Household Indebtedness and the Macroeconomic Effects of Tax Changes*

October 2020

Sangyup Choi† Junhyeok Shin‡

Yonsei University Yonsei University

Abstract

This study is an attempt to investigate whether household indebtedness influences the macroeconomic effects of the U.S. tax policy. We apply a state-dependent local projection method to the exogenous tax shock series by Romer and Romer (2010) and find that a tax cut strongly stimulates the output when households are highly indebted. The expansionary effect of a tax cut in the period of high household debt is particularly significant for (i) consumption than investment; (ii) a personal income tax than a corporate income tax; (iii) during bad times than good times. These findings support household indebtedness as a measure of liquidity constraint for wealthy hand-to-mouth households at the macro-level. In response to a tax cut, households increase (decrease) labor supply when they are highly indebted (not indebted). This lack of a neoclassical wealth effect further contributes to an increase in the output. The state-dependent effects of tax policy, which influence the disposable income of the household directly, are more notable than those of the government spending policy, lending further support to the role of the household liquidity constraint channel of tax policy.

JEL Classification: E32; E62; G51; H30

Keywords: Tax policy; Household debt; Liquidity constraints; Nonlinearity; Local projections

† School of Economics, Yonsei University, 50 Yonsei-ro, Seodaemun-gu, Seoul 03722, South Korea. Email address: sangyupchoi@yonsei.ac.kr

‡ School of Economics, Yonsei University, 50 Yonsei-ro, Seodaemun-gu, Seoul 03722, South Korea. Email address: junhyeok.shin@yonsei.ac.kr

I. INTRODUCTION

The effects of fiscal policy on the macroeconomy have long been a crucial feature of macroeconomic research and policy discussion. Given its importance, the size of the fiscal multiplier has been studied both theoretically and empirically (Blanchard and Perotti, 2002; Mountford and Uhlig, 2009; Christiano et al., 2011; Ramey, 2011; Woodford, 2011). However, recent studies suggest that the effects of fiscal policy on the macroeconomy are nonlinear and vary across the states of the economy. For example, empirical studies such as Auerbach and Gorodnichenko (2012), Baum et al. (2012), Bachmann and Sims (2012), Fazzari et al. (2015) suggest that government spending policy is more effective during recessions as compared to expansions.

However, studies on the state-dependent fiscal multiplier do not necessarily come to the same conclusion. For example, Ramey and Zubairy (2018) use the unemployment rate as a state variable and find that the size of the U.S. government spending multipliers is below unity irrespective of the level of slack in the economy. Ziegenbein (2017), Eskandari (2019), and Demirel (forthcoming) use the same state variable to find that the short-term impact of tax changes on output and employment is lower during bad times characterized by slower growth or higher unemployment. Contrary to the case of government spending shocks, Sims and Wolff (2018) provide a theoretical framework with tax shocks recording a larger impact on output during expansions than during recessions. Biolsi (2017) claims that the state-dependent effects of both government spending and tax policy are sensitive to the choice of threshold for the level of slack in the economy. These findings indicate that a distinction of a type of fiscal policy (government spending vs. tax) and a choice of the state variable is crucial for a comprehensive understanding of the state-dependent effects of fiscal policy.

The majority of studies related to the dependence of fiscal multipliers on the state are in the context of a phase of business cycles. However, the constrained monetary policy and rising public debt during and after the global financial crisis have a theoretical and empirical appeal that the effects of fiscal policy may also depend on the stance of the monetary policy (Eggertson and Krugman, 2012; Miyamoto et al., 2018) or the level of government debt (Ilzetzki et al., 2013; Fotiou et al., 2020; Huidrom et al., forthcoming). For example, Eggertson and Krugman (2012)

develop a theoretical framework to illustrate the effect of fiscal policy under the zero nominal interest rate. Fotiou et al. (2020) and Huidrom et al. (forthcoming) use a nonlinear Vector Autoregression (VAR) model to show that fiscal multipliers are smaller when government debt is higher.

Our study is the first to investigate whether the impact of tax policy depends on the indebtedness of households, thus making an important contribution to the rapidly-growing literature on the state-dependent effects of fiscal policy. A wide-ranging area of research on the role of household debt in explaining the degree of damage to the economy during the Great Recession (Mian et al., 2013) as well as the business cycles worldwide (Mian et al., 2017) has emerged in the global financial crisis triggered by the U.S. subprime housing crisis. Following this strand of the literature, the level of household debt becomes a crucial factor in understanding the transmission of monetary policy (Alpanda and Zubairy, 2019; Cloyne et al., 2020) and government spending policy (Andrés et al., 2015; Bernardini and Peersman, 2018).

Recent studies such as Eggertsson and Krugman (2012), Kaplan and Violante (2014), and Andrés et al. (2015) have investigated the theoretical link between debt overhang and fiscal policy and presented heterogeneous agent models where fiscal policy is more effective when a larger proportion of households are liquidity-constrained. A common presumption behind these studies is that debtors are more subject to borrowing constraints, suggesting significant adjustments in their consumption in response to conditions that alter their income unexpectedly (Deaton, 1991; Shapiro and Slemrod, 2003; Agarwal et al., 2007). According to Hubbard et al. (1986) and Galí et al. (2007), even the households with a positive net worth act on a rule of thumb to an extent to which their assets are illiquid.

As a response to an exogenous fiscal shock, such a theoretical prediction has gained strong empirical support from recent studies leveraging the micro-level consumption response. For example, Cloyne and Surico (2017) demonstrate using household-level expenditure survey data that households with mortgage debt exhibit large and significant consumption responses to exogenous tax changes. Using individual credit card balance data, Demyanyk et al. (2019) find that the Department of Defense spending facilitates consumption to a higher degree by more credit-constrained individuals than by less credit-constrained ones. While the use of micro-level data

strengthens the identification of the heterogeneous transmission channel of the tax policy, the household debt-dependent effects of the tax policy have not been tested at the aggregate level.[1]

We adopt the state-dependent local projection method proposed by Ramey and Zubairy (2018), which is a nonlinear extension of Jórda (2005) to estimate the effects of tax policy depending on the state of the household indebtedness. To address the concern of endogeneity regarding the tax policy and macroeconomic variables, we use the narrative tax shock series by Romer and Romer (2010), which is majorly exogenous to the state of the economy.

We closely follow Bernardini and Peersman (2018) and Alpanda and Zubairy (2019) for measuring the state of household indebtedness, focusing on the debt gap, which is the deviation of household debt-to-GDP ratio from its trend.[2] They use the cyclical position of the household debt instead of its level to isolate the role of financial development in driving the long-term household debt. This is because an accumulation of debt that is driven by long-term financial deepening does not necessarily provide useful information about the liquidity constraint faced by households.

We provide strong empirical evidence that expansionary tax policy can be markedly effective in stimulating the economy when household indebtedness is high using the U.S. data from 1955Q1 to 2011Q4. It is consistent with the findings of Bernardini and Peersman (2018), which is a study closely related to ours, that focuses on the state-dependent effects of the U.S. government spending policy. They demonstrate that government spending multipliers rise during periods of private—including both household and corporate—debt overhang. While our work shares many similarities with Bernardini and Peersman (2018), it varies in several important dimensions. Notably, we study a more direct consequence of the tax policy on household liquidity constraints and do not include corporate debt in measuring indebtedness to avoid complication in the interpretation of our findings.

[1] To the best of our knowledge, the existing studies on the state-dependent effects of the tax policy have been limited than those of the government spending policy, and only investigated the role of the phase of business cycles, the level of slack in the economy, financial conditions, and the degree of macroeconomic uncertainty (Biolsi, 2017; Ziegenbein, 2017; Eskandari, 2019; Demirel, forthcoming).

[2] In a related study, Alpanda and Zubairy (2019) find that the effect of macroeconomic policy may depend on the level of household debt by showing that the expansionary monetary policy becomes less effective under the condition of high household debt.

The analysis of tax policy provides a better response to the extent of the direct impact of tax changes on the current disposable income of households as compared to changes in government spending. Moreover, both theoretical predictions and empirical evidence on the effect of government spending shocks on consumption have not reached a consensus, confounding the identification of the mechanism from the findings of Bernardini and Peersman (2018). Thus, analyzing the state-dependent effects of tax policy would be complementary to Bernardini and Peersman (2018) and enhance our understanding of the state-dependent effects of fiscal policy.

While investigating the response of each component of GDP, such a state dependence is primarily driven by consumption, which is directly affected by the current disposable income in the presence of borrowing constraints. The response of investment does not vary statistically between the states for the majority of specifications. It is different from the finding of Bernardini and Peersman (2018) while studying government spending as they demonstrate a stronger state dependence for investment than consumption, particularly when a narrative measure (Ramey, 2011) identifies the government spending shocks. Our finding is also in sharp contrast to Eskandari (2019), who finds that the state dependence of tax multipliers is driven by investment, not consumption.

Moreover, the decomposition of the responses to personal income and corporate income tax shocks reveals that the strong expansionary impact of a tax cut on output and consumption during the high household debt period is driven by a personal income tax, not a corporate income tax, which further supports the household liquidity constraint as a transmission channel of the tax policy. Such a decomposition is not feasible in the case of government spending policy studied in Bernardini and Peersman (2018).

We further analyze the impact on labor markets and find a strong state dependence in the response of both extensive and intensive margins (i.e., employment and average hours worked) of labor, but not real wages. The contractionary effect of a tax cut during the low-debt state can be due to a decrease in labor supply because of the negative wealth effect from a tax cut dominating the substitution effect. Such a negative wealth effect is absent when households are heavily indebted. In combination, our empirical evidence points to the relevance of the household liquidity constraint channel via changes in consumption and labor supply decisions, which is distinct from

the mechanism suggested for understanding the state-dependent effects of the tax policy in the literature.

Our key findings are robust to controlling for monetary policy, subsequent fiscal policy, and augmented state classifications based on the phase of business cycles, the slack of labor markets, and financial market conditions that may confound the state-dependent effects of the tax policy. Importantly, the state-dependent effects are more pronounced during bad times, consistent with the implication of unfavorable economic and financial conditions on further tightening the liquidity constraint when households are heavily indebted. Furthermore, they are robust to alternative criteria for identifying a period of household indebtedness and correcting potential bias in computing impulse response functions using local projections (Teulings and Zubanov, 2014).

The remainder of the paper is organized as follows. In Section II, the analytical methods adopted in the study are outlined with a brief review of the data used. In Section III, we summarize the empirical findings and provide a series of robustness checks. Section IV presents the conclusion.

II. EMPIRICAL FRAMEWORK

A. State-dependent local projection method

In this section, we describe the main empirical framework used in the analysis. We employ the methodology of Jórda (2005) for estimating the response of various macroeconomic variables to tax shocks. The local projection method has been advocated by Auerbach and Gorodnichencko (2012) and Ramey and Zubairy (2018), among others, as a flexible alternative to VAR specifications without imposing the pattern generated by structural VARs. We iteratively estimate the following regression to calculate Jórda's impulse response function:

$$y_{t+h} = \alpha_h + \beta_h shock_t + \Phi_h(L)X_t + \varepsilon_{t+h}, \;\; for\ h = 0,1,2,\cdots, \tag{1}$$

where y_t is the dependent variable whose response is our ultimate interest; $shock_t$ is an exogenous tax shock; $\Phi_h(L)$ is a lag polynomial; and X_t is a set of control variables.

In Equation (1), β_h shows the response of the dependent variable after h quarters from the shock. Therefore, a series of β_h illustrates the dependent variable's impulse response function to

a shock. In our analysis, β_h implies the cumulative impact of tax changes on dependent variables after h quarters. For example, if the output is used as a dependent variable, its value can be considered as the cumulative multiplier of a tax change. One of the potential problems of Jórda's method is the serial correlation of the error terms, and in our case, the extent of the persistence of the dependent variable. To handle this problem, we adopt Newey-West heteroskedasticity and autocorrelation corrected (HAC) standard errors from Newey and West (1987).

This model can be conveniently transformed into a state-dependent model to test whether the effects of tax shocks depend on the state of the economy. While the estimated responses obtained from the non-linear VAR models are based on the assumption that the state of the economy remains constant over the impulse-response horizons, this assumption may not be a good approximation if the underlying states are only short-lived (Ramey and Zubairy, 2018). Compared to VAR models, in this direct regression approach, if the average shock is likely to change the state of the economy, it will be reflected in the impulse response estimate. Natural transitions between states that are independent of the shock should be captured by the state-dependent control variables. Thus, the coefficients on the state-dependent constant terms and control variables will capture information on the average behavior of the economy to transition to the other state at future horizons. Notably, we bias our estimates toward not finding the differential effects of the tax shock across states to the extent that we estimate the properties of a given state by partially using the dynamics of a system in another state.

We closely follow the state-dependent local projection used by Ramey and Zubairy (2018). The nonlinear version of the regression model using the smooth transition function can be specified as follows:

$$y_{t+h} = F(z_{t-1})\left[\alpha_{H,h} + \beta_{H,h} shock_t + \Phi_{H,h}(L)X_t\right] + \left(1 - F(z_{t-1})\right)\left[\alpha_{L,h} + \beta_{L,h} shock_t + \Phi_{L,h}(L)X_t\right] + \varepsilon_{t+h}. \quad (2)$$

In this model, we allow variation in coefficients according to the levels of household debt to acquire a state-dependent impulse response function. Specifically, the first part of Equation (2) accounts for the high-debt period, and the second part corresponds to the low-debt period, where $F(z_t)$ captures a probability that the economy falls in a state of high household indebtedness. Thus,

a series of $\beta_{H,h}$ for $h = 1,2, \ldots$ denotes the impulse response to tax shocks in a state of high debt, whereas a series of $\beta_{L,h}$ describes the same in a low-debt state.

B. Identifying household debt indebtedness

We should identify the periods that consist of the high-debt state to differentiate between the impact of a tax shock in a state of high and low debt, respectively. We use the proportion of household debt to GDP for measuring the level of household debt as this would eliminate the effect of economic development on the growth of household debt itself. Following Klein (2017), Bernardini and Peersman (2018), and Alpanda and Zubairy (2019), the debt gap is measured as a deviation of the debt-to-GDP ratio from its long-existing trend, which represents the long-term secular trend in household debt driven by financial development.

A high level of household debt to GDP does not inherently convert into the binding liquidity constraint if the rising debt is a result of financial deepening. The long-term trend is defined using the Hodrick and Prescott (HP) filter with a smoothing parameter of $\lambda = 10^4$, as in Alpanda and Zubairy (2019).[3] We handle the so-called endpoint problem of the two-sided HP filter by filtering the household debt to GDP data from 1951Q4 to 2015Q4 and only including the data from 1955Q1 to 2011Q4 in our analysis. The availability of the narrative tax shock series restricts the sample period.[4]

We follow Gordon and Krenn (2010) and Ramey and Zubairy (2018) for the analysis and divide all national account variables such as output, private consumption, and private fixed investment with the potential GDP calculated by the Congressional Budget Office. In other words, before the estimations, we transform each variable as follows: $y_{t+h} = \frac{Y_{t+h} - Y_{t-1}}{PGDP_{t-1}}$, where Y_t is the real GDP or its components, and $PGDP_t$ is the potential GDP. This normalization ensures that all the coefficients are in the same unit, thereby allowing for the direct construction of the tax

[3] The choice of $\lambda = 10^4$ implies twice the typical business cycle. There is minimal change in our findings when using $\lambda = 10^6$, as in Bernardini and Peersman (2018). We use the Band-pass filter of Baxter and King (1999) for checking robustness.

[4] Although Romer and Romer's narrative tax shock series is only available until 2007Q4, the local projection method does not require the same sample size of dependent and independent variables. Since the horizon for impulse response functions is 20 quarters, we can evaluate the effect of the exogenous tax shock up to 2011Q4.

multipliers. We include four lags of the dependent variables of interest for each estimation, the ratio of government spending to GDP, and the exogenous series of tax shock as controls to deal with any possible serial correlation of the variables and omitted variable bias. If the dependent variable is not the real GDP, we still control for the four lags of output to minimize the omitted variable bias.

We employ the following smooth transition function used by Auerbach and Gorodnichenko (2012) to separate the states; $F(z_t) = \frac{exp(\gamma z_t)}{1+exp(\gamma z_t)}$, where z_t is the measure of the household debt gap explained above.[5] This method is similar to the smooth transition autoregressive model developed by Granger and Terasvirta (1993), which allows the impact of tax policy to shift smoothly between the states by considering a continuum of states to compute the impact, resulting in a more precise estimate. The smooth transition function transforms the household debt gap measure into a probability between zero and one. The transformed value would be close to one when the debt gap is higher (high-debt state), and close to zero if the debt gap is lower (low-debt state). The parameter γ governs the speed of transition between the two states, hence the smooth transition function converges to a binary indicator when $\gamma \to \infty$. Following Auerbach and Gorodnichencko (2012), we choose $\gamma = 1.5$, but our key findings are not sensitive to the choice of γ. The probability of being in the states of high debt is plotted in Figure A.1 in the Appendix with the recession period defined by the National Bureau of Economic Research.

We prefer this continuous transition between states to the use of a binary indicator in Klein (2017) and Bernardini and Peersman (2018), who use a similar variable (private sector debt gap) as the main state variable. While using a dummy variable offers a simpler economic interpretation, moderate and severe indebtedness is treated the same. Given that we focus on the household liquidity constraint channel as a potential mechanism of state dependence on the effects of tax changes, information on the tightness of liquidity constraints—measured in the probabilistic sense—provides additional information not captured by a binary indicator.[6]

[5] The original state variable in Auerbach and Gorodnichenko (2012) is a moving average of the GDP growth rate.

[6] We also use a binary indicator for robustness checks and our key findings still hold in this case.

C. Identifying narrative tax shocks

The fundamental challenge in identifying the effects of tax changes on the macroeconomy is that tax policy can change in response to the underlying economic conditions. We mitigate the endogeneity concerns using the exogenous tax changes identified through a narrative approach by Romer and Romer (2010). They create an exogenous measure of tax shock by using narrative records such as presidential speeches and Congressional reports. Their narrative shock series identifies the size, timing, and principal motivation for all the crucial post-war tax policy actions. They distinguish legislated changes into those taken for reasons related to prospective economic conditions as well as for more exogenous reasons. We use this sequence of tax shock series for the identification of the exogenous tax policy in our analysis. Panel A of Figure A.2 in the Appendix shows Romer and Romer's narrative tax shock as a share of the GDP.

Furthermore, we strengthen our identification by using the unanticipated tax shock series constructed by Mertens and Ravn (2013). The unanticipated tax shock excludes tax policies where the delay between legislation and implementation is longer than a quarter. This method addresses the issues about the so-called fiscal foresight due to the time lag between the announcement and implementation of tax policy (Leeper et al., 2013). Since we condition the effect of tax policy on the state of household debt, we further investigate whether changes in personal income tax have varying results from corporate income tax. If our measure of household debt captures the tightness of household liquidity constraints, state-dependent effects are possibly higher for the case of personal income tax than corporate income tax. Panels B and C of Figure A.2 plot the unanticipated personal income tax shock and the corporate income tax shock as a share of the GDP, respectively. Finally, in Table A.1 in the Appendix, we summarize the variables used in the empirical analysis.

III. EMPIRICAL FINDINGS

A. Main results

Figure A.3 in the Appendix shows the impulse response of the real GDP, consumption, and fixed investment to an exogenous tax cut from the linear model. The qualitative findings are consistent with those of the previous studies that use the same narrative tax shocks, and a tax cut leads to increased output in the short and medium run, such as Romer and Romer (2010), Mertens and Ravn (2014), and Demirel (forthcoming). While the maximum effect of an exogenous tax cut

on the real GDP corresponds to one percent of the GDP (1.7%), which is smaller than that (2.9%) of Romer and Romer (2010), this disparity is a result of different estimation techniques (local projection vs. autoregressive distributed lag model).[7] The size and the timing of the maximum effect are consistent with Demirel (forthcoming), recording a maximum increase of 2.1% in real GDP after eight quarters using essentially the same methodology and a similar sample period.

Figure 1 presents the state-dependent effect of an exogenous tax cut on GDP, which is our key focus. The responses in two different states indicate a marked difference. While the first two quarters after the tax shock record a statistically insignificant response, an exogenous tax cut stimulates the output only during the state of high household debt. The same scale of the tax cut is followed by a decreasing output when the household debt is low. For example, the maximum effect after eight quarters is a 5.2% cumulative increase in the real GDP from its potential under an extremely high level of debt, whereas the response is -3.8% under an extremely low level of debt. Our key findings suggest that tax cuts are particularly effective in stimulating the aggregate economy when households are heavily indebted on average.

State-dependent tax multipliers. The tax multiplier is defined as the dollar change in GDP over a specified period resulting from a dollar change in tax revenues during the same period. While this statistic is widely used in academic and policy discussions to quantify the effectiveness of tax policy, it requires caution as we do not aim to compare the size of the multipliers directly with that found in the literature, given the potential pitfalls in the measurement and construction of multipliers, particularly when they are based on a state-dependent model (e.g., Sims and Wolff, 2018).

In the empirical literature, it is common not to estimate multipliers directly, but instead to first estimate the elasticity of output in terms of government expenditure or tax revenue, then transform it by multiplying with the inverse of the average government expenditure or tax revenue share of output (e.g., Blanchard and Perotti, 2002). However, such a naive approach has been criticized recently. For example, Mountford and Uhlig (2009) argue that multipliers should be

[7] See Chahrour et al. (2012), Favero and Giavazzi (2012) and Mertens and Ravn (2014) for learning to reconcile the difference in the magnitude of tax multipliers found in the literature. However, our primary concern is not the size of multipliers per se, but whether it varies systematically depending on the state of household debt.

calculated as the integral of the output response divided by the integral of government expenditure or tax revenue response. Besides, Ramey and Zubairy (2018) posit that the share of government spending on GDP has changed substantially in the historical sample, causing a bias. Sims and Wolff (2018) argue that this conventional approach is particularly misleading in the calculation of state-dependent tax multipliers.

Following Ramey and Zubairy (2018), we compute the tax multiplier for a linear model in three steps: (i) estimate Equation (1) for the GDP of each horizon j up to h and sum the β_j; (ii) estimate Equation (1) for tax revenues of each horizon j up to h and sum those β_j; (iii) compute the multiplier as the answer to step (i) divided by the answer to step (ii).[8] However, constructing tax multipliers in a nonlinear model has further complications. Scaling the output response by the tax revenue response evaluated in that same state confounds the state-dependent response of output to an extent to which the response of tax revenues to exogenous tax shocks also varies across states. There is an additional obstacle to our probabilistic setup compared to the binary model of Ramey and Zubairy (2018). As shown in Figure A.4, the tax revenues response to a one percent exogenous tax cut are similar on impact but diverge sharply over time because they are based on the two extreme states. The tax revenue responses even show the opposite signs in the medium term, which poses difficulty in interpreting the integral of tax revenue response.

We follow Sims and Wolff (2018) and scale the output response (at a particular realization of the state) by the tax revenue response to a tax rate cut measured in the linear model. It ensures that any movements in the multiplier over the state space are a result of the variations in the output response to a tax cut across states and not the variation in the tax revenue response to a tax rate cut. Table 1 presents a summary of the tax multipliers on impact and at their maximum (occurring after two years) for both linear and nonlinear cases. Based on the practice followed in the literature, a positive (negative) value indicates an increase (decrease) in output after a tax cut.

[8] One should take caution in interpreting the state-dependent tax multipliers because the first-stage F-statistics are often below ten if we take the one-step instrumental variable regression. This is especially true for the state of low debt in the medium term, unlikely to satisfy the instrument relevance condition. See Biolsi (2017) for the same conclusion regarding the instrument relevance condition of Romer and Romer's narrative tax shock series. This is another reason to take caution in interpreting the size of the state-dependent tax multipliers. For the military news shock series on excluding World War II, see Ramey and Zubairy (2018) for a similar conclusion.

While the size of state-dependent multipliers appears to be implausibly large, it is notable that this is measured by the effects of a tax cut during the extreme states (corresponding to $F(z_t) = 0$ or 1), which are rare in the data. We ease the comparison with the existing studies on the state-dependent effects of tax policy by presenting the estimates of tax multipliers using a binary indicator, which calculates the average output response when the household debt to GDP ratio is above and below the trend. The tax multipliers obtained by dividing state-dependent responses of output by state-dependent responses of tax revenues are also provided. In either case, tax multipliers are positive only during the high-debt state, and their variations between the states are highly statistically significant. The expansionary impact of a tax cut during the state of high debt is larger than the contractionary impact during the state of low debt, squaring with a positive multiplier in the linear model.[9]

Previous studies, such as Ziegenbein (2017), Sims and Wolff (2018), Eskandari (2019), and Demirel (forthcoming), provide theoretical and empirical evidence that tax multipliers are smaller during the period of slack or recessions, which is dramatically opposite to the majority of studies on government spending multipliers.[10] Our findings suggest that the state of household debt is critical in understanding the effectiveness of tax policy, along with the state of business cycles measured by the output growth or the unemployment rate. Importantly, the robustness checks conducted later demonstrate that our high-debt condition does not necessarily pick up the expansionary phase of the economy, suggesting that the household debt channel is independent of other mechanisms.

Response of component of GDP. We consider the state-dependent responses of consumption and investment to the same shock for understanding the source of asymmetry in output responses between the states. Figure 2 depicts the state-dependent responses of two national account variables (private consumption and private fixed investment) to an exogenous tax shock.

[9] By construction, the unconditional probability of the high-debt state equals the low-debt state in our model.

[10] For example, Ziegenbein (2017) and Demirel (forthcoming), using a search model of unemployment, argue that an increased labor market slack or tighter credit conditions in contractionary periods can reduce the responsiveness of labor supply to changes in labor income taxes, resulting in smaller effects on output from tax changes.

Interestingly, we find that the state-dependent output response is primarily driven by the consumption response and not by investment.

While the state-dependent consumption response is similar to the real GDP, the responses of investment are not statistically different between the states. The investment response is statistically insignificant over most horizons for both states. The weaker state-dependent investment response is consistent with Mian et al. (2017), indicating that an increase in household debt is closely linked to consumption and less related to business investment. Our finding is distinct from Eskandari (2019), who uses the unemployment rate, GDP growth, and uncertainty as a state variable and finds that the state dependence of tax multipliers is driven by investment, not consumption. It can also be interpreted as evidence that the borrowing decisions of households, not businesses, are primarily responsible for the household debt-dependent impact of tax policy via the implication of household liquidity constraints on the marginal propensity to consume.

Figures 3 and 4 present the linear as well as the state-dependent effects of an exogenous tax shock on the subcomponents of private consumption and private fixed investment. The strong state-dependent response of consumption is largely preserved for each subcomponent. The most noticeable state dependence is observed for the consumption of durable goods, but the consumption of non-durable goods and services shows a similar state-dependent pattern. This finding is in sharp contrast to the case of the government spending policy that exhibits an opposite state-dependent pattern between the response of output and durable goods to government spending shocks (Berger and Vavra, 2014).[11]

In the case of investment, the level of household debt is only important for the response of non-residential investment, which is consistent with the implication of state-dependent tax policy on labor markets studied later. We demonstrate that the absence of the neoclassical wealth effect of tax policy during the high-debt state substantially increases household labor supply. Given the stronger household consumption demand and the higher marginal product of capital due to increased labor supply, firms are encouraged to invest and hire more. However, it is notable that this mechanism is not a direct consequence of tax policy on relaxing the borrowing constraints of

[11] Berger and Vavra (2014) show that the response of output to fiscal stimulus is stronger during recessions, whereas the response of durable consumption is stronger during expansions.

a firm but rather the consequence of household inter and intra-temporal decisions under liquidity constraints.

On the other hand, the response of residential investment is statistically insignificant in both states, which indicates that expansionary tax policy does not contribute to an increase in the supply side of the U.S. housing markets in either condition. We further investigate the state-dependent effects of tax policy on the housing market in the following section to shed light on the implication of the interaction between housing markets and household debt.

B. Robustness checks

We provide several sensitivity tests in this subsection to exhibit that our primary finding, which states that an exogenous tax reduction has a significant expansionary effect only during the period of household indebtedness, is robust to various alternative specifications.

Response of tax revenue in the short run. Our first concern is that the nature of tax policy also depends on the level of household debt. The measure of exogenous tax shocks is based on a narrative account, and each tax change has various motivations. Our findings might simply illustrate this difference to the extent to which the motivation behind tax changes systematically depends on the state of household indebtedness. We guard against this possibility by checking whether the response of tax revenues to an exogenous tax shock systematically varies depending on the state of household debt.

Following Ramey and Zubairy (2018), we use federal current receipts from the National Income and Product Accounts data to measure government tax revenue and estimate the state-dependent response to the one percent of a tax cut. Figure A.4 in the Appendix shows that no significant distinction appears in the responses between the two states in the short run, suggesting an absence of inherent asymmetry in the type of tax policy based on the state of household debt. While the responses vary in the medium term, they are guided by the asymmetric response of real GDP to the tax cut as the tax revenue expands with the increase in real GDP.[12] We control for the lags in the share of the federal current revenue in GDP to ensure that the response of tax revenue

[12] As explained earlier, the various responses to tax revenue in the medium term still complicate the calculation of state-dependent tax multipliers beyond the short run.

is still irrelevant to findings. Figure A.5 in the Appendix shows that the main finding hardly changes.

Alternative state variables. Despite the evidence on the strong state-dependent effects of tax shocks on the macroeconomy, the state of household debt may overlap with the state of other economic variables that drive the state-dependent effects instead. Since the literature has already identified the alternative state-dependent effects of tax policy, addressing this possibility is crucial for establishing new empirical findings. First, we investigate whether our definition of the high-debt state simply proxies economic expansions during which tax multipliers are known to be larger (Ziegenbein, 2017; Sims and Wolff, 2018; Eskandari, 2019; Demirel, forthcoming). The correlation between the HP-detrended household debt gap and real GDP is indeed positive (0.13) though not strong, which suggests that the role of household debt may be masked by the role of business cycles. While the lags of the real GDP are always included in our regression framework, we cannot rule out this possibility without augmenting the alternative state into our local projection framework.

We estimate the following Equation (3) where the additional state variable captured by a binary indicator $I^S(w_t)$ is augmented to the original local projections:

$$\begin{aligned} y_{t+h} = {} & F^D(z_{t-1})I^S(w_{t-1})\left[\alpha_{HH,h} + \beta_h^{HH} shock_t + \Phi_{HH,h}(L)X_t\right] \\ & + F^D(z_{t-1})\left(1 - I^S(w_{t-1})\right)\left[\alpha_{HL,h} + \beta_h^{HL} shock_t + \Phi_{HL,h}(L)X_t\right] \\ & + \left(1 - F^D(z_{t-1})\right)I^S(w_{t-1})\left[\alpha_{LH,h} + \beta_h^{LH} shock_t + \Phi_{LH,h}(L)X_t\right] \\ & + \left(1 - F^D(z_{t-1})\right)\left(1 - I^S(w_{t-1})\right)\left[\alpha_{LL,h} + \beta_h^{LL} shock_t + \Phi_{LL,h}(L)X_t\right] + \varepsilon_{t+h}, \quad (3) \end{aligned}$$

where the indicator variable $I^S(w_t) = 1$ when the additional variable of concern w_t, such as output growth, is higher than its trend.[13] $F^D(z_t)$ still measures the probability that the economy belongs to the high-debt gap state. As a result, β_h in each term of Equation (3) implies the impulse

[13] Here, we do not use the smooth transition function to calculate the probability of an additional state. Since our method is already based on the probability of the high debt state, this approach will yield estimates under an implausible scenario with little practical implication (for example, simultaneous extreme household indebtedness and extreme economic boom).

response of y_{t+h} to the shock under the four (two-by-two) possible joint combinations of the household indebtedness and an additional state variable.

Figure A.6 in the Appendix shows the estimation results. In both expansions and recessions, the effects of a tax cut on consumption and output are expansionary (recessionary) when the state of household indebtedness is high (low). While the impulse responses are less precisely estimated due to the limited size of the effective sample used for estimation, we still confirm the household debt state-dependent effects of tax policy regardless of the phase of business cycles. The state-dependent effects of tax policy are more noticeable when output growth is below its trend.

We further confirm the robustness of our key finding by associating the household debt state with the labor market slack state, which is the original state variable considered in Ramey and Zubairy (2018). The slack of labor markets may provide additional information not captured by the phase of business cycles studied above. Following Ramey and Zubairy (2018), we define an economy to be in a slack state when the unemployment rate is above a certain threshold. Since our sample is smaller than that in Ramey and Zubairy (2018), we use the sample median of 5.7 as a threshold. As shown in Figure A.7 in the Appendix, our major observations still hold in this case. If anything, the state-dependent impact of tax policy is stronger when the unemployment rate is above its historical median.[14]

The status of our household debt may also overlap with the state of financial market conditions, which may influence the impact of tax policy through a different channel. We measure financial market conditions using a credit spread (spread between Aaa-grade corporate bonds and Baa-grade corporate bonds), which is consistently available over a long period. We use the deviation of the credit spread from its trend using the HP filter, which is consistent with the definition of the debt gap measure. The correlation between the high-debt state and the high-spread state is nil (0.05), indicating that the high-debt state is likely to capture an underlying orthogonal state to the financial market conditions and alleviates our concern.[15]

[14] Our finding is robust to the alternative threshold using the mean of the unemployment rate in the sample (6%).

[15] The correlation remains low when alternative measures for household debt and financial market conditions are taken using the band-pass filter of Baxter and King (1999).

Figure A.8 in the Appendix confirms the household debt state-dependent effects of tax policy. Again, the state-dependent effects of tax policy are more prominent when financial market conditions are tightened (i.e., credit spread is above its trend). Further, we estimate the response of the key variables to the tax cut with the credit spread controlled. Figure A.9 in the Appendix illustrates that the key findings are still preserved when the financial market conditions measured by the credit spread are controlled for.

In combination with the previous results of using real GDP growth and the unemployment rate, it suggests that tax cuts are particularly effective in stimulating the economy, notably by an increase in consumption when both conditions are satisfied, that is high household indebtedness and bad economic/financial conditions. While our findings appear to refute a larger tax multiplier during good times than bad times shown by Ziegenbein (2017), Sims and Wolff (2018), Eskandari (2019), and Demirel (forthcoming), their analysis does not condition on the state of household indebtedness, which is crucial in understanding a household's intertemporal consumption decision. Indeed, the results of augmented local projections are completely consistent with the implication of the household liquidity constraint channel because this constraint is likely to bind more during bad times than good times.

Interaction with monetary policy. The interaction between fiscal and monetary policy can also influence the sign and the size of the impact of fiscal policy on the macroeconomy. To the extent to which fiscal policy affects the macroeconomy by both inter- and intra-temporal substitution effects and a wealth effect, the ultimate effect on the economy also hinges on current and future monetary policy behavior (Christiano et al., 2011; Davig and Leeper, 2011). For example, if the monetary policy is more expansionary during the high household debt period, it will mask the effect of tax policy on output. Thus, to isolate the role of household debt, we should investigate whether the stance of monetary policy to the tax cut systematically varies between the states.

We use the effective federal funds rate to measure the stance of monetary policy because our estimation period ends before the period with binding zero-lower bound. Figure 5 shows the state-dependent response of both the CPI and federal funds rate. Despite the strong expansionary output response, largely driven by an increase in consumption, the inflationary pressure is muted in the high-debt state, which is in contrast to the low-debt state where inflation picks up in response

to the tax cut. This finding indicates that a substantial slack still remains in the economy when households are heavily indebted, allowing for more accommodative monetary policy in the same state without generating inflation.

However, the significant expansionary effect of a tax cut during the high-debt state is not simply masked by the expansionary effect of monetary policy. The state-dependent impact on the federal funds rate is statistically significant only in the short term and quickly become insignificant after a year when the output and consumption effects of tax policy are strongly state-dependent. If anything, the response of monetary policy is more contractionary during the high-debt state after six quarters, which goes against finding a strong expansionary effect on output in this state. We estimate the effects of the tax shock after controlling for the federal funds rate and its four lags to further verify that our results are not driven by the state-dependent monetary policy stance. Figure A.10 in the Appendix illustrates that the dynamics of GDP, consumption, and investment hardly change from the baseline model.

Alternative definition of states. In defining a state, we used the probabilistic framework to allow for a smooth transition between the states. While we prefer the smooth transition function over a binary indicator for the reasons explained above, we still test the robustness of our findings using a dummy variable $I_t \in \{0,1\}$ that holds a value of one when HP-detrended household debt is positive. As in Equation (2), the binary indicator I_t enters with a lag. Figure A.11 in the Appendix illustrates that the result is qualitatively similar, but the state-dependent effects are less extreme than the baseline analysis as expected.

We further confirm that our key findings hold when we employ the Baxter and King (1999) band-pass filter to detrend the household debt variable. Figure A.12 in the Appendix displays that the baseline findings hardly change when using the band-pass filter for isolating the frequencies between 4 and 64 quarters to define the measure of household debt gap.

Accounting for potential bias in the estimates. Teulings and Zubanov (2014) posit a potential bias in the local projections estimator. In their analysis of the effect of the banking crisis on the loss of output, the bias occurs as in the regression of GDP at $t + k$ on the banking crisis dummy at t, which underlies this estimator, there will be observations in which the GDP is already affected by the crisis. However, the corresponding banking crisis dummy is zero. In our context, GDP,

consumption, or investment can be already affected by the exogenous tax shock, yet the corresponding tax shock series records zero. Teulings and Zubanov (2014) suggest controlling for the forward values of the crisis dummy over the forecast horizons to correct this bias. Following the same, we control for the future value of tax shocks occurring over the estimation horizons (between periods t and $t + k - 1$). Figure A.13 in the Appendix shows that the baseline results barely change, suggesting that the bias is unlikely an issue here.

C. Additional exercises

This section presents a set of additional exercises, which help in understanding the source of state dependence we find in the baseline analysis. In particular, the disaggregation of exogenous tax changes into their subcomponents (personal and corporate) allows us to test our identifying assumption that the household debt gap proxies the degree of household liquidity constraint at the macro-level. Analyzing the effects of tax shocks on other primary macroeconomic variables provides us further insights into the functioning of the potential mechanism.

Personal vs. corporate income tax shocks. Considering the concern about fiscal foresight, Mertens and Ravn (2013) separate the exogenous tax shock series of Romer and Romer (2010) into the one anticipated by economic agents and the one that is not (i.e., tax policies whose delay between legislation and implementation is shorter than a quarter). Mertens and Ravn (2013) further distinguish them into the changes in unanticipated personal and corporate income tax using the unanticipated tax shock series. Given our focus on household debt as a state variable, we analyze the form of tax shock that generates the strong state dependence we documented. Since we only consider the unanticipated tax shock here, this exercise also alleviates the remaining concern about the predictability of the shock series identified by Romer and Romer (2010).

However, the disaggregation of the exogenous tax shocks raises new problems as a result of the correlation between legislated changes in personal and corporate taxes. We follow Mertens and Ravn (2013) to resolve this issue by incorporating both types of tax shocks and their lags in the estimation to capture the orthogonal component embedded in each type of tax shocks. We estimate the following equation:

$$y_{t+h} = F(z_{t-1})\left[\alpha_{H,h} + \beta_{H,h}^{P} shock_t^{Personal} + \beta_{H,h}^{C} shock_t^{Corporate} + \Phi_{H,h}(L)X_t\right] +$$
$$\left(1 - F(z_{t-1})\right)\left[\alpha_{L,h} + \beta_{L,h}^{P} shock_t^{Personal} + \beta_{L,h}^{C} shock_t^{Corporate} + \Phi_{L,h}(L)X_t\right] + \varepsilon_{t+h}, \qquad (4)$$

where $shock_t^{Personal}$ and $shock_t^{Corporate}$ denote the surprise personal income tax shock and corporate income tax shock, respectively. The identifying assumption in Equation (4) is similar to the short-run identification used in the VAR model of Mertens and Ravn (2013), where the shock of interest is placed second in the Cholesky ordering, allowing for the contemporaneous effect of the other type of tax shocks, resulting in more conservative estimates.

Panel A in Figure 6 shows the response of output, consumption, and investment to the reduction in personal income tax, whereas Panel B displays the reduction in corporate income tax. In Panel A, the state dependence in the response of output is less pronounced in the short run as compared to the baseline results. However, the consumption response suggests that the strong expansionary effect of a tax cut during the high household debt state is entirely driven by the reduction in personal income tax, which is consistent with the outcome of relaxing household liquidity constraints. The response of investment to the personal income tax shock is not strongly dependent on the state of the household debt. This finding is consistent with no plausible first-order effect of personal income tax changes on corporate balance sheet conditions, which supports our identification scheme.

Contrarily, the effect of a decrease in corporate income tax is expansionary when household debt is low, which is primarily influenced by the response of private investment. Unlike the case of the personal income tax cut, the reduction in corporate income tax affects output mostly through the investment channel, which is consistent with its underlying motive. The consumption response to the corporate income tax shock does not depend strongly on the state of household indebtedness in the short run, consistent with the fact that adjustments in corporate income tax do not directly affect the household liquidity constraint.

Tax cut vs. tax increase. Owing to the linear structure of the VARs used in the earlier empirical studies, the literature overlooked the possible asymmetry between the macroeconomic impact of tax cuts and tax raises. Our estimated effect of a tax shock in the baseline analysis treats an increase and a decrease in tax symmetrically. However, a few studies investigate this potential asymmetry

(Jones et al., 2015; Hussain and Malik, 2016) and find that a tax cut has a significant expansionary impact on the U.S. economy, whereas the same size of a tax increase does not have a significant recessionary impact. To the degree to which a tax cut is more likely than a tax increase during bad times, the state-dependent effects of tax policy documented in the existing studies may obscure their sign-dependent effects.[16]

The existing literature also points to an asymmetric response of consumption to positive and negative transitory income shocks with the presence of household borrowing or liquidity constraints (Deaton, 1991; Bunn et al., 2018). In our case, an expansionary impact of a tax reduction during the high-debt state may not result in the same degree of contractionary effect of a tax increase. We test this possibility by estimating the following equation:

$$y_{t+h} = F(z_{t-1})\left[\alpha_{H,h} + \beta_{H,h}^{Pos} shock_t^{Pos} + \beta_{H,h}^{Neg} shock_t^{Neg} + \Phi_{H,h}(L)X_t\right] + \left(1 - F(z_{t-1})\right)\left[\alpha_{L,h} + \beta_{L,h}^{Pos} shock_t^{Pos} + \beta_{L,h}^{C} shock_t^{Neg} + \Phi_{L,h}(L)X_t\right] + \varepsilon_{t+h}, \quad (5)$$

where $shock_t^{Pos}$ denotes the exogenous tax increase, while $shock_t^{Neg}$ denotes the exogenous tax cut (i.e., $shock_t^{Pos} = max\{shock_t, 0\}$ and $shock_t^{Neg} = min\{shock_t, 0\}$).

In Figure 7, we summarize the results of this exercise. In the case of the tax cut in Panel A, we switch the response sign to be consistent with the baseline analysis and leave the response sign for the tax increase in Panel B. Overall, the state-dependent effect of tax shocks, particularly for consumption, is somewhat more prominent and precisely estimated for the tax cut than the tax increase. This is unsurprising because the baseline finding is based on the average effects of the tax reduction and increase, and reductions are more frequent than increases in our sample period.

However, the effects of the tax increase also depend on the state of household debt. A tax increase is contractionary only during the period of high household indebtedness, which is consistent with the implication of tightening liquidity constraints. If household liquidity constraints are not binding (i.e., during the low-debt period), tightening the constraint may not lead to a decline in consumption. However, if the constraint is already binding (i.e., during the high-debt period),

[16] See Barnichon and Matthes (2017) for a similar argument about the government spending policy.

further tightening of the constraint may lead to a larger decline in consumption and output. Overall, this observation is consistent with Klein (2017), who asserts that fiscal austerity is particularly painful in periods of private-debt overhang using the large consolidation episodes from the 12 OECD countries. The effects of a tax increase on private fixed investment indicate patterns that are quite different from those of private consumption. The investment response is not statistically significant for most horizons, and, if anything, investment increases during the high-debt state in the medium term.

Effects on the labor market. In this section, we examine the state-dependent effects of tax shocks on labor market variables to shed further light on the mechanism at hand. Since one of the main channels through which fiscal policy affects the output in a neoclassical model is household labor supply decisions driven by the wealth effect, investigating the state-dependent response of labor market variables helps in interpreting our key findings. Sequentially, as summarized in Figure 8, we explore the response of employment, average hours worked, and real wages to the tax shock.[17]

The strong asymmetry in the employment response resembles that of output and consumption, suggesting that the labor supply channel of a standard neoclassical model is functioning in addition to the Keynesian aggregate demand channel. The contractionary effect of a tax reduction in the low-debt state can be attributed to a decrease in labor supply due to the standard negative wealth effect from a tax cut dominating the substitution effect. Such a negative wealth effect is absent when households are heavily indebted, which is consistent with the ample micro-level evidence about the consequence of liquidity constraints on labor supply decisions (e.g., Del Boca and Lusardi, 2003; Rossi and Trucchi, 2016; Dao Bui and Ume, 2020). The response of average hours worked is also state-dependent, but at a lower level than employment.

Interestingly, the response of real wages does not depend on the state of household debt, particularly in the short run, implying that the response of labor demand should also be state-dependent (increases during the high-debt and decreases during the low-debt state). Labor supply and demand move in the same direction subject to the state of household debt; thus, their effects

[17] The precise description of each variable is as follows: the total number of nonfarm employees, average weekly hours of production and nonsupervisory employees, and average hours earnings of production and nonsupervisory employees deflated by the CPI, respectively. All the data are downloaded from the Bureau of Labor Statistics.

on real wages are effectively canceled. The increased labor demand squares with the increased business investment demand during the high-debt state presented earlier (Figure 3). Considering the combination of the absence of the wealth effect in the neoclassical model and the relaxation of household liquidity constraint in the Keynesian model together can account for the strong expansionary effects on consumption and output when households are heavily indebted.

Effects on the housing market. We examine the state-dependent response of housing market variables to the exogenous tax shock. Given that we proxy household liquidity constraints by its indebtedness, this exercise illustrates how household liquidity constraints interact with housing market conditions. We use the median sales price of houses from the U.S. Census Bureau to measure housing prices at the national level. We take the number of new private housing units authorized by the U.S. Census Bureau to measure the supply side of housing markets.

Figure 9 depicts the responses of the housing market variables to the exogenous tax reduction. In contrast to the consumption and labor responses, the responses of housing prices and housing supply do not depend on the underlying state of the household debt, suggesting that our findings do not simply capture the interaction between housing cycles and tax policy. Consistent with the residential investment case (Figure 3), this finding highlights the particular role of household liquidity constraint captured by its indebtedness and consumption and labor decisions of households.

Government spending vs. tax shocks. So far, our analysis has exclusively focused on exogenous tax shocks affecting household disposable income, thereby interacting directly with household indebtedness. Contrarily, the type of government spending shocks, such as military news, studied in the literature (e.g., Bernardini and Peersman, 2018) does not affect household liquidity constraints directly, suggesting a different transmission channel from ours. Moreover, in comparison to the case of tax policy, both theoretical predictions and empirical evidence about the effect of government spending policy on consumption have not reached a consensus, creating an additional challenge for identifying a channel. For example, while standard neoclassical models predict that consumption will decline following a rise in government expenditure, the new Keynesian models often predict the opposite.

To the extent to which the channel through government spending policy influences the macroeconomy shows variations from tax policy, the state of household indebtedness does not necessarily play an identical role in transmitting government spending shocks. We explore this possibility by re-examining the work by Bernardini and Peersman (2018). Following Bernardini and Peersman (2018), we use innovations to government purchases similar to Blanchard and Perotti (2002) and Ramey (2011)'s narratively identified defense news shocks to identify exogenous shifts in government spending. Despite the stronger exogeneity of the narrative defense news shock series, we give more weight to the findings by following Blanchard and Perotti (2002) because our sample only starts from 1955, and the defense news shock series is considered less informative for government expenditure in a sample that excludes both the big wars (Ramey, 2011).

Figure 10 shows both linear and state-dependent responses of the real GDP, consumption, and investment to a one percent increase in government spending using the Blanchard and Perotti (2002) specification. While we confirm the stronger expansionary effect of the spending increase during the high-debt state in Bernardini and Peersman (2018), the state-dependent effects are much weaker than the case of tax shocks overall. Moreover, we do not find a stronger increase in private consumption, which has the most important role in transmitting the tax policy when households are heavily indebted. Such a weak state-dependent effect is also confirmed when using a binary indicator over a probabilistic setup (Figure A.14), and military spending news shocks by Ramey (2011) (Figure A.15 in the Appendix).

It is not clear whether the reduced role of household indebtedness in explaining the macroeconomic impact of government spending policy than tax policy truly reflects a different underlying mechanism or is merely a product of weak statistical power in the identified government spending shock series during the post-war sample. Nevertheless, it appears that tax policy—compared to government spending policy—has more discernible interaction with the state of household indebtedness and more potential for stimulating output when households are heavily indebted based on recent U.S. data. The recent studies by Candelon and Lieb (2013) and Arin et al. (2015) consider the state-dependent effects of the government spending and tax policy jointly and argue that active spending policies should be preferred to tax cuts during recessions. Our finding sheds new light on the existing literature by presenting new evidence that tax cuts should be preferred to government spending when households are heavily indebted.

IV. CONCLUSION

In this study, we find that the effectiveness of tax policy can be enhanced when households are heavily indebted using state-dependent local projections applied to the exogenous tax shock series constructed by Romer and Romer (2010). The findings remain robust after controlling for other confounding factors, such as the stance of monetary policy and subsequent fiscal policy. The primary mechanism through which such state-dependent effectiveness of tax policy manifests is the response of private consumption, which is consistent with the underlying identifying assumption that the level of household debt proxies household liquidity constraints in the presence of wealthy hand-to-mouth households (Kaplan and Violante, 2014). The sharp difference in the response of employment and hours worked between the high and low-debt states helps in understanding the additional source of asymmetry in tax multipliers. While a tax cut reduces labor supply through a wealth effect when the level of household indebtedness is low, the wealth effect is largely absent when households are liquidity-constrained.

As the household debt is augmented with other states of the economy, such as the phase of business cycles, slack of labor markets, and financial market conditions, the household debt-dependent effects of tax policy still hold. If anything, these effects are more noticeable during bad times, consistent with the implication of unfavorable economic and financial conditions on further tightening the liquidity constraint when households are heavily indebted. We find that the state-dependent effects on output and consumption are mostly driven by the personal income tax shock using a breakdown of the exogenous tax shocks into unanticipated personal income tax and corporate income tax shocks. In our sample from 1955 to 2011, the effectiveness of tax policy depends much more on the state of household indebtedness than government spending policy, further lending support to the liquidity constraint channel of tax policy.

With inference from the recent study by Alpanda and Zubairy (2019) that monetary policy becomes less effective when the level of household indebtedness is high, our findings provide a clear policy implication. An aggressive fiscal stimulus through a tax cut is much needed during periods with high household debt because tax policy is the most effective, and monetary policy is the least effective during these periods.

References

Agarwal, Sumit, Chunlin Liu, and Nicholas S. Souleles. "The reaction of consumer spending and debt to tax rebates—evidence from consumer credit data." Journal of Political Economy 115, no. 6 (2007): 986-1019.

Alpanda, Sami, and Sarah Zubairy. "Household debt overhang and transmission of monetary policy." Journal of Money, Credit and Banking 51, no. 5 (2019): 1265-1307.

Andrés, Javier, José E. Boscá, and Javier Ferri. "Household debt and fiscal multipliers." Economica 82 (2015): 1048-1081.

Arin, K. Peren, Faik Koray, and Nicola Spagnolo. "Fiscal multipliers in good times and bad times." Journal of Macroeconomics 44 (2015): 303-311.

Auerbach, Alan J, and Yuriy Gorodnichenko. "Measuring the Output Responses to Fiscal Policy." American Economic Journal: Economic Policy 4, no. 2 (2012): 1–27.

Bachmann, Rüdiger, and Eric R. Sims. "Confidence and the transmission of government spending shocks." Journal of Monetary Economics 59, no. 3 (2012): 235-249.

Barnichon, Regis, and Christian Matthes. "Understanding the Size of the Government Spending Multiplier: it's in the Sign." Mimeo (2017).

Baum, Anja, Marcos Poplawski-Ribeiro, and Anke Weber. "Fiscal Multipliers and the State of the Economy." IMF Working Papers 12, no. 286 (2012): 1.

Baxter, Marianne, and Robert G. King. "Measuring Business Cycles: Approximate Band-Pass Filters for Economic Time Series." Review of Economics and Statistics 81, no. 4 (1999): 575–93.

Berger, David, and Joseph Vavra. "Measuring how fiscal shocks affect durable spending in recessions and expansions." American Economic Review 104, no. 5 (2014): 112-15.

Bernardini, Marco, and Gert Peersman. "Private Debt Overhang and the Government Spending Multiplier: Evidence for the United States." Journal of Applied Econometrics 33, no. 4 (2018): 485–508.

Biolsi, Christopher. "Nonlinear effects of fiscal policy over the business cycle." Journal of Economic Dynamics and Control 78 (2017): 54-87.

Blanchard, O., and R. Perotti. "An Empirical Characterization of the Dynamic Effects of Changes in Government Spending and Taxes on Output." Quarterly Journal of Economics 117, no. 4 (2002): 1329–68.

Bunn, Philip, Jeanne Le Roux, Kate Reinold, and Paolo Surico. "The consumption response to positive and negative income shocks." Journal of Monetary Economics 96 (2018): 1-15.

Candelon, Bertrand, and Lenard Lieb. "Fiscal policy in good and bad times." Journal of Economic Dynamics and Control 37, no. 12 (2013): 2679-2694.

Chahrour, Ryan, Stephanie Schmitt-Grohé, and Martín Uribe. "A model-based evaluation of the debate on the size of the tax multiplier." American Economic Journal: Economic Policy 4, no. 2 (2012): 28-45.

Christiano, Lawrence, Martin Eichenbaum, and Sergio Rebelo. "When Is the Government Spending Multiplier Large?" Journal of Political Economy 119, no. 1 (2011): 78–121.

Cloyne, James S., and Paolo Surico. "Household debt and the dynamic effects of income tax changes." Review of Economic Studies 84.1 (2017): 45-81.

Cloyne, James, Clodomiro Ferreira, and Paolo Surico. "Monetary policy when households have debt: new evidence on the transmission mechanism." Review of Economic Studies 87, no. 1 (2020): 102-129.

Davig, Troy, and Eric M. Leeper. "Monetary–fiscal policy interactions and fiscal stimulus." European Economic Review 55, no. 2 (2011): 211-227.

Dao Bui, Kien, and Ejindu S. Ume. "Credit Constraints and Labor Supply: Evidence From Bank Branching Deregulation." Economic Inquiry 58, no. 1 (2020): 335-360.

Deaton, Angus. "Saving and Liquidity Constraints." Econometrica (1991): 1221-1248.

Del Boca, Daniela, and Annamaria Lusardi. "Credit market constraints and labor market decisions." Labour Economics 10, no. 6 (2003): 681-703.

Demirel, Ufuk Devrim. "The Short-Term Effects of Tax Changes: The Role of State Dependence." Journal of Monetary Economics (forthcoming).

Demyanyk, Yuliya, Elena Loutskina, and Daniel Murphy. "Fiscal stimulus and consumer debt." Review of Economics and Statistics 101.4 (2019): 728-741.

Eggertsson, Gauti B., and Paul Krugman. "Debt, Deleveraging, and the Liquidity Trap: A Fisher-Minsky-Koo Approach." Quarterly Journal of Economics 127, no. 3 (2012): 1469–1513.

Eskandari, Ruhollah. "State-dependent macroeconomic effects of tax changes." Mimeo (2019).

Favero, Carlo, and Francesco Giavazzi. "Measuring tax multipliers: The narrative method in fiscal VARs." American Economic Journal: Economic Policy 4, no. 2 (2012): 69-94.

Fazzari, Steven M., James Morley, and Irina Panovska. "State-dependent effects of fiscal policy." Studies in Nonlinear Dynamics & Econometrics 19, no. 3 (2015): 285-315.

Fotiou, Alexandra, Wenyi Shen, and Shu-Chun S. Yang. "The Fiscal State-Dependent Effects of Capital Income Tax Cuts." Journal of Economic Dynamics and Control (2020): 103860.

Galí, Jordi, J. David López-Salido, and Javier Vallés. "Understanding the effects of government spending on consumption." Journal of the European Economic Association 5, no. 1 (2007): 227-270.

Gordon, Robert J., and Robert Krenn. "The end of the Great Depression: VAR insight on the roles of monetary and fiscal policy." NBER Working paper 16380 (2010): 183-231.

Granger, Clive, and Timo Teräsvirta. "Modelling Non-Linear Economic Relationships." Oxford University Press, 1993.

Hubbard, R. Glenn, Kenneth L. Judd, Robert E. Hall, and Lawrence Summers. "Liquidity constraints, fiscal policy, and consumption." Brookings Papers on Economic Activity 1986, no. 1 (1986): 1-59.

Huidrom, Raju, M. Ayhan Kose, Jamus J. Lim, and Franziska L. Ohnsorge. "Why do fiscal multipliers depend on fiscal Positions?" Journal of Monetary Economics (forthcoming).

Hussain, Syed M., and Samreen Malik. "Asymmetric effects of exogenous tax changes." Journal of Economic Dynamics and Control 69 (2016): 268-300.

Ilzetzki, Ethan, Enrique G. Mendoza, and Carlos A. Végh. "How big (small?) are fiscal multipliers?" Journal of Monetary Economics 60, no. 2 (2013): 239-254.

Jones, Paul M., Eric Olson, and Mark E. Wohar. "Asymmetric tax multipliers." Journal of Macroeconomics 43 (2015): 38-48.

Jordà, Òscar. "Estimation and Inference of Impulse Responses by Local Projections." American Economic Review 95, no. 1 (2005): 161–82.

Kaplan, Greg, and Giovanni L. Violante. "A model of the consumption response to fiscal stimulus payments." Econometrica 82, no. 4 (2014): 1199-1239.

Klein, Mathias. "Austerity and private debt." Journal of Money, Credit and Banking 49, no. 7 (2017): 1555-1585.

Leeper, Eric M., Todd B. Walker, and Shu-Chun Susan Yang. "Fiscal foresight and information flows." Econometrica 81, no. 3 (2013): 1115-1145.

Mertens, Karel, and Morten O. Ravn. "The dynamic effects of personal and corporate income tax changes in the United States." American Economic Review 103, no. 4 (2013): 1212-47.

Mertens, Karel, and Morten O. Ravn. "A reconciliation of SVAR and narrative estimates of tax multipliers." Journal of Monetary Economics 68 (2014): S1-S19.

Mian, Atif, Kamalesh Rao, and Amir Sufi. "Household balance sheets, consumption, and the economic slump." Quarterly Journal of Economics 128.4 (2013): 1687-1726.

Mian, Atif, Amir Sufi, and Emil Verner. "Household debt and business cycles worldwide." Quarterly Journal of Economics 132.4 (2017): 1755-1817.

Miyamoto, Wataru, Thuy Lan Nguyen, and Dmitriy Sergeyev. "Government spending multipliers under the zero lower bound: Evidence from Japan." American Economic Journal: Macroeconomics 10, no. 3 (2018): 247-77.

Mountford, Andrew, and Harald Uhlig. "What are the effects of fiscal policy shocks?" Journal of Applied Econometrics 24.6 (2009): 960-992.

Newey, Whitney K., and Kenneth D. West. "A Simple, Positive Semi-Definite, Heteroskedasticity and Autocorrelation." Econometrica 55, no. 3 (1987): 703-708.

Ramey, Valerie A. "Identifying Government Spending Shocks: It's All in the Timing." The Quarterly Journal of Economics 126, no. 1 (2011): 1–50.

Ramey, Valerie A., and Sarah Zubairy. “Government Spending Multipliers in Good Times and in Bad: Evidence from US Historical Data.” Journal of Political Economy 126, no. 2 (2018): 850–901.

Romer, Christina D, and David H Romer. “The Macroeconomic Effects of Tax Changes: Estimates Based on a New Measure of Fiscal Shocks.” American Economic Review 100, no. 3 (2010): 763–801.

Rossi, Mariacristina, and Serena Trucchi. “Liquidity constraints and labor supply.” European Economic Review 87 (2016): 176-193.

Shapiro, Matthew D., and Joel Slemrod. “Consumer response to tax rebates.” American Economic Review 93, no. 1 (2003): 381-396.

Sims, Eric, and Jonathan Wolff. “The state-dependent effects of tax shocks.” European Economic Review 107 (2018): 57-85.

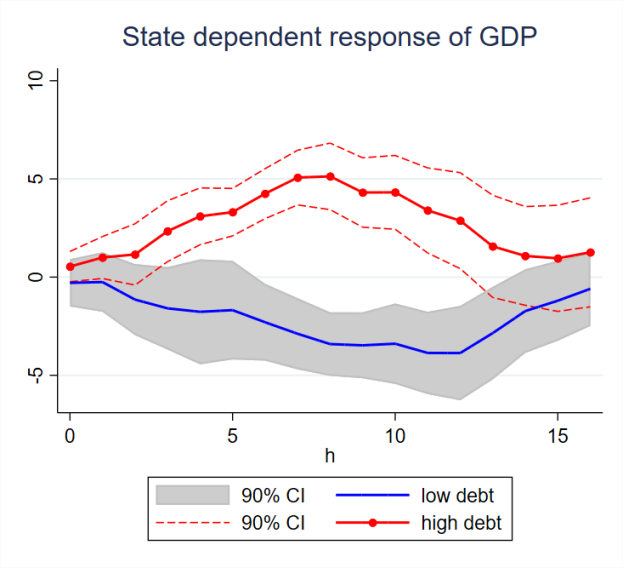
Teulings, Coen N., and Nikolay Zubanov. “Is economic recovery a myth? Robust estimation of impulse responses.” Journal of Applied Econometrics 29, no. 3 (2014): 497-514.

Woodford, Michael. “Simple analytics of the government expenditure multiplier.” American Economic Journal: Macroeconomics 3, no. 1 (2011): 1-35.

Ziegenbein, Alexander. “Can tax cuts restore economic growth in bad times?” Mimeo, 2017.

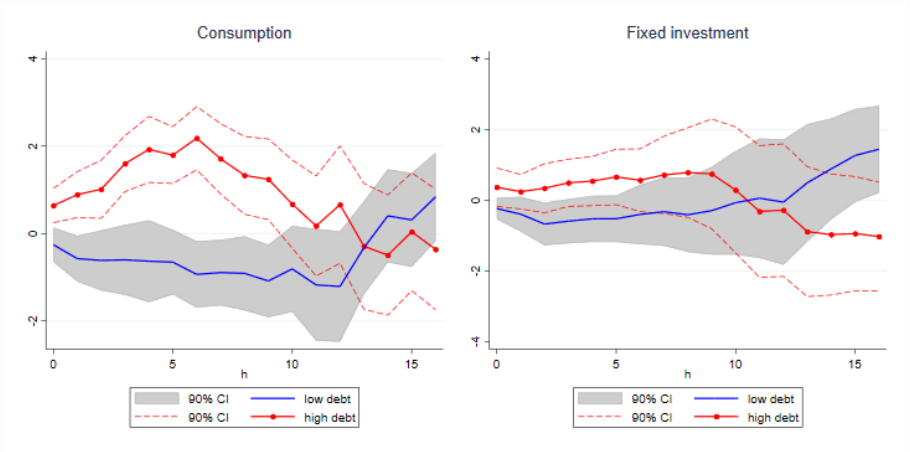
Figures and Tables

Figure 1. State-dependent effect of an exogenous tax cut on output



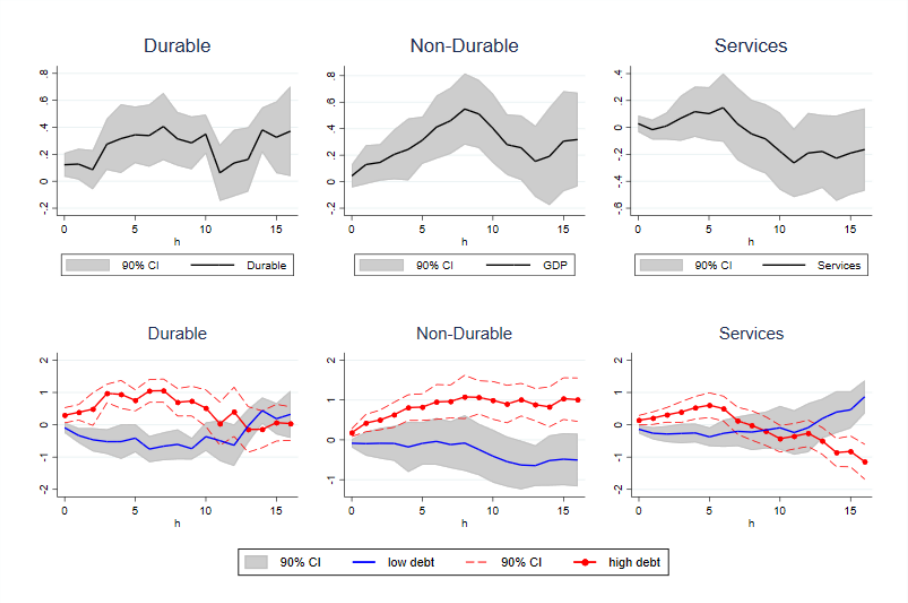
Note: This graph shows the state-dependent impulse response of GDP with a 90% confidence interval to an exogenous tax cut estimated using sample data from 1955Q1 to 2011Q4. The dependent variable and the tax shock are normalized by potential GDP estimated by the Congressional Budget Office. Heteroskedasticity and autocorrelation consistent (HAC) standard errors of Newey and West (1987) are used.

Figure 2. State-dependent effect of an exogenous tax cut on consumption and investment



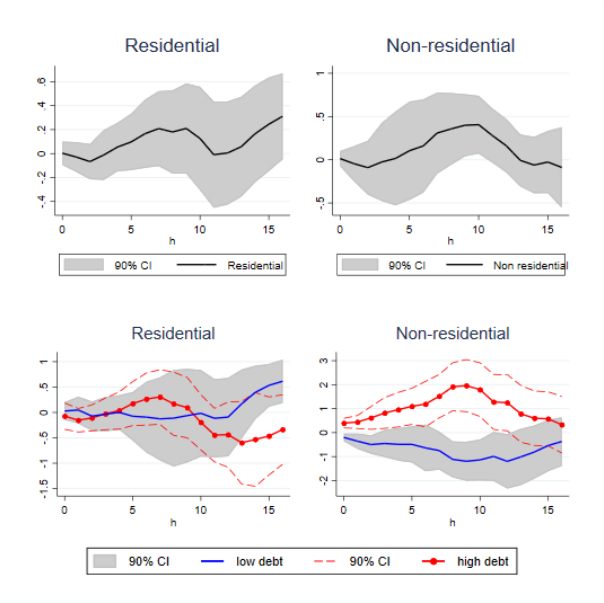
Note: This graph shows the state-dependent impulse response of private consumption (left) and private fixed investment (right) with a 90% confidence interval to an exogenous tax cut estimated using sample data from 1955Q1 to 2011Q4. The dependent variable and the tax shock are normalized by potential GDP estimated by the Congressional Budget Office. Heteroskedasticity and autocorrelation consistent (HAC) standard errors of Newey and West (1987) are used.

Figure 3. State-dependent effect of an exogenous tax cut on components of consumption



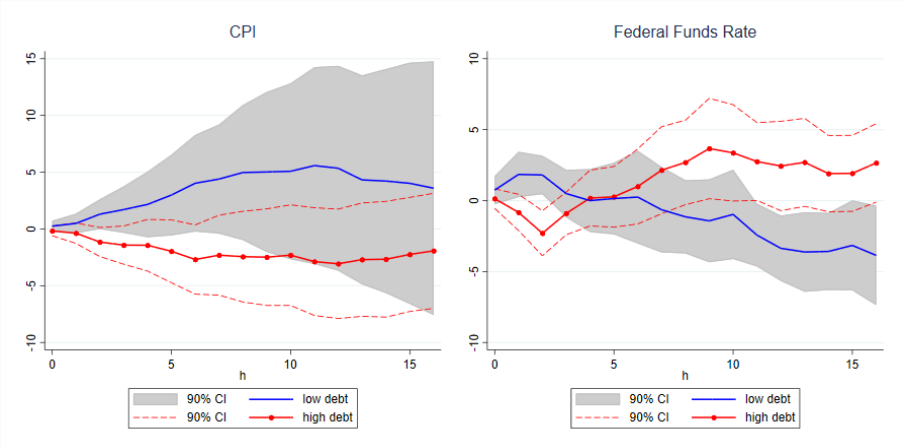
Note: This graph shows the linear (top) and state-dependent (bottom) impulse response of durable, non-durable, and service consumption with a 90% confidence interval to an exogenous tax cut estimated using sample data from 1955Q1 to 2011Q4. The dependent variable and the tax shock are normalized by potential GDP estimated by the Congressional Budget Office. Heteroskedasticity and autocorrelation consistent (HAC) standard errors of Newey and West (1987) are used.

Figure 4. State-dependent effect of an exogenous tax cut on components of investment



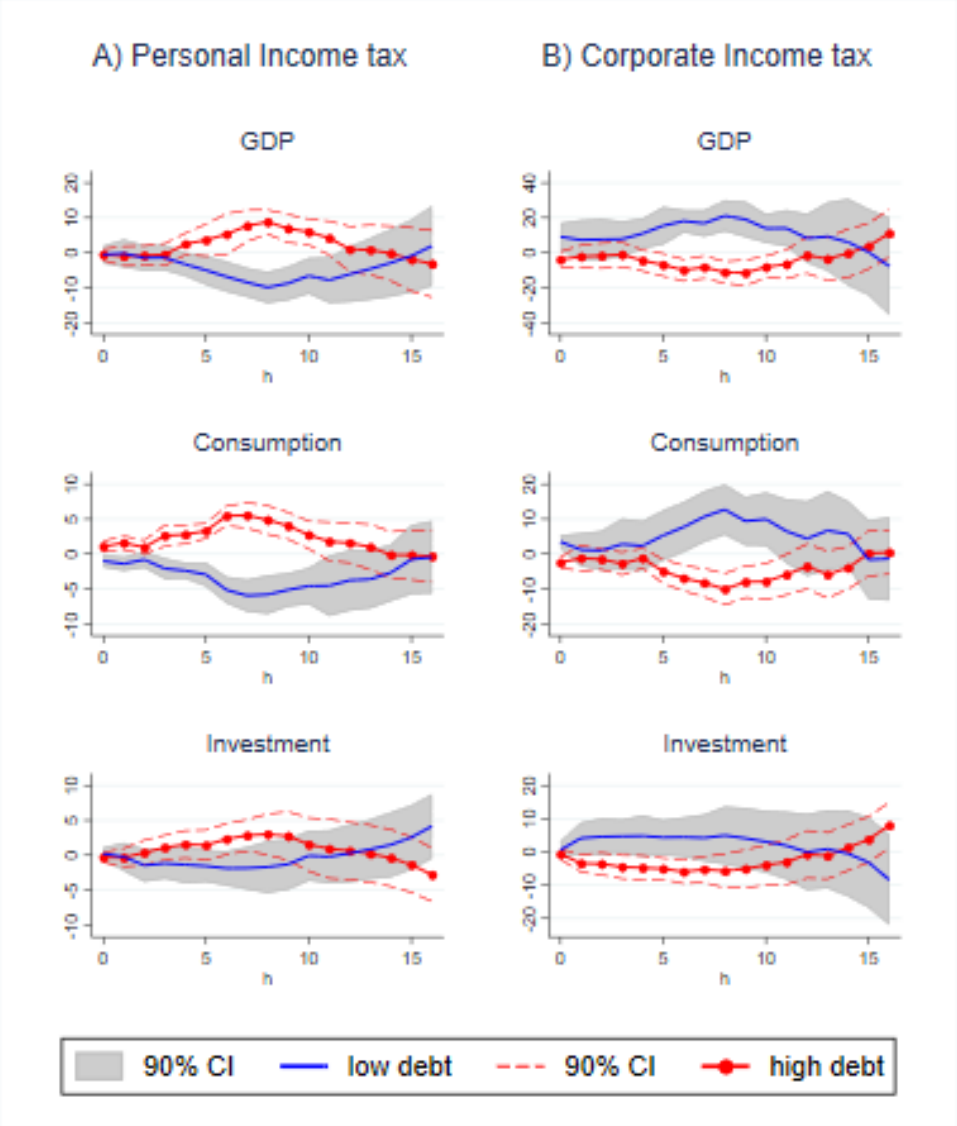
Note: This graph shows the linear (top) and state-dependent (bottom) impulse response of residential and non-residential investment with a 90% confidence interval to an exogenous tax cut estimated using sample data from 1955Q1 to 2011Q4. The dependent variable and the tax shock are normalized by potential GDP estimated by the Congressional Budget Office. Heteroskedasticity and autocorrelation consistent (HAC) standard errors of Newey and West (1987) are used.

Figure 5. State-dependent effect of an exogenous tax cut on the CPI and policy rate



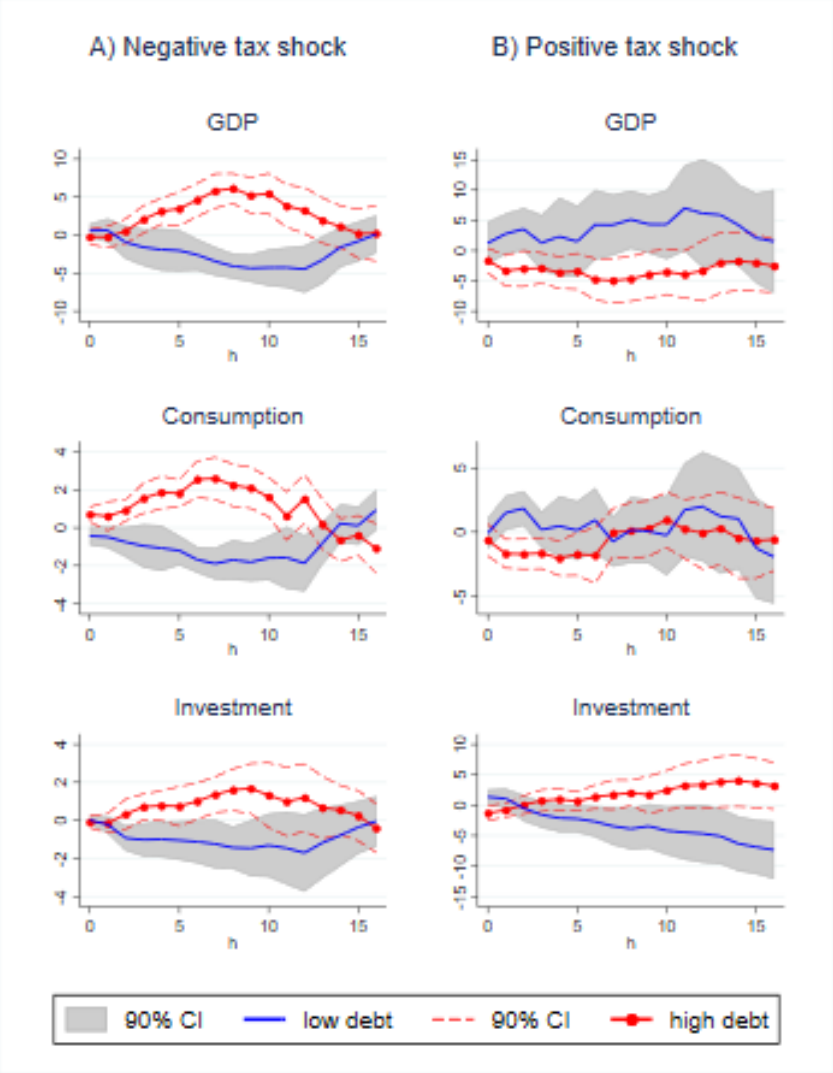
Note: This graph shows the state-dependent impulse response of the CPI (left) and federal funds rate (right) with a 90% confidence interval to an exogenous tax cut estimated using sample data from 1955Q1 to 2011Q4. The tax shock is normalized by potential GDP estimated by the Congressional Budget Office. The CPI and the federal funds rate are incorporated in logged value and level, respectively. Heteroskedasticity and autocorrelation consistent (HAC) standard errors of Newey and West (1987) are used.

Figure 6. State-dependent effect of unanticipated personal and corporate tax changes



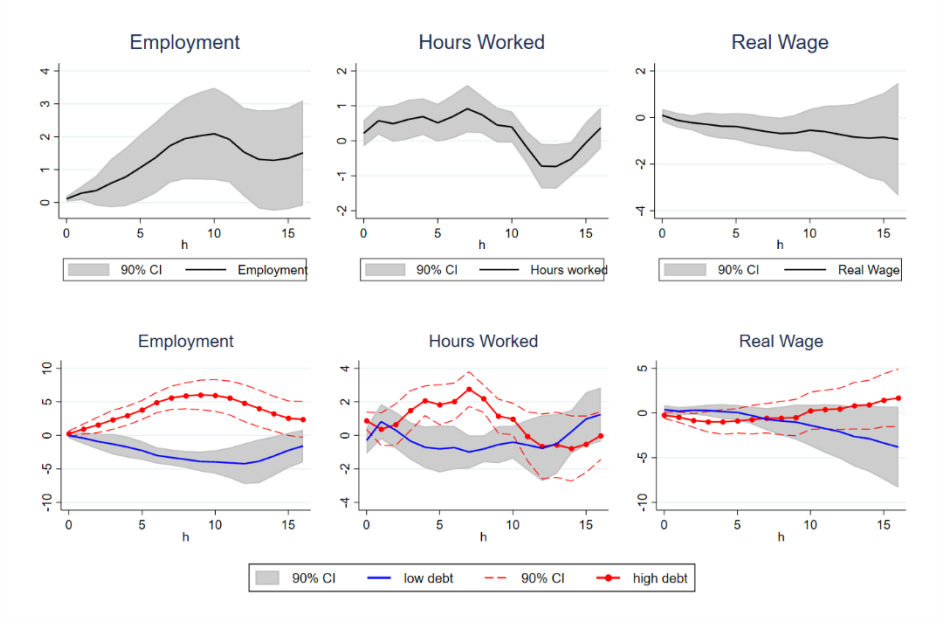
Note: This graph shows the state-dependent impulse response of output, consumption, and investment with a 90% confidence interval to an unanticipated personal income tax cut (Panel A) and corporate income tax cut (Panel B) estimated using sample data from 1955Q1 to 2011Q4. The dependent variable and the tax shock are normalized by potential GDP estimated by the Congressional Budget Office. Heteroskedasticity and autocorrelation consistent (HAC) standard errors of Newey and West (1987) are used.

Figure 7. State-dependent effect of the positive vs. negative tax shock



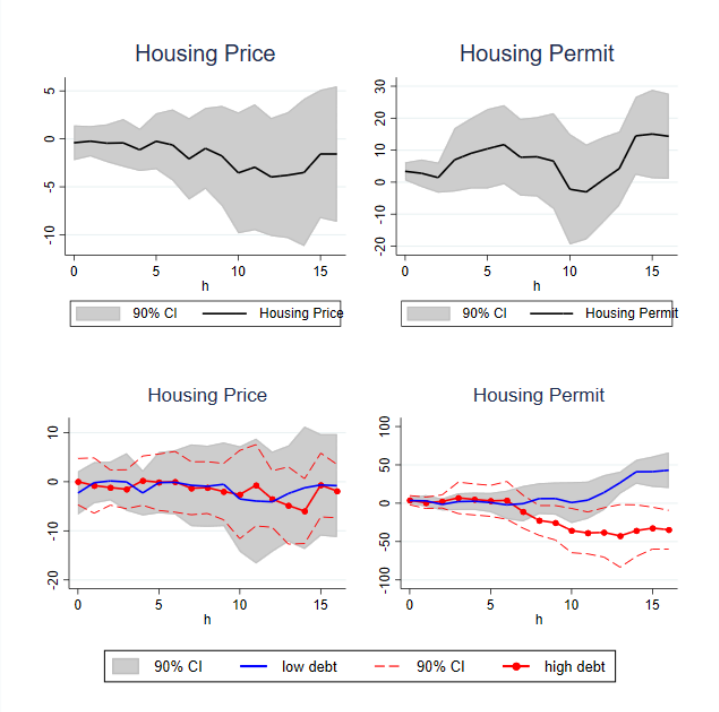
Note: This graph shows the state-dependent impulse response of output, consumption, and investment with a 90% confidence interval to a negative exogenous tax shock (panel A) and a positive exogenous tax shock (panel B) estimated using sample data from 1955Q1 to 2011Q4. The dependent variable and the tax shock are normalized by potential GDP estimated by the Congressional Budget Office. Heteroskedasticity and autocorrelation consistent (HAC) standard errors of Newey and West (1987) are used. For the case of the tax decrease in Panel A, we switch the sign of the response consistent with the baseline analysis.

Figure 8. State-dependent effect of an exogenous tax cut on labor market variables



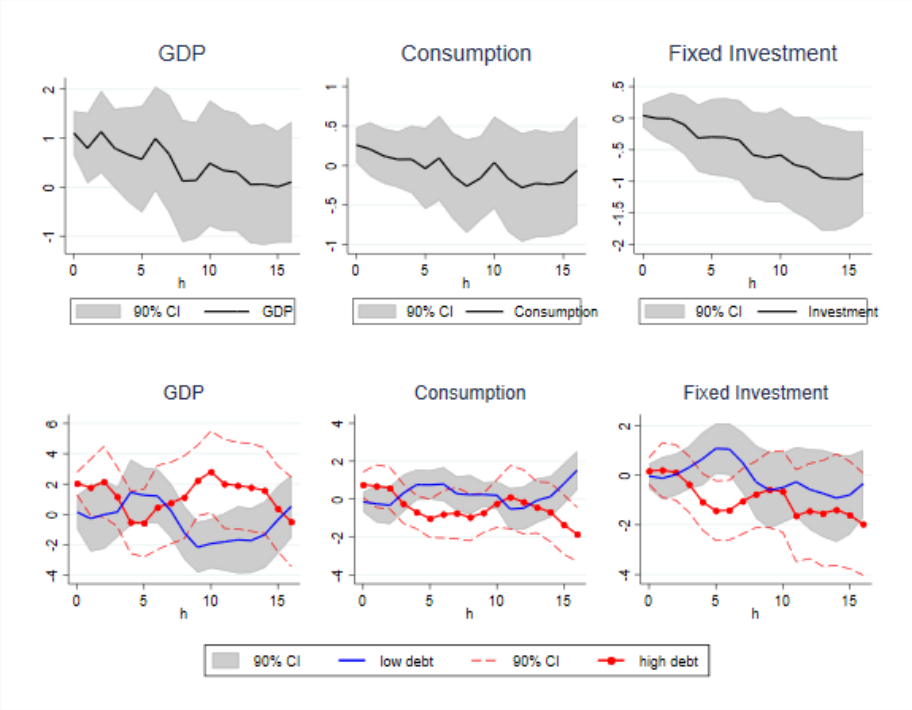
Note: This graph shows both linear (top) and state-dependent (bottom) impulse response of employment, hours worked, and real wages with a 90% confidence interval to an exogenous tax cut estimated using sample data from 1955Q1 to 2011Q4 (employment and hours worked) and from 1964Q1 to 2011Q4 (real wage). The dependent variable and the tax shock are normalized by potential GDP estimated by the Congressional Budget Office. Heteroskedasticity and autocorrelation consistent (HAC) standard errors of Newey and West (1987) are used.

Figure 9. State-dependent effect of an exogenous tax cut on housing market variables



Note: This graph shows both linear (top) and state-dependent (bottom) impulse response of housing prices and housing permits with a 90% confidence interval to an exogenous tax cut estimated using sample data from 1963Q1 to 2011Q4 (housing prices) and from 1960Q1 to 2011Q4 (housing permit). The dependent variable and the tax shock are normalized by potential GDP estimated by the Congressional Budget Office. Heteroskedasticity and autocorrelation consistent (HAC) standard errors of Newey and West (1987) are used.

Figure 10. State-dependent effect of a government spending increase using Blanchard and Perotti (2002)



Note: This graph shows the linear (top) and state-dependent (bottom) impulse response of GDP, consumption, and investment with a 90% confidence interval to an exogenous government spending increase estimated using sample data from 1955Q1 to 2011Q4. The government spending shock is identified as in Blanchard and Perotti (2002). The dependent variable and the spending shock are normalized by potential GDP estimated by the Congressional Budget Office. Heteroskedasticity and autocorrelation consistent (HAC) standard errors of Newey and West (1987) are used.

Table 1. Estimates of tax multiplier across the state of household indebtedness

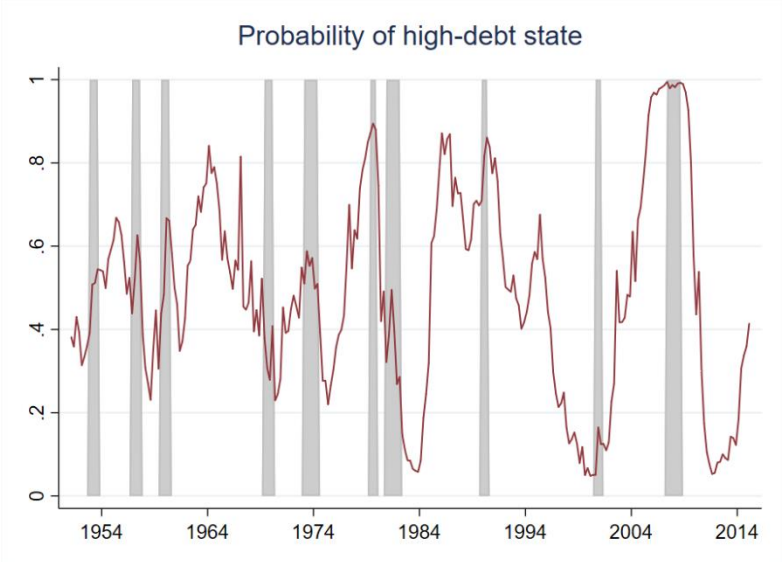
	Linear model	High debt	Low debt
Smooth transition			
On impact	0.30	1.28	-0.70
2-year	3.24	11.33	-6.71
Binary indicator			
On impact	0.30	0.79	-0.71
2-year	3.24	5.62	-1.17
Binary indicator (state-by-state)			
On impact	0.30	0.53	-1.07
2-year	3.24	5.76	-1.98

Note: Reported numbers are the estimated percentage changes in output on impact and a two-year horizon resulting from a change in revenues by one percent of output over the same period in different states of the economy.

Appendix

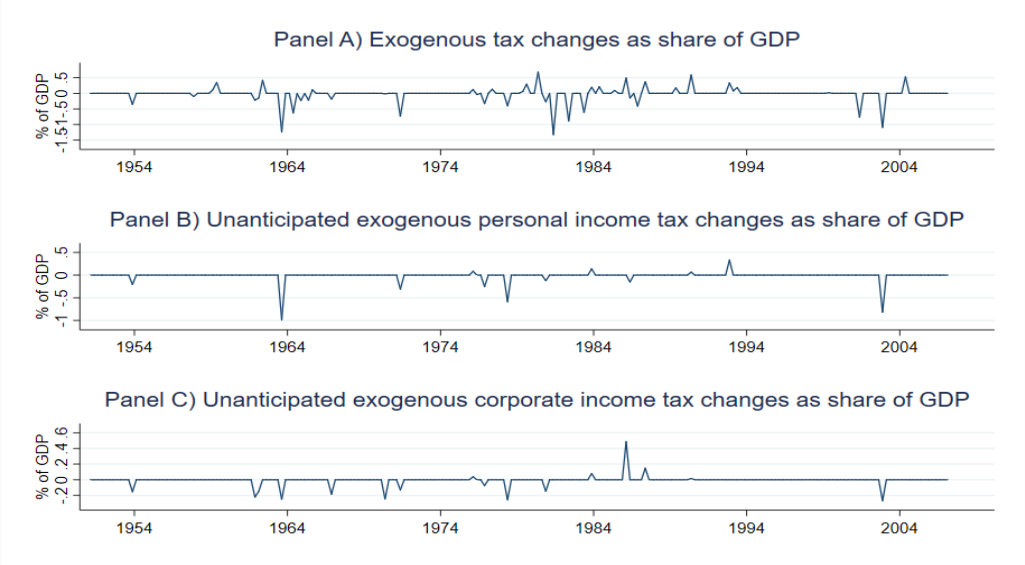
A. Additional figures and tables

Figure A.1. Probability of the high household debt state



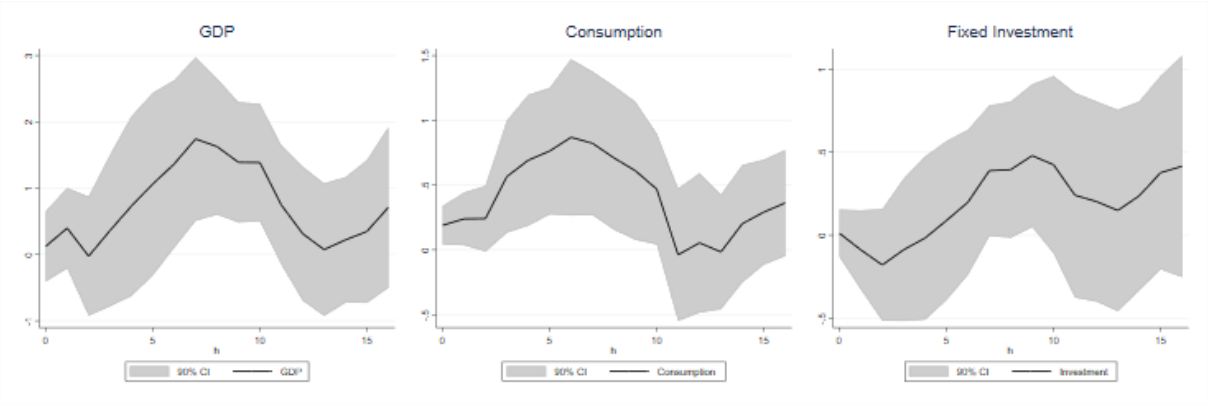
Note: This graph shows the probability of a high-household debt state to occur calculated using household debt to GDP ratio from 1951Q4 to 2015Q4 through the smooth transition function. The shaded area denotes the recession period defined by the National Bureau of Economic Research.

Figure A.2. Narrative exogenous tax shocks



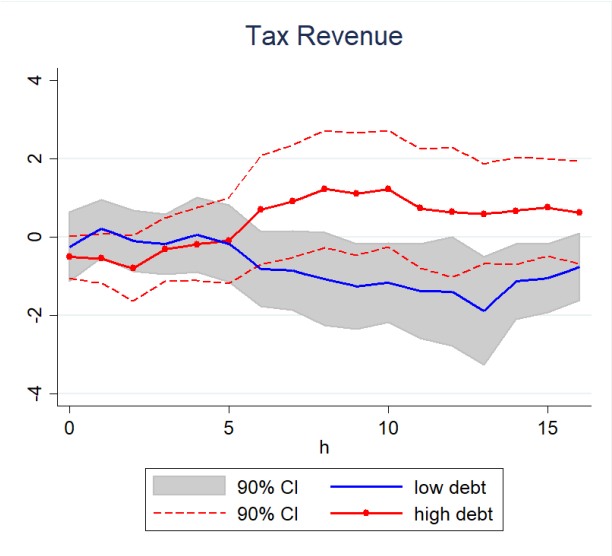
Note: This graph plots measures of exogenous tax changes. In Panel A, narrative tax shock from Romer and Romer (2010) as a share of nominal GDP is shown. The bottom figures display the unanticipated exogenous personal income tax shock (Panel B) and the corporate income tax shock (Panel C) from Mertens and Ravn (2012).

Figure A.3. Effect of an exogenous tax cut on output, consumption, and investment.



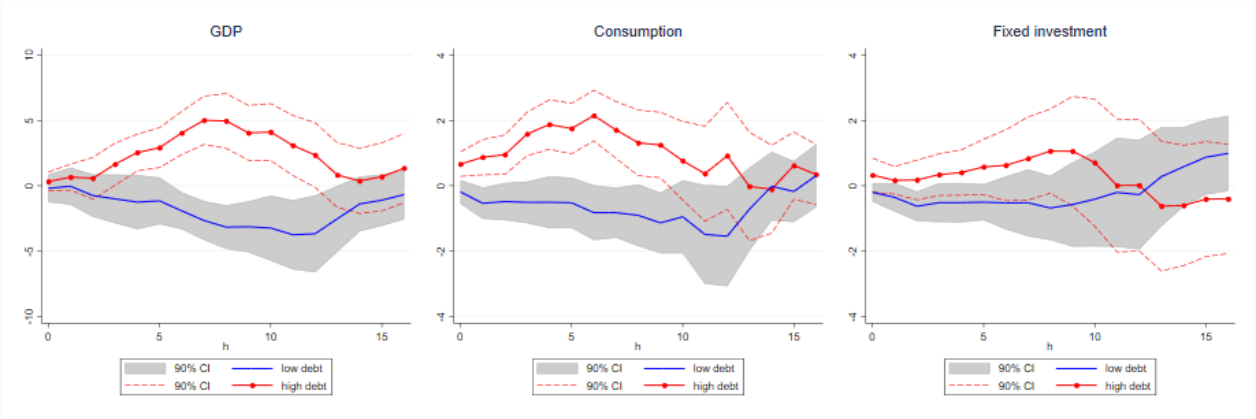
Note: This graph shows the impulse response of GDP, private consumption, and private fixed investment with a 90% confidence interval to an exogenous tax cut estimated using sample data from 1955Q1 to 2011Q4. The dependent variable and the tax shock are normalized by potential GDP estimated by the Congressional Budget Office. Heteroskedasticity and autocorrelation consistent (HAC) standard errors of Newey and West (1987) are used.

Figure A.4. State-dependent effect of an exogenous tax cut on tax revenue



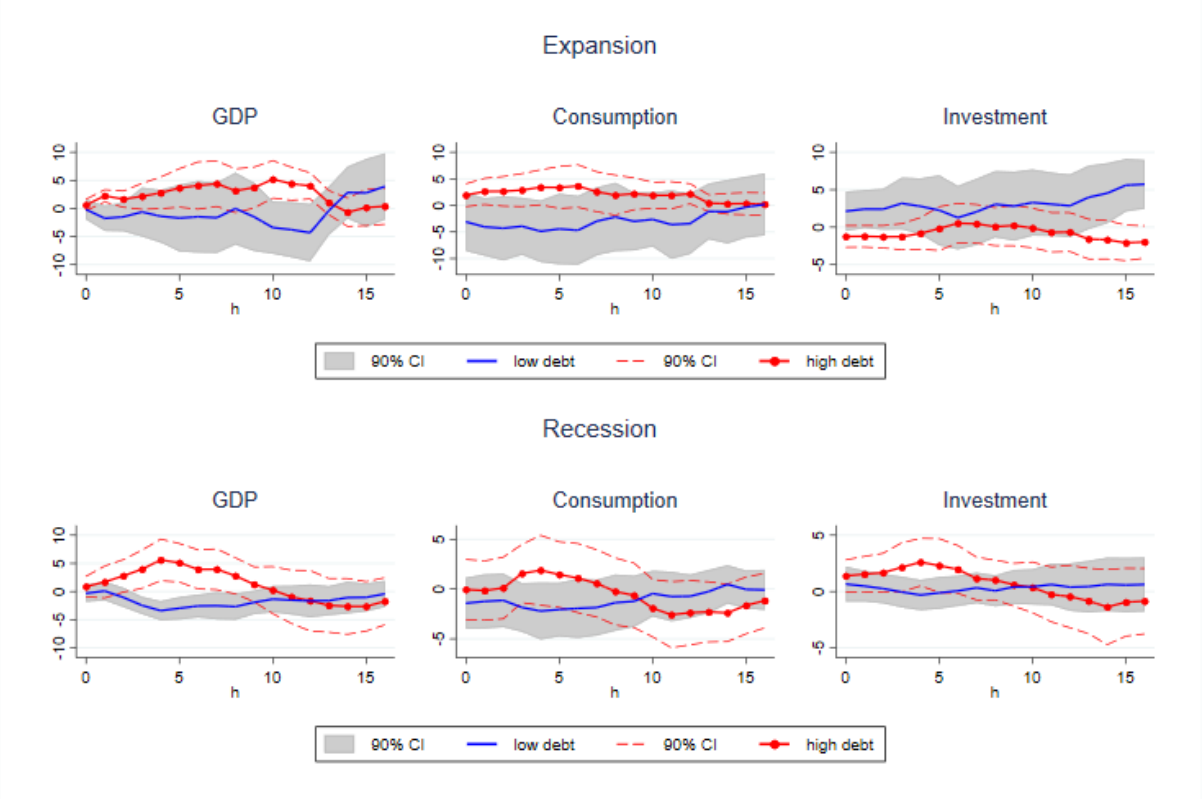
Note: This graph shows the state-dependent impulse response of tax revenues with a 90% confidence interval to an exogenous tax cut estimated using sample data from 1955Q1 to 2011Q4. The dependent variable and the tax shock are normalized by potential GDP estimated by the Congressional Budget Office. Heteroskedasticity and autocorrelation consistent (HAC) standard errors of Newey and West (1987) are used.

Figure A.5. State-dependent effect of an exogenous tax cut controlling for the tax revenue response



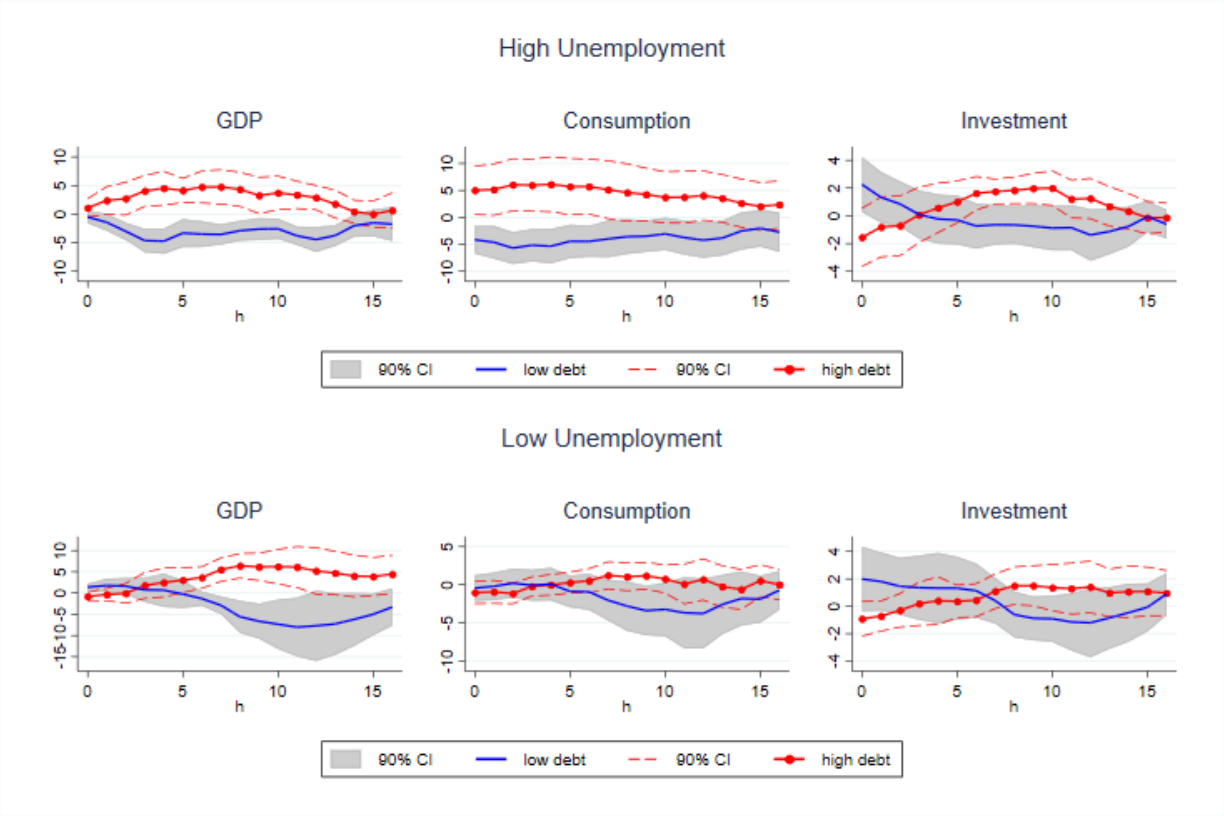
Note: This graph shows the state-dependent impulse response of GDP, private consumption, and private fixed investment with a 90% confidence interval to an exogenous tax cut estimated using sample data from 1955Q1 to 2011Q4. The dependent variable and the tax shock are normalized by potential GDP estimated by the Congressional Budget Office. Heteroskedasticity and autocorrelation consistent (HAC) standard errors of Newey and West (1987) are used.

Figure A.6. State-dependent effect of an exogenous tax cut interacting with other states: business cycles



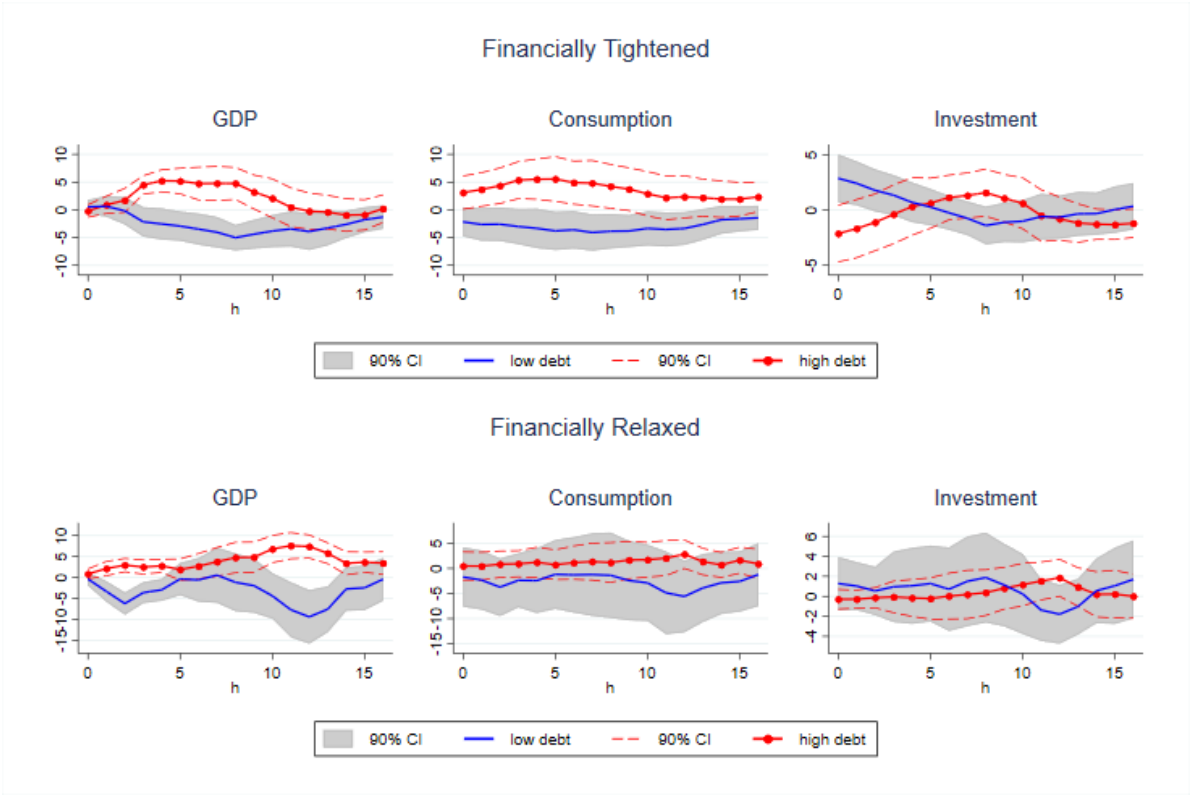
Note: This graph shows the state-dependent impulse response of GDP, consumption, and investment with a 90 % confidence interval to an exogenous tax cut for the four different states using a combination of two state variables, the state of household indebtedness and business cycles. The dependent variables and the tax shock are normalized by potential GDP estimated by the Congressional Budget Office, and sample data from 1955Q1 to 2011Q4 are used. Heteroskedasticity and autocorrelation consistent (HAC) standard errors of Newey and West (1987) are used.

Figure A.7. State-dependent effect of an exogenous tax cut interacting with other states: labor market slack



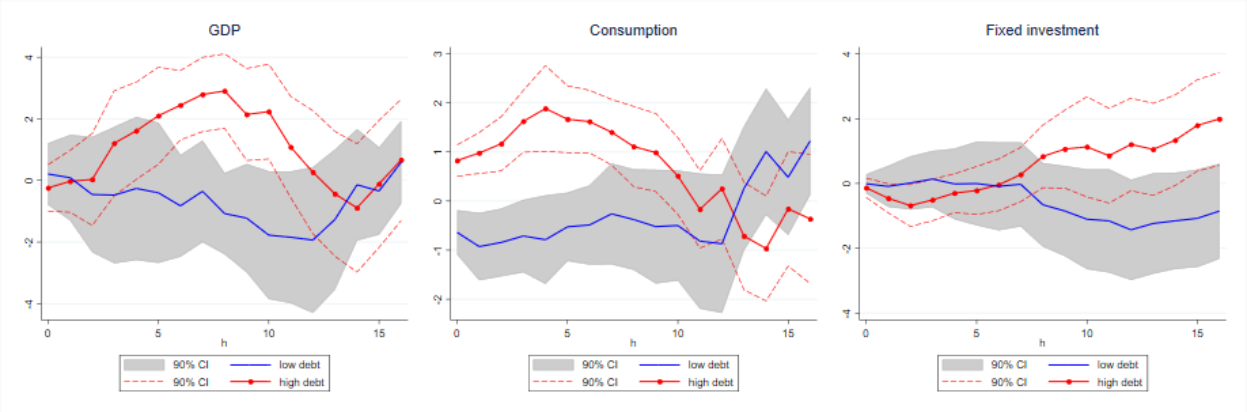
Note: This graph shows the state-dependent impulse response of GDP, consumption, and investment with a 90 % confidence interval to an exogenous tax cut for the four different states using a combination of two state variables, the state of household indebtedness and labor market slack. The dependent variables and the tax shock are normalized by potential GDP estimated by the Congressional Budget Office, and sample data from 1955Q1 to 2011Q4 are used. Heteroskedasticity and autocorrelation consistent (HAC) standard errors of Newey and West (1987) are used.

Figure A.8. State-dependent effect of an exogenous tax cut interacting with other states: financial market conditions



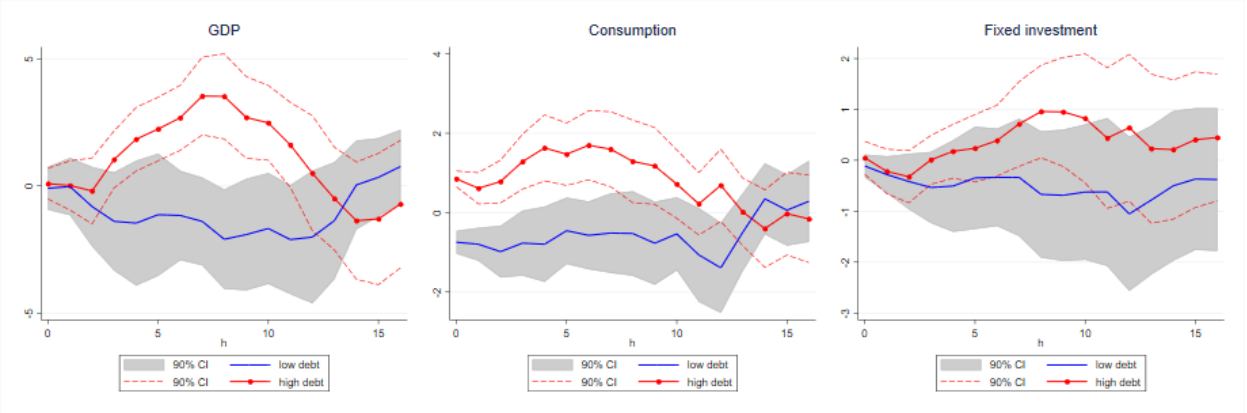
Note: This graph shows the state-dependent impulse response of GDP, consumption, and investment with a 90 % confidence interval to an exogenous tax cut for the four different states using a combination of two state variables, the state of household indebtedness and financial market conditions. The dependent variables and the tax shock are normalized by potential GDP estimated by the Congressional Budget Office, and sample data from 1955Q1 to 2011Q4 are used. Heteroskedasticity and autocorrelation consistent (HAC) standard errors of Newey and West (1987) are used.

Figure A.9. State-dependent effect of an exogenous tax cut controlling for financial conditions



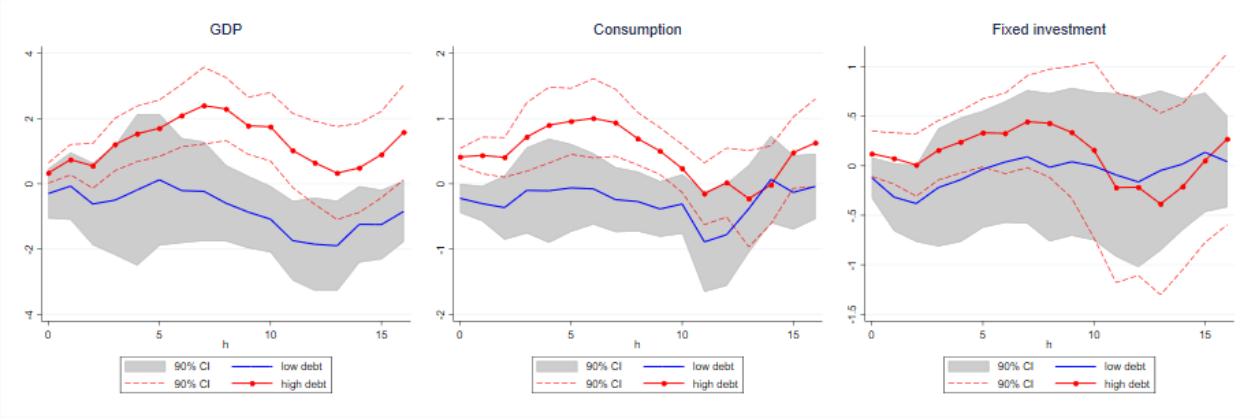
Note: This graph shows the state-dependent impulse response of GDP, private consumption, and private fixed investment with a 90% confidence interval to an exogenous tax cut estimated using sample data from 1955Q1 to 2011Q4. The dependent variable and the tax shock are normalized by potential GDP estimated by the Congressional Budget Office. Heteroskedasticity and autocorrelation consistent (HAC) standard errors of Newey and West (1987) are used.

Figure A.10. State-dependent effect of an exogenous tax cut after controlling for the monetary policy stance



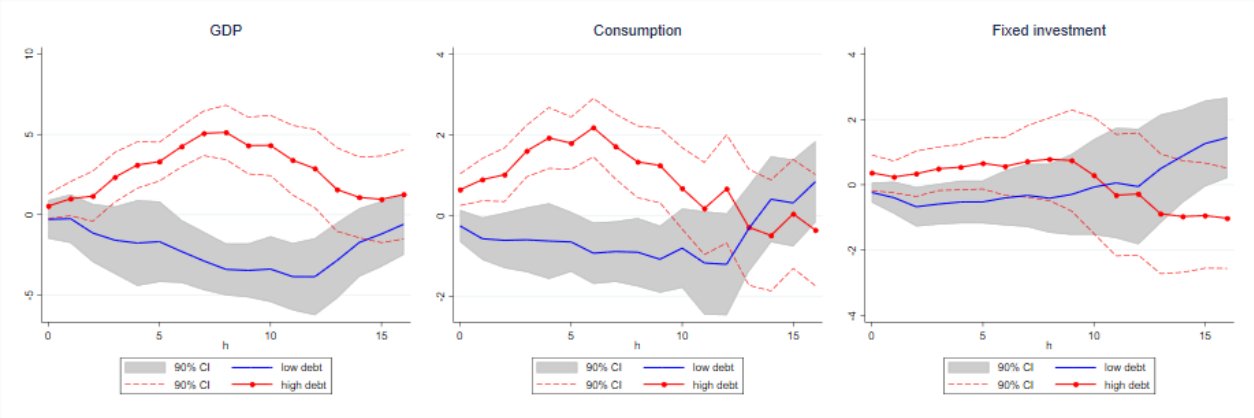
Note: This graph shows the state-dependent impulse response of GDP, private consumption, and private fixed investment with a 90% confidence interval to an exogenous tax cut estimated using sample data from 1955Q1 to 2011Q4. The dependent variable and the tax shock are normalized by potential GDP estimated by the Congressional Budget Office. Heteroskedasticity and autocorrelation consistent (HAC) standard errors of Newey and West (1987) are used.

Figure A.11. State-dependent effect of an exogenous tax cut using an alternative definition of the state using a binary indicator



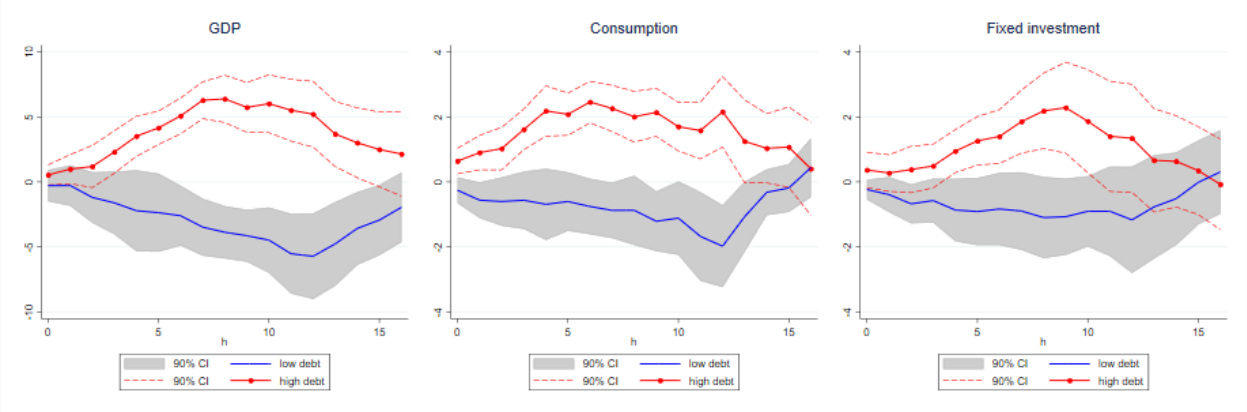
Note: This graph shows the state-dependent impulse response of GDP, private consumption, and private fixed investment with a 90% confidence interval to an exogenous tax cut estimated using sample data from 1955Q1 to 2011Q4. The dependent variable and the tax shock are normalized by potential GDP estimated by the Congressional Budget Office. Heteroskedasticity and autocorrelation consistent (HAC) standard errors of Newey and West (1987) are used.

Figure A.12. State-dependent effect of an exogenous tax cut using an alternative definition of the state using a band-pass filter



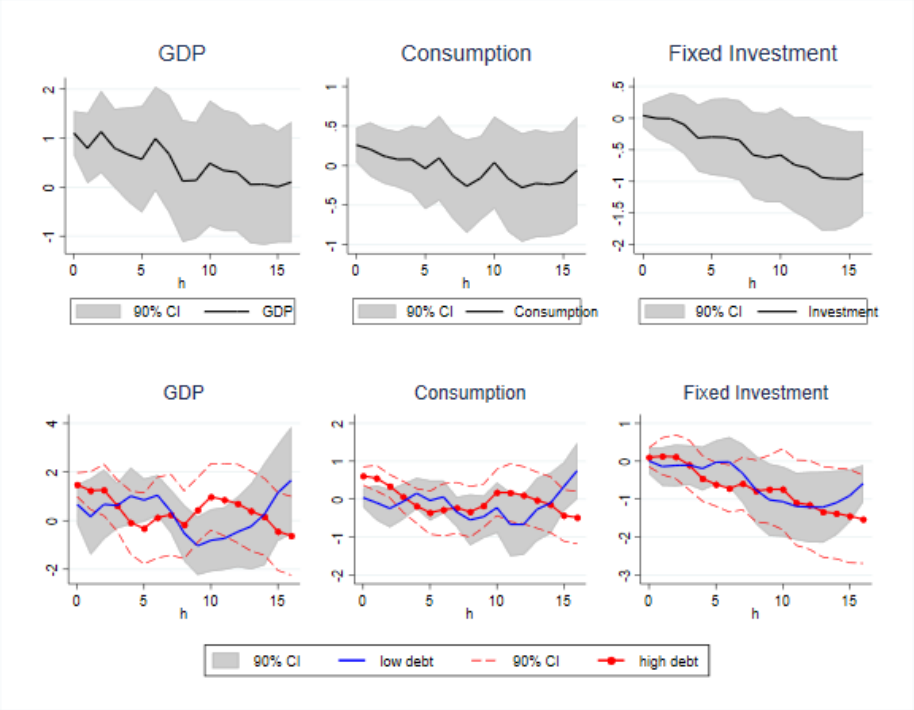
Note: This graph shows the state-dependent impulse response of GDP, private consumption, and private fixed investment with a 90% confidence interval to an exogenous tax cut estimated using sample data from 1955Q1 to 2011Q4. The dependent variable and the tax shock are normalized by potential GDP estimated by the Congressional Budget Office. Heteroskedasticity and autocorrelation consistent (HAC) standard errors of Newey and West (1987) are used.

Figure A.13. State-dependent effect of an exogenous tax cut after controlling for the future tax shocks



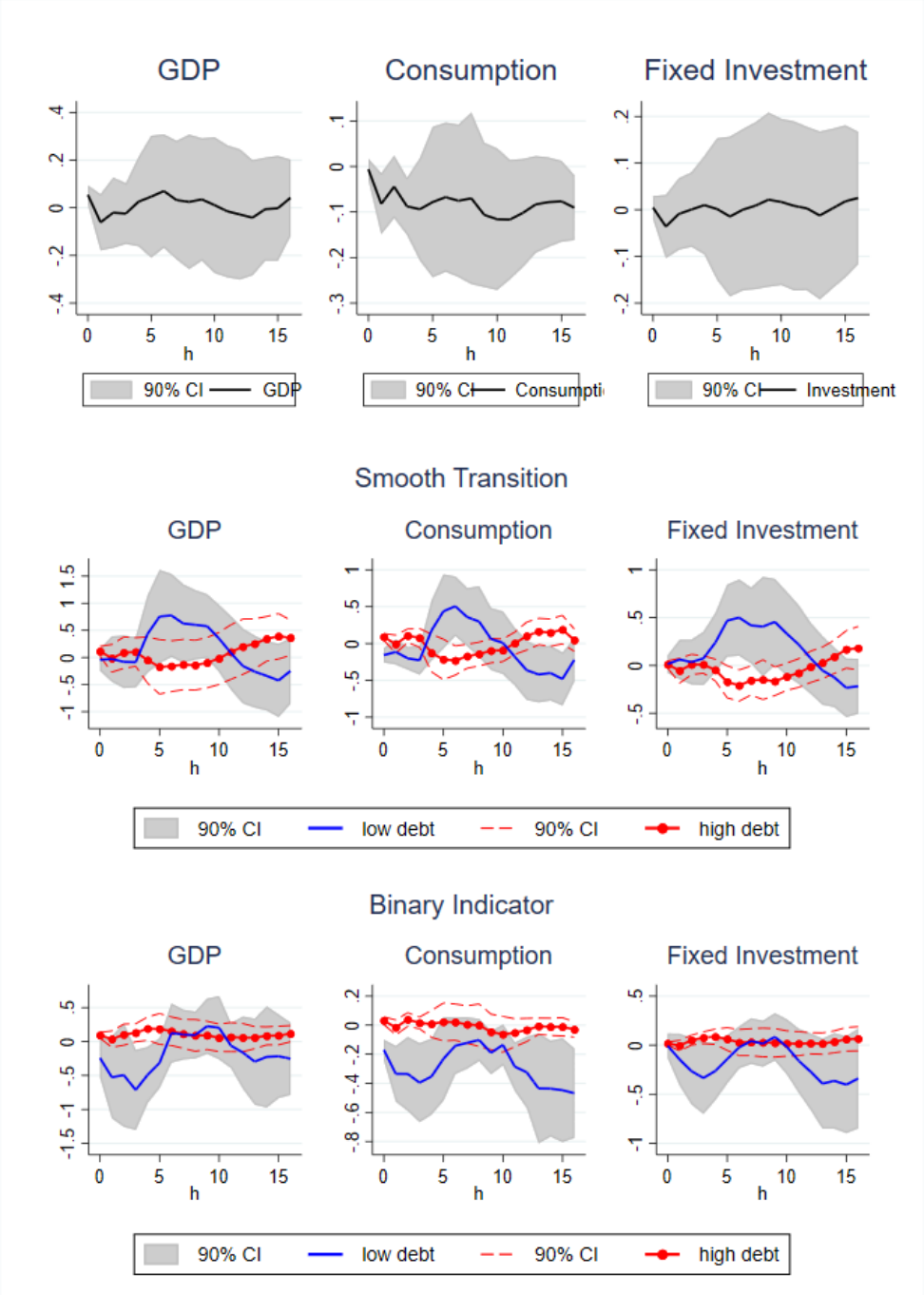
Note: This graph shows the state-dependent impulse response of GDP, private consumption, and private fixed investment with a 90% confidence interval to an exogenous tax cut estimated using sample data from 1955Q1 to 2011Q4. The dependent variable and the tax shock are normalized by potential GDP estimated by the Congressional Budget Office. Heteroskedasticity and autocorrelation consistent (HAC) standard errors of Newey and West (1987) are used.

Figure A.14. State-dependent effect of a government spending increase using Blanchard and Perotti (2002) and a binary indicator



Note: This graph shows the linear (top) and state-dependent (bottom) impulse response of GDP, consumption, and investment with a 90% confidence interval to an exogenous government spending increase estimated using sample data from 1955Q1 to 2011Q4. The government spending shock is identified as in Blanchard and Perotti (2002). The dependent variable and the spending shock are normalized by potential GDP estimated by the Congressional Budget Office. Heteroskedasticity and autocorrelation consistent (HAC) standard errors of Newey and West (1987) are used.

Figure A.15. State-dependent effect of a government spending increase using military spending news shock



Note: This graph shows the linear (top) and state-dependent (smooth transition for middle and a binary indicator for bottom) impulse response of GDP, consumption, and investment with a 90% confidence interval to an exogenous government spending increase estimated using sample data from 1955Q1 to 2011Q4. The government spending shock is identified by the military spending news shock of Ramey (2011). The dependent variable and the spending shock are normalized by potential GDP estimated by the Congressional Budget Office. Heteroskedasticity and autocorrelation consistent (HAC) standard errors of Newey and West (1987) are used.

Table A.1. Data description

Data	Source	Definition
Real GDP	Bureau of Economic Analysis	The value of the goods and services produced in the United States.
Consumption		Personal consumption expenditures. Goods and services purchased by households and nonprofit institutions serving households.
Durable consumption		Personal consumption expenditure on durable goods (goods with at least 3 years of useful life on average).
Non-durable consumption		Personal consumption expenditure on non-durable goods (goods with less than 3 years of useful life on average).
Service consumption		Personal consumption expenditure on services (commodities that cannot be stored or inventoried and that are usually consumed at the place and time of purchase).
Fixed investment		Spending by private businesses, nonprofit institutions and households on fixed assets in the U.S. economy.
Residential investment		Spendings on residential structures and equipment.
Non-residential investment		Spending on non-residential structures, equipment and intellectual property products.
Government spending		Government consumption and expenditures and gross investment. Spending by the government to produce and provide services to the public.
Tax revenue		Federal current receipt. Federal government's revenue, including current tax receipts and contributions for government social insurance. (FGRECPT)
Potential GDP	Congressional Budget Office	CBO's estimate of the output the economy would produce with a high rate of use of its capital and labor resources.
Consumer Price Index	Bureau of Labor Statistics	CPI for all urban consumers. (CIPAUCSL)
Employment		The total number of nonfarm employees.
Hours worked		Average weekly hours of production and nonsupervisory employees.
Wages		Average hours earnings of production and nonsupervisory employees.
Household debt	FRED	Household and nonprofit organizations; Debt securities and loans (CMDEBT).
Federal Funds Rate		The effective federal funds rate.

Credit spread	Moody's	The difference between the Baa corporate bond yield and Aaa corporate bond yield.
Housing price	U.S. Census Bureau	The median sales price of houses.
Housing permits		New private housing units authorized.
Tax shock	Romer and Romer (2010)	Series of exogenous tax shock based on analysis of narrative sources such as presidential speeches, reports of Congressional committees, etc.
Personal/corporate tax shock	Mertens and Ravn (2013)	Unanticipated tax shock based on series of Romer and Romer (2010). Tax changes whose lag between legislation and implementation is longer than a quarter are excluded as they are "anticipated" by economic agents.
Military spending news shock	Ramey (2011)	Series of exogenous changes in government expenditure based on news reports about military spending.

Note: This table provides the source and description of the data used in the analysis.