How Does Monetary Policy Affect Household Indebtedness?*

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Abstract

As a matter of accounting, households' debt-to-income ratios change due to primary deficits or "Fisher effects" from interest costs, income growth, and inflation. With micro data covering the universe of Norwegian households for more than 20 years, we decompose the importance of these channels for households' debt dynamics over time and for responses to monetary policy shocks. On aggregate, primary deficits account for approximately two thirds of changes in household debt-to-income ratios. Fisher effects are important only among highly leveraged households. After interest rate hikes, primary deficits and Fisher effects move in opposite directions as one would expect, but the former dominates so that debt-to-income ratios fall. This holds across household groups, even among those with the highest leverage. An upshot is that changes in borrowing and repayment behavior dominate the mechanical effects via nominal income growth in the transmission of monetary policy shocks to debt-to-income ratios.

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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 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 theoretical motivation behind macroprudential policies is based 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). Irrespective of the mechanism, households do not internalize these effects, and there is a role for policies that dampen debt accumulation in expansions. Farhi and Werning (2016) and Korinek and Simsek (2016) show that one should use precise macroprudential tools (e.g., debt-to-income or loan-to-value constraints) to this end. However, if the macroprudential tools are imperfect, the central bank can potentially use its interest rate policy to reduce debt build-up in expansions (Caballero and Simsek, 2020).

The question then becomes: how will interest rate policy affect household indebtedness? On the one hand, one may conjecture that tighter monetary policy will motivate households to borrow less, consistent with textbook intertemporal substitution effects. On the other hand, higher interest rates may cause lower income growth and weaker debtor cash flows to finance repayment. The latter will in turn pull household indebtedness up. Moreover, this second force is most potent for those households who initially are the most indebted and therefore are likely to be a main source of concern when it comes to financial stability. 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 provide micro-level evidence on how strong the abovementioned channels are and estimate how monetary policy shocks transmit to household indebtedness. We utilize administrative records covering the universe of Norwegian households over 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 the interpretation of our results, this is a setting where nearly all debt consists of mortgage loans with adjustable interest rates.

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

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

where $b_{i,t}$ is household i's debt-to-income ratio at the end of period t, g is real income growth, π is inflation, and r is the nominal interest rate. Our terminology 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.[1]

Our first contribution is to quantify the role of primary deficits and Fisher effects in accounting 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, real income growth contributed the most.

Equation (1) highlights that Fisher effects are likely to be more important for households with initially high debt. When we sort households by debt-to-income at the start of the year, we indeed find that primary deficits explain approximately all annual changes in debt-to-income among the 60 percent of households with the lowest debt levels. In contrast, Fisher effects are sizable among households with high initial debt levels, accounting for about half of the changes in their debt-to-income. This variation across the debt distribution partly reflects the mechanical logic of equation (1), as Fisher effects are weighted by initial indebtedness. Importantly though, it also reflects that households with high debt tend to have a higher real income growth.

Our second contribution is to estimate how changes in monetary policy affect households' debt-to-income ratios through primary deficits 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, we find that on average across households, 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 debt-to-income moderately in the short run.

More suprisingly, this pattern holds across a variety of household stratifications. In particular, it even holds for households with high intial debt-to-income ratios and therefore a high weight on Fisher effects in the accounting identity (1). It also holds for households with both high debt-to-income and high probabilities of job loss, a group likely to be financially vulnerable and thus of primary interest for financial stability considerations. An upshot is that behavior dominates the mechnical Fisher effects in the transmission of monetary policy shocks to household indebtedness

[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).

in Norway over this period.

Related Literature. Our estimates are informative to evaluate leaning-against-the-wind policies in economic models. For example, Gelain et al. (2017) and Svensson (2017) argue that it makes little sense to target households' indebtedness if debt levels are mainly tied to housing and follow predetermined amortization plans. The reason is, monetary policy mainly affects debt-to-income ratios through Fisher effects. Our evidence indicates that this logic might not be important in practice. Although long-term debt contracts might limit the influence of monetary policy on household debt, primary deficits do respond to monetary policy. Moreover, since nominal income responses to monetary policy 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, 2022; Beraja, Fuster, Hurst, and Vavra, 2018; Berger, Milbradt, Tourre, and Vavra, 2021; 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 by providing micro-level estimates to inform models 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 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 it seems that interest hikes moderately reduce household debt. At the same time, evidence on the macro-level response of debt-to-income is ambiguous.[2] Relative to this literature, our main contribution is to use detailed micro-level data and estimate the effects of monetary policy across the entire debt-to-income distribution, as well as parsing out other household groups. We believe this approach adds value because it isolates the households with high debt and high income risk who arguably represent a particularly relevant subset of the population for financial stability questions.

[2] A related study which focuses 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.

Roadmap. 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 Data

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

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

or in first-differenced form

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

Here d is the *primary deficit* divided by income, r is the *nominal interest rate*, g is *real 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 end 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 registries. Because Norway taxes both wealth and income, tax registry data provide a precise 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 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 (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).

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 end of the year t 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, $D_{i,t-1}$ and $D_{i,t}$, and compute

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

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 accumulated uniformly 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

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

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 individuals 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 industry dummies and a second-order polynomial in tenure. 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 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 high observations of debt or income (top 0.5%) because households sometimes experience extraordinarily high observed debt or high income due to particular events in our annual data, for instance if they are in the middle of a housing transaction where they buy a new house in one calendar year and sell their old house in the next year, or if they receive extraordinary bonus payments. Furthermore, we drop observations with income or implied spending less than the social security minimum, debt-to-income ratio above 10, large changes in debt-to-income (top/bottom 1%), and unreasonable values of implied interest rates or real income growth (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 154%. During our sample period, households increased this ratio, as seen from the positive average primary deficit. The average 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.

Variable	All	Debt-to-income Quintiles 1	2	3	4	5
Age	53.61	67.46	55.75	51.83	47.67	43.24
Less than high school education	0.33	0.50	0.38	0.30	0.24	0.22
High school education	0.37	0.33	0.37	0.39	0.39	0.38
College education	0.30	0.17	0.25	0.31	0.37	0.40
Debt-to-income b in %	153.67	8.14	32.34	96.79	207.24	428.32
Debt D (USD 1,000)	99.66	4.19	19.88	64.94	151.30	260.90
Income Y (USD 1,000)	60.12	43.70	60.01	65.30	71.57	63.06
Change in debt-to-income Δb	4.83	8.14	15.68	12.02	5.07	-15.35
Primary deficit d	5.00	8.14	15.22	10.55	3.21	-10.83
Fisher effects F	-0.16	0.00	0.46	1.46	1.87	-4.52
Interest rate r in %	5.21	5.34	4.86	5.35	5.21	5.20
Real income growth g in %	3.85	2.81	2.35	3.25	4.29	6.47
Inflation π in %	2.01	2.01	2.01	2.01	2.01	2.01
Predicted job separation rate in %	5.60	5.66	5.37	5.40	5.47	5.95
Observations	30,007,251	7,100,405	4,886,315	6,006,863	6,006,998	6,006,670

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. 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 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 slightly above the population average. Given that they are young and income tends to increase with age, they have high income relative to their age.[3] Second, the most indebted households face higher job separation risk, as predicted by sector of employment and tenure in their current job. Hence, some of the highly-leveraged households do seem financially vulnerable, in the sense that they might come in a position where they struggle to service their debt. Third, the highly leveraged 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 correlation with (young) age and 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

[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.

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. Around 80% of Norwegian households own a house in our sample period. Almost all (97%) debt in our sample is mortgage loans linked to home ownership. The typical mortgage contract in Norway is a 25-year loan with an adjustable interest rate.[4] The contract is typically an annuity contract in which the sum of debt repayment and interest costs is the same each month. Interest rate adjustments typically happen within weeks following a change in the policy rate by the central bank. When the interest rate changes, the monthly payments are also adjusted such that the sum of debt repayment and interest costs stays constant at a new level going forward.

Monetary policy has been conducted under a flexible inflation targeting regime since 2001. 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 its potential. Following the 2007-2008 global financial crisis, Norges Bank has emphasized financial stability as a separate concern in addition to inflation and output.[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. Our 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]

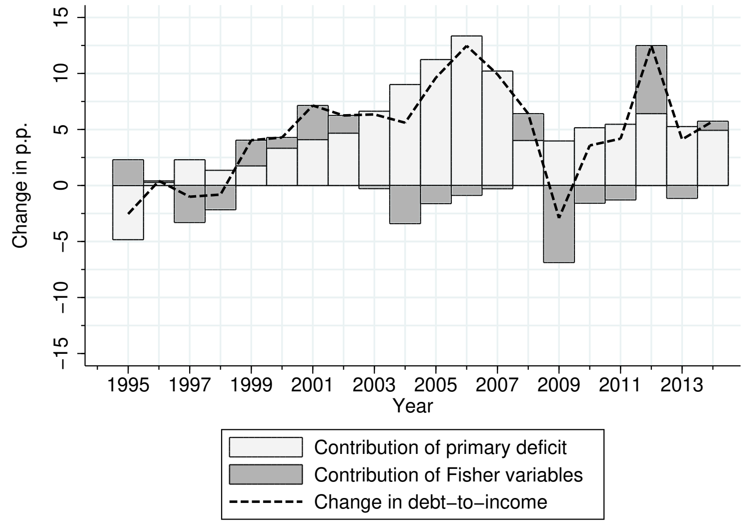
Figure 1 decomposes the average debt-to-income growth across all households in each year in our sample period. In panel (a), the dashed curve displays each year's debt-to-income change, the dark bars show the contributions from the Fisher effects and the light grey bars show the contributions from primary 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

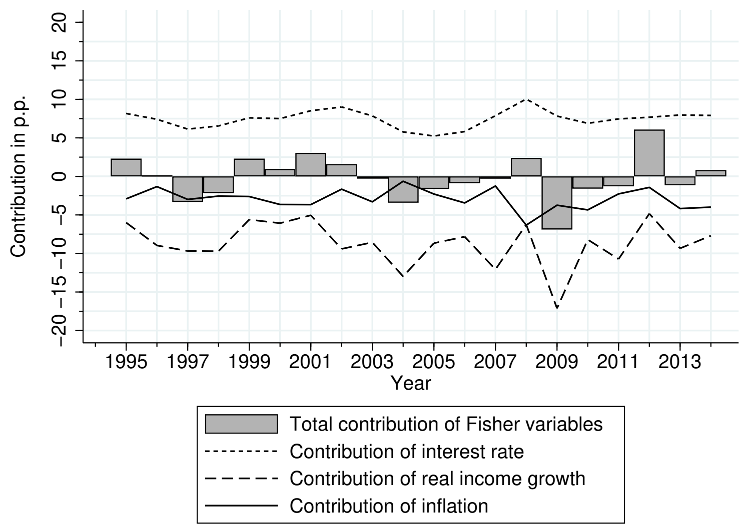
[4]More than 90 percent of all household debt has adjustable interest rates (Holm et al., 2021).

[5]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.

[6]Because this exercise relies on an approximation, there will be an approximation error. As shown in Figure A.2 in the Online Appendix, this error term is small and stable over time.



(a) Historical decomposition of debt-to-income



(b) Historical decomposition of Fisher effects

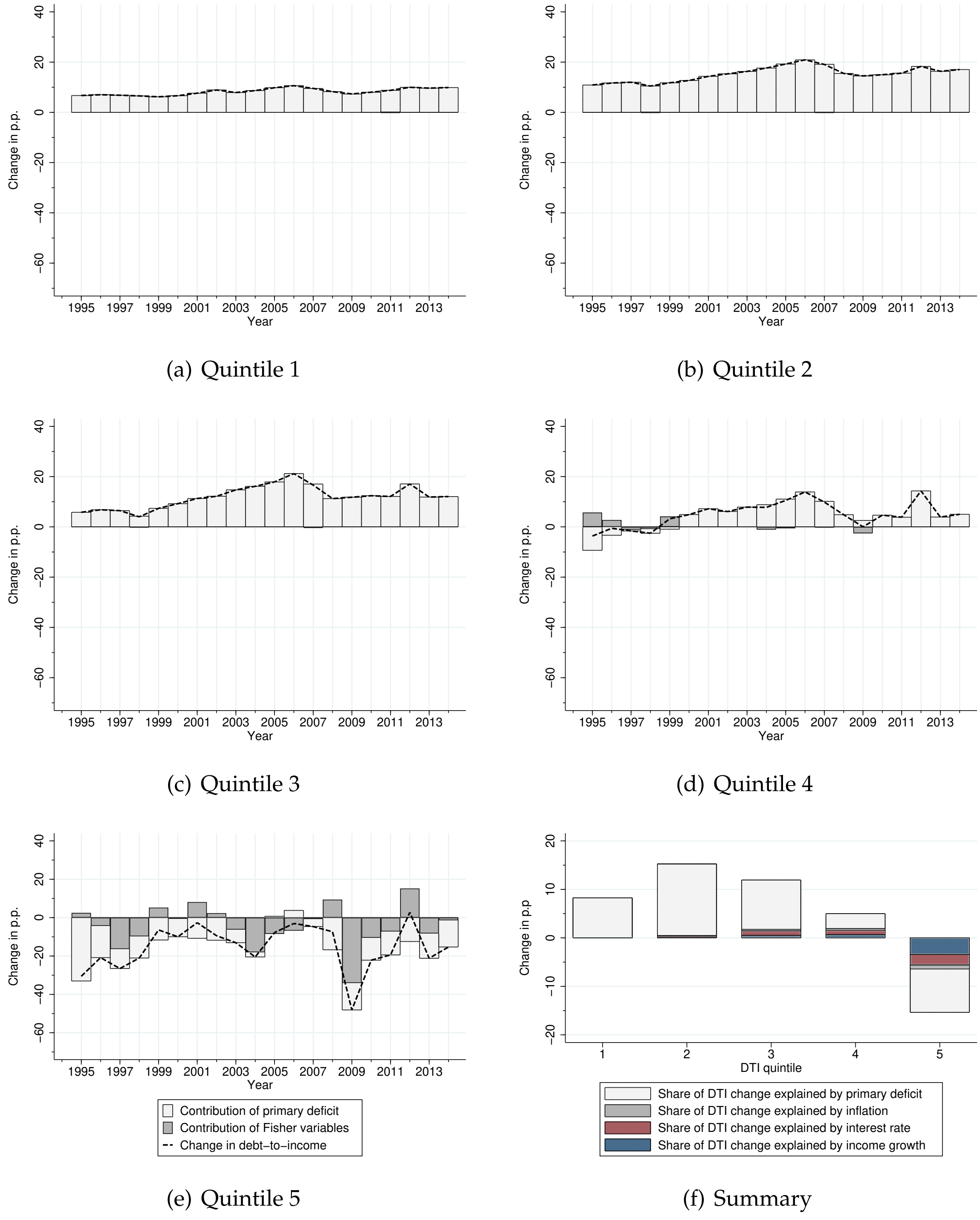
Notes: Figure (a) plots the sample average of change in debt-to-income, and the contribution from primary deficit and Fisher variables as defined in (1). Total Fisher variable contributions are calculated from the exact formula in both figures (a) and (b). In figure (a) the primary deficits are calculated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

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 behind 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.

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 households with low debt. 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.



(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 height 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 $t-1$.

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 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 important among the most indebted households. In the next section, we 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.

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

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

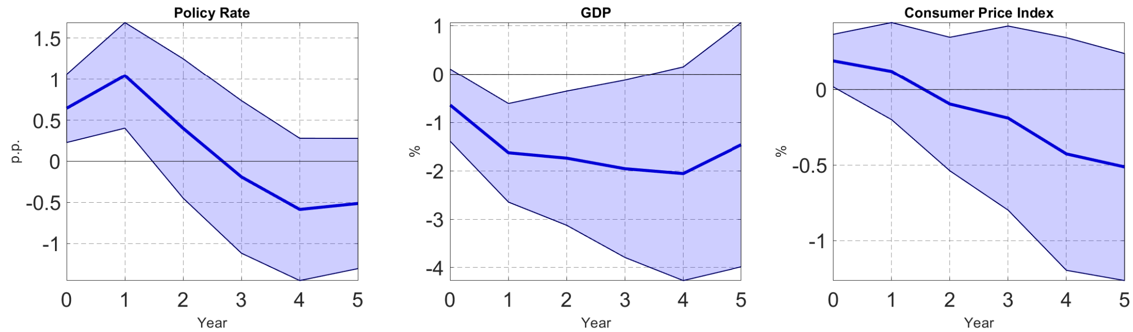
where y_i is the outcome variable of interest, h is the horizon after the shock occurred, δ_i^j is a household fixed effect, ϵ_t^{MP} is the monetary policy shock in year t, $\mathbf{X}$ is a set of controls, and $u_{i,t}^h$ is the error term. In our preferred specification we include two lags of the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

Figure 3(b) shows the responses of the debt-to-income ratio (b_t), the primary deficit (d_t), and Fisher effects $\left(\frac{r_t - g_t - \pi_t}{1 + g_t + \pi_t} b_t\right)$ to a 1 percentage point increase in the interest rate.[8]

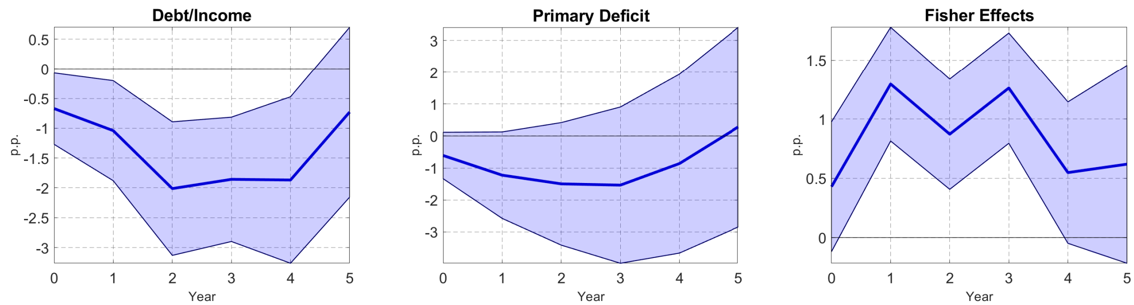
[7] We show in the Online Appendix that our results are insensitive to excluding years after the financial crisis where financial stability concerns entered the central bank interest rate decision informally.

[8] Since changes debt-to-income from $t-1$ to $t+h$ equals the sum of primary deficits and Fisher effects, we estimate the cumulative response of the primary deficit and Fisher effects:

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



(a) Macro Responses



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

Notes: Impulse responses to a 1 percentage point contractionary monetary policy shock. The shaded areas display 90 percent confidence bands, computed using Newey and West (1987) (macro responses) and Driscoll and Kraay (1998) (micro data) standard errors. The figures with the primary deficits and Fisher effects display cumulative responses.

Figure 3: Impulse responses to monetary policy.

The average debt-to-income response to a monetary tightening is negative, small, and relatively short-lived. The maximum response after 2-3 years is around 2 percentage points (relative to an average debt-to-income ratio of 154%) and the effect is almost back to zero after five years.

Focusing on the decomposition, we find that the debt-to-income 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 Fisher effects are weaker than the negative primary deficit response, resulting in a negative debt-to-income response.[9]

For completeness, we also present the impulse responses of debt and income as an alternative decomposition in Figure A.3 in the Online Appendix. Debt responds similarly to the primary

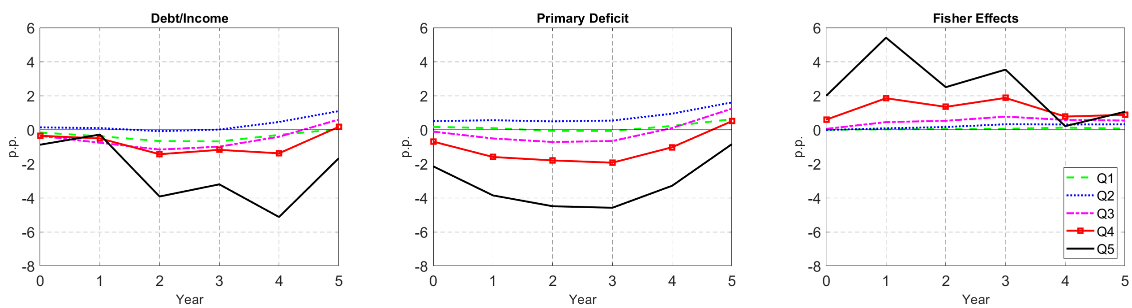
[9]While Figure 3(b) is constructed such that the primary deficit and Fisher effect responses sum to the debt-to-income response, the point estimates of the primary deficit and Fisher effect responses do not sum exactly to the debt-to-income response because different parts of the population respond differently to monetary policy and hence the estimates from each regression is obtained using different implicit regression weights.

deficit response. Income is less affected in the short-term and declines only after year 3.

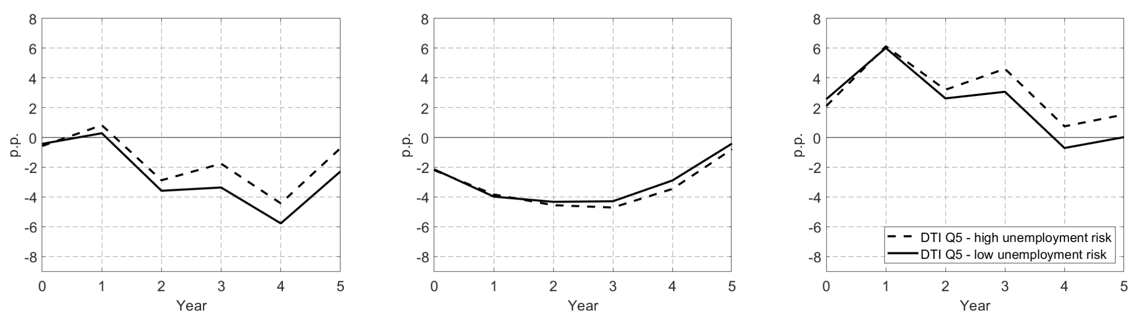
Initial indebtedness and responses to monetary policy. Next, we explore how the responses to monetary policy shocks vary across the debt-to-income distribution. To this end, we estimate a version of (4), but within groups g. The specification we use is

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

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.5 and A.6.



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



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

Notes: Impulse responses to a 1 percentage point contractionary monetary policy shock. Confidence bands for the figures are presented in Figure A.5 (by the DTI distribution) and A.6 (by unemployment risk within quintile 5 of the DTI distribution) in the Online Appendix. The figures with the primary deficits and Fisher effects display cumulative responses.

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 groups, although the responses are insignificant within each but one group (Q3). 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. Primary deficits fall more strongly the higher is initial indebtedness. Hence, even though Fisher effects respond strongly to monetary policy in the top debt-to-income quintile, debt-to-income falls because primary deficits drop even more than the Fisher effects increase.

High debt and high unemployment 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. 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 future job loss (unemployment) is regressed on predetermined characteristics (time and industry-fixed effects, and a second-order polynomial in tenure).

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 (5.14%).[10] We find that among households with high debt levels, both those with high and those with low risk respond to higher interest rates by reducing their primary deficits. Moreover, they do this to approximately the same extent. Their Fisher effects are also of similar magnitudes, reflecting that the two groups have the same initial indebtedness and similar income responses to the shock. Hence, also among households with high debt levels and high unemployment risk where it is likely that risks to financial stability are concentrated, monetary policy shocks reduce debt-to-income ratios. [11]

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 have been important for yearly changes in debt-to-income ratios among indebted households over the 22-year sample we observe, monetary policy shocks work mainly through primary deficits. Hence, it does seem that households respond to interest hikes by borrowing less and repaying more. In this sense, behavior dominates the mechanical Fisher effects in transmitting monetary policy shocks to household indebtedness.

[10] The average job separation rate differs substantially between the two groups. The average job separation rate among individuals with low (below median) risk is 2.5% while it is 8.9% for those with high risk. Figure A.1 displays the distribution of predicted job separation rates.

[11] Figure A.6 in the Online Appendix displays these responses with confidence bands, and as one would expect from observing the mean responses, the small differences observed are far from statistically significant.

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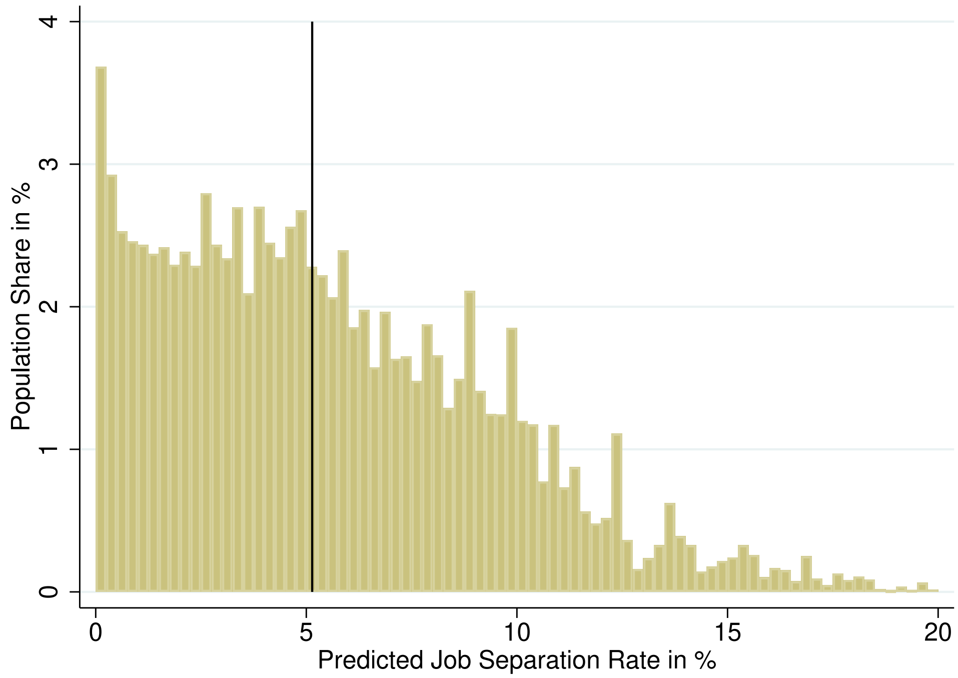
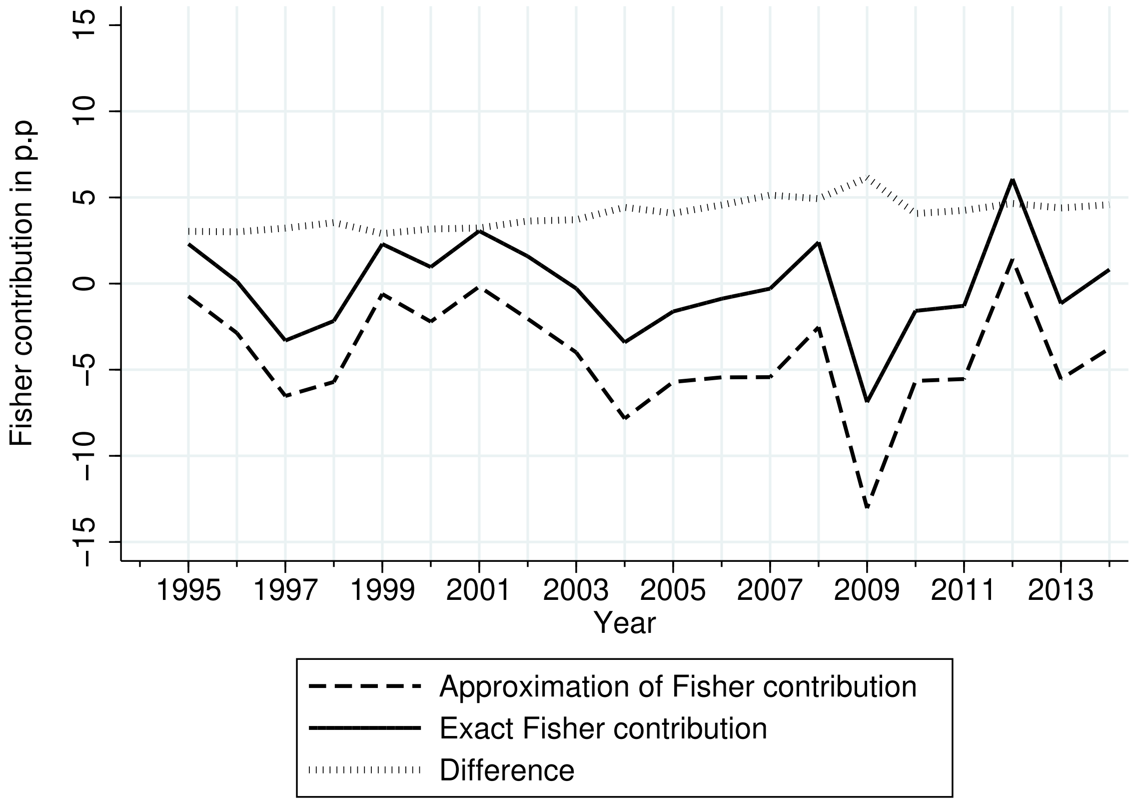
Online Appendix

A Extra Figures



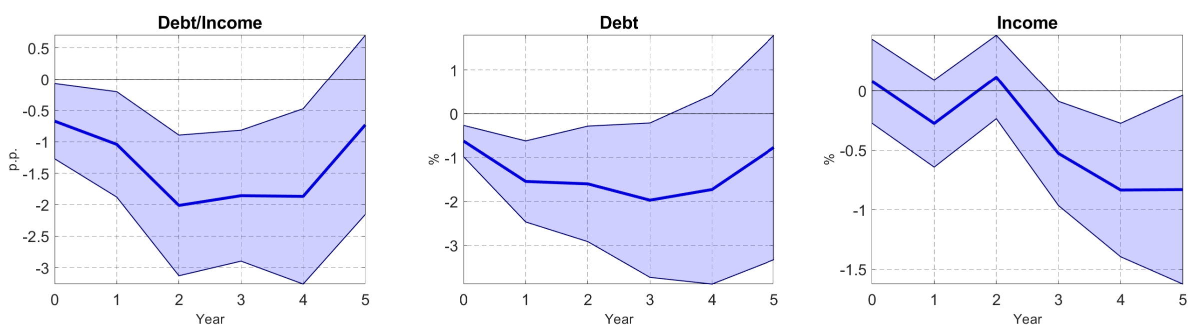
Notes: The figure shows the distribution of the predicted job separation rate from a probit regression of a dummy for receiving unemployment insurance the next year on a full set of time and industry dummies, and a second-order polynomial in tenure. The black line shows the median predicted job separation rate.

Figure A.1: Predicted job separation rate.



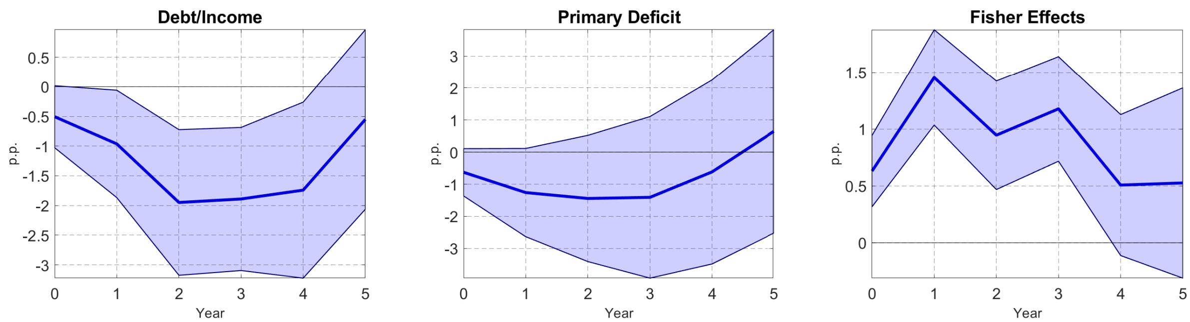
Notes: The figure plots total Fisher contribution as calculated from the exact formula as in Equation 1 (solid line), the approximate version used to decompose into individual contribution as displayed in Figure A.2 (dashed line), and the difference between the two (dotted line).

Figure A.2: Exact versus approximate Fisher effects.



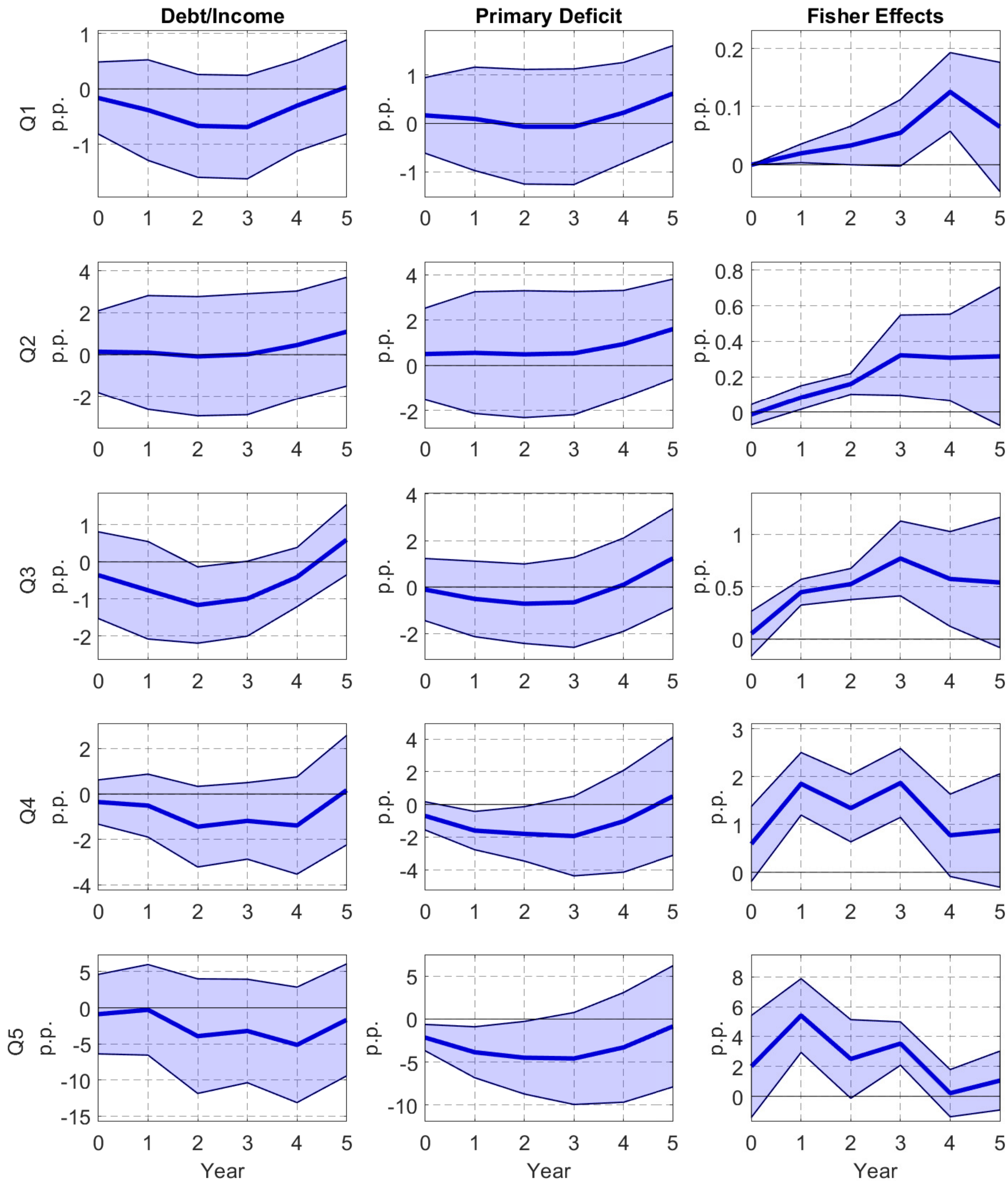
Notes: Impulse responses to a 1 percentage point contractionary monetary policy shock. 90 percent confidence band shown, computed using Driscoll and Kraay (1998) standard errors.

Figure A.3: Average debt-to-income responses to monetary policy.



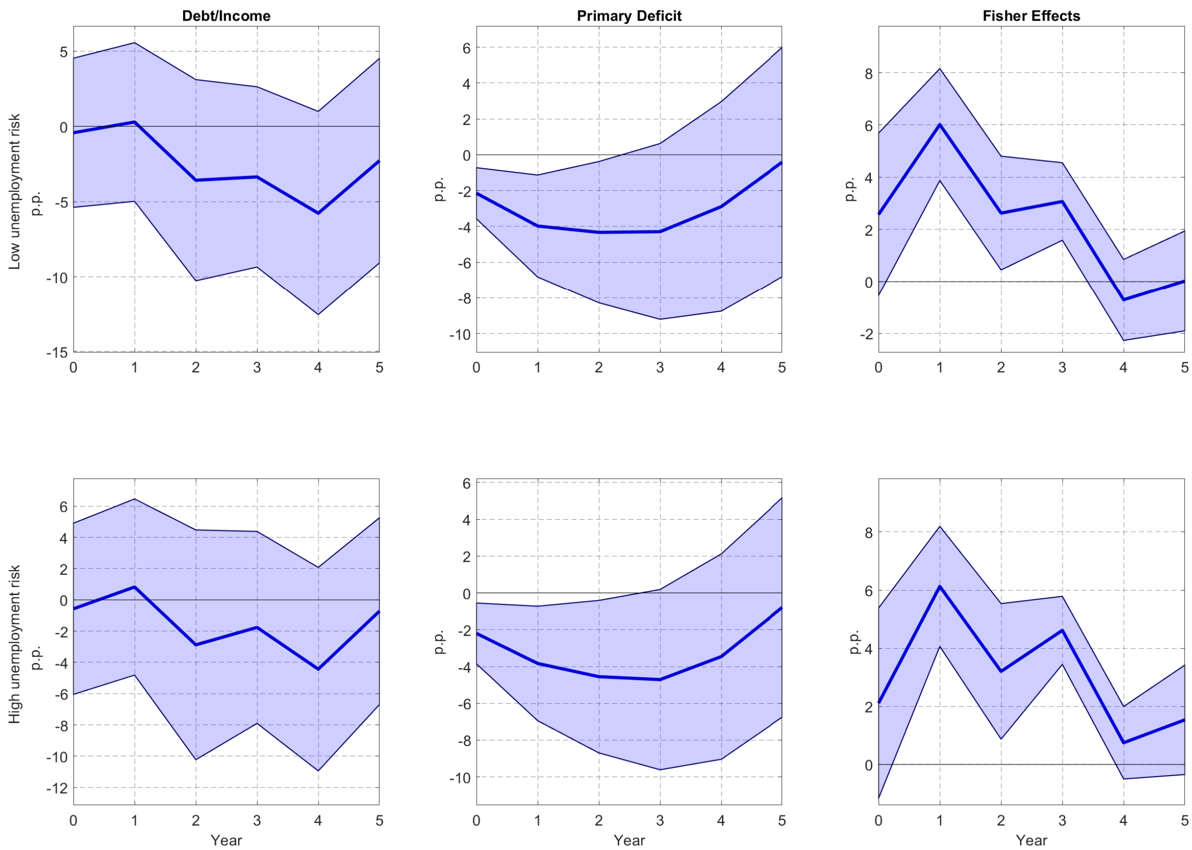
Notes: Impulse responses to a 1 percentage point contractionary monetary policy shock. 90 percent confidence band shown, computed using Driscoll and Kraay (1998) standard errors. The figures with the primary deficits and Fisher effects display cumulative responses.

Figure A.4: Average debt-to-income responses to monetary policy. Robustness to dropping years after 2008.



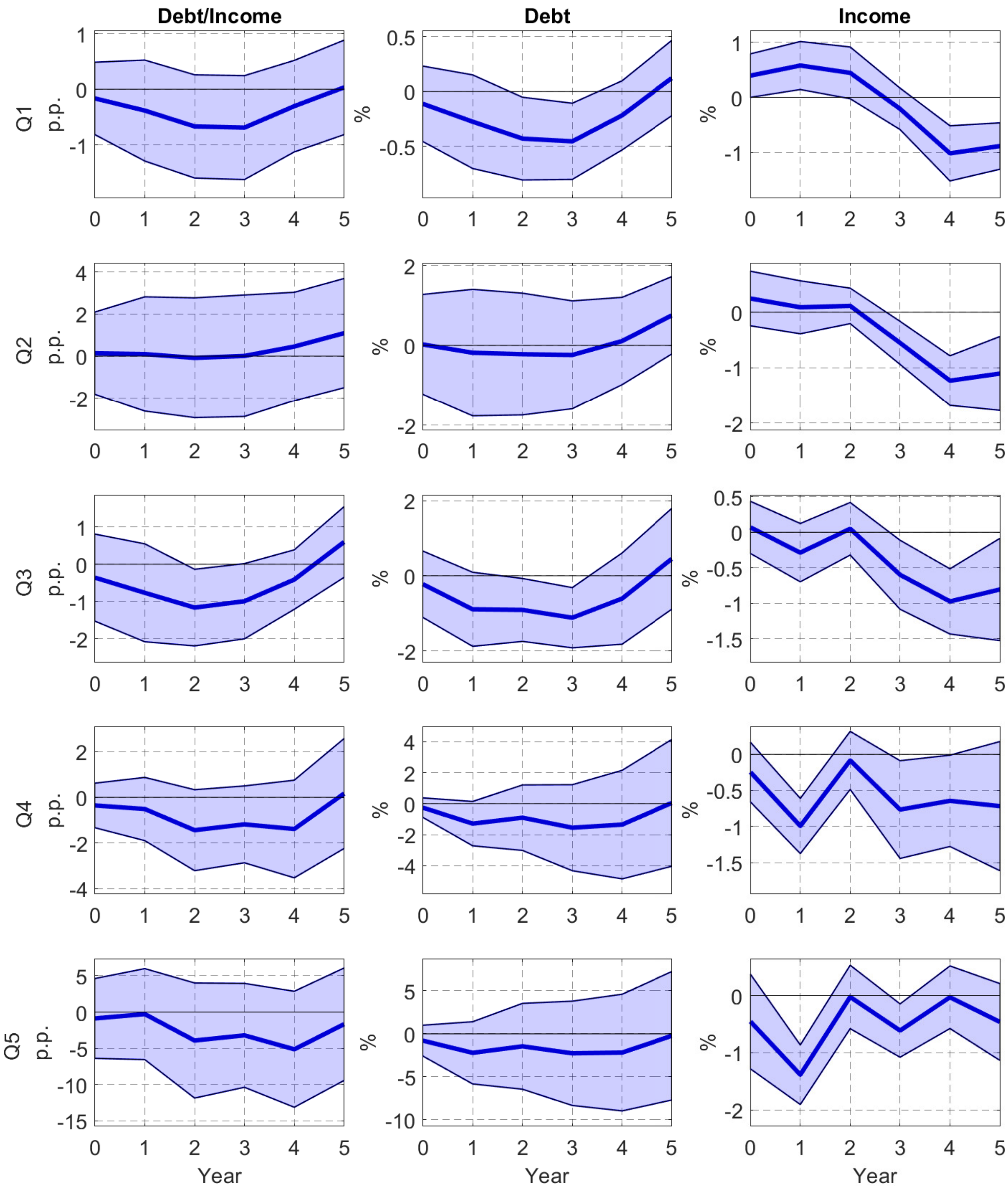
Notes: Impulse responses to a 1 percentage point contractionary monetary policy shock. 90 percent confidence band shown, computed using Driscoll and Kraay (1998) standard errors. The figures with the primary deficits and Fisher effects display cumulative responses.

Figure A.5: 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. 90 percent confidence band shown, computed using Driscoll and Kraay (1998) standard errors. The figures with the primary deficits and Fisher effects display cumulative responses.

Figure A.6: 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. 90 percent confidence band shown, computed using Driscoll and Kraay (1998) standard errors.

Figure A.7: Debt-to-income responses to monetary policy by quintiles of debt-to-income in $t-1$.