up or is unwound among households with high debt-to-income ratios.

3.3 Decomposition among Stayers and Movers

If households tend to follow amortization plans that are set upon the origination of their mortgage, we would expect Fisher effects to be important. This would occur if refinancing or re-adjusting the amortization plan is costly. In contrast, if households flexibly choose how much to borrow or repay each year, we would expect that mechanical Fisher effects are less important relative to nominal debt changes. One specific situation in which households are likely to re-set their amortization plan is when they change their home and get a new mortgage. Hence, to focus on the extent to which amortization plans may be important, we separate between "movers" and "stayers". A household is a mover in the year it gets a new home address. A household is a stayer if it does not move.

In Figure 3 we decompose debt-to-income growth in each of the two groups. From panel (a) we see that each year, nominal debt changes and Fisher effects are of approximately the same size among stayers. Panel (b) shows that this is very different in the year households move. Here nominal debt changes completely outsize Fisher effects.

Because relatively few households move in any given year (less than 10 percent), the population-wide average effects might be driven by stayers despite the relatively small movements per household in this group. In Figure 4, we therefore consider the total nominal debt changes and attribute them to movers and stayers in panel (a), and we do the same for Fisher effects in panel (b). Of the population-average nominal debt changes, approximately half come from stayers and half from movers. In panel (b) we see that Fisher effects predominantly come from stayers.

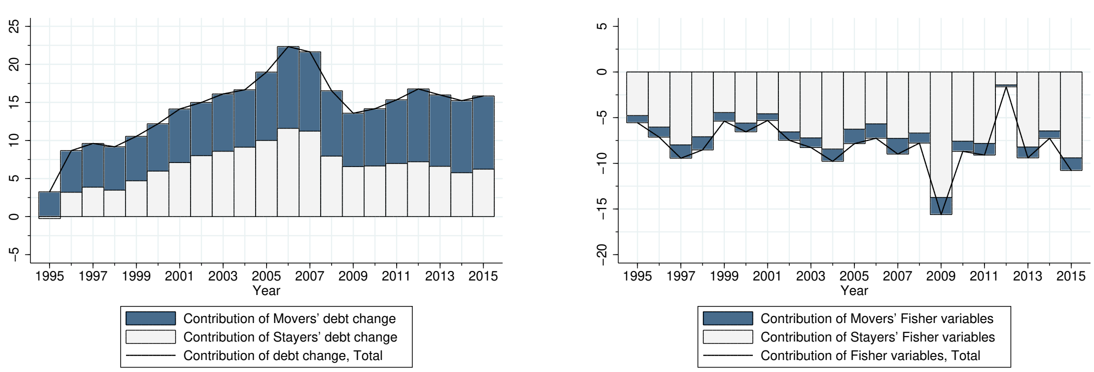


(a) Decomposition of DTI among stayers **(b)** Decomposition of DTI among movers

Notes: Panel (a) decomposes the debt-to-income ratio among households who do not change address within the year. Panel (b) decomposes the debt-to-income ratio among households who change address within the year.

Figure 3: Historical decomposition of debt-to-income changes for movers and stayers.

The insight here is that the extensive margin in the housing market, moving, makes a big difference in terms of what drives the debt-to-income ratio. Consistent with our priors, Fisher effects are more important among people who stay in their existing homes and thus are more likely to be under a pre-set debt amortization plan. This pattern is consistent with the results of Bernstein and Koudijs (2021). They find that in the Netherlands, amortization plans seem to bind and determine saving in the first years after households buy new homes. When we next estimate responses to monetary policy shocks, we will therefore zoom in on housing tenure to see if Fisher effects play a particular role among recent home buyers.



(a) Nominal debt changes **(b)** Fisher effects

Notes: Panel (a) plots the total yearly nominal debt changes and decomposes them into contributions from households that change address and households that do not change address within the year. Panel (b) plots the total yearly Fisher effects and decomposes them into contributions from households who change address and households who do not change address within the year.

Figure 4: Movers' and stayers' contribution to nominal debt changes and Fisher effects.

4 Evidence from Monetary Policy Shocks

The descriptive results revealed that nominal debt changes have been the main driver behind the evolution of household debt-to-income ratios in our sample, but that Fisher effects are important among households with high debt burdens and who do not move. How do these results carry over to monetary policy effects? Do interest hikes lower debt burdens by reducing nominal debt growth or do they work in the opposite direction as Fisher effects reduce nominal income? We now turn to address these questions by direct estimation of how monetary policy shocks affect households' debt-to-income ratios.

Our empirical strategy is to use local projections (Jordà, 2005) together with a series of monetary policy shocks from Holm et al. (2021). These shocks are identified with a narrative approach following Romer and Romer (2004), using real-time forecasts by Norges Bank. This approach estimates the systematic relationship between interest rate setting and the Central Bank's view on the current and future state of the economy and then identifies shocks as deviations between the actual policy rate and what the systematic relationship implies that it should be. Further details are provided in Holm et al. (2021). We report the shocks' main macroeconomic effects in Figure A.2, based on the same type of local projections that we later use on our microdata, as specified in (4) and explained in the text below that equation. After a contractionary monetary policy shock, the policy rate remains high for an extended period before it undershoots below its starting value in response to low output and inflation. Output falls and then recovers in a hump-shaped manner, whereas the price level responds moderately. Hence, even before turning to our rich microdata, we know that nominal income responses at the micro level will not be due to the inflation term in the Fisher effects in Equation (3) above, and we, therefore, will not explore this channel further when dissecting how debt-to-income reacts to monetary policy.

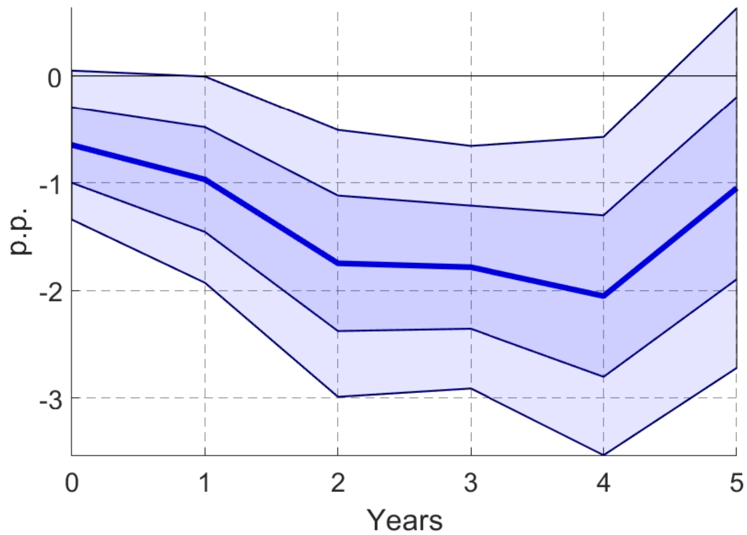
In what follows, we first study average effects across all households in our sample. We then explore how the responses vary across subgroups of the population where we have reasons to believe that debt-to-income ratios will behave differently. Finally, we consider how two alternative measures of households' financial vulnerability respond to monetary policy shocks.

4.1 Average Responses to Monetary Policy

To obtain the average effects of monetary policy shocks, we estimate the equation

$$y_{h,t+j} - y_{h,t-1} = \delta_h^j + \beta^j \epsilon_t^{MP} + \gamma' \mathbf{X}_{h,t-1} + u_{h,t}^j, \tag{4}$$

where $y_{h,t+j}$ is the outcome variable of interest for household h observed j years after the shock occurred, ϵ_t^{MP} is the monetary policy shock in year t, δ_h^j is a household fixed effect, $\mathbf{X}$ is a set of controls, and $u_{h,t}^j$ is the error term. Our baseline specification includes two lags of the right-hand



Notes: The response of debt-to-income to a one percentage point contractionary monetary policy shock. The shaded areas display 68 and 95 percent confidence bands, computed using Driscoll and Kraay (1998) standard errors.

Figure 5: The debt-to-income response to monetary policy

side variables and three lags of monetary policy.[9]

Figure 5 shows our estimated response of the debt-to-income ratio to a 1 percentage point increase in the interest rate.[10] Figure 6 decomposes the debt-to-income response to contributions from nominal debt changes and Fisher effects in panels (a) and (b), and then decomposes the Fisher effects into the non-interest and interest components using equation (2).

The average debt-to-income response after a monetary tightening is negative, small, and relatively short-lived, as seen in Figure 5. The maximum response after 2-4 years is around 2 percentage points (compared to an average debt-to-income ratio of about 160%) and the effect reverts toward zero after five years.

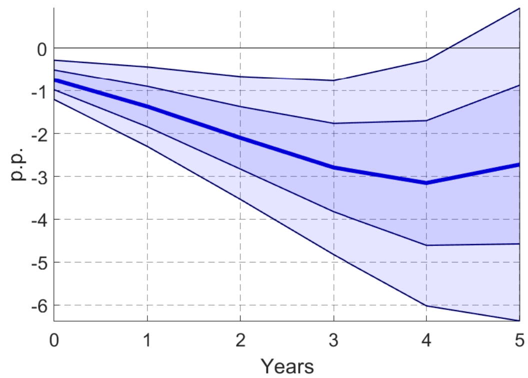
Figure 6 shows that the debt-to-income response is driven by reduced nominal debt (note that the scale on the vertical axes varies across the four plots). That is, households repay faster or take up less new debt when the interest increases, as seen in panel (a). Fisher effects work in the opposite direction, as seen in panel (b), in line with the common arguments put forth that

[9]We show in Figure A.3 in the Appendix that our results are insensitive to excluding years after the financial crisis where financial stability concerns are believed to have influenced the central bank interest rate decisions.

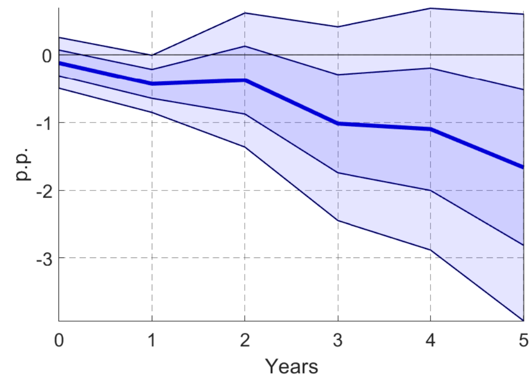
[10]In the empirical estimation, we use the following decomposition to estimate the effects of monetary policy on debt-to-income, nominal debt changes, and Fisher effects

$$DTI_{h,t+j} - DTI_{h,t-1} = \frac{B_{h,t+j} - B_{h,t-1}}{Y_{h,t-1}} - \frac{B_{h,t+j}}{Y_{h,t+j}} \frac{Y_{h,t+j} - Y_{h,t-1}}{Y_{h,t-1}}$$

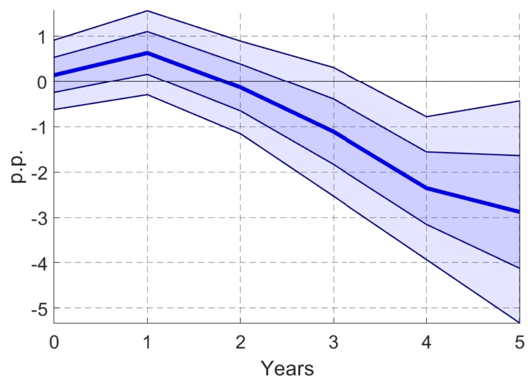
where j is the horizon as in (4). We thus replace the left-hand side variable in (4) with its counterpart in the equation above.



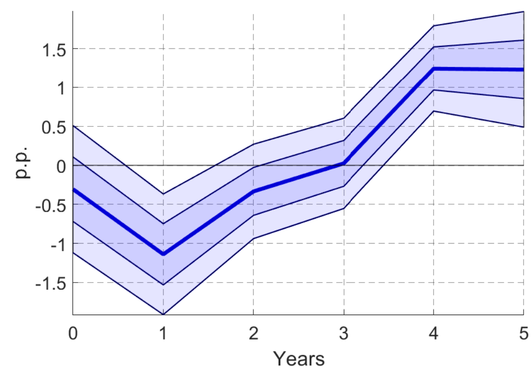
(a) Nominal debt change



(b) Fisher effects



(c) Non-interest income



(d) Net interest income

Notes: Impulse responses to a one percentage point contractionary monetary policy shock. The shaded areas display 68 and 95 percent confidence bands, computed using Driscoll and Kraay (1998) standard errors.

Figure 6: Decomposition of the debt-to-income response to monetary policy

tighter monetary policy will reduce disposable nominal household income, but the sum of Fisher effects is small (see, e.g., Svensson, 2017). In panels (c) and (d), where Fisher effects are split into non-interest and net interest income, we see why they sum to approximately zero. In the short run, net interest income drops somewhat because interest rates increase and households have more debt than deposits, but the effect on total nominal income is negligible since non-interest income does not fall until some time later. At horizons 4 and 5 years there is a sizable drop in non-interest income, but by this time net interest income is in positive territory as households have reduced their debt and because the interest rate is endogenously lowered 4 years after the initial shock.

Hence, the conventional view that tighter monetary policy reduces household indebtedness by making households accumulate less debt qualitatively holds on average in our sample. Quantitatively, the effect is moderate, as the debt-to-income ratio falls by at most two percentage points (after two years) in a sample where the average debt-to-income ratio is about 160%.

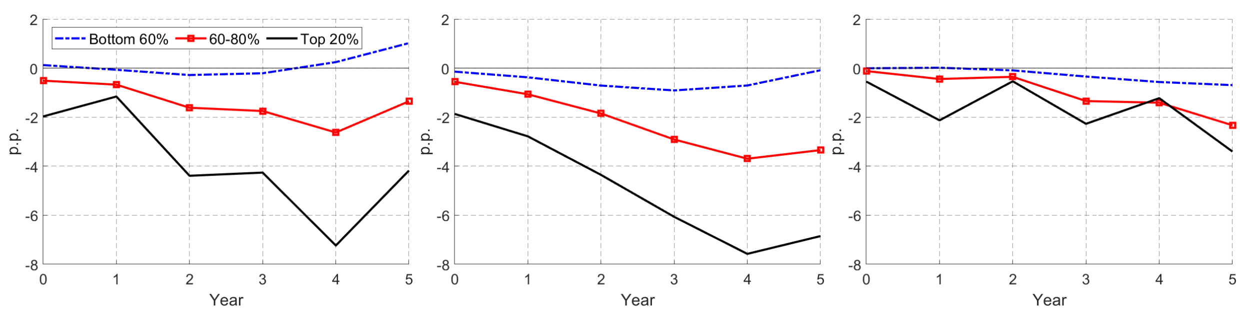
4.2 Responses to Monetary Policy by Initial Indebtedness

Our historical decomposition exercise revealed that Fisher effects were unimportant for households with low to moderate debt levels, but mattered a great deal for the evolution of debt-to-income ratios among households with high indebtedness. Moreover, high-debt households are the main group of concern for questions of financial stability. It is therefore natural to ask if the average results found above mask important heterogeneity across households with different degrees of indebtedness.

We explore heterogeneous effects with the same strategy as outlined above, but with the modification that the regression equation (4) applies within groups g. The specification we now use is

$$y_{i,t+h} - y_{i,t-1} = \delta_i^h + \beta_g^h \epsilon_t^{MP} + \gamma_g' \mathbf{X}_{i,t-1} + u_{i,t}^g, \qquad \forall\ i \in g \tag{5}$$

where the responses to monetary policy shocks are allowed to differ between household groups g. The notation is the same as in equation (4) above. To study heterogeneity by indebtedness, we consider the distribution of debt-to-income ratios each year and group households according to which quintile they are in at the beginning of the year. Then we estimate equation (5) separately for every quintile.



(a) Debt-to-Income **(b)** Nominal debt change **(c)** Fisher Effects

Notes: Impulse responses to a 1 percentage point contractionary monetary policy shock for households beginning the year along the distribution of initial debt-to-income ratios. Confidence bands are displayed in Figure A.4 in the Appendix.

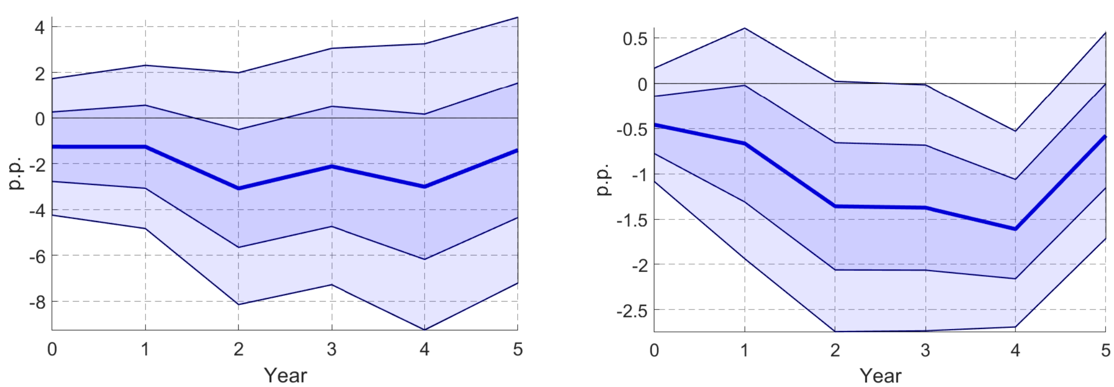
Figure 7: Monetary policy responses by initial debt-to-income

Figure 7 displays impulse responses of debt-to-income, nominal debt changes, and Fisher effects across the debt-to-income distribution. In the figure we have collapsed quintiles 1 to 3 into one group because their responses are very similar. We see that among households in these three bottom quintiles, very little happens to their debt-to-income ratio after a monetary policy shock. The average responses shown above were instead driven by households in the two upper quintiles. Among these households, the debt-to-income ratios fall, particularly so among the households that are the most indebted initially. As we saw for the average effects, the response is driven primarily by reduced nominal debt.[11]

The main insight here is that there is no sign that Fisher effects make indebtedness respond positively to interest hikes among high-debt households. This is a stark result, given that this is the group where Fisher effects have the strongest potential to affect indebtedness, as mathematically seen in equation (1), and where Fisher effects have been quantitatively important over our sample period, as seen in Figure 2. However, the Fisher effects have simply not been particularly important for the propagation of monetary policy shocks in our sample. Instead, even among the most indebted households, monetary policy has worked primarily by influencing households' choice of how much to borrow or repay, and not by mechanically lowering their nominal income.

4.3 Responses to Monetary Policy by Housing Tenure

Section 3.3 showed that the relative importance of nominal debt changes and Fisher effects varied greatly between households who move and households who stay in the same house. The differences align with a prior that homeowners tend to follow pre-set amortization plans, but when they buy a new home they take up new debt or repay independently of what their previous plan stipulated. By the same logic, the mechanical Fisher effects should have the greatest potential to drive responses to monetary policy among households who are more constrained by their amortization schedules.



(a) Recent movers

(b) Not recent movers

Notes: Impulse responses of debt-to-income ratios after a one percentage point contractionary monetary policy shock. Recent movers are households who have moved within the last two years before the shock. Not recent movers are households who have lived at the same address for three years or more before the shock. The shaded areas display 68 and 95 percent confidence bands, computed using Driscoll and Kraay (1998) standard errors.

Figure 8: The debt-to-income response to monetary policy by housing tenure

Unlike in Section 3.3, we now cannot distinguish between households who move and house-

[11] Responses across the debt-to-income distribution with confidence bands are provided in the Appendix, Figure A.4.

holds who stay. The reason is, moving or staying is an endogenous choice, likely to be influenced by the interest rate. Instead, we separate between households with short and long tenure in their current residence before the shock occurred (i.e., in $t-1$). This distinction is motivated by the aforementioned study of Bernstein and Koudijs (2021) whose evidence suggests exactly that amortization plans seem to bind more intensively for households who have recently bought a new home. We follow their lead and distinguish households who have moved within the last two years from households who have lived three years or more in their current home.

Estimated impulse responses for these two distinct groups are presented in Figure 8. We see that the two groups react very similarly. The estimates are naturally much more precise in the group of households who have not recently moved, but the point estimates lie close to each other. While not displayed here, the same qualitative pattern holds for nominal debt changes and Fisher effects.

The main takeaway is the same as in Section 4.2. Even within the group where we a priori have reason to believe the Fisher effects could be large and make households' debt-to-income ratios increase after an interest hike, there is no sign that this actually happens.

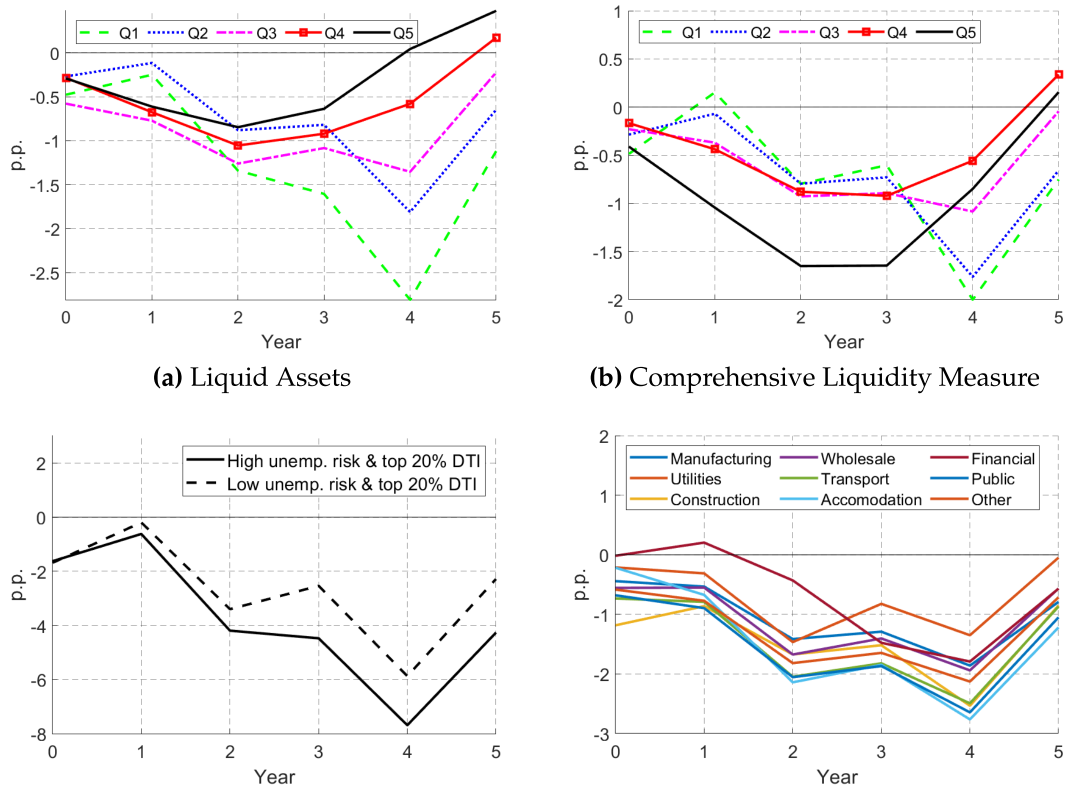
4.4 Responses to Monetary Policy by Liquidity and Income Risk

The policy concern with high debt-to-income ratios is mainly rooted in the fear that indebtedness makes households vulnerable to sudden income drops, in particular unemployment, as such events would force them to cut their consumption radically or default on their debt contracts. Moreover, earnings and thus Fisher effects might well be the most responsive to monetary policy shocks among exactly those workers who are at risk of suddenly losing income in general.

We, therefore, consider the role of liquidity, as low-liquidity households might struggle more after a sudden income shortfall and income risk. Liquidity is measured in two alternative ways. First, we simply stratify households by deposits held at the beginning of the year of the monetary policy shock. Second, we consider a richer measure of available resources which includes home equity beyond a threshold of 30 percent, meant to capture that households with low leverage can use their home equity as a credit line. This measure also includes income above a "reference consumption level" as defined by an external third party, SIFO.[12] Our comprehensive liquidity measure is then deposits plus income minus reference consumption plus the maximum of zero and 70% of housing value minus debt. Unemployment risk is obtained from a probabilistic regression

[12]Reference consumption is computed by the Norwegian institution SIFO, and its calculator is available at https://www.oslomet.no/en/about/sifo/reference-budget. Inputs to the algorithm are number of persons with their gender and age, number of cars, and income per household. Its formal description: "Based on baskets of goods and services that are necessary for an acceptable standard of living, the reference budget presents ordinary consumer expenditure for different types of households. The budget can be adapted to households of different sizes as well as to different age and gender compositions. It covers both current expenses such as food, clothing, toiletries etc. and expenses related to less frequent purchases, such as furniture and electrical appliances. [...] A reasonable, or acceptable, standard of living assumes a consumption level that is generally accepted in Norwegian society".

model where future job loss (unemployment) is regressed on predetermined characteristics (time- and industry-fixed effects and a second-order polynomial in tenure).[13] Across sectors we are particularly interested in the public sector workers because they are likely to be highly secure whereas privately employed workers are more exposed to changing market conditions.



(a) Liquid Assets **(b)** Comprehensive Liquidity Measure

(c) Predicted Unemployment Risk **(d)** Sector of Employment

Notes: Debt-to-income responses to a 1 percentage point contractionary monetary policy shock for different household groups. Liquid assets is measured as deposits. Our comprehensive liquidity measure is the sum of deposits, income and home equity above 30% of the house value, minus reference consumption as computed by the external third-party SIFO. Predicted unemployment risk is based on a probabilistic regression model. Sector of employment is defined by the sector in which the household's main earner worked in the year before each monetary policy shock.

Figure 9: The debt-to-income response to monetary policy by liquidity, predicted unemployment risk and sector of employment

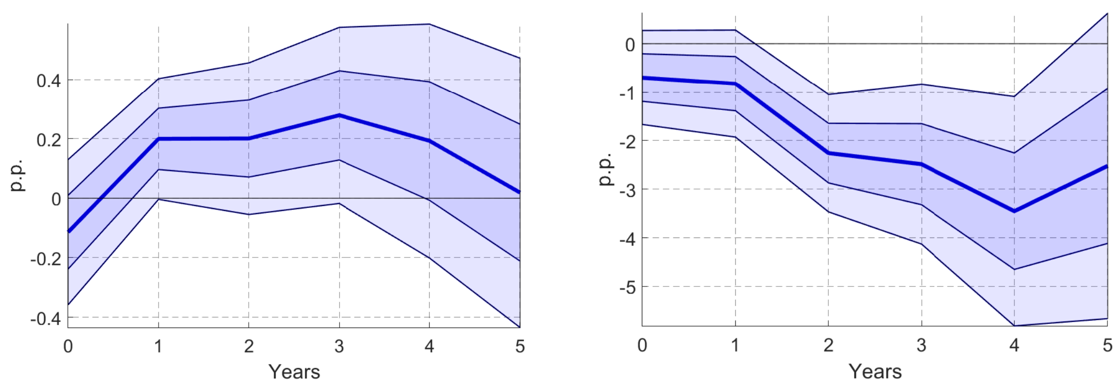
Figure 9 shows the results. There are some differences. Panel (a) shows that the debt-to-income response reverts faster back to zero among households with higher deposits initially, which is largely due to reduced interest income from the endogenous drop in interest rates 4 and 5 years after the shock. Panel (b) shows that households with high values of our comprehensive

[13]Figure A.1 in the Appendix shows the distribution of predicted unemployment risk in our data. We here present results by unemployment risk within the top quintile of debt-to-income ratios only. Results do not differ in any important way if we differentiate by unemployment risk in the entire population.

liquidity measure cut debt-to-income somewhat more in the short run than households with low values do. Panel (c) shows a slightly lower debt-to-income drop for households with low predicted unemployment risk. Panel (d) shows that there is a larger drop in debt-to-income ratios among public sector workers than in some of the private sectors. But overall these differences are relatively small.[14] The main takeaway here is that the same pattern of debt-to-income responses tends to hold across different households. When the interest rate rises, households tend to borrow less or repay debt, in line with standard intertemporal substitution effects, while the counteracting Fisher effects are timid.

4.5 Loan-to-Value Ratios and Net Debt

Our entire analysis has focused on households' ratio of debt relative to their income. While this is the main measure of household debt burdens emphasized in the literature, one might consider other measures too. One such measure is the ratio of debt relative to the value of households' homes, i.e., the loan-to-value ratio. Moreover, we are zooming in on a limited part of the household balance sheet by focusing on debt. It might well be that our estimated responses to monetary policy hikes reflect that households run down liquid assets to repay their debt.



(a) Loan-to-value **(b)** Net Debt-to-Income

Notes: Impulse responses to a one percentage point contractionary monetary policy shock. The shaded areas display 68 and 95 percent confidence bands, computed using Driscoll and Kraay (1998) standard errors.

Figure 10: Loan-to-value and net debt responses to monetary policy

We, therefore, estimate responses of loan-to-value ratios and net debt relative to income. Net debt is simply computed as debt minus deposits divided by disposable nominal income. We employ the same local projection framework as before. Figure 10 displays results as impulse responses.

[14]Responses with confidence bands are reported in the Appendix, Figures A.5, A.6, A.7, and A.8.

We see that the average loan-to-value ratio responds moderately, and to some extent positively after an interest hike. Hence, focusing on this measure there is something to the qualitative argument that interest hikes are counterproductive for reducing household leverage. The reason is that house prices fall. However, the response is small and hardly statistically significant at any horizon.

The ratio of net debt relative to income falls after interest hikes. The response is quite similar to what we saw for the debt-to-income ratio in Figure 5. Hence, our results suggest that households are not lowering their debt-to-income ratio by reducing their liquid reserves.

5 Conclusions

With precise balance-sheet data, we have documented how different households' debt burdens are driven by nominal debt changes and Fisher effects. Our central finding is that Fisher effects were important for yearly changes in debt-to-income ratios among indebted households over the 22-year sample we observe, but still, monetary policy shocks worked mainly through nominal debt changes. Moreover, the latter effect is remarkably stable across different households. In this sense, households' choice of how much to borrow and repay has dominated the mechanical Fisher effects in transmitting monetary policy shocks to household indebtedness.

In terms of the debate on whether monetary policy should lean against the wind, our estimates align with the conventional belief that higher interest rates lower household indebtedness. But we note that our estimates are quite moderate. For instance, after a one percentage point shock to the policy rate, the average debt-to-income ratio drops by two percentage points after two years. This does not come across as a large effect in a sample where the average debt-to-income ratio is about 160%, which should be factored in when different policy objectives are traded off against each other.

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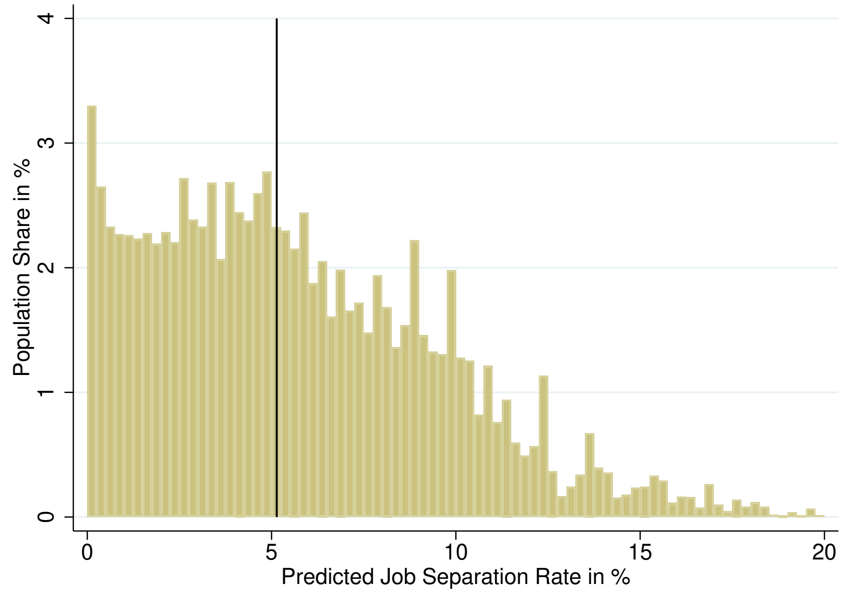
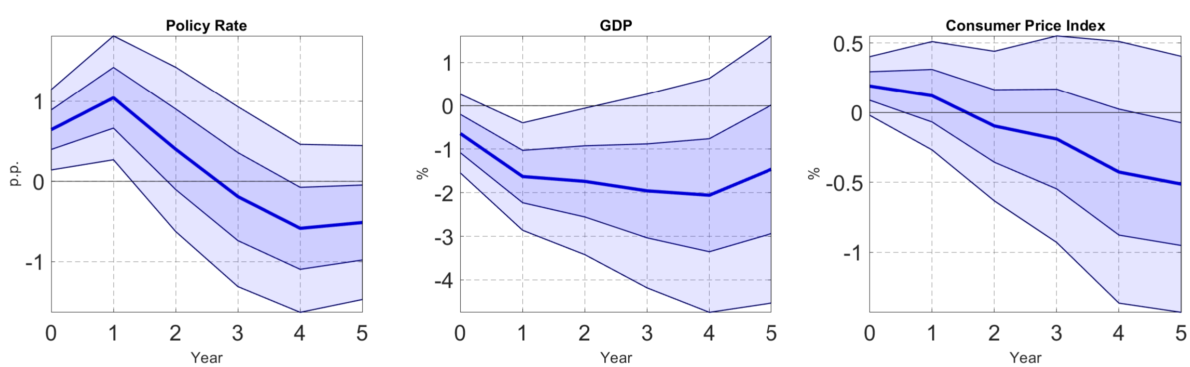
Appendix

A Additional Figures



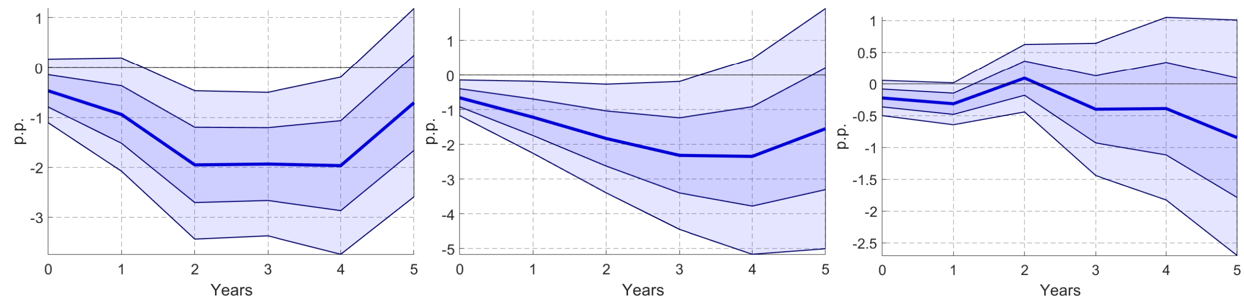
Notes: The figure presents the distribution of predicted job separation rates among households in our sample, using an estimated probit model with industry dummies and job tenure. The solid black line is the median predicted job separation rate.

Figure A.1: The distribution of predicted job separation rates.



Notes: Impulse responses to a 1 percentage point contractionary monetary policy shock. The shaded areas display 68 and 95 percent confidence bands, computed using Newey and West (1987) (macro responses) standard errors.

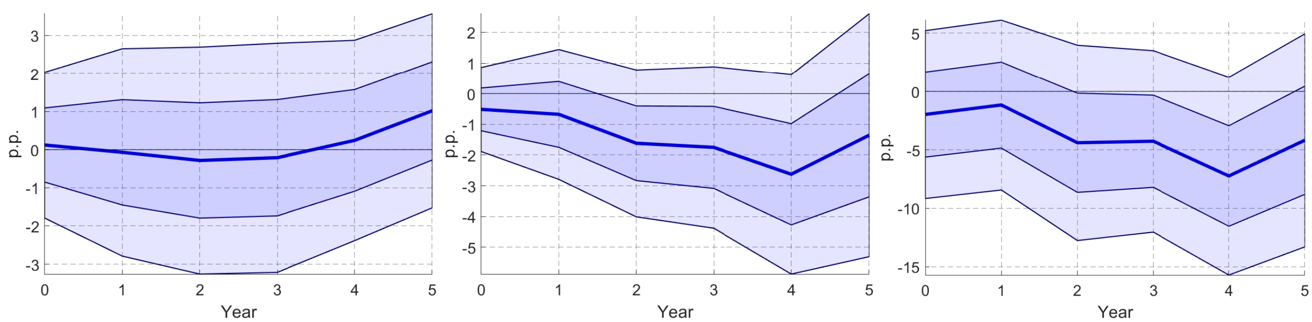
Figure A.2: Macro responses to monetary policy shocks



(a) Debt-to-income change **(b)** Nominal debt change **(c)** Fisher effects

Notes: Impulse responses to a one percentage point contractionary monetary policy shock. The shaded areas display 68 and 95 percent confidence bands, computed using Driscoll and Kraay (1998) standard errors.

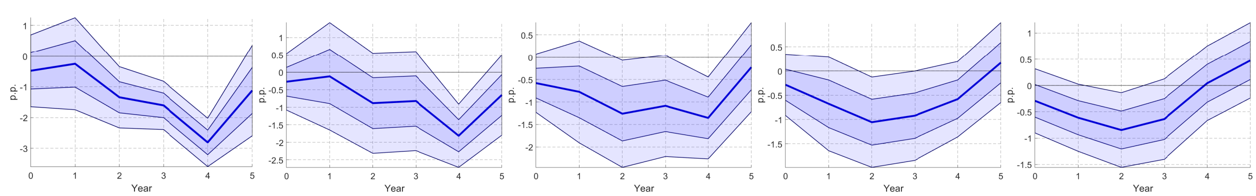
Figure A.3: Decomposition of the debt-to-income response to monetary policy. Robustness to excluding monetary policy shocks after 2008.



(a) Bottom 60% **(b)** 60-80% **(c)** Top 20%

Notes: Debt-to-income responses to a 1 percentage point contractionary monetary policy along the distribution of initial debt-to-income ratios. The shaded areas display 68 and 95 percent confidence bands, computed using Driscoll and Kraay (1998) standard errors.

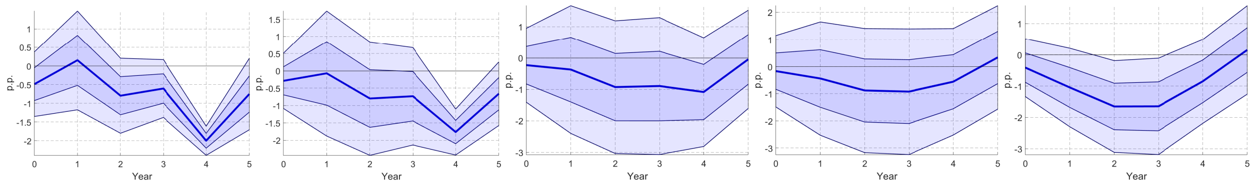
Figure A.4: Debt-to-Income Responses to Monetary Policy by Initial Debt-to-Income



(a) 0-20% **(b)** 20-40% **(c)** 40-60% **(d)** 60-80% **(e)** 80-100%

Notes: Debt-to-income responses to a 1 percentage point contractionary monetary policy shock for households along the distribution of initial liquid assets. Liquid assets are defined as the sum of deposits, stocks, bonds, and stock funds. The shaded areas display 68 and 95 percent confidence bands, computed using Driscoll and Kraay (1998) standard errors.

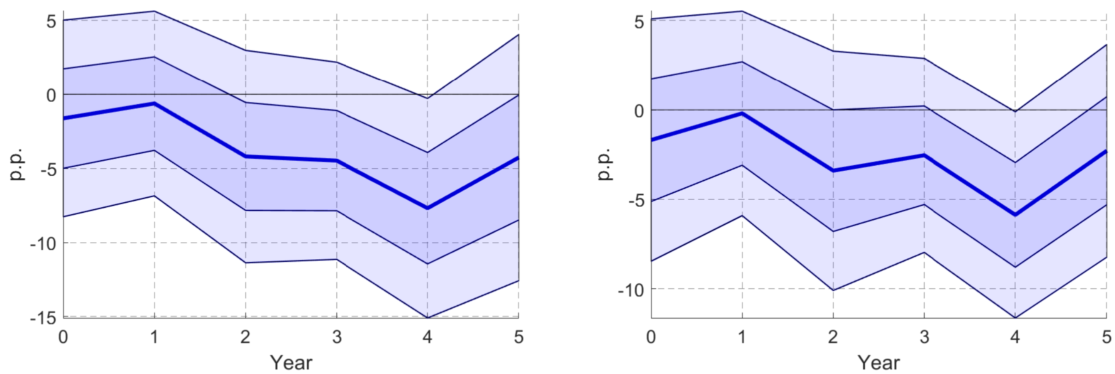
Figure A.5: Debt-to-Income Responses to Monetary Policy by Initial Liquid Assets.



(a) 0-20% **(b)** 20-40% **(c)** 40-60% **(d)** 60-80% **(e)** 80-100%

Notes: Debt-to-income responses to a 1 percentage point contractionary monetary policy shock for households along the distribution of initial liquidity. We define liquidity as disposable income + subsistence spending + (0.7·housing wealth - debt)$\mathbb{1}_{0.7\cdot\text{housing wealth}>\text{debt}}$ + deposits. The shaded areas display 68 and 95 percent confidence bands, computed using Driscoll and Kraay (1998) standard errors.

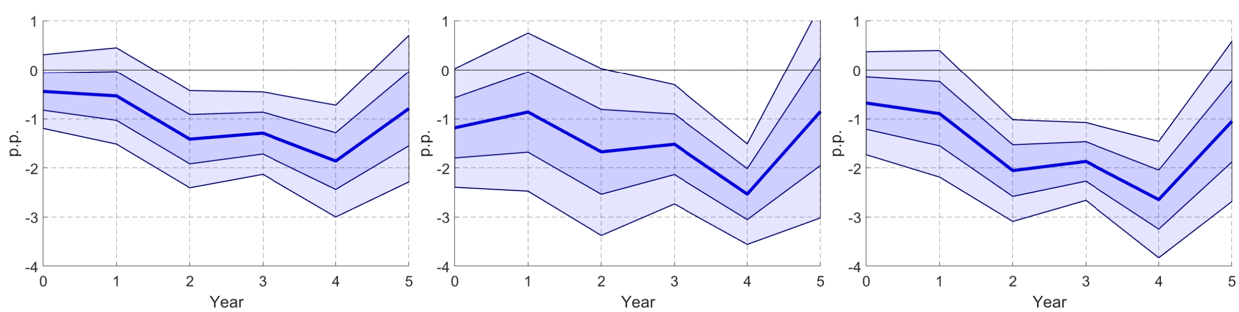
Figure A.6: Debt-to-Income Responses to Monetary Policy by Initial Comprehensive Liquidity Measure.



(a) High unemployment risk & top 20% DTI **(b)** Low unemployment risk & top 20% DTI

Notes: Debt-to-income responses to a 1 percentage point contractionary monetary policy shock for households along the distribution of initial debt-to-income and unemployment risk. The shaded areas display 68 and 95 percent confidence bands, computed using Driscoll and Kraay (1998) standard errors.

Figure A.7: Debt-to-Income Responses to Monetary Policy by Initial Debt-to-Income and Unemployment Risk



(a) Manufacturing **(b)** Construction **(c)** Public

Notes: Debt-to-income responses to a 1 percentage point contractionary monetary policy shock for households by sector of employment. The shaded areas display 68 and 95 percent confidence bands, computed using Driscoll and Kraay (1998) standard errors.

Figure A.8: Debt-to-Income Responses to Monetary Policy by Sector of Employment