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How Does Monetary Policy Affect Household Indebtedness?*

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Abstract

Households' debt-to-income ratios change due to (a) primary deficits or (b) "Fisher effects" from interest costs, income growth, and inflation. With Norwegian micro data, we estimate how monetary policy affects household indebtedness by debt levels. In response to interest rate hikes, channel (a) pulls debt-to-income ratios down while channel (b) pushes debt-to-income ratios up. Channel (a) dominates even among highly indebted households where Fisher effects are forceful. However, among indebted households with high unemployment risk, we find no discernible effect on debt-to-income ratios, indicating that monetary policy has limited potential to contain debt where the largest risks are concentrated.

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1 Introduction

Historical studies reveal that run-ups in household debt are associated with deeper macroeconomic recessions and financial crises (Jordà, Schularick, and Taylor, 2013, 2015b, 2016; Mian, Sufi, and Verner, 2017; 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). But how does monetary policy actually affect household indebtedness?

On the one hand, it is natural to conjecture that tighter monetary policy will motivate households to borrow less, consistent with textbook intertemporal substitution effects. But on the other hand, higher interest rates may cause lower income growth and weaker debtor cash flows to finance repayment, which can pull indebtedness as measured by debt-to-income ratios in the opposite direction. Because precise documentation of these opposing forces is missing, even the sign of how household indebtedness responds to monetary policy is an unsettled empirical question.

We therefore provide micro-level evidence on how strong the two aforementioned channels are and estimate how monetary policy shocks transmit to household indebtedness. We utilize administrative records covering the universe of Norwegian households over more than 20 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 the interpretation of our results, this is a setting with predominately adjustable interest rate debt contracts.

Our point of departure is the law of motion for a household's debt-to-income ratio, approximated by

$$\underbrace{\Delta b_{i,t+1}}_{\text{Change in debt-to-income}} \approx \overbrace{d_{i,t}}^{\text{Primary deficit}} + \underbrace{(r_{i,t} - g_{i,t} - \pi_t) b_{i,t}}_{\text{Fisher effects}}, \tag{1}$$

where $b_{i,t}$ is household i's debt-to-income ratio at the beginning of period t, g is real income growth, π is inflation, and r is the nominal interest rate. Our terminology here follows Mason and Jayadev (2014), who used this relationship to decompose the evolution of aggregate leverage among US households. The primary deficit $d_{i,t}$ captures net new borrowing while "*Fisher effects*" summarize the mechanical influence of interest rates, real income growth, and inflation on households' debt-to-income ratio.[1]

Our first contribution is to quantify the role of primary deficits and Fisher effects in accounting

[1] The joint effects of interest rates, real income growth, and inflation are named after Irving Fisher who emphasized them in his famous studies of the Great Depression (Fisher, 1933).

for the evolution of household indebtedness in the micro data. On average across households, we find that primary deficits have been more important than Fisher effects for debt-to-income growth over our sample period. Among the Fisher variables, income growth contributed the most.

Equation (1) implies that Fisher effects are likely to be more important for households who are heavily indebted. We therefore sort households by their debt-to-income ratio at the start of each year. This sorting reveals that primary deficits explain nearly all the annual changes in debt-to-income ratios among the 60 percent of households with lowest debt levels, whereas Fisher effects are sizeable among households with high initial debt levels. Hence, Fisher effects are most influential for those households who are typically believed to be most vulnerable to macroeconomic recessions, namely the most indebted ones. This variation across the debt distribution partly reflects the mechanical logic of equation (1), but it is also due to the fact that households with high debt tend to have high income growth.

In the second part of our study, we estimate how changes in monetary policy affect households' debt-to-income ratios through primary deficits and Fisher effects. We here 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, we find that primary deficits fall after interest rates go up. Fisher effects pull in the opposite direction, but their responses are weaker than those through primary deficits. Hence, on average tighter monetary policy reduces the debt-to-income ratio moderately in the short run, but after five years these effects have died out and there is no discernible effect on the household debt-to-income ratio.

As expected from equation (1), responses via Fisher effects are larger for households with higher debt-to-income ratios. But more surprisingly, the same holds for primary deficits. In all debt-to-income quintiles, primary deficits fall more than Fisher effects increase after interest rate hikes. Hence, the responses of household indebtedness to monetary policy shocks are negative throughout the debt-to-income distribution.

In a final exercise, we explore the role of unemployment risk. By dividing the population into households with low (below median) and high (above median) predicted unemployment risk, we show that among highly-indebted households, the negative response of debt-to-income to an interest rate increase is primarily driven by households with low (less than median) unemployment risk. Among highly-indebted households with high unemployment risk, on the other hand, there is no discernible effect of monetary policy shocks on debt-to-income levels. Hence, while our findings align with the conventional view that interest rate hikes lower average debt-to-income ratios, monetary policy seems to be a blunt tool for stabilizing debt-to-income ratios among the households who arguably are the main concern for financial stability, namely those who are both highly indebted and highly exposed to unemployment risk.

Our estimates are informative for attempts to evaluate leaning-against-the-wind policies in economic models. Here Gelain et al. (2017) and Svensson (2017) argue that it makes little sense to target households' indebtedness because debt levels are mainly tied to housing, primary deficits tend to follow predetermined amortization plans, and hence monetary policy mainly affects debt-to-income ratios through Fisher effects. Our findings go somewhat against this logic. Although long-term debt contracts might limit the influence of monetary policy on household debt, primary deficits do respond to monetary policy. And since income responses are delayed and relatively small, these primary deficit 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 shape the influence of monetary policy more generally (Eichenbaum, Rebelo, and Wong, 2018; Beraja, Fuster, Hurst, and Vavra, 2018; Berger, Milbradt, Tourre, and Vavra, 2018; Wong, 2019; Kinnerud, 2021). Similarly, 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). Hopefully our study proves useful to this research agenda too, as we provide micro-level estimates that can inform models of how monetary policy affects household debt-to-income ratios in an adjustable interest rate environment.

Existing evidence on household debt dynamics primarily stems from macro data. Mason and Jayadev (2014) propose and apply the decomposition framework that we use. They show that much of the historical variation (from 1929 to 2011) in the US household debt-to-income ratio is explained by Fisher effects rather than primary deficits. 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). They find somewhat conflicting results, but overall it seems that household debt is moderately reduced by interest hikes while the response of debt-to-income is ambiguous.[2] Relative to this literature, our contribution is to use detailed micro-level data and estimate the effects of monetary policy through primary deficits and Fisher effects separately, across the entire debt-to-income distribution. We believe this approach adds value because it allows us to isolate the households with high debt and high unemployment risk households who arguably are the important subset of the population for financial stability questions.

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

2 Data

Our study aims to isolate the importance of each component in the law of motion for households' debt-to-income ratio b,

$$b_{i,t+1} = d_{i,t} + \frac{1 + r_{i,t}}{1 + g_{i,t} + \pi_t} b_{i,t}, \tag{2}$$

or in first-differenced form

$$\Delta b_{i,t+1} = b_{i,t+1} - b_{i,t} = d_{i,t} + \frac{r_{i,t} - g_{i,t} - \pi_t}{1 + g_{i,t} + \pi_t} b_{i,t}. \tag{3}$$

Here d is primary deficit divided by income, r is the nominal interest rate, g is income growth and π is inflation. The subscripts i and t denote household and time period, respectively. Note the timing convention, where $b_{i,t}$ is the ratio of debt at the beginning of year t relative to income obtained over the course of year t.

Equations (2) and (3) are commonly applied in assessments of public debt (see, e.g., Hall and Sargent, 2011), but less so for private debt. For household debt, the decomposition has to our knowledge only been utilized by Mason and Jayadev (2014). Our study differs as we will zoom in at the individual household level, reflected by the subscript i in equation (2). Hence, our approach requires panel data on each household's debt, primary deficits, income, and average interest rate on outstanding debt. The inflation rate is common for all.

We utilize data from Norwegian administrative registers. Because Norway taxes both wealth and income, tax registry data provide a precise account of yearly 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 are thus of particularly high quality. All assets and liabilities are reported at the end of the year, 31 December. This means that for each household 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).

Variable definitions. We construct each component in (2) as follows. The debt-to-income ratio $b_{i,t}$ is constructed by dividing outstanding debt at the beginning of the year t, $D_{i,t}$ defined as the stock of debt on 31 December in year $t-1$, by disposable income received over the year t. Debt includes all outstanding liabilities including home mortgages, car loans, and credit card debt. Disposable income $Y_{i,t}$ consists of the sum of labor income, transfers, interest income and dividends, minus taxes and interest expenses.

We directly observe each household's yearly interest expenses. To obtain household i's interest *rate* on debt, $r_{i,t}$, we combine these directly observed interest expenses with beginning and end-of-year outstanding debt, $D_{i,t}$ and $D_{i,t+1}$, and compute

$$r_{i,t} = \frac{Interest\ Expenses_{i,t}}{(D_{i,t} + D_{i,t+1})/2}.$$

The numerator reflects that we do not observe when during the year debt is accumulated, and therefore apply an approximation. The approximating assumption is that debt is uniformly accumulated across the year.

As explained in the introduction, we summarize the mechanical contributions from interest rates, real income growth, and inflation to changes in households' debt-to-income ratio as Fisher effects, $F_{i,t}$. From equation (3), these effects are

$$F_{i,t} = \frac{r_{i,t} - g_{i,t} - \pi_t}{1 + g_{i,t} + \pi_t} b_{i,t},$$

where real income growth, $g_{i,t}$, is measured as the growth rate of disposable income adjusted for inflation. The inflation rate, π_t, is measured as the growth rate of the consumer price index. Each household's primary deficit, $d_{i,t}$, is thereafter residually determined from (3).

In a final exercise we will distinguish households by their likelihood of becoming unemployed. To that end, we compute the predicted job separation rate at the individual level using a probit regression of a dummy for receiving unemployment insurance the next year on a full set of time, age, and industry dummies, and a second-order polynomial in tenure. Our sample for computing the predicted unemployment rate is restricted to the working age population (24-62 years) that currently holds a job.

Sample selection. From the universe of households we restrict our analysis to households with adult members of age 24 or older. In addition, we drop extreme observations in debt and income (top 1%), households with a debt-to-income ratio above 10, households with extreme changes in debt-to-income (top/bottom 1%), and households with extreme values of implied interest rates and real income growth rates (top/bottom 5%).

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 about 194, meaning that households hold about 94% more debt than income. During our sample period, households tended to increase this ratio, as seen from the positive primary deficit. The Fisher effects are close to zero, reflecting that on average across time and households, the real interest rate has been close to the real income growth rate.

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 leveraged households tend to be younger and have more formal education. Their high debt-to-income ratio is due to a particularly high debt level, while their income is almost at the same level as the population average. Given that they

Variable	All	Debt-to-income Quintiles 1	2	3	4	5
Age	49.50	55.86	52.72	49.82	46.24	42.88
Less than high school education	0.28	0.38	0.33	0.26	0.23	0.22
High school education	0.38	0.37	0.39	0.39	0.39	0.38
College education	0.33	0.25	0.28	0.35	0.38	0.40
Debt-to-income b in %	193.93	32.93	72.14	147.29	251.31	465.98
Debt D (USD 1,000)	123.25	18.45	45.34	103.23	180.62	268.60
Income Y (USD 1,000)	63.92	57.36	62.23	69.10	70.75	60.14
Change in debt-to-income Δb	2.68	24.32	12.66	6.56	-2.05	-28.11
Primary deficit d	2.72	24.06	11.27	4.61	-4.35	-21.99
Fisher effects F	-0.04	0.26	1.40	1.95	2.30	-6.13
Interest rate r	0.05	0.05	0.05	0.05	0.05	0.05
Real income growth g	0.04	0.02	0.03	0.04	0.04	0.07
Inflation π	0.02	0.02	0.02	0.02	0.02	0.02
Predicted job separation rate in %	5.80	5.88	5.65	5.48	5.67	6.27
Observations	24,908,303	4,972,981	4,982,846	4,984,475	4,984,080	4,983,921

Notes: The table presents means of each variable across all individual-year observations and within debt-to-income quintiles. Debt and income are denoted in 2011 USD.

Table 1: Summary Statistics, 1994–2015.

are young and income tends to increase with age, it follows that they have high income relative to their age.[3] Second, the most indebted households face higher unemployment risk, suggesting that at least part of these highly-leveraged households face high unemployment risk and are especially vulnerable to adverse shocks. Third, the highly leveraged households also tend to have higher real income growth $g_{i,t}$, which is known to correlate with being younger and having higher education (see, e.g., Blundell, Graber, and Mogstad, 2015). A consequence of the high real income growth is that Fisher effects are negative among highly indebted households because their income growth is higher than their real interest rate. In all the other debt-to-income quintiles, the Fisher effects are positive. We dissect the contributions from primary deficits and Fisher effects in Section 3.

Institutional setting. Almost all debt in our data is mortgage loans linked to home ownership. Around 80% of Norwegian households own a house in our sample period. The typical mortgage contract in Norway is a 25-year annuity loan with an adjustable interest rate.[4] Interest rate adjustments typically happen within weeks following a change in the policy rate by the central

[3]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.

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

bank.

Monetary policy has been conducted under a flexible inflation targeting regime since the late 1990s. Norges Bank had an inflation target of 2.5% in our sample period and at the same time sought to minimize deviations of output from potential output. Following the 2007-2008 global financial crisis, Norges Bank has emphasized financial stability as well as output and inflation targets.[5]

3 Historical Decomposition of Debt-to-income Movements

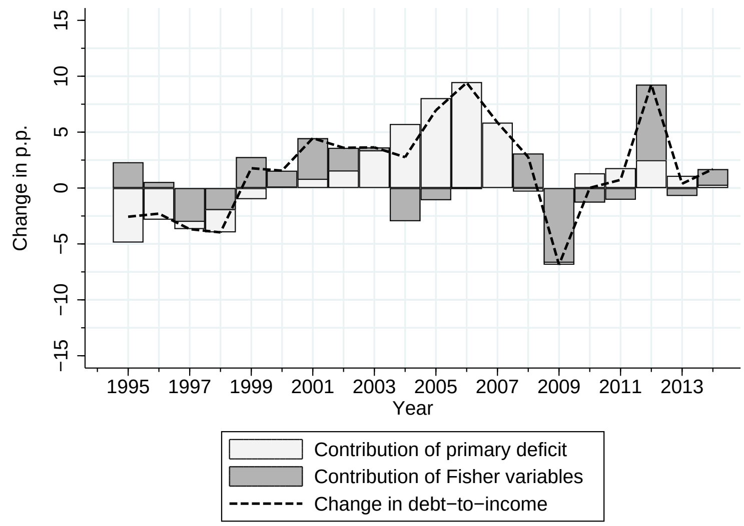
In this section, we dissect the annual growth in debt-to-income ratios over our sample period. This decomposition is based on equation (3), which is an accounting identity that holds exactly by construction. Up to a first order, it can in turn be approximated by (1) in the introduction, which allows us to further distinguish the three different components of the Fisher effects from each other.[6]

Figure 1 decomposes the average debt-to-income growth across all households in each year in our sample period. In panel (a), the dashed curve displays each year's debt-to-income change, the dark bars show the contributions from the Fisher effects and the light grey bars show the contributions from primary deficits. The two bars sum up to the debt-to-income line. We see that both primary deficits and Fisher effects have been important for debt-to-income growth. There are several periods where the two forces pull in opposite directions, for instance around 2010 where they almost cancel each other out. In most years, primary deficits have contributed toward higher debt-to-income growth, whereas the direction of the Fisher effects has alternated.

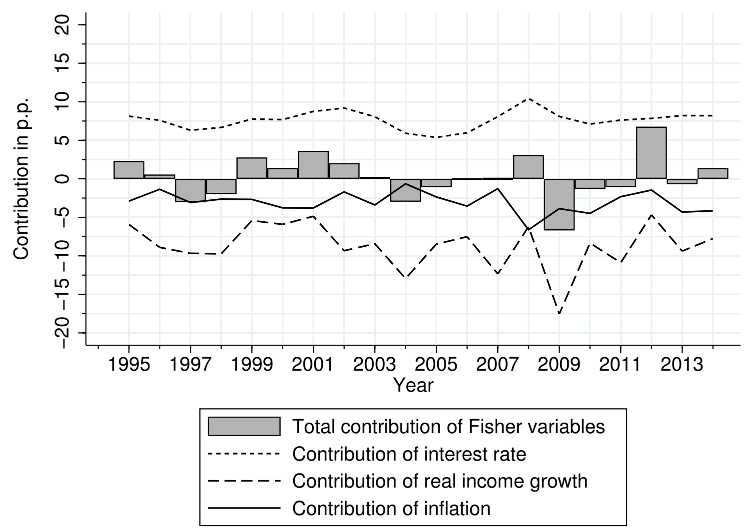
Panel (b) decomposes the Fisher effects further, using the linear approximation in (1) to attribute each year's total Fisher effect (dark gray bars) to contributions from interest rates (dotted line), real income growth (dashed line), and inflation (solid line). Because real income growth and inflation have been positive every year, they have always contributed to lower debt-to-income growth and therefore consistently lie in the negative region of the plot. Likewise, positive interest rates necessarily lift debt-to-income growth up, and hence lie in the positive region of the plot. The interest rate contribution is stable, reflecting that on the one hand interest rates have fallen over the period, while on the other hand household indebtedness has increased. The take-away from panel (b) is that income growth is the most important component of the Fisher effects. In the years where Fisher effects have been particularly forceful in pulling debt-to-income growth down, it is because income growth has been particularly high. When the Fisher effects have been positive, it is because income growth has been particularly low.

[5]The financial stability target was formalized in March 2018, when the formulation "counteract the build-up of financial imbalances" was included in the central bank's mandate.

[6]Because this exercise relies on an approximation, there will be an approximation error. As shown in Figure A.1 in the Appendix A.1, this error term is small and stable over time.



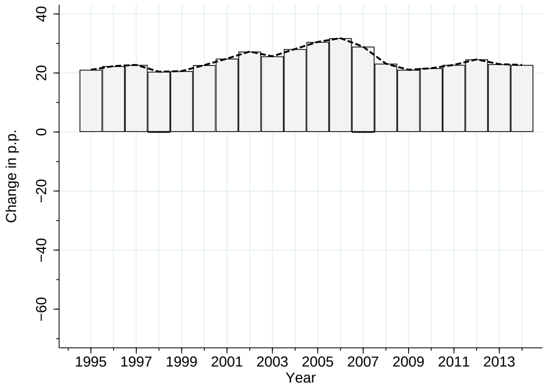
(a) Historical decomposition of debt-to-income



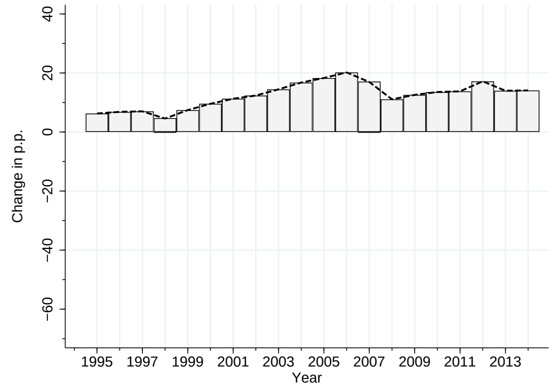
(b) Historical decomposition of Fisher effects

Notes: Figure (a) plots the sample average of change in debt-to-income, and the contribution from primary deficit and Fisher variables as defined in (1). Total Fisher variable contributions are calculated from the exact formula in both figures (a) and (b). In figure (a) the primary deficits are calculated residually as the difference between change in debt-to-income and Fisher variable contribution. In figure (b) the individual contributions from interest rate, income growth and inflation is calculated from the approximation of (1).

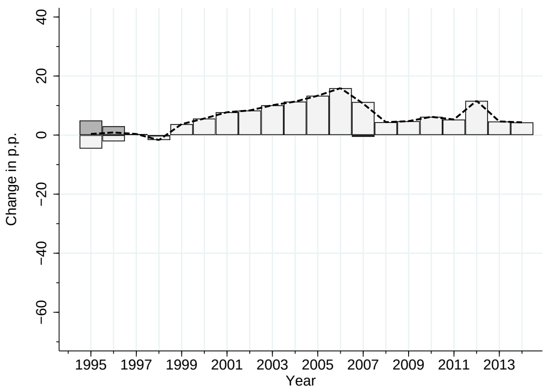
Figure 1: Historical decomposition of debt-to-income changes and Fisher effects.



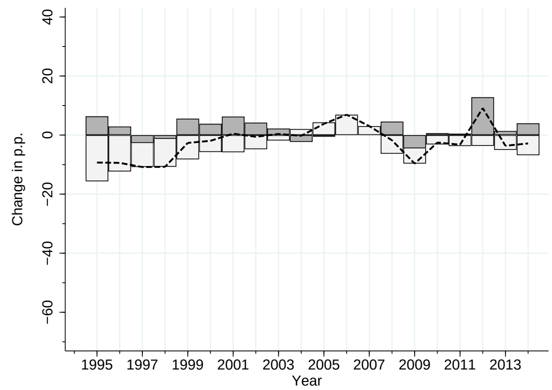
(a) Quintile 1



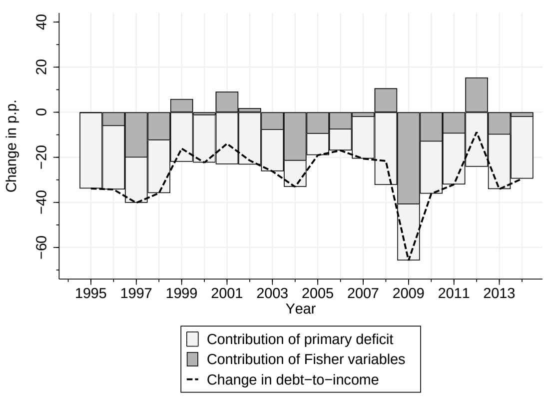
(b) Quintile 2



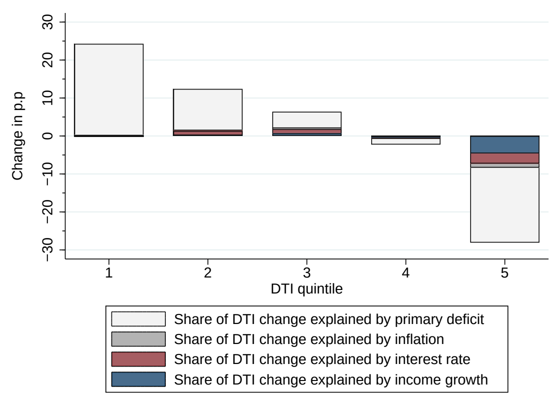
(c) Quintile 3



(d) Quintile 4



(e) Quintile 5



(f) Summary

Notes: See note to Figure 1 for figures (a)-(e). The hight of bars in (f) measures the average change in debt-to-income ratios within each debt-to-income quintile, across all sample years.

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

Fisher effects work through households' pre-existing stocks of debt. Hence, they are more important for highly indebted households, who notably constitute a group of primary interest in questions about financial stability. 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 this growth is almost entirely accounted for by primary deficits. Hence, the Fisher effects we previously observed in the aggregate, do not stem from the low-indebted households. Panel (d) shows how the fourth debt-to-income quintile is a middle ground, where debt-to-income growth is moderate, fluctuates around zero, and is driven both by primary deficits and Fisher effects. Panel (e) shows that highly indebted households tend to reduce their debt burden every year through negative primary deficits, i.e., debt repayment. The Fisher effects have contributed in the same direction due to high income growth in this group, as we saw in Table 1. By comparing Figure 2(e) to Figure 1(a), we conclude that the average Fisher effects are largely driven by the highly indebted households.

Panel (f) in Figure 2 collapses the time dimension and presents the relative contributions of Fisher effects and primary deficits across the debt-to-income distribution, on average over the sample period. The figure succinctly illustrates how Fisher effects have contributed to debt-to-income reduction among the most indebted households, but that primary deficits have been more important also in this subgroup.

These results illustrate the importance of focusing on distributions when trying to understand time variation in household indebtedness. In particular, while Fisher effects seem to be irrelevant for households with low debt burdens, they are more important for the most indebted households. In the next section, we therefore explore how monetary policy affects primary deficits, Fisher effects and debt-to-income ratios in different parts of the debt-to-income distribution.

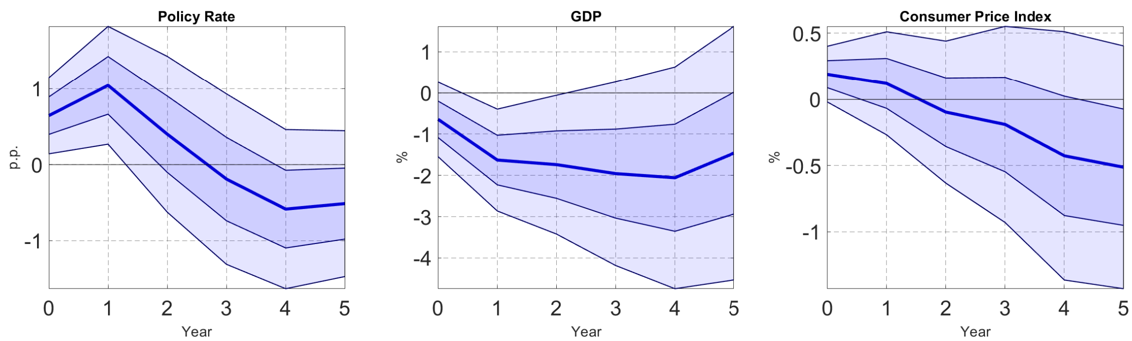
4 Monetary Policy Shocks and Household Indebtedness

Our approach in this section uses local projections (Jordà, 2005) to trace out the response of debt-to-income ratios, primary deficits and Fisher effects to monetary policy shocks. Monetary policy shocks are identified with a narrative approach following Romer and Romer (2004), using real-time forecasts by Norges Bank and are taken from Holm et al. (2021). Figure 3(a) displays the estimated effects on the policy rate, GDP, and the consumer price index. We see that the shocks have persistent effects on the policy rate, and that prices and aggregate activity respond in a conventional manner.

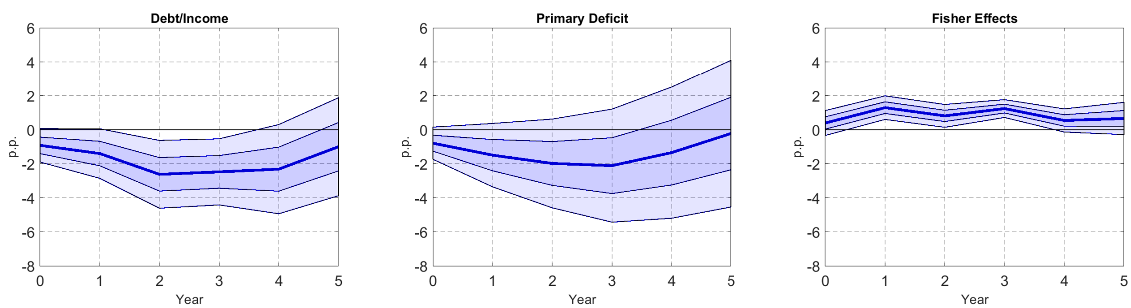
We first examine how the average household responds to monetary policy. For household i and year t, we estimate the equation

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

where y_i is the outcome variable of interest, h is the horizon after the shock occurred, δ_i^j is a household fixed effect, ϵ_t^{MP} is the monetary policy shock in year t, $\mathbf{X}$ is a set of controls, and $u_{i,t}^h$ is the error term. In our preferred specification we include two lags of the right-hand side variables and three lags of monetary policy.[7]



(a) Macro Responses



(b) Average Debt-to-income Responses in Micro Data

Notes: Impulse responses to a 1 percentage point contractionary monetary policy shock. 95 and 68 percent confidence bands shown, computed using Driscoll and Kraay (1998) standard errors.

Figure 3: Impulse responses to monetary policy.

Figure 3(b) shows the responses of the debt-to-income ratio (b_t), the primary deficit (d_t), and Fisher effects $\left(\frac{r_{i,t}-g_{i,t}-\pi_t}{1+g_{i,t}+\pi_t} b_{i,t}\right)$ to a 1 percentage point increase in the interest rate. The average debt-to-income response to a monetary tightening is negative. This response is driven by a fall in primary deficits. Fisher effects move in the opposite direction, in line with the arguments put forth in the debate on monetary policy. That is, tighter monetary policy tends to raise interest rates, reduce income growth, and reduce inflation, which together contribute to increase the debt-to-income ratio. However, these effects are dominated by the negative response of primary deficits. For completeness, we also present the impulse responses of debt and income as an alternative

[7] We show in Appendix A.2 that our results are insensitive to excluding years after the financial crisis where financial stability concerns entered the central bank interest rate decision informally.

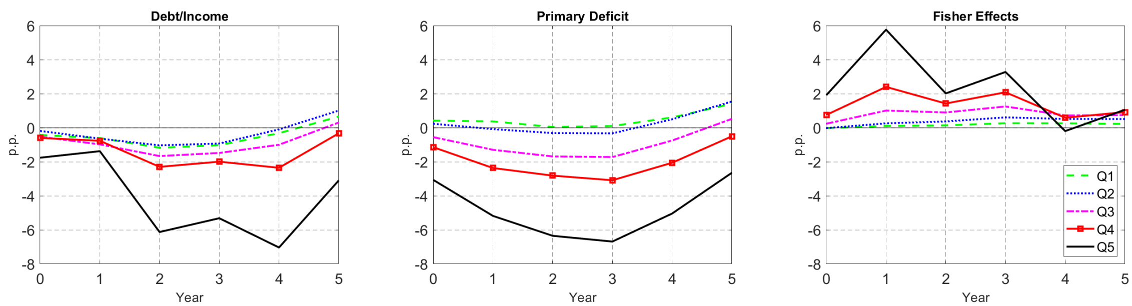
decomposition in Figure A.2 in Appendix A.2. Debt responds similarly to the primary deficit response. Income is less affected in the short-term and declines significantly only after year 3.

Note that the debt-to-income response to monetary policy is small and relatively short-lived. The maximum response after 2-3 years is slightly below 3 percentage points, implying that the debt-to-income ratio declines from an average of about 194% to around 191%. After five years, the debt-to-income reduction is around 1 percentage point and statistically insignificant.

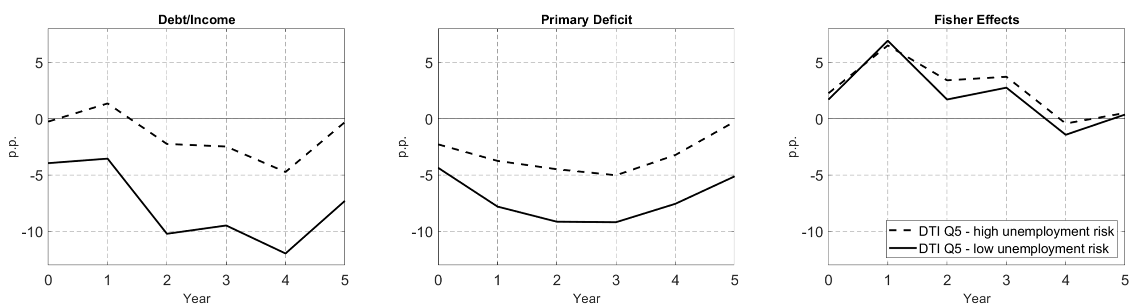
Next, we explore how the responses to monetary policy shocks vary across the debt-to-income distribution. To this end, we estimate a version of (4), but within groups g. The specification we use is

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

where the responses to monetary policy shocks are allowed to differ between debt-to-income groups g. All variables are defined as in (4) above. Figure 4(a) displays impulse responses of debt-to-income, primary deficits, and Fisher effects along quintiles of the debt-to-income distribution in the year before the monetary policy shock occurred. Confidence bands are displayed in Figure A.4.



(a) Average Debt-to-income Responses by DTI Quintiles



(b) Average Debt-to-income Responses in Quintile 5 of the DTI Distribution by Unemployment Risk

Notes: Impulse responses to a 1 percentage point contractionary monetary policy shock.

Figure 4: Impulse responses to monetary policy by DTI quintiles and unemployment risk.

The upshot is that debt-to-income ratios respond negatively to tighter monetary policy within all sub-groups. To the right we see that transmission through Fisher effects scale with initial indebtedness. This is not surprising, given our decomposition results in Section 3 and the mechanics of equation (3). More surprisingly, the same applies to primary deficits which fall more strongly the higher is initial indebtedness. Hence, even though Fisher effects respond relatively strongly in the top debt-to-income quintile, their debt-to-income ratio falls because their primary deficits drop even more than the Fisher effects increase.

The policy concern for high debt-to-income ratios is rooted in the fear that it makes households vulnerable to sudden income drops, in particular unemployment. We therefore zoom in on the households who are both highly indebted and have high unemployment risk. The latter we obtain from the probabilistic regression model explained in Section 2, where unemployment is regressed on predetermined characteristics.

In Figure 4(b), we explore the responses among the most indebted households, stratified by whether their predicted unemployment risk is above or below the median (5.2%). We find that both high and low risk households with high debt levels respond to higher interest rates by reducing their primary deficits. However, the primary deficits of households with low unemployment risk is about twice as responsive to monetary policy. The result in Figure 4(a) that highly-leveraged households on average reduce their debt-to-income ratio is therefore driven mainly by highly-leveraged households with low unemployment risk. Instead, among households with high debt levels and high unemployment risk where it is likely that risks to financial stability are concentrated, monetary policy has almost no discernible effect on the debt-to-income ratios.[8]

In Appendix A.2, we present extensions and robustness exercises for our results on the monetary transmission to household indebtedness. An argument that has been emphasized in the policy debates, is that debt is likely to be insensitive to monetary policy because households mostly adjust their debt in relation to housing transactions, which are infrequent. To see whether this argument is important, we distinguish between households who move and households who stay at their existing address within each year. Figure A.7 shows that within both groups, debt-to-income ratios decline in response to monetary policy shocks. Accordingly, the margin of mover vs. stayer does not seem to be important for understanding how households adjust debt in response to monetary policy. Another exercise is designed to address whether our results are driven by the central bank's concerns for debt after the financial crisis. Figure A.8 shows that we find similar results when excluding the years after the financial crisis.

[8]Figure A.5 in Appendix A.2 illustrates that the average debt-to-income response of the highly-indebted with high unemployment risk is statistically insignificant.

5 Conclusions

With precise micro data, we have documented how households' debt burdens are driven by primary deficits and Fisher effects. Our central finding is that while Fisher effects are important for yearly changes in debt-to-income ratios among indebted households, monetary policy shocks work mainly through primary deficits. Hence, interest hikes lead to lower debt-to-income ratios at the household level.

However, we find no effect on the debt-to-income levels of households who are both highly indebted and have high unemployment risk. This suggests that for the objective of preventing financial stability risks from building up in the most vulnerable segments of the population, one should not expect too much from monetary policy.

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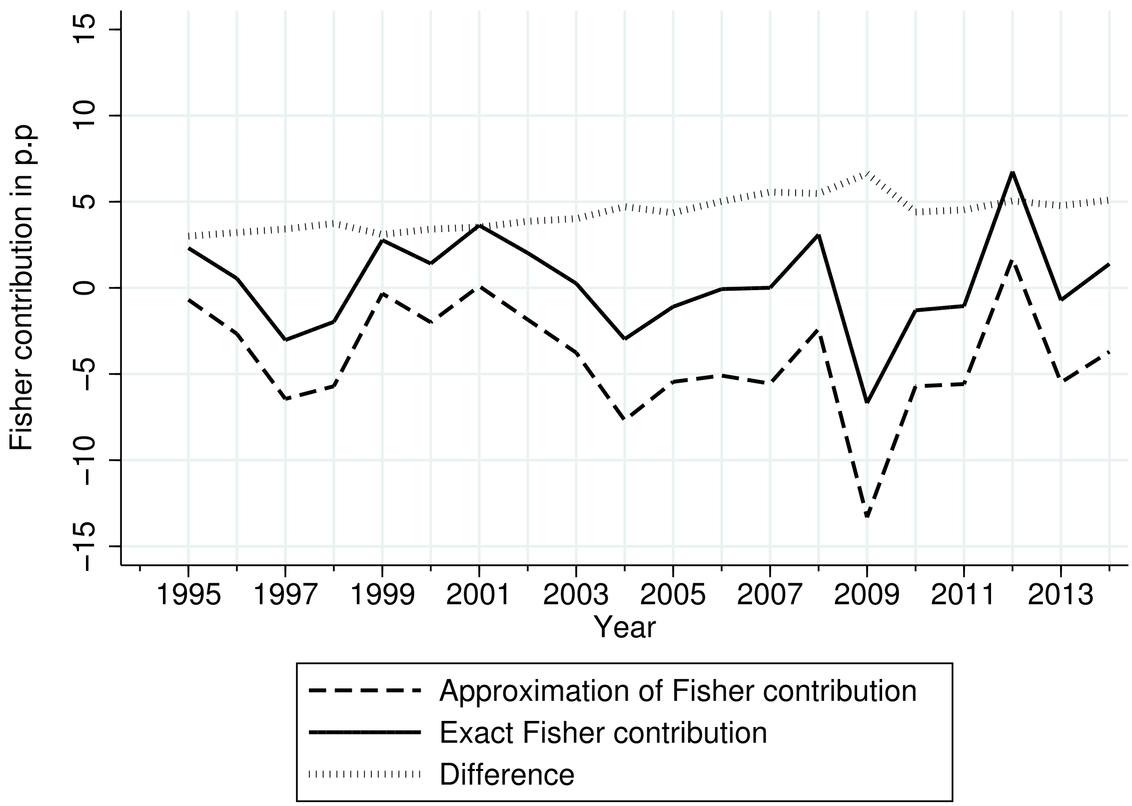
A Online Appendix

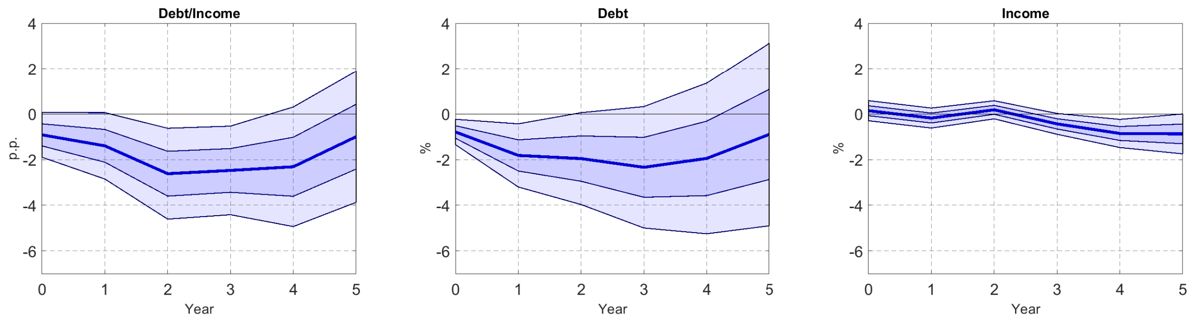
A.1 Approximation Error in Linearized Decomposition Exercise



Notes: The figure plots total Fisher contribution as calculated from the exact formula as in Equation 1 (solid line), the approximate version used to decompose into individual contribution as displayed in Figure A.1 (dashed line), and the difference between the two (dotted line).

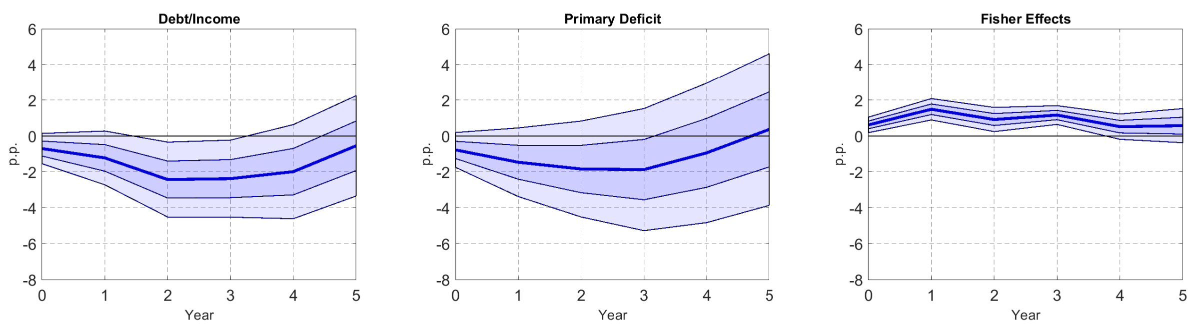
Figure A.1: Exact versus approximate Fisher effects.

A.2 Additional Monetary Policy Responses



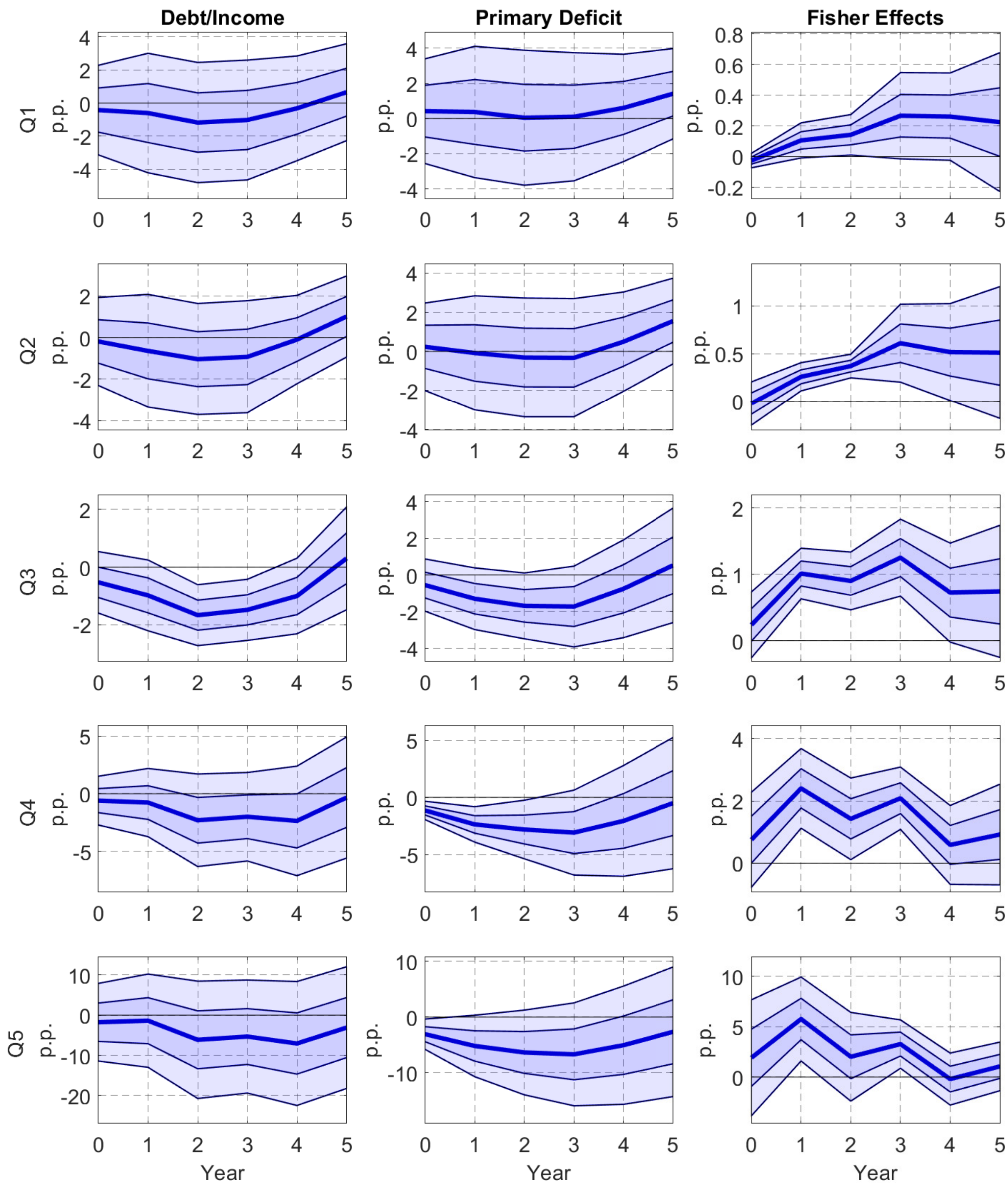
Notes: Impulse responses to a 1 percentage point contractionary monetary policy shock. 95 and 68 percent confidence bands shown, computed using Driscoll and Kraay (1998) standard errors. Movers are defined as those who move in period t.

Figure A.2: Average debt-to-income responses to monetary policy.



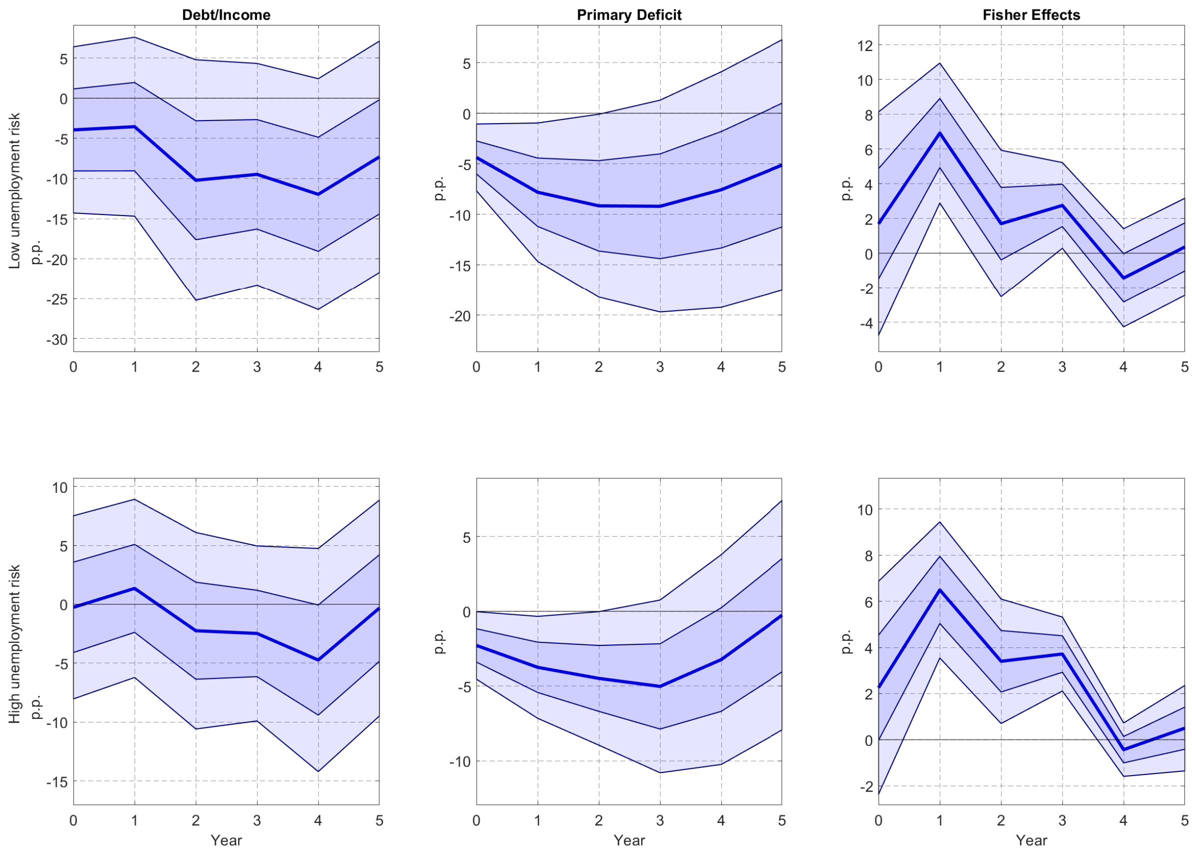
Notes: Impulse responses to a 1 percentage point contractionary monetary policy shock. 95 and 68 percent confidence bands shown, computed using Driscoll and Kraay (1998) standard errors. Movers are defined as those who move in period t.

Figure A.3: Average debt-to-income responses to monetary policy. Robustness to dropping years after 2008.



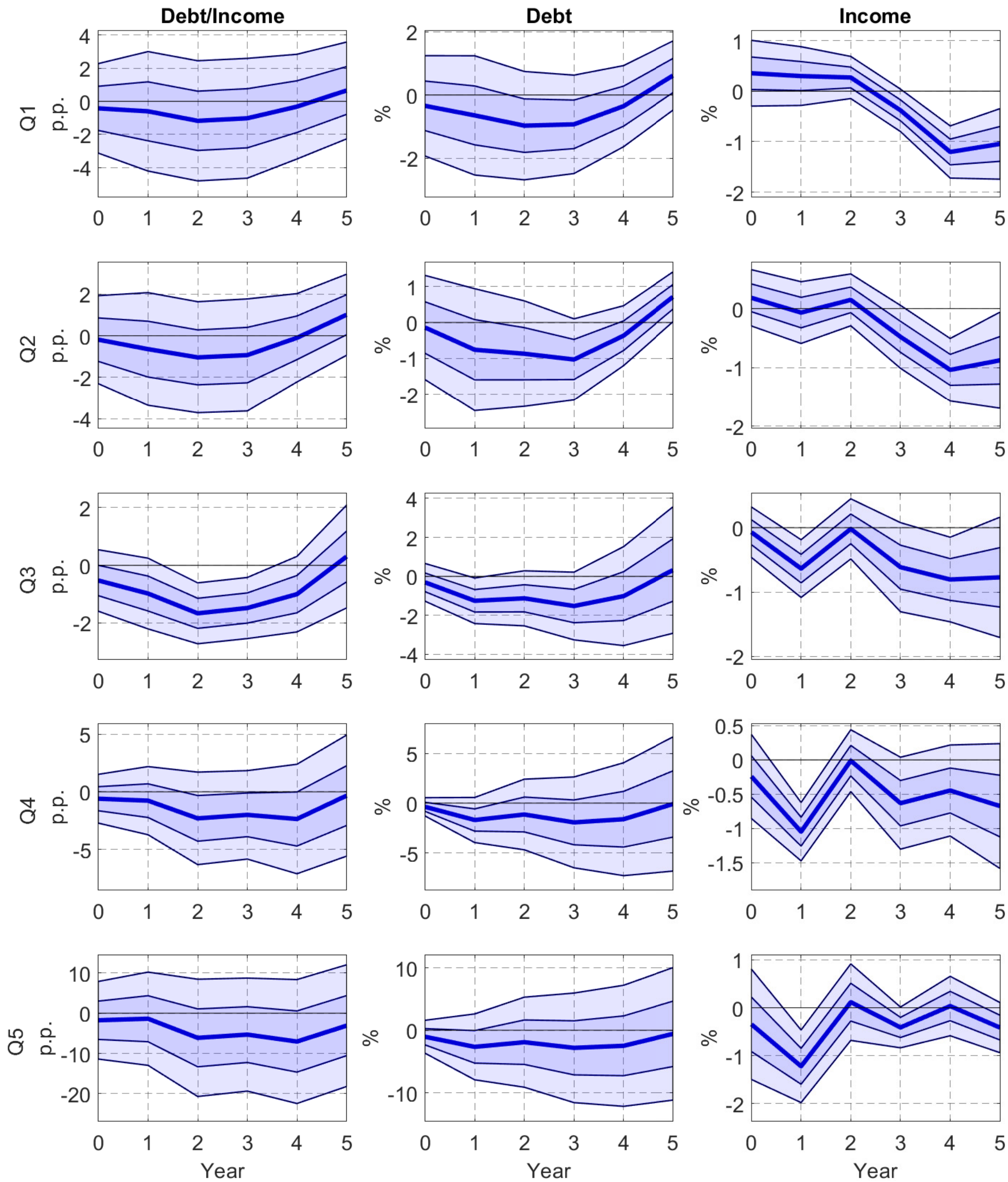
Notes: Impulse responses to a 1 percentage point contractionary monetary policy shock. 95 and 68 percent confidence bands shown, computed using Driscoll and Kraay (1998) standard errors.

Figure A.4: Debt-to-income responses to monetary policy by quintiles of debt-to-income in $t-1$.



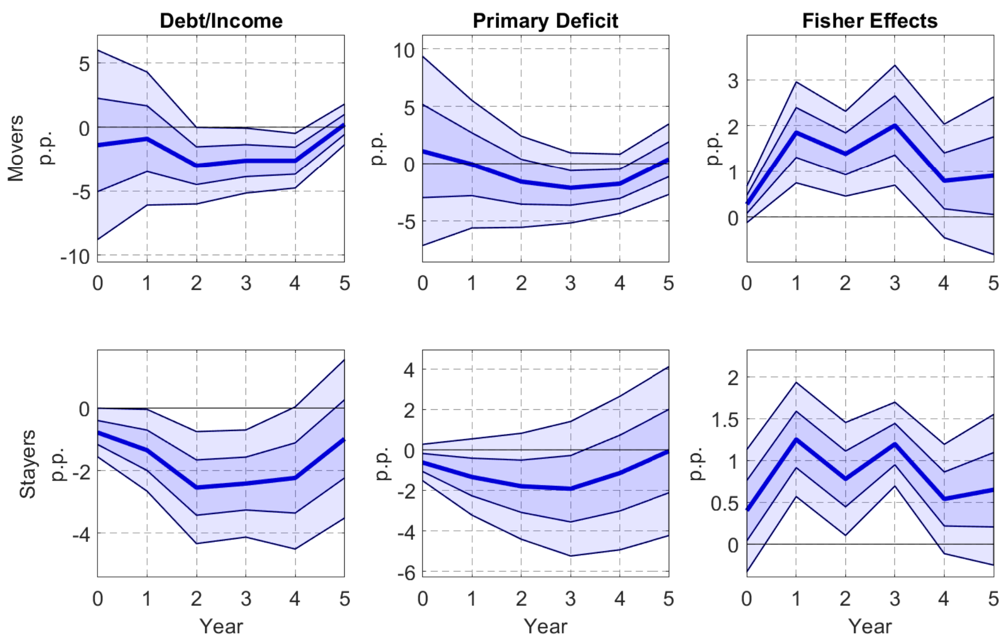
Notes: Impulse responses to a 1 percentage point contractionary monetary policy shock. 95 and 68 percent confidence bands shown, computed using Driscoll and Kraay (1998) standard errors.

Figure A.5: Debt-to-income responses to monetary policy in quintile 5 of the DTI distribution by unemployment risk.



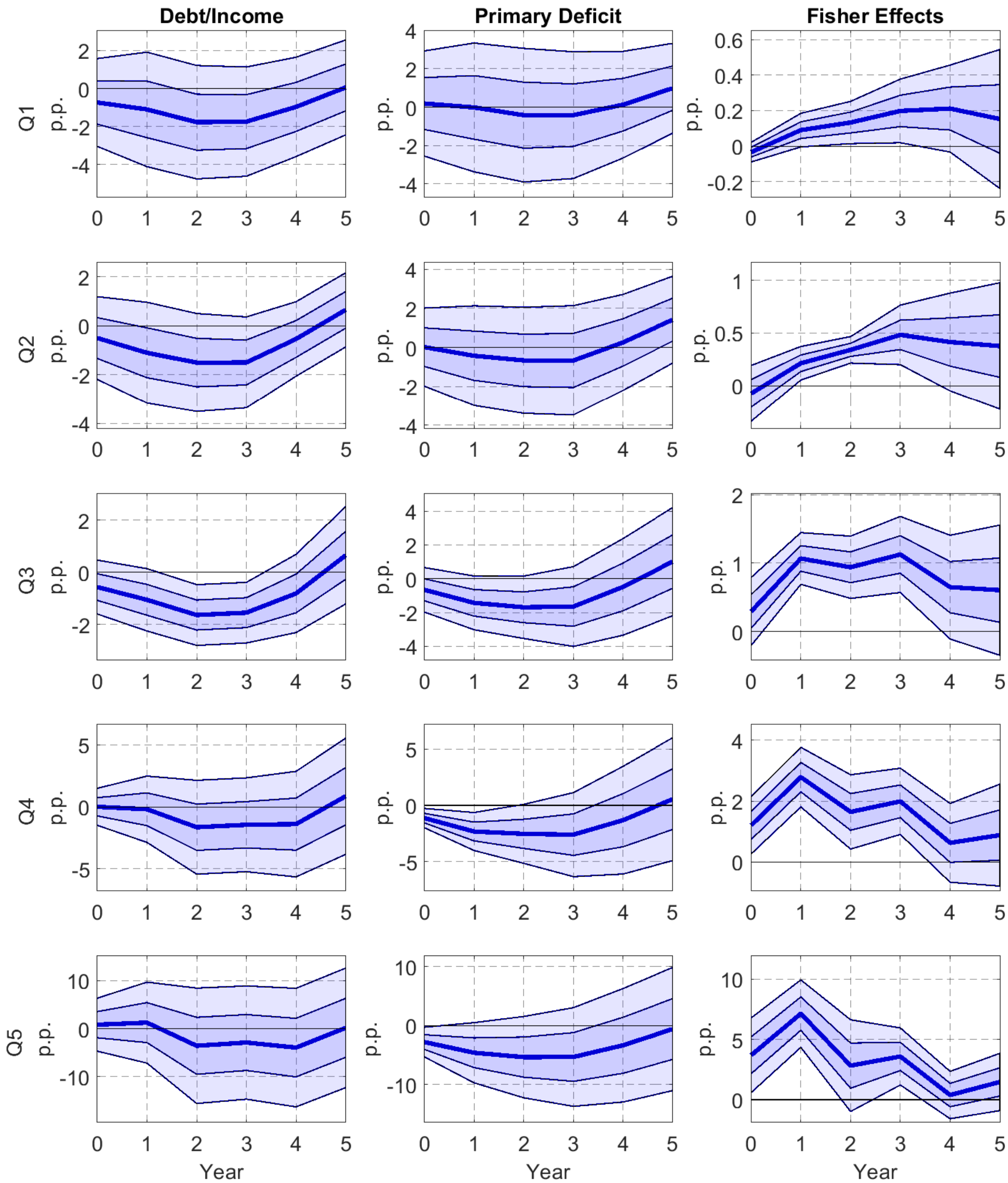
Notes: Impulse responses to a 1 percentage point contractionary monetary policy shock. 95 and 68 percent confidence bands shown, computed using Driscoll and Kraay (1998) standard errors. Movers are defined as those who move in period t.

Figure A.6: Debt-to-income responses to monetary policy by quintiles of debt-to-income in $t-1$.



Notes: Impulse responses to a 1 percentage point contractionary monetary policy shock. 95 and 68 percent confidence bands shown, computed using Driscoll and Kraay (1998) standard errors. Movers are defined as those who move in period *t*.

Figure A.7: Debt-to-income responses to monetary policy by movers and stayers.



Notes: Impulse responses to a 1 percentage point contractionary monetary policy shock. 95 and 68 percent confidence bands shown, computed using Driscoll and Kraay (1998) standard errors.

Figure A.8: Debt-to-income responses to monetary policy by quintiles of debt-to-income in $t-1$. Robustness to dropping years after 2008.