

Debt Burdens and the Interest Rate Response to Fiscal Stimulus: Theory and Cross-Country Evidence*

Work in Progress

Jorge Miranda-Pinto^{†1}, Daniel Murphy^{‡2}, Kieran James Walsh^{§3}, and Eric R. Young^{¶4}

¹University of Queensland

²University of Virginia Darden School of Business

³University of Virginia Darden School of Business

⁴University of Virginia and Zhejiang University

14th February 2018

Abstract

We document that the interest rate response to fiscal stimulus (IRRF) is lower in countries with high inequality. To interpret this evidence we develop a model in which households have minimum consumption constraints. In equilibrium, many households with low wealth hit this constraint and take on debt in the face of adverse shocks. Now debt-burdened, these households use additional income to deleverage. In economies with more debt-burdened households, increases in government spending tighten credit conditions less (relax credit conditions more), leading to smaller increases (larger declines) in the interest rate. Using data from the Panel Study of Income Dynamics, we show that low-wealth households behave as predicted by the model.

*We would like to thank Philip Lane, Frank Warnock, and seminar participants at UVA (Darden Business School and Department of Economics), Fed Board, Barcelona Summer Institute, ICEF-HSE, LAEF conference on Fiscal Policy, and INFINITY Valencia for helpful comments.

[†]Email: j.mirandapinto@uq.edu.au

[‡]Email: murphyd@darden.virginia.edu

[§]Email: walshk@darden.virginia.edu

[¶]Email: ey2d@virginia.edu

1 Introduction

The size and length of the Great Recession have renewed attention on fiscal policy as a stabilization tool. The design of optimal fiscal policy depends on an understanding of transmission mechanisms. The interest rate response to fiscal stimulus (IRRF) is of central importance, as it dictates the extent to which stimulus crowds out investment and potentially future output.

Despite the relevance of the interest rate channel, the literature has yet to offer clarity on how or why the interest rate responds to government spending and on what the IRRF can teach researchers about the underlying structure of the macroeconomy. This lack of attention and clarity may be due to an apparent conflict between theory and empirical findings. While standard theory (of both classical and Keynesian underpinnings) predict that interest rates rise in response to government spending, studies based on the U.S. and U.K. tend to find a negative effect on interest rates (e.g., [Barro \(1987\)](#) and, more recently, [Ramey \(2011\)](#) and [Fisher and Peters \(2010\)](#)). Similarly puzzling is the evidence that government spending tends to be associated with local currency depreciation rather than appreciation ([Ravn et al. \(2012\)](#), [Corsetti et al. \(2012a\)](#), [Faccini et al. \(2016\)](#)).¹

In this paper we use cross-country evidence to investigate the interest rate channel of fiscal policy. We document that there is substantial heterogeneity in the interest rate response to fiscal stimulus (IRRF) across OECD countries, with approximately half of the countries experiencing a decline in government bond yields in response to an expansion of government consumption. Existing theory offers little guidance on the mechanisms that could account for these patterns. General equilibrium models are generally unable to explain negative IRRFs, and to date no theory of which we are aware has been proposed to account for heterogeneity in the IRRF (except with respect to the zero lower bound).

To shed light on the mechanisms responsible for this variation, we regress the IRRFs on country-level characteristics. We document that country-level income inequality is the strongest predictor of the IRRF. In particular, higher inequality is associated with a lower IRRF, both unconditionally and conditional on other potential country-level determinants of the IRRF. This result is surprising, given that one might expect high inequality to be associated with credit-constrained households with high marginal propensities to consume that would, all else equal, push up the IRRF. The negative relationship between inequality and the IRRF suggests new theory is needed to understand the data.

¹The standard mechanism is straightforward. Increased government spending crowds out private consumption. The interest rate increases to clear the goods' market with lower private consumption. The higher interest rate attracts foreign capital which in turn appreciates the currency.

To rationalize this evidence, we propose that high inequality is associated with low-income households who have high marginal propensities to save (near-zero MPCs) due to the desire to maintain a sufficiently high level of consumption even in the face of adverse shocks. When an adverse shock hits a household, it chooses to accumulate debt rather than let consumption fall below a threshold level. The household is then *debt-burdened* in the sense that it uses additional income to delever rather than to further increase consumption. The high level of debt is optimal conditional on the minimum consumption threshold, but it is high relative to an environment without a minimum consumption threshold. Once this debt is accumulated, households delever quickly to avoid the possibility that another adverse shock requires that its consumption falls below the threshold level. The minimum consumption thresholds could represent, for example, aspects of current consumption (e.g., housing or auto maintenance) that are determined by prior decisions and costly to adjust in the short-term, as in [Chetty and Szeidl \(2007\)](#). Rather than move out of their home, households increase debt that they pay off with future income.

We demonstrate the relevance of minimum consumption thresholds in both two-period and infinite-horizon settings. The two-period model demonstrates in a simple setting how minimum consumption thresholds push down the IRRF relative to a frictionless benchmark. In this simple model, we impose that the consumption of low-wealth households is binding at the minimum level. The government hires workers, including *debt-burdened* low-wealth households. An increase in government spending redistributes income to these low-wealth households who have low MPCs. The redistribution toward low-MPC households pushes down the equilibrium real interest rate.

To explore the implications of minimum consumption levels in a dynamic setting with precautionary motives, we extend the canonical [Aiyagari \(1994\)](#) model. In our model, there is a utility cost from consuming below the minimum consumption threshold. In addition, households are subject to shocks that alter such a threshold. The calibrated model predicts that many low-wealth households are indeed debt-burdened in equilibrium. These households have high propensities to delever and hence low marginal propensities to consume (MPCs). That is, unlike in standard dynamic heterogeneous-agent models, in our framework low-income consumers can have relatively low MPCs if they are against their minimum consumption level and hence debt-burdened. However, very low-wealth consumers are borrowing-constrained in equilibrium and cannot even afford to achieve their minimum desired consumption level. These households have very high MPCs, consistent with conventional wisdom.

The existence of debt-burdened households in our model is consistent with recent evidence from microdata. [Misra and Surico \(2014\)](#) find that low-income households have lower propensities to spend tax rebates than high-income households, corroborating evidence from prior studies ([Shapiro and Slemrod \(2003\)](#)). Nearly one-third of all U.S. households use addi-

tional income from tax breaks to pay down debt rather than spend (Sahm et al. (2015)). The decline in debt balances following a positive income shock is also consistent with evidence from Singapore (Agarwal and Qian (2014)). Finally, Italian households with debt appear to have lower marginal propensities to consume than households with no debt (Jappelli and Pistaferri (2014)). Sahm et al. (2015) note that this behavior of what they refer to as *balance-sheet households* is starkly different from what standard theory would predict. Our model of debt-burdened households offers a potential reconciliation between the empirics and theory.

To further corroborate the household behavior predicted by our model, we examine evidence from the Panel Study of Income Dynamics (PSID). The panel structure of the PSID allows us to observe a household’s consumption between 1999 (when the consumption information was first introduced in the survey) until the most recent wave of data. The theory predicts that low-wealth households experiencing an increase in the minimum consumption threshold (e.g., due to a medical emergency) take on debt initially. They delever out of additional income more quickly than do similar households that did not experience the expenditure shock. The rate of deleveraging for high-wealth households does not depend on prior shocks (conditional on net worth) because they are away from the minimum consumption constraint and can smooth consumption. This is the pattern we observe in the data. We find that conditional on household net worth, low-wealth households with past high expenditure delever more quickly when subsequent income is higher. For wealthy households, the rate of deleveraging out of large income increases does not depend on prior episodes of high expenditure.

Finally, we examine the relationship between inequality and the IRRF in the theoretical model. Consistent with the cross-country evidence, higher inequality and debt burdens are negatively related to the IRRF.

Our theoretical and empirical results relate to a number of strands of the literature. Recent empirical work documents determinants of fiscal output multipliers (Brinca et al. (2016), Ilzetzki et al. (2013), Corsetti et al. (2012b)). We augment this evidence by relating heterogeneity in the interest rate effect of fiscal policy to income inequality.

Our evidence of negative IRRFs in a number of countries potentially helps resolve a previously puzzling finding that expansionary government spending shocks appear to cause exchange rate appreciation (see, e.g. Corsetti et al. (2012a)). The standard Mundell-Fleming model predicts that exchange rates should increase as domestic interest rates rise, attracting capital inflows. Evidence against exchange rate appreciation has been interpreted as a rejection of Mundell-Fleming (Ravn et al. (2012)). Our paper offers potential reconciliation between the data and the Mundell-Fleming interest-rate-channel of exchange rate movements.

Perhaps the closest paper to ours in terms of developing new models of consumer behavior is Kaplan and Violante (2014), who develop a heterogeneous-agent model in which wealthy

households have high marginal propensities to consume due to liquidity constraints. Their theory helps rationalize recent evidence on heterogeneity in MPCs from the microdata. Our model likewise helps understand a number of recent facts to emerge from the literature that explores consumer behavior in the microdata, as discussed above.

The notion of debt burdens in our model is distinct from the notion of debt overhang in other recent macroeconomic models in which consumer debt plays a central role. In [Eggertsson and Krugman \(2012\)](#), consumers optimally take on high debt, either due to impatience or in anticipation of high future income. This debt only becomes a burden (or overhang) once an unanticipated credit constraint forces them to delever. In the absence of the credit constraint, these consumers would prefer to have higher debt. In our model, debt-burdened consumers maintain high debt balances because of a minimum consumption constraint rather than impatience or expected income growth. Recent empirical work ([Demyanyk et al. \(2016\)](#)) highlights the importance of credit-constrained consumers for the transmission of fiscal policy during the great recession, consistent with [Eggertsson and Krugman \(2012\)](#), but not during periods of economic expansion. Our theory offers a new notion of debt burdens that is potentially relevant over the business cycle, including non-crisis periods.

The remainder of the paper proceeds as follows. Section 2 documents the relationship between the IRRF and inequality. Section 3 presents a qualitative theory of debt-burdened households. Section 4 presents the quantitative model. Section 5 offers external validation of the model using data from the PSID. Section 6 shows how the theoretical IRRFs depend on inequality. Section 7 concludes.

2 The interest rate response to fiscal stimulus across countries

To estimate country-level IRRFs, we collect quarterly data on real government consumption, real GDP, and interest rates across countries. Obtaining reliable country-level estimates of the IRRF requires a sufficient time span of data. Therefore we limit our focus to OECD countries, most of which provide quarterly data that spans a period of over twenty years. The primary data source is the OECD. We supplement the OECD numbers with data from Haver when the Haver sample extends the OECD sample. A detailed description of the data used to estimate fiscal shocks is in Table 5 of our Appendix.

Our study focuses on government bond yields because they are the interest rate that is the most widely available for our sample. An advantage of examining yields on longer-dated bonds is that yields are not directly controlled by central banks but depend on credit conditions more generally. Our sample includes all OECD countries for which we observe government bond yields for at least 10 consecutive years prior to the end of our estimation

period, 2007. Our baseline estimation period ends in 2007 in order to avoid structural breaks that may have been associated with the global financial crisis. The results presented below are similar when we include the most recent data, however.

We also examine data on shorter-term interest rates, which we refer to as policy rates. We use direct measures of central bank policy rates when available. For countries that do not have policy rate data, we use the short-term interest rate series in [Ilzetzi et al. \(2013\)](#). The policy rates for members of the European Monetary Union (EMU) are equal to European Central Bank rates.

2.1 Country-level estimates of fiscal shocks

We identify government spending shocks following the approach in [Blanchard and Perotti \(2002\)](#). The key identification assumption is that, within a quarter, government spending is predetermined with respect to other macro variables. Hence government spending responds contemporaneously to its own shock but not to other shocks in the economy. Based on the delay in the political process that typically justifies this restriction, much of the literature has adopted the Blanchard-Perotti approach (e.g., [Bachmann and Sims \(2012\)](#), [Auerbach and Gorodnichenko \(2012\)](#), [Rossi and Zubairy \(2011\)](#), [Brinca et al. \(2016\)](#)).

Despite the widespread use of the Blanchard-Perotti approach and the plausibility of its identifying assumptions, there are potential limitations. If changes in government spending are anticipated, the Blanchard-Perotti approach will not capture the exogenous component of government spending ([Ramey \(2011\)](#)). To overcome this challenge, [Ramey \(2011\)](#) uses news about future defense spending to identify fiscal shocks. As [Ilzetzi et al. \(2013\)](#) point out, this approach is not viable when estimating fiscal shocks across countries. Data on military buildups on which the estimates are based are not available across countries, and even within the U.S. there is little variation in the military measure in the post-war period. Therefore, we adapt the Blanchard-Perotti approach. We acknowledge the potential limitations of this approach but note that the estimated effects of stimulus on interest rates are relatively consistent across empirical specifications, at least for the U.S. ([Murphy and Walsh \(2017\)](#)). As a robustness check, we also identify shocks using semi-annual data on forecast errors for government spending, as in [Auerbach and Gorodnichenko \(2013\)](#). We find a similar negative relationship between the IRRF and inequality to the results presented below based on the [Blanchard and Perotti \(2002\)](#) shocks.²

We identify fiscal shocks independently for each country in our sample. To do so, we estimate

$$A_0 X_t = \sum_{j=1}^4 A_j X_{t-j} + \varepsilon_t, \quad (1)$$

²See Figure 6 in our Appendix.

where $X_t = [G_t, Y_t, r_t]'$ consists of log real government spending G_t , log real GDP, and government bond yields r_t . $\varepsilon_t = [\nu_t, \varepsilon_t^2, \varepsilon_t^3]$ is a vector of structural shocks, and v_t is the shock to government spending. The identifying assumption amounts to a zero restriction on the (1,2) and (1,3) elements of A_0 . Unlike [Blanchard and Perotti \(2002\)](#), we do not have quarterly data on tax revenue for our sample.^{3,4}

We estimate impulse responses of real GDP and interest rates to the fiscal shocks. For the purpose of our cross-country analysis, we summarize the information in the impulse responses by examining the cumulative 4-quarters impulse response to government consumption shocks. Let ρ_h be the horizon h impulse response of interest rates. To account for the variation across countries in the precision of the estimated impulse responses, we divide ρ_h by the range between the upper (95%) and lower (5%) bounds of the bootstrap confidence intervals of the IRRFs, yielding $\hat{\rho}_h$.⁵ Finally, the country-level interest rate response to a standard-deviation shock to government consumption is computed as:

$$IRRF = \sum_{h=0}^3 \hat{\rho}_h.$$

Figure 1 depicts the substantial variation in the IRRF varies across countries. In half of the countries in the sample (14 countries), the response of interest rates to government consumption shocks is negative. In Switzerland a one standard deviation shock *increases* interest rates by 0.8 percentage points on average over four quarters. In the U.S., a standard deviation shock to government expenditure *decreases* interest rates by 0.32 percentage points.

2.2 Inequality and the IRRF

Here we demonstrate that higher inequality is associated with a lower IRRF. Our measure of inequality is the ratio of the income of the richest 10 percent of the population to the income of the poorest 10 percent, which is provided by the OECD. For each country, we take the average over 2001-2013 (inequality is stable over time within countries). There is substantial cross-sectional dispersion in income inequality in our sample. The U.S. is the most unequal country of the sample with an average ratio of 6.2, while Denmark has a ratio of 2.8. Figure 2 documents the inverse relationship between the IRRF and inequality. Indeed, the U.S., which is among the most unequal countries, also has one of the lowest

³To explore how important is the omission of the tax revenue data, we check how the interest response to fiscal shocks in the VAR changes when tax revenue is included for the U.S. We find that the cumulative one year interest rate response is practically unchanged when tax revenue is added to the VAR. This is consistent with the findings in [Ilzetki et al. \(2013\)](#) with respect to the output multiplier.

⁴We follow [Auerbach and Gorodnichenko \(2012\)](#) and estimate the VAR with the variables in log levels to preserve the cointegration relations. The fiscal shocks backed out from the VAR are stationary.

⁵The results are nearly identical without variance adjusting the IRRFs. The variance adjustment helps limit the possibility that the results presented in 1 below are driven by countries with large (in absolute value) but imprecisely estimated IRRFs.

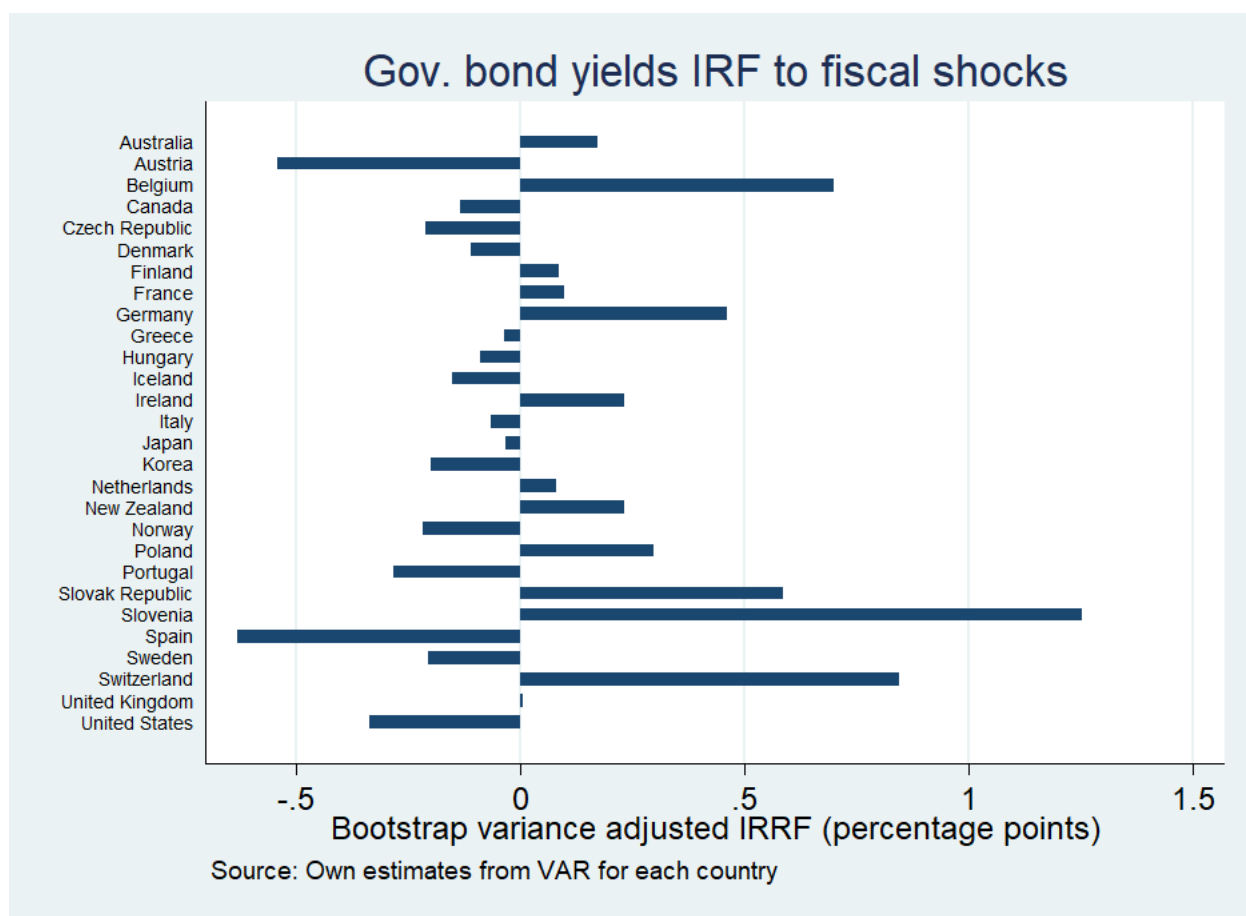


Figure 1
Effect of fiscal shocks on government bond yields across OECD Countries

(most negative) IRRFs.

What could account for this inverse relationship? One possibility is that monetary policy may be more accommodative of fiscal shocks in unequal countries. The same relationship does not hold when examining policy rates, suggesting that government spending relaxes credit markets relatively more in unequal countries, beyond any response of monetary policy to government spending shocks.⁶ This is consistent with the evidence in [Murphy and Walsh \(2017\)](#) that monetary accommodation cannot fully account for the negative IRRF in the U.S.

To further isolate the role of inequality from central bank policy and other determinants, we regress the IRRF on measures of central bank independence and financial openness. We use inflation volatility as a measure of central bank independence. There exists a central bank independence (CBI) index from [Dincer and Eichengreen \(2014\)](#). However, this index is only available for a sub-sample of 14 countries. Thus, motivated by [Alesina and Summers](#)

⁶See Figure 7 in our Appendix.

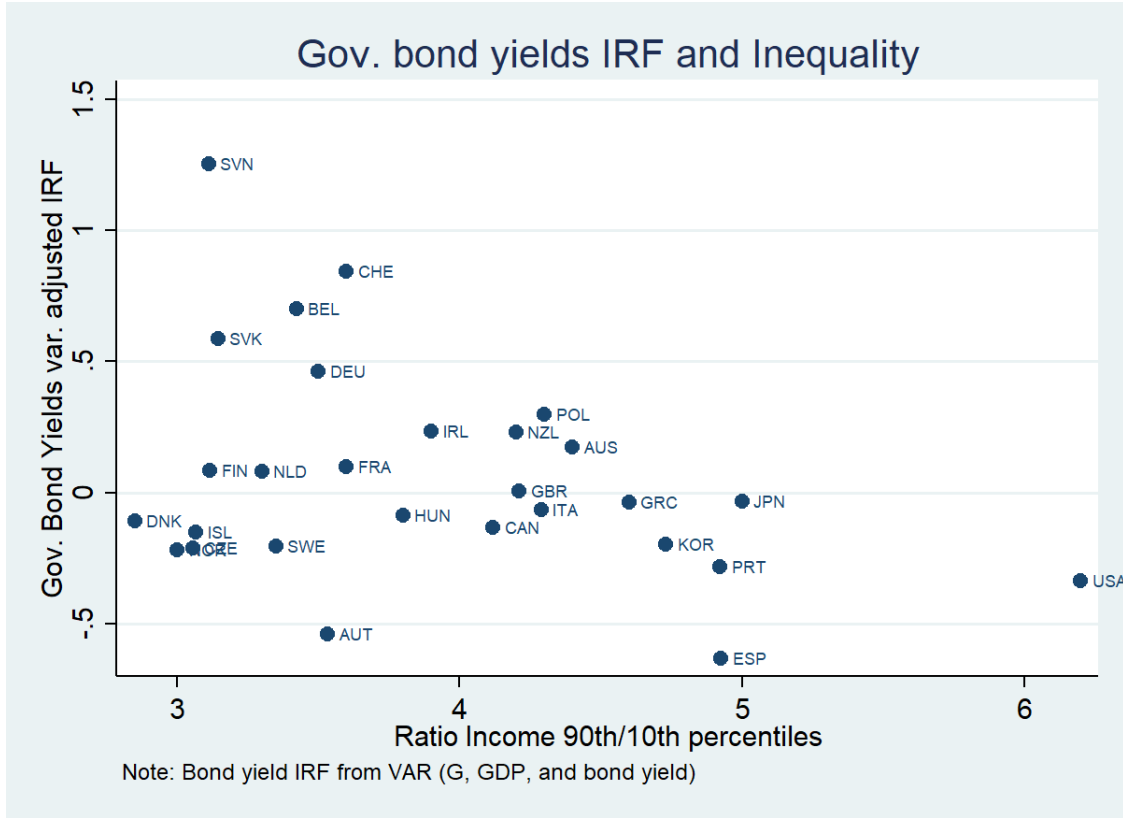


Figure 2
Inequality and Gov. Bond Yield Response

(1993), who find that the CBI is negatively correlated with the average inflation rate and the volatility of inflation for 16 developed countries in their sample, we use the volatility of inflation as a proxy for central bank independence. Our inflation measures are from the OECD. There is substantial variation: in Iceland and the Slovak Republic the standard deviation of inflation exceeds 3%, while in Germany and Switzerland it is below 1%. Our measure of financial openness, from Lane and Milesi-Ferretti (2007), is financial assets plus liabilities, over GDP. Mundell-Fleming predicts that countries that are more open to international financial markets have smaller or zero response of interest rates to fiscal shocks.

Table 1 shows that the dependence of the IRRF on inequality, conditional on these other determinants. A one standard deviation increase in inequality is associated with an 15 basis point decline in the IRRF. This relationship remains when adding inflation volatility and financial openness in the regression (columns 2 and 3). It is possible that the relationship between inequality and the IRRF is due to a higher elasticity of output with respect to fiscal stimulus (perhaps due to slack, as in Murphy and Walsh (2017)) in countries with high inequality. In this case, interest rates would increase less in countries with more inequality, resulting in higher fiscal multipliers. One way to control for this channel is to include the fiscal multiplier in the regression. Here we define the fiscal multiplier as the cumulative

multiplier over a horizon of one year, consistent with [Ilzetzi et al. \(2013\)](#):

$$\frac{\sum_{h=0}^3 y_h}{\sum_{h=0}^3 g_h}, \quad (2)$$

where y_h and g_h are the impulse responses of output and government consumption at horizon h . Including the cumulative multiplier has no effect on the estimated dependence of the IRRF on inequality (column 4). These results suggest that the measured relationship is not driven by other mechanisms associated with high fiscal multipliers.⁷

Table 1
Gov. Bond Yields Response and Country Characteristics

VARIABLES	(1) Bond IRRF	(2) Bond IRRF	(3) Bond IRRF	(4) Bond IRRF
p9010	-0.15** (0.07)	-0.13** (0.06)	-0.12* (0.07)	-0.13* (0.07)
St. Dev. Inflation		0.09 (0.08)	0.09 (0.09)	0.08 (0.08)
Financial Openness			0.06 (0.08)	0.07 (0.08)
Fiscal Mult. 4 qtrs				-0.07 (0.08)
Constant	0.78* (0.38)	0.54 (0.37)	0.41 (0.38)	0.51 (0.44)
Observations	28	28	28	28
R-squared	0.12	0.17	0.20	0.22

* Note: The standard deviation of inflation is measured using the 4 quarters percent change of the CPI index from the OECD databases. Our measure of financial openness is the ratio financial assets plus liabilities to GDP ([Lane and Milesi-Ferretti \(2007\)](#)). Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

3 Theory: debt-burdened households and interest rates

In a standard economy with a representative agent or aggregation, the interest rate is invariant to the income/wealth/debt distribution, and the interest rate unambiguously rises in response to government spending shocks: when the government uses resources today, market clearing requires the interest rate to rise to induce the representative agent to forgo

⁷A similar relationship between inequality and the IRRF (as in Table 1) holds if we use the GINI coefficient of income instead of the ratio p90p10.

consumption today for consumption tomorrow. Therefore, market frictions are required for interest rate responses that are potentially negative and depend on the wealth distribution.

Here we develop a framework in which the distribution of debt is crucially important for the transmission of fiscal policy. The simplest version of our model predicts that the fraction of households with low MPCs (high marginal propensities to save) is increasing in the amount of credit/debt in the economy. When there are sufficiently high levels of debt outstanding, there is a strong desire to delever out of additional income, and increases in income from the government push down the equilibrium interest rate.

We are of course not the first to explore the importance of debt for the transmission of fiscal policy (e.g., [Eggertsson and Krugman \(2012\)](#)). What is unique about our framework is that indebted households are not credit constrained but instead want to delever out of additional income (they are “savings constrained”). How does such a situation emerge?

We consider a friction - a minimum consumption level - that results in some agents having high debt and unable to lower consumption to delever. A minimum consumption level could represent, for example, a subsistence level of consumption or aspects of current consumption (e.g., rent) that are determined by prior decisions and costly to adjust in the short-term (similar to “consumption commitments” in [Chetty and Szeidl \(2007\)](#)). When low-income households experience an adverse shock, such as an increase in the minimum expenditure threshold or a decline in income, they borrow more than they would in the absence of the minimum consumption constraint. We refer to this excess debt as debt burden: households pay off the debt as soon as they receive additional income. In this sense, these households are *savings*-constrained (rather than credit-constrained).

Before outlining the full quantitative model, we first outline the intuition behind our mechanism in a two-period model. This simple model abstracts from uncertainty and precautionary savings to isolate the role of debt-burdened households. We then examine a dynamic model in which precautionary savings and minimum consumption constraints interact. These interactions lead to a number of useful predictions, including MPCs that depend non-monotonically on wealth and IRRFs that depend on measures of wealth and credit.

3.1 Two-Period Model

Suppose there are two agent types, rich (r) and non-rich (p). The measure of non-rich agents is $\pi \in [1/2, 1)$, and the measure of rich agents is $1 - \pi$. The period income of a rich agent is $y^r = 1/(2(1 - \pi))$. The income of non-rich agent is $y^p = 1/(2\pi)$, so total income is $1 = \pi y^p + (1 - \pi)y^r$. A useful feature of this setup is that a single parameter, π , governs inequality: collectively, the rich always get half of income, but the measure of rich agents falls to 0 as $\pi \rightarrow 1$.

The problem of an arbitrary agent of type $i \in \{r, p\}$ is

$$\begin{aligned} & \max_{c_0, c_1, b} \{ \log(c_0) + \log(c_1) \} \text{ subject to} \\ & (i) : c_0 + qb = y^i + G \\ & (ii) : c_1 = y^i(1 - \tau) + b \\ & (iii) : c_0 \geq \underline{c}, \end{aligned}$$

where $G \in [0, 1)$ is an exogenous wage from the government, τ is the marginal tax rate, b is bond holdings, q is the bond price, and $\underline{c}$ is the minimum consumption level. Since taxes are proportional but government wages are fixed, fiscal policy becomes more progressive on net as inequality rises. Ignoring constraint (iii), the solution is given by

$$c_0^i = \frac{1}{2}G + \frac{1}{2}y^i(1 + q(1 - \tau)). \quad (3)$$

The government pays wages G to the agents, who help the government produce government consumption goods, which are useless for the agents. The budget constraints of the government are

$$\begin{aligned} qB + G &= 0 \\ 0 &= B + \tau, \end{aligned}$$

which imply

$$\frac{G}{q} = \tau. \quad (4)$$

Total output is allocated to consumption by each agent and government consumption. We assume that a fraction ω of government consumption crowds out private resources, while the remaining fraction $(1 - \omega)$ generates income for households but does not utilize private resources. The goods market clearing condition is therefore

$$1 = \omega G + \pi c_0^p + (1 - \pi) c_0^r. \quad (5)$$

This treatment of government spending allows us to parameterize the extent to which interest rates respond to government spending through the standard crowding-out channel.

Equilibrium consists of a bond price, agent consumption, and taxes such that bond and goods markets clear and the government budget constraint is satisfied. Plugging (4) into (3), the agent solution is (still ignoring $\underline{c}$)

$$c_0^i = \frac{1}{2}(1 - y^i)G + \frac{1}{2}y^i(1 + q). \quad (6)$$

Note that if

$$\frac{1}{2} \left(1 - y^i\right) G + \frac{1}{2} y^i (1 + q) \leq \underline{c} \quad (7)$$

then $c_0^i = \underline{c}$, since the consumption lower bound binds. To restrict attention to the case of interest in which $c_0^r > c_0^p = \underline{c}$, we impose the following parameter restriction:

Assumption 1: $\left(\frac{1}{2} - \frac{\omega}{2\pi} - \frac{1}{4\pi}\right) G + \frac{1}{2\pi} \leq \underline{c} < 1 - \omega G$

Assumption 1 requires that the minimum consumption level be sufficiently high but less than total resources. As $\pi \rightarrow 1$, the left-hand-side approaches $\frac{1}{2} - \left(\frac{\omega}{2} - \frac{1}{4}\right) G$. In this case, if $\omega \leq 1/2$ then the right-hand-side $(1 - \omega G)$ strictly exceeds the left-hand-side. Therefore, provided there is sufficiently high inequality and low government waste, there exists $\underline{c} \in (0, 1)$ satisfying Assumption 1.

Now, suppose $c_0^p = \underline{c}$ binds for the non-rich types (we will confirm this is true in equilibrium). Then market clearing requires

$$1 - G\omega = \pi \underline{c} + (1 - \pi) c_0^r.$$

Plugging in (6) and $y^r = 1/(2(1 - \pi))$, we get

$$1 - G\omega = \pi \underline{c} + \left(\frac{1}{2} (1 - \pi) - \frac{1}{4}\right) G + \frac{1}{4} (1 + q),$$

which yields

$$q = 3 - 4\pi \underline{c} + (2\pi - 1 - 4\omega) G. \quad (8)$$

Therefore, in equilibrium we have

$$\begin{aligned} \frac{\partial q}{\partial G} &= 2\pi - 1 - 4\omega \\ &\implies \\ \frac{\partial^2 q}{\partial G \partial \pi} &> 0. \end{aligned}$$

Does (7) hold for the non-rich at the equilibrium interest rate, that is, does $c_0^p = \underline{c}$ bind? Yes, under Assumption 1:

$$\begin{aligned} \frac{1}{2} \left(1 - \frac{1}{2\pi}\right) G + \frac{1}{2} \frac{1}{2\pi} (1 + q) &\leq \underline{c} \\ \iff \\ (2\pi - 1) G + 1 + q &\leq 4\pi \underline{c} \\ \iff (\text{using (8)}) \\ \left(\frac{1}{2} - \frac{\omega}{2\pi} - \frac{1}{4\pi}\right) G + \frac{1}{2\pi} &\leq \underline{c}, \end{aligned}$$

which is the left inequality of Assumption 1. Similarly,

$$\begin{aligned}
c_0^r &> \underline{c} \\
&\iff \\
\frac{1}{2} \left(1 - \frac{1}{2(1-\pi)} \right) G + \frac{1}{2} \frac{1}{2(1-\pi)} (1+q) &> \underline{c} \\
&\iff \\
(2(1-\pi) - 1)G + 1 + q &> 4(1-\pi)\underline{c} \\
&\iff (\text{using (8)}) \\
1 - \omega G &> \underline{c},
\end{aligned}$$

which is the right inequality of Assumption 1. We collect these results in a proposition:

Proposition 1: *Under Assumption 1, in equilibrium rich agents are unconstrained, the non-rich consume the minimum, and there is a closed-form expression for the bond price:*

$$\begin{aligned}
c_0^r &> \underline{c} \\
c_0^p &= \underline{c} \\
q &= 3 - 4\pi\underline{c} + (2\pi - 1 - 4\omega)G.
\end{aligned}$$

Therefore, the response of the gross interest rate $R = 1/q$ to G may be positive or negative and is strictly decreasing in inequality (or, equivalently, the share of non-rich, debt-burdened households) π :

$$\frac{\partial^2 R}{\partial G \partial \pi} < 0.$$

3.1.1 Discussion

Government spending has two effects on the interest rate $R = 1/q$, which are clear from the bond price expression:

$$q = 3 - 4\pi\underline{c} + (2\pi - 1 - 4\omega)G.$$

On one hand, rising G wastes $t = 0$ resources. Excess demand for $t = 0$ goods tends to push up the interest rate (the -4ω term). On the other hand, rising G enriches the debt-burdened non-rich, who have very low MPCs and deleverage or save out of income from the government. Taxes rise, but they are disproportionately paid by the moderate MPC rich. This redistribution from moderate to low MPC agents creates a glut of savings, which tends to push the interest rate down (the 2π term). With sufficient inequality, the second effect dominates.

Finally, suppose that instead of a minimum consumption level, agents are unable to borrow ($b \geq 0$). If this constraint binds for the non-rich then $c_0^p = y^p + G$, and market

clearing gives us

$$\begin{aligned}
1 - G\omega &= \pi c_0^p + (1 - \pi) c_0^r \implies \\
1 - G\omega &= \pi \left(\frac{1}{2\pi} + G \right) + \left(\frac{1}{2} (1 - \pi) - \frac{1}{4} \right) G + \frac{1}{4} (1 + q) \\
&\implies \\
q &= 1 - G[4\omega + 2\pi + 1].
\end{aligned}$$

Unlike with savings constraints, an increase in G unambiguously pushes the interest rate up. Moreover, this effect is even stronger with high inequality (π). With borrowing constraints, rising G redistributes from moderate MPC agents to high MPC ones, which creates a shortage of savings, and with high inequality the mass of high MPC agents is larger.

Finally, note that since agents are not borrowing-constrained, income inequality per se does not drive the interest rate response to government spending: an agent who is income poor at $t = 1$ can potentially cover the minimum consumption level by borrowing against future income. Rather, low wealth is the cause of binding savings-constraints. While in our simple framework wealth and income inequality are governed by the same parameter, π , Proposition 1 is really about low wealth and associated debt burdens. Therefore, the model predicts that in the data drivers of *wealth* inequality, like debt overhang, should determine the interest rate response to fiscal stimulus, above and beyond contemporaneous income inequality.

4 Debt burdens in a Quantitative Bewley model

The model of Section 3.1 predicts that the IRRF depends on the fraction of debt-burdened households. It also implies that inequality and aggregate credit are proxies for debt burden. However, the stylized two-period model abstracts from uncertainty and precautionary motives. Here we explore the implications of minimum consumption levels in a dynamic setting with precautionary motives. To do so, we extend the canonical heterogeneous agent model of Aiyagari (1994) to include fiscal policy and minimum consumption levels. The dynamic setting permits us to explore the circumstances under which agents will be debt-burdened in equilibrium, as well as derive the relationship between MPCs and wealth in a setting with a less trivial distribution of wealth.

4.1 Model

The economy is populated by a measure one continuum of ex ante identical households, an intermediary that manages the assets for the households, a goods-producing firm, and a capital-producing firm. Time is discrete. Within a period, the timing is as follows. First,

the intermediary, which owns the capital between periods, rents the existing capital K to the goods-producing firm at rate r , and the goods-producing firm generates output for sale. Next, the “early” capital market opens. The households’ intermediary then can sell its capital to the capital-producing firm at price q_o . The capital-producing firm buys investment goods from the goods-producing firm and creates new capital (which entails depreciation at rate δ). Then, the “late” capital market opens, and the capital-producing firm can sell the new capital back to the intermediary at price q_n for use in the next period. The intermediary must also pay a flat capital income tax (with a depreciation allowance) of $\tau_k(r - \delta)K$. Therefore, the after-tax (“at”) return on capital from the end of one period to the beginning of the next is $R'_{k,at} = (q'_o + r' - \tau_k(r' - \delta))/q_n$.

But capital isn’t the only asset available to the households via the intermediary. There is also a riskless government bond. Since there is no aggregate uncertainty and since we consider an equilibrium with positive capital and government debt, by no arbitrage the one-period interest rate on government bonds must be $R'_{k,at}$ in equilibrium. In this case, from the household/intermediary perspective, capital and government debt are identical assets, and the households are indifferent to their portfolio composition. Therefore, it is without loss of generality to assume the households save and borrow through shares of the intermediary a' , which cost $q_n a'$ at the end of the current period and yield $(q'_o + r' - \tau_k(r' - \delta))a'$ at the beginning of the next period.

Letting $(a, \epsilon, \underline{c})$ be an arbitrary household’s financial assets, labor productivity, and consumption necessity shock and letting Γ be the cross-household distribution over $(a, \epsilon, \underline{c})$, the dynamic program of the households is

$$v(a, \epsilon, \underline{c}, \Gamma) = \max_{c \geq 0, a' \geq \underline{a}} \left\{ \frac{c^{1-\sigma} - 1}{1-\sigma} - \lambda \max\{\underline{c} - c, 0\} + \beta E \left[v(a', \epsilon', \underline{c}', \Gamma') \mid \epsilon, \underline{c}, \Gamma \right] \right\}$$

subject to

$$(1 + \tau_c)c + q_n a' = (q_o + r)a - \tau_k(r - \delta)a + (1 - \tau_l)w \exp(\epsilon) + T$$

$$\Gamma' = H(\Gamma, B, G, T),$$

where B , G , and T are government debt, purchases, and transfers. c is consumption. If $c < \underline{c}$, then a utility penalty $\lambda(\underline{c} - c)$ is incurred by the household (note that this framework generalizes the simple two-period model in which $\lambda = \infty$). w is the wage per efficiency unit of labor, and (τ_c, τ_l) are flat taxes on consumption and labor income. Finally, $\underline{a} \leq 0$ is an exogenous borrowing limit.

The log of individual labor productivity ϵ and the consumption threshold $\underline{c}$ follow inde-

pendent AR(1) processes:

$$\begin{aligned}\epsilon' &= \rho_\epsilon \epsilon + \sigma_\epsilon \nu'_\epsilon \\ \underline{c}' &= (1 - \rho_c) \underline{c}^* + \rho_c \underline{c} + \sigma_c \nu'_c \\ \nu_i &\sim N(0, 1),\end{aligned}$$

where $\underline{c}^*$ is the unconditional mean of $\underline{c}$.

The goods-producing firm rents capital and labor and produce an output good that can be used for consumption or investment. The production frontier is

$$C + I \leq AK^\alpha N^{1-\alpha},$$

where $A > 0$ is total factor productivity, K is the aggregate capital input, and N is the aggregate labor input (A is convenient for calibration but otherwise serves merely to normalize units). In equilibrium, profit maximization implies

$$\begin{aligned}r &= \alpha AK^{\alpha-1} N^{1-\alpha} \\ w &= (1 - \alpha) AK^\alpha N^{-\alpha}.\end{aligned}$$

The capital-producing firm purchases old capital and buys investment goods (from the goods-producing firm) to produce and sell new capital, solving

$$\max_{K', K, I} \{q_n K' - q_o K - I\}$$

subject to

$$K' = (1 - \delta + a_2) K + \frac{a_1}{1 - \xi^{-1}} I^{1-\xi^{-1}} K^{\xi^{-1}},$$

where

$$\begin{aligned}a_1 &= \delta^{\frac{1}{\xi}} \\ a_2 &= -\frac{\delta}{\xi - 1}\end{aligned}$$

are constants, and $\xi > 1$ is the elasticity of Tobin's q with respect to I/K . Profit maximization implies

$$\begin{aligned}1 &= q_n a_1 \left(\frac{I}{K}\right)^{-\xi^{-1}} \\ q_o &= q_n \left(1 - \delta + a_2 + \frac{a_1}{\xi - 1} \left(\frac{I}{K}\right)^{1-\xi^{-1}}\right).\end{aligned}$$

Now we turn to the government. Since by no arbitrage the government interest rate

must always be $R'_{k,at} = (q'_o + r' - \tau_k(r' - \delta))/q_n$, it is without loss of generality to assume the government sells debt B' at price q_n at the end of the current period, which promises yield $(q'_o + r' - \tau_k(r' - \delta))B'$ at the beginning of the next period. Thus, the government budget constraint is

$$\tau_c C + \tau_k (r - \delta) (K + B) + \tau_l w N + q_n B' = (q_o + r) B + G + T.$$

We suppose that government spending and transfers follow independent AR(1) processes in logs:

$$\begin{aligned} \log(T') &= (1 - \rho_T) \log(T^*) + \rho_T \log(T) + \sigma_T \nu'_T \\ \log(G') &= (1 - \rho_G) \log(G^*) + \rho_G \log(G) + \sigma_G \nu'_G. \end{aligned}$$

Turning off the purchase and transfer shocks, a steady-state equilibrium (given T^* and G^*), consists of constant debt B^* , household distribution Γ^* , law of motion H^* , capital K^* , investment I^* , aggregate consumption C^* , employment N^* , prices (r^* , w^* , q_o^* , and q_n^*), and household decision rules (a^* and c^*) such that $\Gamma^* = H^*(\Gamma^*, B^*, G^*, T^*)$, H^* is generated by optimal household decisions given aggregate quantities and prices, the government budget constraint is satisfied, firms are optimizing, and markets clear:

$$\begin{aligned} K^* + B^* &= \int a^* d\Gamma^* \\ N^* &= \int \exp(\epsilon) d\Gamma^* \\ C^* &= \int c^* d\Gamma^* \\ C^* + I^* &= A K^{*\alpha} N^{*1-\alpha} \end{aligned}$$

Note that, in the steady state, $I^*/K^* = \delta$, and therefore $q_n^* = 1$ and $q_o^* = 1 - \delta$.

Finally, when we look at shocks to steady-state and the transition paths back to it, we assume that labor income taxes adjust to the debt (relative to the steady-state B^*) at rate $\gamma > 0$ to maintain intertemporal solvency:

$$\tau'_l = \tau_l^* \left(\frac{B}{B^*} \right)^\gamma.$$

4.2 Calibration and Solution

We calibrate the parameters of the model to match both macro aggregates and micro facts from the PSID. First, we choose $\alpha = 0.36$ to match capital's share of income and $\delta = 0.0125$ to match the quarterly investment-output ratio. We set $\sigma = 1$ and $\underline{a} = -2$ (implying that the household can borrow roughly half of average annual labor income). We set $\tau_k = 0.27$ and $\tau_c = 0.06$, following Carey and Rabesona (2003), $\xi = 10.5$ (implying relatively low adjustment

costs), and $\gamma = 0.15$ (following Leeper and Walker). We then jointly choose the vector

$$(\rho_\epsilon, \sigma_\epsilon, \rho_c, \sigma_c, \lambda, \underline{c}^*, G^*, T^*, A, \beta, \tau_l^*)$$

to match the Gini coefficients of consumption and earnings (0.3 and 0.6), the correlation between earnings and consumption (0.2), the fraction of borrowers (10 percent), the coefficients of variation of consumption and earnings (0.41 and 0.47), an aggregate capital/output ratio of 12, a government spending to output ratio of 0.2, and to normalize aggregate output to one in the steady state. We minimize the squared residuals from the calibration targets. Table 2 presents the estimated parameter values as well as the deviations from the targets:

Table 2
Calibrated Parameters and Moment Deviations

Parameters	Moments
$\tau_l^* = 0.319$	$\frac{G}{Y} - 0.2 = -0.004$
$\sigma_\epsilon = 0.215$	$\text{Corr}(c, y) - 0.2 = -0.042$
$\sigma_c = 1.273$	$\text{Gini}(c) - 0.3 = -0.127$
$\rho_c = -0.048$	$\text{Gini}(y) - 0.6 = -0.282$
$\lambda = 12.385$	$\mu(a < 0) - 0.1 = 0.094$
$\underline{c} = 0.010$	$\frac{\text{Var}(y)}{E(y)} - 0.47 = 0.159$
$\rho_\epsilon = 0.933$	$\frac{\text{Var}(c)}{E(c)} - 0.41 = -0.256$
$A = 0.749$	$\frac{K}{Y} - 12 = -0.021$
$\beta = 0.982$	$Y - 1 = 0.014$

We choose $\rho_G = 0.9786$, $\sigma_G = 0.0163$, $\rho_T = 0.9137$, and $\sigma_T = 0.051$, based on a simple VAR of transfers and spending.

Finally, we calibrate our model to match moments from the PSID. In particular, as shown in Table 3, we match the coefficient of variation of consumption and income.⁸

Table 3
Matching moments from the PSID

	Mean		
	PSID	$\underline{c} = 0$	Calibrated model
Coeff of variation: Consumption	0.41	0.06	0.41
Coeff of variation: Income	0.47	0.21	0.42
Ratio	0.87	0.28	0.98

⁸We use standard numerical methods to solve for the steady state and the transitional dynamics; a technical appendix outlines the details and is available upon request.

4.3 Quantitative results

The model predicts a nonmonotonic relationship between MPCs and wealth. At very low income/wealth levels, agents are credit-constrained and must violate the minimum consumption threshold, thus incurring a utility cost. These agents have very high MPCs, consistent with conventional wisdom. As wealth rises, households are able to borrow to achieve their minimum consumption threshold. For these households, any additional income/wealth is used to delever and hence they have MPCs of zero. When wealth/income is sufficiently high, households can afford higher consumption levels and spending propensities rise as predicted by standard theories of consumption smoothing.

To illustrate these relationships in the model, Figure 3 shows equilibrium consumption as a function of assets a for different levels of average $\underline{c}$, conditional on a low current-period wage. Without the minimum consumption threshold ($\underline{c} = 0$), consumption falls and the MPC rises as wealth declines. When $\underline{c} > 0$, however, low-wage agents are against the minimum consumption threshold when wealth is sufficiently low. To avoid violating the minimum consumption level, these agents take on debt and have MPCs of zero. This prediction helps reconcile theory with the microdata evidence in [Shapiro and Slemrod \(2003\)](#), [Sahm et al. \(2015\)](#), [Agarwal and Qian \(2014\)](#), and [Jappelli and Pistaferri \(2014\)](#). The higher the minimum consumption threshold, the higher is the range of assets that violates the minimum consumption threshold. When the minimum consumption threshold is high and wealth is very low, agents hit their credit constraint and consumption falls below the minimum consumption threshold. These agents pay the utility cost and, consistent with the standard prediction, have very high MPCs.

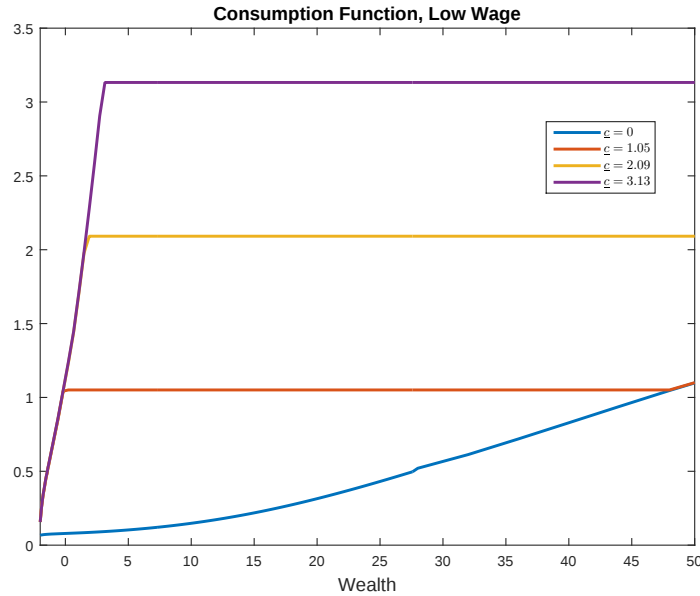


Figure 3
Consumption and Wealth for Low Wage Workers

Figure 4 displays the consumption function for high wage workers. In this case, the region of assets over which agents are against the minimum consumption threshold is smaller – for any given level of $\underline{c}$ – due to the fact that high income (rather than debt) helps to finance minimum consumption levels.

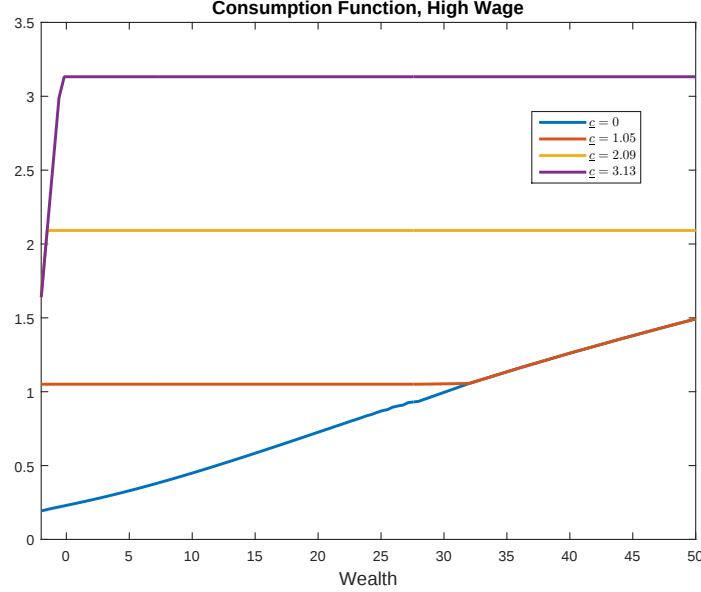


Figure 4
Consumption and Wealth for High Wage Workers

5 External Validation

The theory predicts that households against the minimum consumption threshold delever more quickly out of additional income. Here we explore this prediction using the PSID. The PSID is a unique biennial panel dataset that contains household-level information on expenditure and income. The expenditure data is available as of 1999.

While we cannot observe whether households are against a minimum consumption constraint (which may be household-specific), we do observe whether households experienced large increases in expenditure that are potentially driven by increases in the minimum expenditure threshold. As a proxy for unobservable expenditure and income shocks, we examine abnormally high income and high expenditure. In particular, a household is assumed to experience an increase in the minimum expenditure threshold if, within a period, expenditure exceed the household's average expenditure by over a standard deviation. An income shock is analogously defined.

Table 4 shows the share of households that experience minimum expenditure threshold shocks, as well as the share that experience income shocks in the period after the episode of high expenditure. 37 percent of households experience a high expenditure shock followed

by an abnormal increase in income in the next period. While many households experience consecutive expenditure and income shocks at some point since 1999, many fewer (approximately 4 %) experience consecutive shocks in any given year.

Table 4
Summary Statistics

	N	Mean
Households:		
Has high expenditure	7,475	0.9
Has high income and lagged high expenditure	7,475	0.31
Households-time observations:		
Has high expenditureShock	59,800	0.17
Has high income and lagged high expenditure	59,800	0.04

* Note: A household has high income (expenditure) in periods in which income (expenditure) is over a standard deviation above average income (expenditure) for the household.

With proxies for income and expenditure shocks in hand, we examine whether spending propensities (the inverse of saving/deleveraging propensities) depend on prior episodes of high expenditure. Under the assumption that abnormal increases in consumption represent shocks to the minimum consumption threshold that cause some households to be debt-burdened, we expect that low-wealth households should have lower MPCs out of new income in the presence of past expenditure shocks.

Table 5 shows how spending propensities depend on lagged expenditure shocks for low-wealth and high-wealth households. Low-wealth households are those with average wealth over the sample below the median. Low-wealth households in the PSID indeed exhibit spending propensities that are lower in the presence of prior periods of high expenditure (column 1). In particular, among low-wealth households, a lagged expenditure shock lowers the average propensity to spend out of an income shocks by 0.06, or approximately fifteen percent of the level effect of high income (0.38). High-wealth households do not exhibit a detectable dependence of spending propensities on lagged necessary expenditure shocks (column 2).

Table: Spending Propensity Regressions from the PSID and Model.

Dependent variable: log(consumption)	PSID		Calibrated Model		w/o cbar		High average cbar	
	Low Wealth (1)	High Wealth (2)	Low Wealth (3)	High Wealth (4)	Low Wealth (5)	High Wealth (6)	Low Wealth (7)	High Wealth (8)
High Income	0.384*** (0.017)	0.417*** (0.037)	0.238*** (0.000)	0.089*** (0.000)	0.128*** (0.000)	0.058*** (0.000)	0.286*** (0.000)	0.078*** (0.002)
Lagged High Expenditure	0.052*** (0.013)	0.009 (0.009)	-0.013 (0.294)	-0.047*** (0.000)	0.027*** (0.000)	0.008*** (0.000)	0.041*** (0.001)	-0.056*** (0.000)
High Inc X Lagged High Exp	-0.060*** (0.021)	-0.009 (0.018)	-0.093*** (0.005)	0.022 (0.209)	0.001 (0.847)	-0.002 (0.107)	-0.185*** (0.000)	0.023 (0.343)
N	26166	26159	15750	15750	15750	15750	15750	15750
r ²	0.59	0.64	0.36	0.42	0.88	0.97	0.37	0.39
	High Lambda		Persistent cbar		High variance of cbar			
	Low Wealth (9)	High Wealth (10)	Low Wealth (11)	High Wealth (12)	Low Wealth (13)	High Wealth (14)		
High Income	0.208*** (0.000)	0.100*** (0.000)	0.298*** (0.000)	0.103*** (0.001)	0.304*** (0.000)	0.141*** (0.000)		
Lagged High Expenditure	-0.029** (0.038)	-0.045*** (0.000)	0.070*** (0.000)	-0.012 (0.296)	0.068*** (0.000)	-0.032** (0.032)		
High Inc X Lagged High Exp	-0.077** (0.025)	0.012 (0.512)	-0.139*** (0.000)	0.016 (0.564)	-0.333*** (0.000)	-0.021 (0.596)		
N	15750	15750	15750	15750	15750	15750		
r ²	0.36	0.42	0.27	0.35	0.37	0.42		

Note: A household has high income (consumption) in periods in which income (consumption) is over a standard deviation above average income (consumption) for the household. All regressions control for household wealth and the interaction of wealth with high income. Robust Standard Errors in parentheses. ***p<0.01, ** p<0.05, *, p<0.1.

The calibrated model exhibits similar patterns. Low-wealth households exhibit strong negative spending propensities that mimic those in the PSID (column 3), and high-wealth households do not exhibit spending propensities that depend on lagged expenditure (column 4). Column 5 demonstrates the importance of the minimum consumption threshold in driving the results. The simulated model without minimum consumption levels does not deliver spending propensities for low-wealth households that depend on prior consumption. The remaining columns demonstrate the sensitivity of the regression results to changes in the model parameters. The magnitude of the negative coefficient on the interaction term is increasing in the size, persistence, and the variance of the minimum consumption threshold. Each of these parameter changes increases the fraction of households that are debt-burdened and thus the estimated average effect of lagged expenditure on current spending propensities.

6 Model IRRFs and Inequality

Given the model’s prediction that higher average minimum consumption thresholds (and associated debt burdens) are associated with a higher fraction of agents with low MPCs, it follows that a government spending-induced increase in income for low wealth households should tighten credit markets (raise interest rates) less in economies with more agents that are against their minimum consumption threshold (e.g., debt-burdened). In our setting, the fraction of debt-burdened households is increasing in the minimum consumption threshold and inequality. Therefore, we would expect lower IRRFs as we increase $\underline{c}$ and inequality. This is the pattern our model produces. In particular, consistent with the cross-country evidence, higher inequality is associated with a lower IRRF (Figure 5).

7 Conclusion

We present new evidence that the effect of government spending on interest rates varies across countries, with half of OECD countries exhibiting a negative interest rate response. The IRRF is decreasing in country-level inequality, contrary to the predictions of existing heterogeneous agent models.

We interpret this evidence through the lens of a theoretical framework in which the interest rate response to demand stimulus depends on the share of consumers who are debt-burdened. In our setting, debt burdens do not reflect credit constraints but rather result from households’ minimum consumption needs. Adverse idiosyncratic shocks, such as emergency expenditures or temporary declines in income, cause households to take on debt rather than experience a decline in non-emergency consumption. This additional debt is burdensome in the sense that households pay it off more quickly out of additional income than they

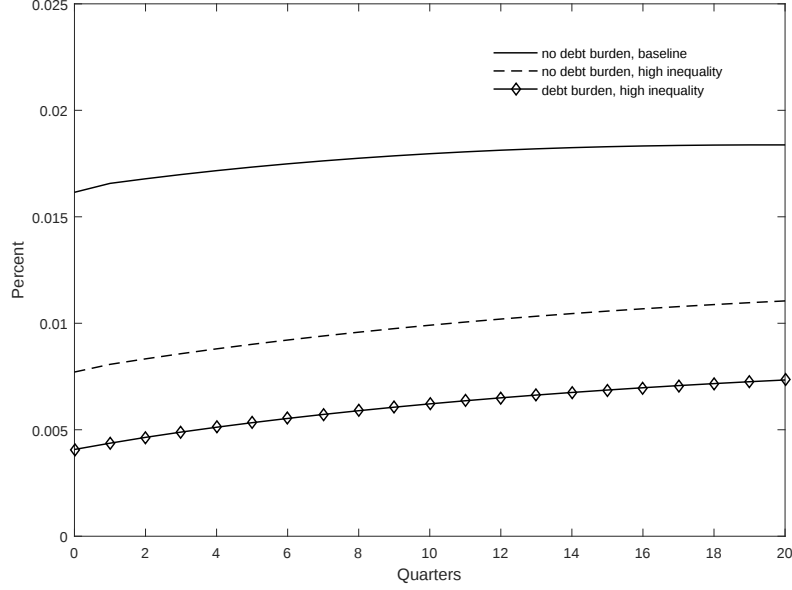


Figure 5
Model IRRFs

would in the absence of a minimum consumption constraint. Quick debt repayment helps households avoid very low future consumption (and associated welfare loss) in the event of future adverse shocks.

After formalizing our mechanism in a two-period setting, we show that such households exist in equilibrium in a calibrated dynamic model. The dynamic model predicts heterogeneity in MPCs that is consistent with recent evidence from microdata. Very low-wealth, low-income households tend to be credit-constrained and exhibit high MPCs. As wealth/income rise, more households are debt-burdened (savings-constrained) and exhibit low MPCs. Thereafter MPCs are increasing in wealth as fewer households need to borrow to afford their minimum consumption needs.

We validate the consumer behavior implied by our model using the PSID. In both the theory and the data, spending (savings) propensities depend on households' exposure to necessary expenditure shocks that potentially render them debt-burdened. This pattern cannot be replicated in standard heterogeneous-agent models.

Finally, we demonstrate that the relationship between the IRRF and inequality in our model is consistent with the relationship observed in the cross-country data: higher inequality is associated with a lower (and potentially negative) IRRF, and this relationship is stronger the more debt-burdened agents there are in the economy.

Overall, we present a new set of facts in international finance and a new framework for interpreting the facts based on heterogeneous MPCs. The new framework also helps reconcile theory with recent evidence from microdata on heterogeneity in MPCs.

References

- Agarwal, S. and Qian, W. (2014). Consumption and debt response to unanticipated income shocks: Evidence from a natural experiment in singapore. *American Economic Review*, 104(12):4205–30.
- Aiyagari, S. R. (1994). Uninsured idiosyncratic risk and aggregate saving. *Quarterly Journal of Economics*, 109(3):569–684.
- Alesina, A. and Summers, L. H. (1993). Central bank independence and macroeconomic performance: Some comparative evidence. *Journal of Money, Credit and Banking*, 25(2):151–162.
- Auerbach, A. and Gorodnichenko, Y. (2012). Measuring the output responses to fiscal policy. *American Economic Journal: Economic Policy*, 4(2):1–27.
- Auerbach, A. and Gorodnichenko, Y. (2013). Output spillovers from fiscal policy. *American Economic Review: Papers and Proceedings*, 103(3).
- Bachmann, R. and Sims, E. R. (2012). Confidence and the transmission of government spending shocks. *Journal of Monetary Economics*, 59(3):235–249.
- Barro, R. J. (1987). Government spending, interest rates, prices, and budget deficits in the United Kingdom, 1701-1918. *Journal of Monetary Economics*, 20(2):221–247.
- Blanchard, O. and Perotti, R. (2002). An empirical characterization of the dynamic effects of changes in government spending and taxes on output*. *The Quarterly Journal of Economics*, 117(4):1329.
- Brinca, P., Holter, H. A., Krusell, P., and Malafry, L. (2016). Fiscal multipliers in the 21st century. *Journal of Monetary Economics*, 77:53–69.
- Chetty, R. and Szeidl, A. (2007). Consumption commitments and risk preferences. *Quarterly Journal of Economics*, 122(2):831–877.
- Corsetti, G., Meier, A., and Mueller, G. J. (2012a). Fiscal Stimulus with Spending Reversals. *The Review of Economics and Statistics*, 94(4):878–895.
- Corsetti, G., Meier, A., and Mueller, G. J. (2012b). What determines government spending multipliers? *Economic Policy*, 27(72):521–565.
- Demyanyk, Y., Loutskina, E., and Murphy, D. (2016). Fiscal Stimulus and Consumer Debt.

- Dincer, N. N. and Eichengreen, B. (2014). Central Bank Transparency and Independence: Updates and New Measures. *International Journal of Central Banking*, 10(1):189–259.
- Eggertsson, G. B. and Krugman, P. (2012). Debt, Deleveraging, and the Liquidity Trap: A Fisher-Minsky-Koo Approach. *The Quarterly Journal of Economics*, 127(3):1469–1513.
- Faccini, R., Mumtaz, H., and Surico, P. (2016). International fiscal spillovers. *Journal of International Economics*, 99(C):31–45.
- Fisher, J. and Peters, R. (2010). Using Stock Returns to Identify Government Spending Shocks. *Economic Journal*, 120(544):414–436.
- Ilzetzki, E., Mendoza, E. G., and Vegh, C. A. (2013). How big (small?) are fiscal multipliers? *Journal of Monetary Economics*, 60(2):239–254.
- Jappelli, T. and Pistaferri, L. (2014). Fiscal policy and mpc heterogeneity. *American Economic Journal: Macroeconomics*, 6(4):107–136.
- Kaplan, G. and Violante, G. L. (2014). A model of the consumption response to fiscal stimulus payments. *Econometrica*, 82(4):1199–1239.
- Lane, P. R. and Milesi-Ferretti, G. M. (2007). The external wealth of nations mark II: Revised and extended estimates of foreign assets and liabilities, 1970-2004. *Journal of International Economics*, 73(2):223–250.
- Misra, K. and Surico, P. (2014). Consumption, Income Changes, and Heterogeneity: Evidence from Two Fiscal Stimulus Programs. *American Economic Journal: Macroeconomics*, 6(4):84–106.
- Murphy, D. and Walsh, K. (2017). Government Spending and Interest Rates. *Mimeo University of Virginia*.
- Ramey, V. A. (2011). Identifying Government Spending Shocks: It’s all in the Timing. *The Quarterly Journal of Economics*, 126(1):1–50.
- Ravn, M. O., Schmitt-Grohé, S., and Uribe, M. (2012). Consumption, government spending, and the real exchange rate. *Journal of Monetary Economics*, 59(3):215–234.
- Rossi, B. and Zubairy, S. (2011). What Is the Importance of Monetary and Fiscal Shocks in Explaining U.S. Macroeconomic Fluctuations? *Journal of Money, Credit and Banking*, 43(6):1247–1270.

- Sahm, C. R., Shapiro, M. D., and Slemrod, J. (2015). Balance-Sheet Households and Fiscal Stimulus: Lessons from the Payroll Tax Cut and Its Expiration. NBER Working Papers 21220, National Bureau of Economic Research, Inc.
- Shapiro, M. D. and Slemrod, J. (2003). Consumer response to tax rebates. *American Economic Review*, 93(1):381–396.

7.1 Appendix: Tables

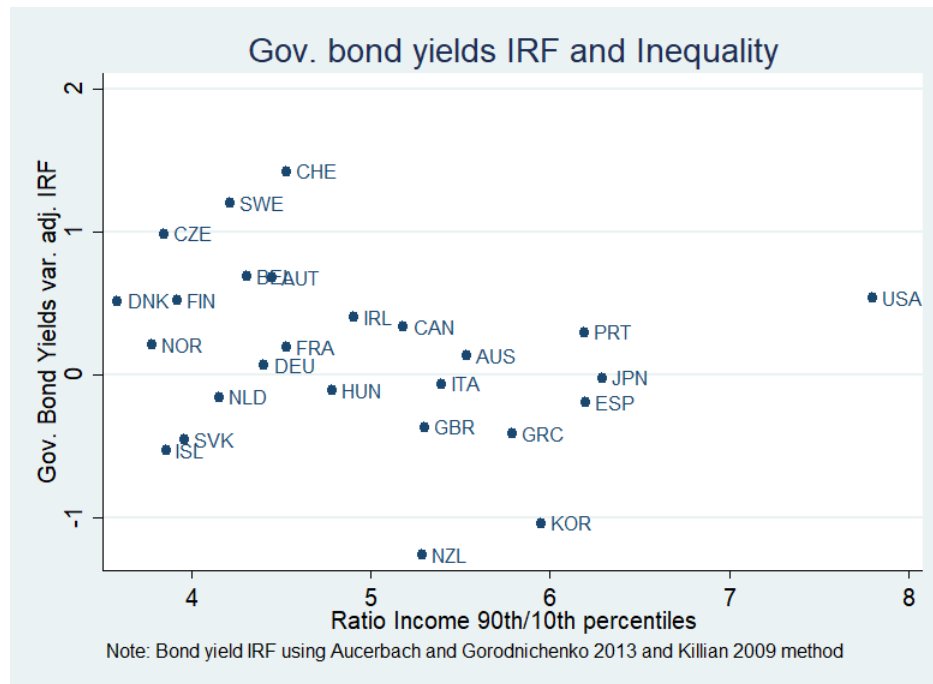


Figure 6
Inequality and Gov. Bond Yield Response (Robustness)

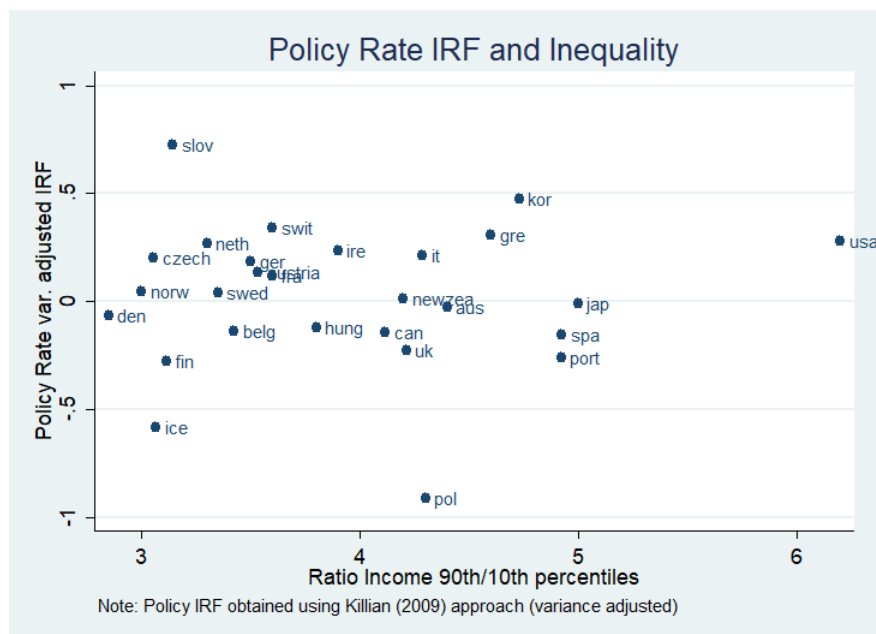


Figure 7
Inequality and Policy Rates Response

Table 5
Sample for VAR estimation

Country	G		GDP		Interest Rates		Credit BIS
	OECD	Haver	OECD	Haver	bond ylds.	policy rate	
Australia	1959-Q4		1959-Q3		1957-Q1	1969-Q3	1977-Q4
Austria	1988-Q1		1988-Q1		1971-Q1	1957- <i>Q1</i> *	1995-Q4
Belgium	1995-Q1		1995-1		1957-Q1	1957- <i>Q1</i> *	1980-Q4
Canada		1957-Q1		1957-Q1	1957-Q1	1957-Q1	1969-Q2
Czech Republic	1996-Q2		1996-Q1		2000-Q2	1995-Q4	1995-Q4
Denmark		<i>1977-Q1</i>		<i>1977-Q1</i>	1960-Q1	1957-Q1	1994-Q4
Finland	1990-Q1		1990-Q1		1988-Q1	1957- <i>Q1</i> *	1970-Q4
France	1955-Q1		1955-Q1		1957-Q1	1964- <i>Q1</i> **	1977-Q4
Germany	1970-Q1		1970-Q1		1957-Q1	1957- <i>Q1</i> *	1971-Q1
Greece	1970-Q1		1970-Q1		1992-Q4	1957- <i>Q1</i> *	1994-Q1
Hungary	1995-Q1		1995-Q1		2001-Q1	1981-Q1	1989-Q4
Iceland	1997-Q1		1997-Q1		1992-Q1	1964-Q1	
Ireland	1997-Q1		1997-Q1		1964-Q1	1957- <i>Q1</i> **	2002-Q1
Italy	1981-Q4		1981-Q4		1958-Q1	1964- <i>Q1</i> *	1960-Q4
Japan		1957-Q1		1957-Q1	1966-Q4	1957-Q1	1964-Q4
Korea		<i>1960-Q1</i>		<i>1960-Q1</i>	1973-Q2	1999-Q2	1962-Q4
Netherlands	1988-Q1		1988-Q1		1964- <i>Q4</i> **		1990-Q4
New Zealand	1987-Q2		1987-Q2		1964-Q1	1999-Q1	1990-Q4
Norway		1961-Q1		1961-Q1	1961-Q4	1964- <i>Q1</i> **	1975-Q1
Poland	1995-Q1		1995-Q1		2001-Q1	1998-Q1	1995-Q4
Portugal	1995-Q1		1995-Q1		1957-Q1	1957- <i>Q1</i> *	1979-Q4
Slovak Republic	1997-Q1		1997-Q1		2000-Q1	1993- <i>Q2</i> **	
Slovenia	1995-Q1		1995-Q1		2002-Q2	1992-Q1	
Spain	1995-Q1		1995-Q1		1978-Q1	1964- <i>Q1</i> *	1980-Q4
Sweden	1960-Q1		1960-Q1		1960-Q1	1960- <i>Q1</i> **	1980-Q1
Switzerland	1980-Q1		1980-Q1		1964-Q1	1964-Q1	1999-Q4
United Kingdom	1955-Q1		1955-Q1		1957-Q1	1959-Q1	1966-Q4
United States	1955-Q1		1955-Q1		1957-Q1	1983-Q3	1956-Q3

* Supplemented by ECB policy rates since 1999-Q1

** Supplemented by by short term rates from [Ilzetzki et al. \(2013\)](#) and ECB rates

Note: *Information in cursive means data were not originally seasonally adjusted*