Saving Constraints, Debt, and the Credit Market Response to Fiscal Stimulus: Theory and Cross-Country Evidence*

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Abstract

We document that the interest rate response to fiscal stimulus is lower in countries with high inequality or high household debt. To interpret this evidence we develop a model in which households take on debt to maintain a minimum consumption threshold. 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. To validate our mechanism we confirm that the pre-Global Financial Crisis consumption response to fiscal stimulus is lower in countries with high inequality or household debt and in U.S. counties with high household debt. An implication of our theoretical and empirical results is that the sign of the debt-dependence of the effects of fiscal stimulus varies with credit conditions.

Keywords: interest rates, fiscal stimulus, household debt, inequality
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1 Introduction

The size and length of the Great Recession 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, which we call the IRRF, is of central importance, as it controls the extent to which stimulus crowds out investment and therefore 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. This lack of attention and clarity may be due to an apparent conflict between theory and empirical findings. While standard theory (of both neoclassical and New Keynesian underpinnings) predicts that interest rates rise in response to government spending, studies based on the U.S. and U.K. tend to find a zero or negative effect on interest rates (e.g., Barro (1987) and, more recently, Ramey (2011) and Fisher and Peters (2010)). Related and also puzzling is the evidence that government spending tends to be associated with local currency depreciation rather than appreciation (e.g., Ravn et al. (2012), Corsetti et al. (2012a), Faccini et al. (2016)).[1]

In this paper we use cross-country evidence, supplemented with U.S. regional microdata, to investigate the credit market effects of fiscal policy. We focus on government bond yields instead of short-term interest rates to capture financial market conditions rather than the stance of monetary policy. We employ two approaches to identifying fiscal shocks. First, we follow Blanchard and Perotti (2002), who exploit relatively high frequency data and legislative lags to construct government spending innovations that are plausibly exogenous to current economic conditions. We also use the approach proposed by Auerbach and Gorodnichenko (2013), which, unlike that of Blanchard and Perotti (2002), takes into account the anticipation of government spending plans by using surveys of professional forecasters from OECD databases. We focus on the period before the Global Financial Crisis (GFC) since interest rates arguably respond to shocks differently in crisis periods.

We document that there is substantial heterogeneity in the 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 for longer-term nominal government bond yields,

[1] The mechanism that would imply currency *appreciation* from government spending (vs. the depreciation seen in the data) is straightforward. Increased government spending crowds out private activity. The interest rate increases to clear the goods market, and higher rates attract foreign capital inflows, which appreciate the currency.

and no theory of which we are aware has been proposed to account for heterogeneity in the IRRF (except with respect to fiscal shocks *at* versus *away from* 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 and household debt are the strongest predictors of the IRRF. In particular, higher inequality and higher household debt are 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 or leverage to imply the existence of many credit-constrained households with high marginal propensities to consume (see, for example, Huggett (1993), Aiyagari (1994), and Brinca et al. (2016)) that would, all else equal, push up the IRRF. The negative relationship between inequality or household debt and the IRRF suggests new theory is needed to understand the data.

To rationalize this evidence, we propose a theory that builds on the insights in Chetty and Szeidl (2007) and our companion paper, Miranda-Pinto et al. (2018). In Miranda-Pinto et al. (2018), we demonstrate that a dynamic heterogeneous-agent model featuring time-varying minimum consumption thresholds can rationalize many aspects of the household-level joint dynamics of consumption and income.[2] These minimum consumption thresholds represent stochastic maintenance costs for aspects of current consumption that are determined by prior decisions and costly to adjust in the short-term ("consumption commitments" -Chetty and Szeidl (2007)). For example, automobiles (committed consumption) may break down and require repairs. In a stationary equilibrium, the consumption of many low-wealth, low-income households is pushed up by these minimum consumption thresholds (relative to consumption in the absence of the thresholds), rendering them *debt-burdened* or *saving-constrained*. These households use all additional income to delever rather than to increase consumption.

Here we embed minimum consumption thresholds (saving constraints) in a two-period general equilibrium model to demonstrate that the existence of these high-debt, saving-constrained households can help rationalize our evidence on the relationship between the IRRF and inequality (debt). The model illustrates in a simple setting how saving constraints generate an inverse relationship between inequality (and debt) and the IRRF. In our model, a fraction of households are sufficiently poor that they hit the minimum consumption constraint in the first period (consistent with the prevalence of saving constraints among low-wealth households in Miranda-Pinto et al. (2018)). Government spending redistributes income to poor, saving-constrained households with low MPCs. More specifically, in producing government goods, the government hires and pays wages to workers, which are comprised

[2]Specifically, Miranda-Pinto et al. (2018) presents evidence that 1) household-level consumption is as volatile as household income on average, 2) household-level consumption is relatively uncorrelated with income, 3) a large fraction of high-debt households exhibit marginal propensities to consume near zero (consistent with evidence in Bunn et al. (2018), Sahm et al. (2015) and Misra and Surico (2014)), and 4) lagged high expenditure is associated with low contemporaneous spending propensities.

of both high-debt (saving-constrained) low-income agents (for whom the minimum threshold is binding) and unconstrained rich agents. Taxes are proportional to income, so wages associated with government production redistribute resources to the low-wealth households with zero MPCs. This redistribution to low-MPC households relaxes credit markets and puts downward pressure on the equilibrium interest rate, as government wages help poor workers delever. With higher inequality, more households are saving-constrained, household debt is higher, and government spending relaxes credits market more (tightens them less). This pattern offers an explanation for why the IRRF is lower in countries with higher inequality (and household debt).

The relative credit market relaxation in our theory is driven by low MPCs due to the prevalence of saving-constrained households. This credit market relaxation can manifest in a low interest rate response and/or a low consumption response to fiscal stimulus. We therefore test the prediction that consumption should (weakly) increase less after fiscal shocks in countries or counties with higher household debt. To test this prediction, we use cross-country and U.S. cross-county data to study how the private consumption response to government spending shocks depends on households' debt. The cross-country and cross-county evidence support this implication. We find that the 4-quarter response of consumption to government spending shocks is smaller in countries with high inequality or high household debt. This result is consistent with prior evidence in Jappelli and Pagano (1989), who find that among a subsample of OECD countries, consumption is less responsive to income in countries with higher levels of consumer debt. We also test this prediction using pre-Great Recession county-level data for the U.S., and we find that government spending increases auto registrations (a common proxy for consumption) less in counties with high household debt.

Our empirical and theoretical results relate to a number of other strands of the literature. Recent empirical work documents determinants of fiscal output multipliers in cross-country settings (e.g., Brinca et al. (2016), Ilzetzki et al. (2013), Corsetti et al. (2012b)). While we likewise examine cross-country determinants of the effects of fiscal shocks, our focus is on heterogeneity in interest rates (and consumption) rather than output, and we consider OECD countries exclusively.

Our evidence that the consumption response to government spending is *lower* in the presence of high household debt differs from recent evidence in Demyanyk et al. (2019) (which shares a co-author with this study) that consumer debt during the Great Recession was associated with higher consumption responses to fiscal stimulus. However, the Demyanyk et al. (2019) evidence is based on an episode in which credit conditions were very tight, while our evidence is based on a longer span of time with looser credit conditions. To demonstrate the role of credit tightness in our theoretical framework, in our Appendix we introduce credit restrictions in our two-period model. When credit is sufficiently tight, poor households become credit-constrained rather than saving-constrained (they cannot even meet their minimum consumption threshold in the first period) and exhibit large MPCs. In that case, the consumption response to fiscal stimulus is increasing in inequality and debt, consistent with the evidence in Demyanyk et al. (2019) and with the theoretical predictions in Eggertsson and Krugman (2012). But under normal (looser) credit conditions, high-debt households are saving-constrained and exhibit low MPCs. We test this prediction using *pre-crisis* data across U.S. counties and find that consumption is indeed less responsive to fiscal stimulus in regions with more debt. This is consistent with the evidence in Demyanyk et al. (2019) that fiscal multipliers were, if anything, lower in high-debt cities in the mid-2000s.

In light of the evidence in Demyanyk et al. (2019), an implication of our study is that not only is the effect of fiscal stimulus dependent on debt but also that the sign of this debt-dependence potentially varies with credit conditions. We examine a setting in which credit is relatively loose (and hence households are saving-constrained), but in crisis periods or in non-OECD countries, poor households may be credit-constrained rather than saving-constrained.

Finally, our evidence of negative IRRFs in a number of countries potentially helps resolve the puzzling finding of previous papers that expansionary government spending shocks are not clearly associated with exchange rate appreciations (see, for example, 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 a potential reconciliation between the data and the Mundell-Fleming interest-rate-channel of exchange rate movements.

The remainder of the paper proceeds as follows. Section 2 documents the relationship between the IRRF and inequality and household debt. Section 3 presents a qualitative theory of debt-burdened households to rationalize our findings. Section 4 presents several empirical validation exercises, including cross-county results for the United States. Section 5 concludes.

2 The interest rate response to fiscal stimulus

To estimate country-level fiscal shocks and IRRFs, we collect quarterly data on real government consumption, real GDP, and nominal interest rates across countries. Obtaining reliable country-level estimates of fiscal shocks requires a sufficient timespan of data. Therefore we limit our focus to OECD countries, most of which provide quarterly data that span 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 Figure 5 of Appendix A.[3]

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 they are not directly controlled by central banks but rather 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. The average maturity in our sample is around 8 years. Our baseline estimation period ends in 2007 in order to avoid structural breaks that may have been associated with the GFC and to focus on the transmission mechanism of government spending shocks outside crisis times. In Appendix A 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 Ilzetzki et al. (2013). The policy rates for members of the European Monetary Union are equal to European Central Bank rates.

2.1 Identifying shocks to government consumption expenditures

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 Ilzetzki et al. (2013) point out, this approach is not viable when estimating fiscal shocks across countries. Data on news about 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 news measure in the post-war period. Therefore, we adopt 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.

[3] Each country's nominal quantities are put in real terms by deflating by the country's consumer price index. Government bond yields are kept as nominal due to lack of data on inflation expectations.

(see the discussion in Murphy and Walsh (2018)). 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 show in Appendix A.1 that the main results of the paper also hold when we use the semi-annual government innovations from their work.

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

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

where $X_t = [G_t, Y_t, r_t]'$ consists of log real government final consumption expenditure G_t, log real GDP, and government bond yields r_t. $\varepsilon_t = [\nu_t, \varepsilon_{2,t}, \varepsilon_{3,t}]$ 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. We use 4 lags of our endogenous variables. Unlike Blanchard and Perotti (2002), we do not have quarterly data on tax revenue for our sample.[4,5]

We estimate impulse responses of 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 average 4-quarter impulse response to government consumption shocks. Let ρ_h be the horizon h impulse response of interest rates (in annualized percentage points). The country-level interest rate response to a standard-deviation shock to government consumption is computed as:

$$IRRF = \frac{1}{4} \sum_{h=0}^{3} \rho_h. \tag{2}$$

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 0.13 percentage points on average over four quarters. In the U.S., a standard deviation shock to government expenditure *decreases* interest rates by 0.06 percentage points.

Next we examine the country-level determinants of the IRRF.

2.2 Determinants of the IRRF

Motivated by prior theoretical work (e.g., Eggertsson and Krugman (2012), Brinca et al. (2016)), we examine whether household debt and inequality can account for the variation

[4] To 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 one year interest rate response is practically unchanged when tax revenue is added to the VAR. This is consistent with the findings in Ilzetzki et al. (2013) with respect to the output multiplier.

[5] We 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.

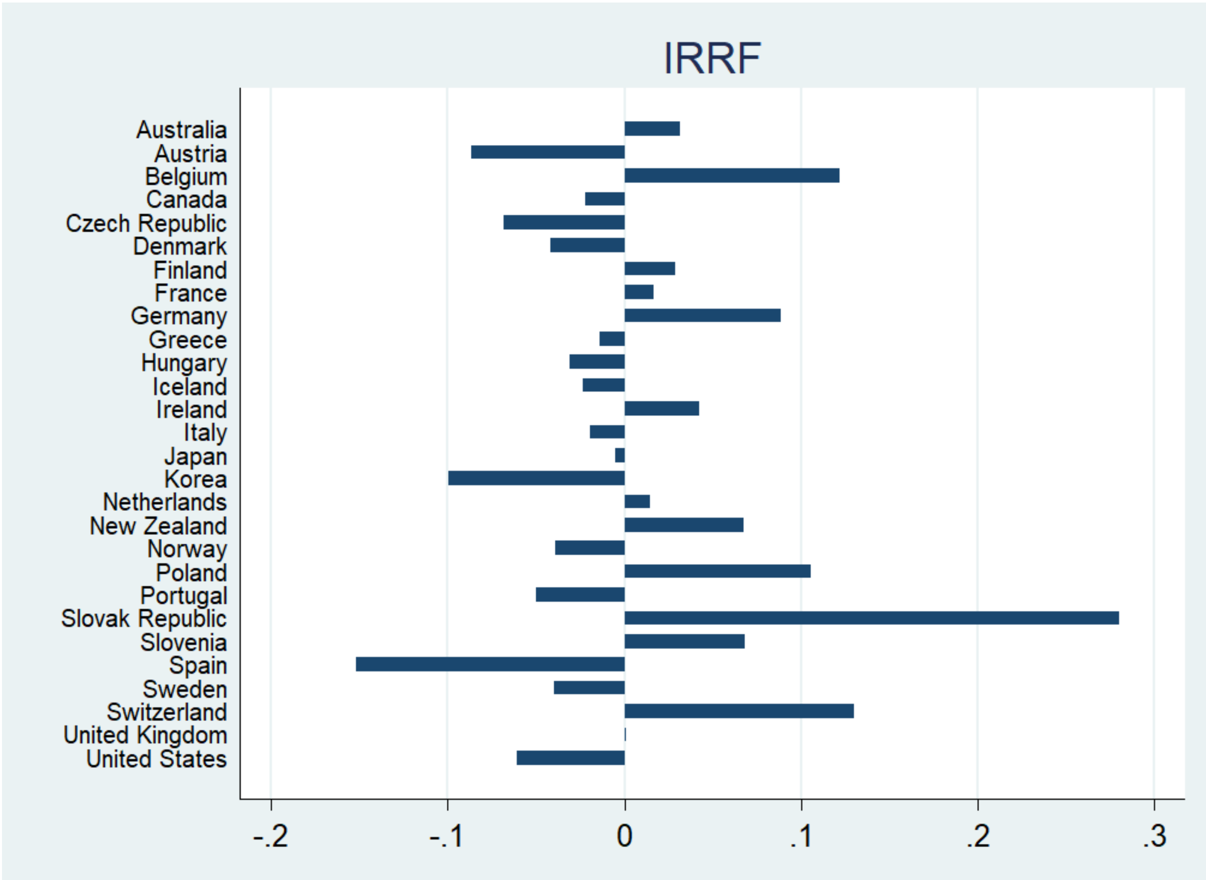

Figure 1

For each country, the figure shows the IRRF (Equation 2) in percentage points estimated from the country-specific start date in Figure 5 through 2007Q4.

in the 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 since 2001, when that data are first available. Income inequality is very stable within countries and exhibits substantial cross-sectional dispersion. The average within-country standard deviation of inequality is 0.15, while the cross country standard deviation of our measure is 1.4. 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. For household debt, we use the household debt-to-income ratio from the OECD Statistics. In particular, we collect for each country, the ratio between households' total liabilities (loans, primarily mortgage loans and consumer credit, and other accounts payable) to net disposable income. We then use, for each country, the sample average.[6] The household debt measure likewise exhibits stronger cross-country variation than within-country variation. We report results that use the entire time series when constructing the country-specific measure, although results are similar when limiting the sample to pre-2008 data (and therefore dropping Korea, which

[6]Data for most countries begins in 1996. Data for Ireland, Poland, Slovenia, Spain and Switzerland are available as of 2003. Korea has data only for the period 2011-2014.

only has post-2008 debt data).

Given that our estimated IRRF across countries is estimated with different degrees of precision, in our regression analysis we use weighted least squares (WLS). Our idea is to give less weight to observations that are estimated with less precision.[7] Our weights are

$$\omega_i = \frac{1}{IRRF_i^{95} - IRRF_i^{5}}, \tag{3}$$

where $IRRF_i^{95}$ and $IRRF_i^{5}$ are the upper (95%) and lower (5%) bounds of the bootstrap confidence intervals of the IRRF of country i, respectively.

Figure 2 documents the unconditional relationship between the IRRF and inequality. The IRRF declines with inequality, a surprising pattern given that inequality is often associated with credit constraints that would be expected to cause a higher IRRF.

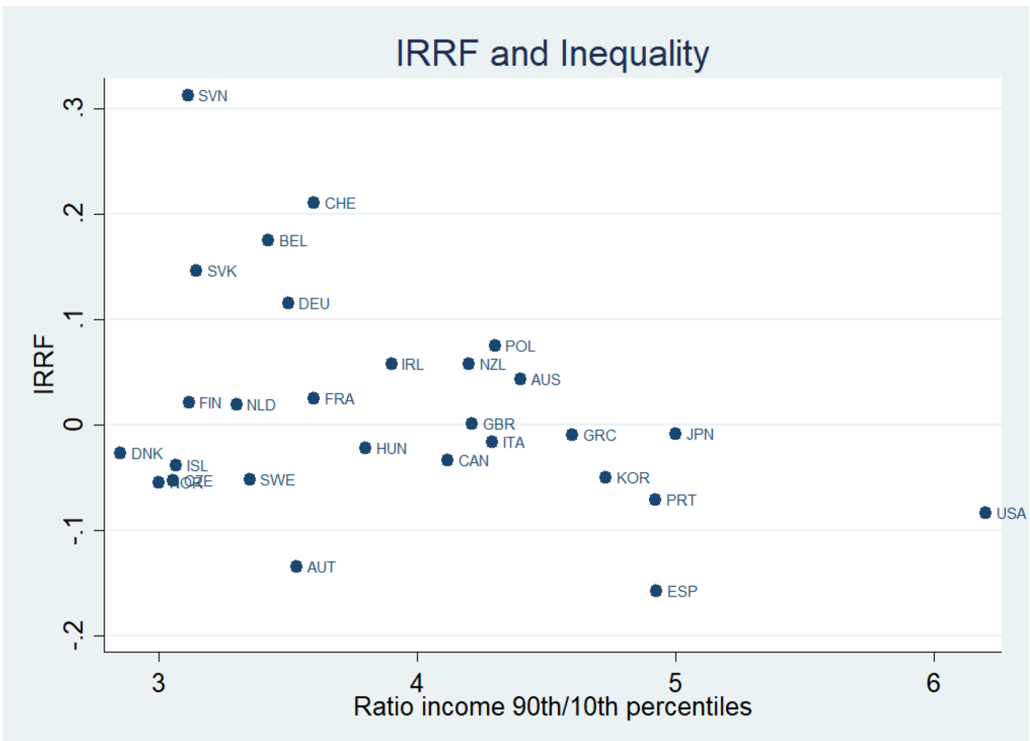

Figure 2

The figure plots $\frac{1}{\omega_i} IRRF_i$ (see Equations 2 and 3) in percentage points (estimated from the country-specific start date in Figure 5 through 2007Q4) against income inequality (from the OECD, averaged over 2001-2013).

[7]WLS provides efficiency gains over OLS and consistent standard errors when all of the error in our regression analysis is attributable to measurement error in the IRRF. When there are additional sources of error (as in the typical case), Lewis and Linzer (2005) show that if the additional error is small relative to the measurement error in the dependent variable, our WLS procedure is similar to feasible generalized least squares that explicitly accounts for both sources of error. However, since "small" is context-dependent, they propose also showing OLS with robust standard errors, which they explain correctly measure the uncertainty in OLS even in small samples. Therefore, we report OLS results with Huber-White standard errors in Appendix tables as well.

It is possible that the surprising relationship between inequality and the IRRF is due to monetary policy that is more accommodative of fiscal shocks in unequal countries. We examine policy rate responses and find that the same relationship does not hold (policy rate responses are independent of inequality), suggesting that government spending relaxes credit markets relatively more in unequal countries, beyond any response of monetary policy to government spending shocks.[8] This is consistent with the evidence in Murphy and Walsh (2018) 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 define a dummy variable for countries with an inflation targeting scheme prior to 2007 (see Carare and Stone (2003)). Our measure of financial openness, from Lane and Milesi-Ferretti (2007), is financial assets plus liabilities, over GDP. The motivation for including this control is that Mundell-Fleming predicts that countries that are more open to international financial markets have smaller or zero responses of interest rates to fiscal shocks.

Motivated by Priftis and Zimic (2018) and Broner et al. (2018) we also control for the fraction of public foreign debt to GDP, obtained from the Quarterly Public Sector Debt statistics (IMF-World Bank). The authors show that fiscal multipliers are larger when government debt is externally financed due to a muted crowding-out of domestic credit markets. We calculate the average fraction of foreign public debt to GDP for the period 2002Q1-2017Q4. We only have this information for 19 of our 28 countries.[9] In Appendix A.3, Table 6, we provide the relevant descriptive statistics of our dependent variable and control variables.

[8] See Figure 8 in Appendix A.2.

[9] We do not have information on the fraction of foreign public debt to GDP for the following countries: Belgium, Denmark, France, Germany, Greece, Japan, New Zealand, Norway, and Poland.

Table 1
IRRF and Country Characteristics

VARIABLES	(1) IRRF	(2) IRRF	(3) IRRF	(4) IRRF
Income ratio 90th/10th	-0.045*	-0.044*	-0.043*	-0.070**
	(0.024)	(0.025)	(0.023)	(0.030)
Financial Openness		0.002		
		(0.008)		
Inflation Targeting			-0.061*	
			(0.035)	
External Government Debt/GDP				-0.000
				(0.002)
Observations	28	28	28	19
R-squared	0.122	0.123	0.218	0.249

Note: This table presents the WLS coefficients of regressing the estimated IRRF against income inequality (from OECD database), financial openness (from Lane and Milesi-Ferretti (2007)), inflation targeting dummy (from Carare and Stone (2003)), and foreign government debt to GDP (from IMF-World Bank QPSD data). The regression weights are $\frac{1}{\omega_i}$ (Equation 3). Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 1 shows the dependence of the IRRF on inequality, conditional on these other determinants. We normalize our covariates, except inflation targeting, by their sample standard deviation. We find that a one standard deviation increase in inequality is associated with a 4.5 basis point decline in the IRRF. The relationship is robust to controlling for countries' financial openness (column 2), inflation targeting (column 3), and the fraction of government foreign debt to GDP (column 4).[10] The same results hold if we instead use OLS and estimate standard errors using the Huber-White approach (see Table 7 in Appendix A.4 and the discussion in Footnote 7).

The theoretical model below offers an interpretation of the relationship between inequality and the IRRF. A key feature of the model is that inequality and household debt affect the IRRF through the same channels. Therefore here we also examine the relationship between the IRRF and the median household debt to income ratio. Table 2 shows that a one standard deviation increase in the household debt to income ratio is associated with a 3.1 basis points reduction in the IRRF. This is also robust to adding controls (columns 2 to 4) and using

[10] The negative coefficient for foreign public debt to GDP is consistent with the predictions in Priftis and Zimic (2018) and Broner et al. (2018).

OLS with Huber-White standard errors (Table 8 of Appendix A.4).

Table 2
IRRF and Country Characteristics

VARIABLES	(1) IRRF	(2) IRRF	(3) IRRF	(4) IRRF
HH debt to income	-0.031*	-0.043**	-0.033*	-0.035
	(0.017)	(0.018)	(0.016)	(0.028)
Financial Openness		0.034		
		(0.022)		
Inflation Targeting			-0.068*	
			(0.034)	
External Government Debt/GDP				-0.007
				(0.029)
Observations	28	28	28	19
R-squared	0.114	0.188	0.232	0.090

Note: This table presents the WLS coefficients of regressing the estimated IRRF against the median household debt to income ratio (from OECD database), financial openness (from Lane and Milesi-Ferretti (2007)), inflation targeting dummy (from Carare and Stone (2003)), and foreign government debt to GDP (from IMF-World Bank QPSD data). The regression weights are $\frac{1}{\omega_i}$ (Equation 3). Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

To summarize our results, the interest rate response to government purchases is heterogeneous across countries and is inversely related to inequality and household leverage. Below we propose a model in which high inequality and high debt are associated with a large fraction of low-income households with high propensities to save (low MPCs). Government consumption redistributes resources to these low-income households and relaxes credit markets.

3 Theory: saving-constrained households, debt, and interest rates

Here we develop a framework in which the distribution of income (and therefore debt) is crucially important for the transmission of fiscal policy. We depart from prior theoretical work on the relationship between debt (or inequaltiy) and fiscal effects (e.g., Eggertsson and Krugman (2012)) in that we abstract from credit constraints. Indeed, models of credit constraints predict that higher inequality and higher debt are associated with a higher consumption response to fiscal stimulus (e.g., Brinca et al. (2016)) that would, all else equal, cause interest rates to rise. Given that our evidence (a) is driven by a period of relatively loose credit and (b) reveals the opposite relationship between debt and fiscal effects, we abstract from credit constraints and instead consider an alternative friction that arises from households' need to cover unexpected expenses such as medical bills and automobile repairs. In a companion paper, Miranda-Pinto et al. (2018), we document the importance of unexpected expenditures - or minimum consumption threshold shocks - in matching key features of the microdata.[11]

Minimum consumption thresholds build on the notion of "consumption commitments" in Chetty and Szeidl (2007) in that they represent stochastic maintenance costs for aspects of consumption that are costly to adjust in the short-term. In Miranda-Pinto et al. (2018) we demonstrate that many low-income households that experiences a high minimum consumption threshold take on debt to cover the expense and use all additional income to delever. We refer to these households as *Saving Constrained* because they borrow more (save less) than they would in the absence of the minimum consumption threshold.

Here we introduce saving constrained households in a general equilibrium setting. Our objective is to demonstrate in a clear and simple setting the interrelationships among debt, inequality, and the IRRF. Therefore, we abstract from the infinite-horizon environment in Miranda-Pinto et al. (2018) and instead consider a two-period setting in which households are subject to a minimum consumption constraint in the first period. This constraint is a reduced-form way of modeling the stochastic minimum consumption thresholds that cause low-income households to be saving constrained in Miranda-Pinto et al. (2018).

To accommodate the possibility that interest rates can fall in response to government spending, we examine a setting that permits slack in labor markets.[12] As discussed in Murphy and Walsh (2018), the existence of slack permits a non-positive interest rate response to government spending. In our model, government spending can cause a negative interest rate response in the presence of slack by redistributing income to low-income, saving-constrained households.

3.1 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 $1-\pi$. Each agent elastically supplies up to

[11] Miranda-Pinto et al. (2018) lays out a theory of saving-constrained households and demonstrates that in a dynamic setting with incomplete markets, saving-constrained households exist in the stationary equilibrium (they do not fully precautionarily save to avoid the constraint in a calibrated model). We show that the existence of saving-constrained households provides an explanation for puzzling aspects of the microdata. For example, household-level consumption is as volatile as income but relatively uncorrelated with income. Furthermore, many high-debt/low-wealth households save all additional income (e.g., Sahm et al. (2015), Misra and Surico (2014)) and in Alaska lower-income households tend to have lower MPCs (Kueng (2018)).

[12] The existence of slack in labor markets is consistent with the empirical evidence in Auerbach et al. (2019).

$\overline{L}$ units of labor in each period, of which there are two: $t \in \{0,1\}$.

In each period, there is a representative private firm that solves

$$\Pi = \max_{\ell} \left(A\ell^{\alpha} - w\ell\right),$$

where w is the wage, which is stuck, and $0 < \alpha < 1$. Given w, firm labor demand is $\ell^* = (w/(\alpha A))^{1/(\alpha-1)}$. We assume that (1) $\overline{L} > \ell^*$, (2) the firm randomly hires among the agents, and (3) $A = (w/\alpha)^{\alpha}$ (a simplifying normalization). Therefore, firm and worker optimization imply that $\Pi + w\ell^* = A\ell^{*\alpha} = 1$, that $\ell^* = \alpha/w$, and that each agent's private sector labor income is $w\ell^* = \alpha$, a fraction π of which goes to non-rich agents. Moreover, since $\ell^* < \overline{L}$ there is slack in the labor market in the sense that each agent is willing to supply more labor than the private sector is willing to hire at the stuck wage w.

In $t = 0$, the government also hires the agents (again, randomly across types). Specifically, the government demands $\widetilde{G} = G/w < \overline{L} - \ell^*$ units of labor, which the agents are willing to supply since $\widetilde{G} + \ell^* < \overline{L}$. The government uses the workers to produce government goods and effectively buys these goods from itself. For the purposes of national accounting, these public purchases are valued at their cost. So, $G = \widetilde{G}w = \pi\widetilde{G}w + (1-\pi)\widetilde{G}w$ is both the public wage paid to each agent and the value of government purchases in the national accounts. GDP or national income is, in the two periods,

$$\begin{aligned} Y_0 &= \Pi + w\ell^* + w\widetilde{G} = A\ell^{*\alpha} + G = 1 + G \\ Y_1 &= \Pi + w\ell^* = A\ell^{*\alpha} = 1 \end{aligned} \tag{4}$$

We assume that the rich collectively own half of firm profits. Thus, the total private sector pre-tax income of the rich is $\Pi/2 + (1-\pi)w\ell^*$, while the income of a rich individual is $y^r = \Pi/(2(1-\pi)) + w\ell^*$. Similarly, the private sector pre-tax income of a non-rich individual is $y^p = \Pi/(2\pi) + w\ell^*$, so $(1-\pi)y^r + \pi y^p = 1$. A useful feature of this setup is that a single parameter, π, governs inequality. As π varies between 1/2 and 1, total private income is fixed at $\Pi + w\ell^* = 1$. However, since the poorest 50% of agents are always non-rich, the total private pre-tax income of the richest 50% of agents is

$$\Pi + w\ell^* - \frac{1}{2}\left(\frac{\Pi}{2\pi} + w\ell^*\right),$$

which is monotonically increasing in π. Also, as $\pi \to 1$, half of firm profits are owned by an increasingly small fraction of agents.

In the first period, the agents and the government trade zero net supply bonds at gross interest rate R. The government pays for purchases with a flat proportional tax τ on private income in the second period. Since $(1-\pi)\, y^r + \pi y^p = 1$, the government budget constraint is

$$RG = \tau. \tag{5}$$

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

$$\begin{aligned} &\max_{c_0, c_1} \{\log(c_0) + \log(c_1)\} \ \textit{subject to} \\ (i) &: c_0 + \frac{1}{R} c_1 = y^i + \frac{1}{R} y^i (1-\tau) + G \\ (ii) &: c_0 \geq \underline{c}, \end{aligned} \tag{6}$$

where $\underline{c}$ is the minimum consumption level. Recall that $G = \widetilde{G} w$ is wage income from government work, and y^i includes both private profits and wages. Since taxes are proportional to private income but government wages are uniform across agents, fiscal policy redistributes from rich to non-rich.

Under the above assumptions, *equilibrium with slack in the labor market* consists of an interest rate R, agent consumption, and taxes τ such that goods markets clear ($\pi \left(c_0^p, c_1^p\right) + (1-\pi)(c_0^r, c_1^r) = (1,1)$), consumption solves the agents' problems (6) given prices and taxes, and the government budget constraint (5) is satisfied ($RG = \tau$).[13] We restrict attention to our case of interest in which equilibrium consumption satisfies $c_0^r > c_0^p = \underline{c}$ (the minimum consumption level binds for the non-rich only).[14] In this *saving-constrained equilibrium*, optimal rich consumption is

$$c_0^r = \frac{1}{2} G + \frac{1}{2} y^r \left(1 + \frac{1}{R}(1-\tau)\right),$$

which after plugging in the government budget constraint (5) becomes

$$c_0^r = \frac{1}{2}(1-y^r)\, G + \frac{1}{2} y^r \left(1 + \frac{1}{R}\right). \tag{7}$$

Finally, imposing market clearing ($\pi c_0^p + (1-\pi)\, c_0^r = 1$) and $y^r = \Pi / (2(1-\pi)) + w\ell^*$, we get

$$\begin{aligned} \frac{1}{R} &= \frac{2(1-\pi\underline{c})}{\frac{\Pi}{2} + w\ell^* (1-\pi)} - \frac{1 - \left(\frac{\Pi}{2(1-\pi)} + w\ell^*\right)}{\frac{\Pi}{2(1-\pi)} + w\ell^*} G - 1 \\ &= \frac{2(1-\pi\underline{c})}{(1-\pi)\, y^r} - \frac{1-y^r}{y^r} G - 1. \end{aligned} \tag{8}$$

[13] The government goods market clears for free since, by assumption, the government consumes whatever it produces. The labor market doesn't clear since each agent is willing to supply $\overline{L}$, while at stuck wage w private and public firms only demand $\ell^* + \widetilde{G} < \overline{L}$ units of labor from each agent.

[14] We discuss the existence of this form of equilibrium in Section 3.2 below.

It immediately follows that

$$\frac{\partial^2 (1/R)}{\partial G \partial \pi} > 0,$$

implying

Proposition 1 *In a saving-constrained equilibrium with slack in the labor market, the interest rate response to fiscal stimulus falls as inequality rises:* $\frac{\partial^2 R}{\partial G \partial \pi} < 0$.

Proposition 1 says that the impact of G on R is declining in inequality. Government spending redistributes from high MPC to low MPC households, which relaxes credit markets more when the economy is populated by a larger fraction of debt-burdened households. Note, however, that in this stripped-down model increasing government purchases actually unambiguously decreases the interest rate, contrary to standard intuition. This is because here government spending destroys no resources.[15] However, it is trivial to include government waste by assuming that government consumption/production G requires an input γG of the consumption good, meaning the public budget constraint becomes $G(1+\gamma)R = \tau$. In that case, the sign of $\partial R/\partial G$ may be positive *or* negative but $\partial^2 R/(\partial G \partial \pi) < 0$ still holds provided γ isn't too large. We explore this case in Section 3.2.

To summarize, a theory with saving constraints suggests that high inequality is associated with a weaker or even negative response of interest rates to government spending. The same is true with respect to debt: at $t = 0$ a non-rich agent is borrowing $\underline{c} - (y^p + G)$, which is increasing in π. This immediately implies that total private debt, $\pi(\underline{c} - (y^p + G))$, is also associated with inequality and a low IRRF.

The Consumption Response to Fiscal Stimulus: The credit market relaxation in response to government purchases manifests entirely in the interest rate response. Since private output is fixed (and under the assumption that the government does not purchase private-sector output, so is aggregate consumption), there is no quantity adjustment from credit market relaxation. In a more complicated setup with elastic private-sector output, however, the adjustment could occur through both prices (the interest rate) and quantities (consumption). In particular, if there were a *private-sector* multiplier from increasing G,[16] equilibrium private consumption could increase from fiscal stimulus, and rising inequality could dampen the consumption response through the delevering of saving-constrained agents. In that case, equilibrium credit market relaxation could manifest both as a lower interest rate and as lower private consumption.

[15] See Murphy and Walsh (2018) for a formal discussion of why excess capacity (or government spending that does not crowd out private resources) implies that interest rates do not rise in response to government spending.

[16] In our setting above, the fiscal multiplier is 1, although this stimulus occurs entirely through government consumption/production (see (4)). The *private-sector* multiplier is 0 since private-sector output is determined by firms' fixed labor demand.

In our setting, aggregate desired consumption is $C = \pi c_0^p + (1-\pi) c_0^r$. By Equation 7, it follows that aggregate desired consumption is (imposing the government budget constraint but not the market clearing interest rate)

$$C = \pi \underline{c} + (1-\pi)\left[\frac{1}{2}(1-y^r) G + \frac{1}{2} y^r \left(1 + \frac{1}{R}\right)\right],$$

and hence, since $y^r = \Pi / (2(1-\pi)) + w\ell^*$,

$$\frac{\partial^2 C}{\partial G \partial \pi} < 0. \tag{9}$$

Therefore, an implication of the theory with saving-constrained households is that the partial equilibrium relationship between inequality (and debt) and the consumption response to fiscal stimulus (CRF) is negative. In our simple theoretical setting there is no general equilibrium relationship due to simplifying assumptions about the supply side of the economy, but in a setting with elastic private-sector output, we would predict the relationship to be negative. Below we confirm that in the data, the CRF is, if anything, inversely related to inequality and debt.

Existence: We have shown that the IRRF and partial equilibrium CRF are declining in both inequality and debt in a *saving-constrained equilibrium with slack in the labor market*, but we did not prove this equilibrium exists. However, it is straightforward to show that it does indeed exist when parameters satisfy the following:

$$\frac{\Pi}{4}\left(\frac{2\pi-1}{\pi}\right) G + \frac{\Pi}{2\pi} + w\ell^* \leq \underline{c} < \min\left\{1, \frac{\Pi}{4}\left(\frac{2\pi-1}{\pi}\right) G + \frac{3}{2}\frac{\Pi}{2\pi} + \frac{1+\pi}{2\pi} w\ell^*\right\} \tag{10}$$

First consider the left inequality, which ensures that $c_0^p = \underline{c}$ (at the equilibrium interest rate (8)). Since $\Pi / (2\pi) + w\ell^* < 1$ for $\pi > 1/2$, there exists $\underline{c} \in (0,1)$ satisfying this condition provided, for example, G is sufficiently small and $\pi > 1/2$. $\underline{c} \leq 1$ is necessary for existence since $c_0^r \geq c_0^p$ and the total private endowment is 1. The right inequality ensures that the expression for the equilibrium interest rate (8) is strictly positive. Since $3/2 > 1$ and $(1 + \pi)/(2\pi) \geq 1$, if we can find $\underline{c} \in (0,1)$ satisfying the left inequality, we can find $\underline{c} \in (0,1)$ satisfying the right as well. Note that if (10) holds, market clearing implies $c_0^r > \underline{c}$.

3.2 Numerical example with government waste

We now generalize the model to the case in which government production requires the consumption good (and hence crowds out the private sector) as well as labor. Suppose that one unit of government output requires an input of γ of the consumption good. The government budget constraint (5) becomes $RG(1+\gamma) = \tau$, and the market clearing condition becomes $\pi\left(c_0^p, c_1^p\right) + (1-\pi)(c_0^r, c_1^r) = (1 - \gamma G, 1)$. Figure 3 shows how the *saving-constrained* *equilibrium with slack in the labor market* changes as we vary inequality (π).[17]

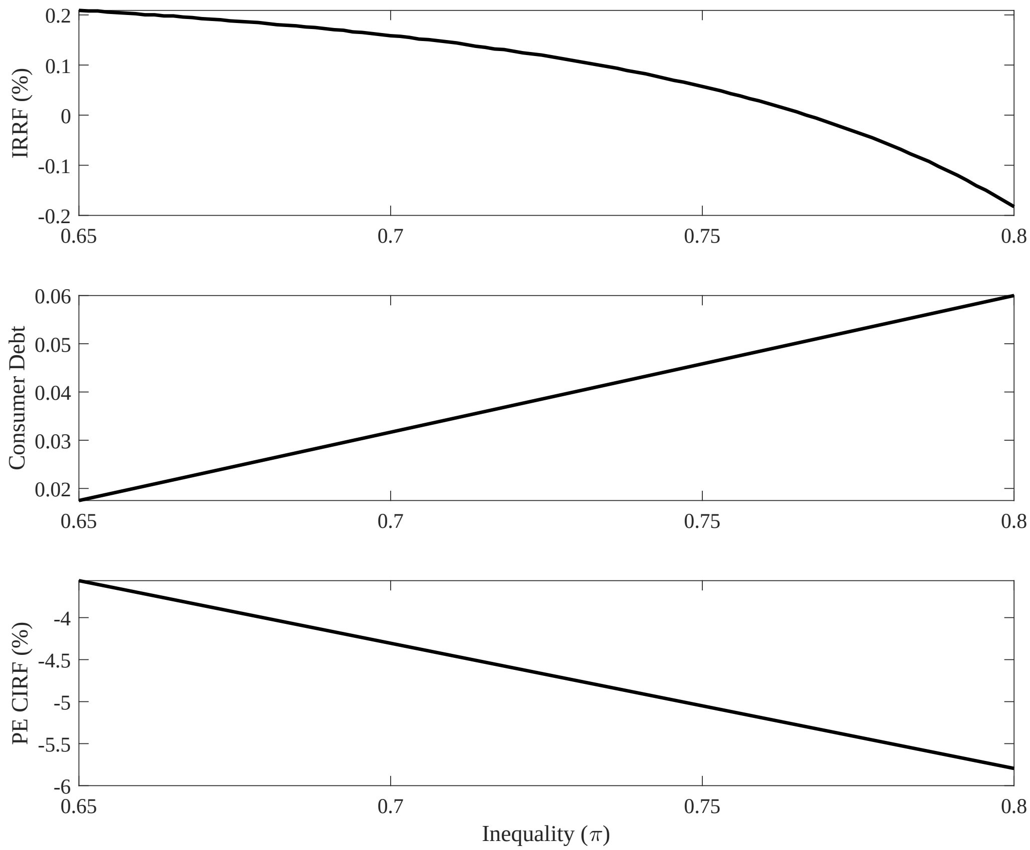

Figure 3

The figure shows how the model's *saving-constrained equilibrium with slack in the labor market*, for the case with government waste $\gamma > 0$, changes as we vary inequality (π). The top panel plots the percentage point change in equilibrium R for an increase in G of .02, the middle panel shows gross private debt, and the bottom panel plots the partial equilibrium consumption response for an increase in G of .02 ($100\Delta C/\Delta G$).

The top panel plots the IRRF, the percentage point change in equilibrium R for an increase in G of .02 (2% of private output), against π. As in the empirical Figure 2, there is an inverse relationship between inequality and the IRRF, and low (high) inequality is associated with positive (negative) IRRFs. The middle panel shows that gross private debt, $\pi(\underline{c} - (y^p + G))$, increases with inequality as more agents become saving-constrained, and the bottom panel illustrates Equation 9's inverse relationship between inequality and the partial equilibrium CRF (defined as $100\Delta C/\Delta G$, holding R fixed). As in the case without government waste γ, both the IRRF and CRF decline as inequality and debt rise.[18]

[17] As an illustrative numerical example, we set $\gamma = .053$, $\alpha = 2/3$, $w = .5$, $G = 0$, $\overline{L} = 5/3$, and $\underline{c} = .95$. With the Section 3.1 normalization $A = (w/\alpha)^{\alpha}$, we get $\ell^* = 4/3$, $A\ell^{*\alpha} = 1$, $\Pi = 1/3$, and $w\ell^* = 2/3$.

[18] Note, however, that with sufficiently high γ it is possible for the IRRF to increase with inequality. This is because with $\gamma > 0$, rising inequality has two opposite effects on the IRRF. On one hand, more agents

3.3 Credit-constrained vs. saving-constrained households

Our theory assumes that low-income households are able to access the credit necessary to achieve their first-period minimum consumption threshold. When this is the case, these households are saving-constrained rather than credit constrained. But if there is a contraction in credit such that poor households cannot even acheive their minimum consumption threshold, they become credit-constrained and exhibit large MPCs.

In Appendix B, we modify our model to examine a situation in which credit is rationed and poor households are rendered credit-constrained. In this case the interest rate response to fiscal shocks is increasing in the fraction of poor credit-constrained households. Thus, a model with tight credit conditions predicts a positive relationship between the IRRF (and CRF) and inequality (and household debt), contrary to what we document for the group of OECD economies before the GFC but consistent with prior evidence on the effect of fiscal stimulus during episodes of tight credit conditions (Demyanyk et al. (2019)).

4 Testing an implication of the model: the consumption response to fiscal stimulus

In this section, we examine how the consumption response to fiscal shocks depends on inequality and household debt. A useful feature of consumption (relative to government bond yields) is that it varies across regions within a country. Therefore, in addition to examining cross-country evidence as in Section 2, we also examine U.S. cross-county evidence by exploiting regional variation in household debt and consumption. To the extent that credit markets are integrated across the U.S., the county-level setting provides a reasonable laboratory for testing our theory's partial equilibrium implication that across regions debt is associated with a lower CRF.

4.1 Cross-country consumption response and debt

Here we test the theory's prediction that the relationship between the correlates of savings constraints (inequality and debt) and the consumption response to fiscal stimulus is non-positive. As in Section 2, we identify fiscal shocks independently for each country in our sample. To do so, we estimate Equation 1, where $X_t = [G_t, Y_t, C_t]'$: X_t consists of log real government spending G_t, log real GDP, and log real private consumption C_t. $\varepsilon_t = [\nu_t, \varepsilon_{2,t}, \varepsilon_{3,t}]$

are saving-constrained, and their delevering relaxes credit markets. On the other hand, the interest rate adjusts to induce the rich to consume an amount sufficient to clear markets. With high γ, the second effect dominates, and high rates are needed to get the rich to forgo consumption at $t = 0$. In this case, as inequality rises, there are fewer rich agents, requiring a lager rate increase to clear markets.

is a vector of structural shocks, and v_t is the shock to government spending. We follow the identification approach of Blanchard and Perotti (2002), as in Section 2.

We summarize the information in the impulse responses by examining the 4-quarter response to government consumption shocks. Let ρ_h^c be the horizon h impulse response of consumption. The country-level consumption response to a standard deviation shock to government consumption is computed as:[19]

$$CRF = \sum_{h=0}^{3} \rho_h^c. \tag{11}$$

To correct for the uncertainty in measuring the CRF, we define ω_i^{CRF} as in Equation 3. The pattern in Figure 4 is consistent with credit market relaxation in response to government purchases. There is a negative relationship between inequality (or household debt) and the 4-quarter response of private consumption to government spending shocks. Tables 3 and 4 show that the relationship between the CRF and income inequality or household debt to income is negative and statistically significant (and Table 10 in Appendix A.4 shows this is also true with OLS and Huber-White robust standard errors).

Figure 4

The figure plots $\frac{1}{\omega_i^{CRF}} CRF_i$ (Equation 11) (estimated from the country-specific start date in Figure 5 through 2007Q4) against income inequality (from the OECD, averaged over 2001-2013) and household debt to income (from the OECD, averaged over 2010-2016) .

[19]In this case, we analyze the *cumulative* 4-quarter instead of the *average* 4-quarter response. The reason is that ρ_h^c measures the percent change in consumption (a flow variable) to a standard deviation shock to government consumption, while ρ_h (used to calculate the IRRF) measures the change in bond yields, to a standard deviation shock to government consumption, in percentage points.

Table 3
CRF and Country Characteristics

VARIABLES	(1) CRF	(2) CRF	(3) CRF	(4) CRF
Income ratio 90th/10th	-0.004**	-0.004**	-0.004**	-0.004
	(0.002)	(0.002)	(0.002)	(0.003)
Inflation Targeting		-0.000		
		(0.004)		
Financial Openness			-0.002	
			(0.002)	
External Government Debt/GDP				0.001
				(0.003)
Observations	28	28	28	19
R-squared	0.152	0.152	0.217	0.126

Note: This table presents the WLS coefficients of regressing the estimated CRF against household debt (from OECD database), inflation targeting dummy (Carare and Stone (2003)), financial openness, and the government external debt to GDP ratio (from IMF-World Bank QPSD data). The regression weights are $\frac{1}{\omega_i^{CRF}}$. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

4.2 U.S. Cross-county consumption response and debt

The cross-country evidence above is somewhat surprising given recent empirical work that finds that high household leverage is associated with higher rather than lower consumption responses to government spending. In particular, Demyanyk et al. (2019) demonstrate that during the great recession, an increase in government spending in a region was associated with a consumption response that was increasing in leverage of households in that region. High debt, they conclude, was associated with high MPCs. In contrast, our cross-county regressions imply that high debt is associated with low MPCs.

To reconcile these findings, it is important to note that the Demyanyk et al. (2019) study is based on the Great Recession, when the supply of credit was limited (see for example, Mian and Sufi (2015)). In our more general framework with minimum consumption thresholds (see Miranda-Pinto et al. (2018)), tight credit conditions can cause high-debt households to be unable to afford even their minimum level of consumption and render them credit-constrained (rather than saving-constrained). But during normal times (with greater credit supply), high debt is instead associated with saving constraints and low MPCs. We formalize this logic in

Table 4
CRF and Country Characteristics

VARIABLES	(1) CRF	(2) CRF	(3) CRF	(4) CRF
HH debt to income	-0.005***	-0.005***	-0.006***	-0.008***
	(0.002)	(0.002)	(0.002)	(0.002)
Inflation Targeting		0.001		
		(0.003)		
Financial Openness			0.001	
			(0.002)	
External Government Debt/GDP				-0.001
				(0.002)
Observations	28	28	28	19
R-squared	0.300	0.301	0.307	0.568

Note: This table presents the WLS coefficients of regressing the estimated CRF against household debt (from OECD database), inflation targeting dummy (Carare and Stone (2003)), financial openness, and the government external debt to GDP ratio (from IMF-World Bank QPSD data). The regression weights are $\frac{1}{\omega_i^{CRF}}$. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Appendix B. Indeed, Demyanyk et al. (2019) presented evidence that government spending multipliers were increasing in debt during the Great Recession but not during the boom period of the mid-2000s. One possible explanation for their findings is that consumption multipliers were lower (or at least not higher) in high-debt areas prior to the Great Recession.

Here we test this hypothesis directly using data across counties in the United States. Our measure of consumption is auto registrations, which has been used as a proxy for broad measures of consumption in cross-sectional analyses of disaggregate levels of economic geography such as counties (e.g., Demyanyk et al. (2019), Mian et al. (2013)). The data are provided by R. L. Polk. The government spending measure is based on the Department of Defense (DOD) spending measure from Demyanyk et al. (2019), which begins in 2001 (see also Auerbach et al. (2019)). Our measure of county-level debt to income, which spans 2001 through 2007, is from Mian and Sufi (2015).

Our empirical specification is

$$\frac{C_{i,t}-C_{i,t-1}}{C_{i,t-1}} = \beta_0 \frac{G_{i,t}-G_{i,t-1}}{Y_{i,t-1}} + \beta_1 \frac{G_{i,t}-G_{i,t-1}}{Y_{i,t-1}} \cdot DTI_{i,t-1} + \gamma DTI_{i,t-1} + \alpha_i + \lambda_t + \epsilon_{i,t},$$

where $Y_{i,t}$ is income in county i in year t, C is auto registrations, DTI is household leverage, G is military spending, and α_i and λ_t are location and time fixed effects. The coefficient of interest is β_1, which is an estimate of the extent to which the consumption response to fiscal stimulus depends on households leverage. We instrument for the change in defense spending (and its interaction with leverage) using the Bartik-type instrument used in Nakamura and Steinsson (2014), Demyanyk et al. (2019), and Auerbach et al. (2019). Specifically, $(\frac{G_{i,t}-G_{i,t-1}}{Y_{i,t-1}})$ is instrumented with $(s_i \cdot \frac{G_t-G_{t-1}}{Y_{i,t-1)}})$ where G_t is aggregate government spending and s_i is the average share of county i in total government spending over the sample period. This IV approach addresses two potential concerns. First, as discussed in Nakamura and Steinsson (2014), it corrects for the possibility that defense spending may respond endogenously to local economic conditions. Second, the instrument captures the component of defense contracts that represents actual spending/production increases and strips out anticipated transitory cash transfers from the DOD to contractors (see Auerbach et al. (2019) for further details).

Our specification is most similar to that of Demyanyk et al. (2019) in that it includes the interaction between defense spending and debt. It differs in a couple of important respects. First, ours is a panel specification, which allows us to absorb county-specific factors in fixed effects. Second, we focus on pre-recession (2001 through 2007) data using county-level data rather than city-level data. Conducting the analysis at the county level provides more cross-sectional variation and a more precise estimate of the debt-dependence of consumption responses to defense spending during periods of normal-to-high credit supply. Third, our dependent variable is the percentage change in consumption (rather than the change normalized by lagged income), which implies that the coefficients on government spending should be interpreted as an elasticity (rather than a multiplier). Since we do not know the value of the automobiles registered, using a percent change is more natural than trying to infer auto values to derive a specific consumption multiplier. That being said, the results we present below are qualitatively similar when normalizing the change in consumption by lagged local income rather than lagged local consumption.

Table 5 shows that the response of auto purchases to local defense spending is indeed lower in counties with higher debt (columns 2 and 3). While the direct response of auto purchases appears negligible (column 1), this measure of the average effects masks heterogeneity due to household leverage. Counties that have higher leverage have a smaller response of auto purchases to government spending.[20] Our evidence from auto purchases is consistent with the evidence in Demyanyk et al. (2019) that fiscal multipliers were, if anything, smaller in high-debt regions during the mid-2000s.

[20]We have run similar specifications using city-level data. While the statistical significance of the interaction term varies across specifications, each similarly exhibits consumption responses that are decreasing rather than increasing in debt in the pre-recession period.

Table 5
Consumption and Household Debt US counties

VARIABLES	(1) $\%\Delta C$	(2) $\%\Delta C$	(3) $\%\Delta C$
$\%\Delta G$	0.19		4.28***
	(0.80)		(1.23)
DTI		-0.05	-0.03
		(0.08)	(0.08)
$\%\Delta G{\cdot}DTI$			-3.58***
			(1.22)
Observations	8286	8286	8286
First-stage F-stat	7.14		8.40

Note: The table presents the coefficients of regressing the percent change in county i's auto registrations ($\%\Delta C$) against household debt to income in county i (DTI) from Mian and Sufi (2015), the percent change in defense spending in county i ($\%\Delta G$), and the interaction between these two covariates. We instrument for the change in defense spending (and its interaction with leverage) using the Bartik-type instrument used in Nakamura and Steinsson (2014), Demyanyk et al. (2019), and Auerbach et al. (2019). Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

5 Conclusion

We present new evidence that, during the years before the Global Financial Crisis, the effect of government spending on interest rates (IRRF) varies across countries, with half of OECD countries exhibiting a negative interest rate response. The IRRF is decreasing in country-level inequality (or household debt), contrary to the predictions of existing heterogeneous agent models with credit constraints.

We interpret this evidence through the lens of a theoretical framework in which the interest rate response to fiscal stimulus depends on the share of consumers who are low-income and burdened with debt due to saving constraints (minimum consumption thresholds). In our setting, debt burdens do not reflect credit constraints but rather result from households' minimum consumption needs. This additional debt is burdensome in the sense that households pay it off more quickly out of additional income than they would in the absence of a minimum consumption constraint. In our companion paper, Miranda-Pinto et al. (2018), we formalize how saving constraints can arise in a heterogeneous-agent model with precautionary saving motives, and we demonstrate that they can rationalize otherwise unexplained features of the microdata. Here we embed saving constraints into a general equilibrium setting to demonstrate implications of macroeconomic shocks for credit markets.

The relative credit market relaxation in our theory is driven by low MPCs due to the prevalence of saving-constrained households. This credit market relaxation can manifest in a low interest rate response and/or a low consumption response to fiscal stimulus. An implication is that the consumption response to fiscal stimulus should also be (weakly) falling in inequality and debt. We find that this pattern holds across the OECD countries in our sample. We also test this prediction using data on auto registrations across U.S. counties prior to the Great Recession. We find that auto registrations are less responsive to government spending shocks in counties with higher consumer leverage, consistent with the theory's prediction.

The new empirical regularities that we document point to important state-dependencies in the transmission of macroeconomic shocks. In particular, high debt can be associated with lower interest rate and consumption responses to fiscal stimulus, contrary to conventional wisdom. Key to reconciling our findings with prior work is the possibility that the relationship between macroeconomic stimulus and debt depends on credit conditions. When credit is loose and poor households can borrow to meet their minimum consumption thresholds, fiscal stimulus can redistribute resources to low-MPC poor households and relax credit markets. When credit conditions are tight, these poor households are credit-constrained and have high MPCs. Therefore, our findings suggest that not only does the effect of fiscal stimulus depend on debt, as has been documented in recent empirical and theoretical work, but that the sign of the debt-dependence varies with credit conditions.

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A Robustness checks and additional tables and figures

	G			GDP		Interest Rates Haver				C	
Country	OECD	Haver	Haver	OECD	Haver	OECD sr	Tbill Haver	Policy Rate	G bond Haver	OECD	Haver
Australia	1959-Q4	1959-Q3	1959-Q3	1959-Q3	1959-Q3	1968-Q1	1969-Q3	1969-Q3	1957-Q1	1959-Q3	-
Austria	1988-Q2	1957-Q1	1999-Q1	1988-Q1	1999-Q1	1989-Q3	-	1957-Q1	1971-Q1	1996-Q1	1996-Q1
Belgium	1995-Q1	1980-Q1	1999-Q1	1995-Q1	1999-Q1	1958-Q1	1957-Q1	1957-Q1	1957-Q1	1995-Q1	1995-Q1
Canada	1961-Q2	1957-Q1	1957-Q1	1961-Q1	1957-Q1	1956-Q1	1957-Q1	1992-Q4	1957-Q1	1982-Q1	1957-Q1
Czech Republic	1996-Q2	1990-Q1	1990-Q1	1996-Q1	1990-Q1	1993-Q1	1993-Q4	1995-Q4	2000-Q2	1996-Q1	1995-Q1
Denmark	1995-Q1	1977-Q1	1977-Q1	1995-Q1	1977-Q1	1987-Q1	-	1957-Q1	1960-Q1	1995-Q1	1995-Q1
Finland	1990-Q1	1970-Q1	1988-Q1	1990-Q1	1999-Q1	1987-Q1	-	1957-Q1	1988-Q1	1990-Q1	1990-Q1
France	1955-Q1	1999-Q1	1999-Q1	1955-Q1	1999-Q1	1955-Q2	1970-Q1	1964Q-1	1957-Q1	1980-Q1	1980-Q1
Germany	1970-Q1	1999-Q1	1999-Q1	1970-Q1	1999-Q1	1960-Q1	1975-Q1	1957-Q1	1957-Q1	1991-Q1	1991-Q1
Greece	1970-Q2	-	-	1970-Q1	2000-Q4	1980-Q2	1985-Q2	1957-Q1	1992-2016	1995-Q1	1995-Q1
Hungary	1995-Q1	1995-Q1	1995-Q1	1995-Q1	1995-Q1	1992-Q2	1989-Q2	1985-Q1	2001-Q1	1995-Q1	1995-Q1
Iceland	1996-Q4	-	1997-Q1	1997-Q1	1997-Q1	1988-Q1	1987-Q3	1964-Q1	1992-Q1	1997-Q1	-
Ireland	1996-Q5	1997-Q1	1999-Q1	1997-Q1	1999-Q1	1984-Q1	1973Q1	195Q17	1964-Q1	1995-Q1	1995-Q1
Italy	1981-Q1	1999-Q1	1999-Q1	1981-Q4	1999-Q1	1978-Q4	1977-Q2	1964-Q1	1958-Q1	1996-Q1	1995-Q1
Japan	1994-Q1	1957-Q1	1957-Q1	1994-Q1	1957-Q1	1985-Q3	1957-Q1	1957-Q1	1966-Q1	1994-Q1	1957-Q1
Korea	1970-Q1	1960-Q1	1960-Q1	1970-Q1	1960-Q1	1991-Q1	-	1999-Q2	1973-Q2	1960-Q1	2001-Q1
Netherlands	1988-Q1	1990-Q1	1990-Q1	1988-Q1	1990-Q1	1986-Q1	1978-Q2	-	1965-Q1	1996-Q1	1995-Q1
New Zealand	1987-Q1	1987-Q2	1987-Q2	1987-Q2	1987-Q2	1974-Q1	1978-Q1	1999-Q1	1964-Q1	1987-Q2	1987-Q2
Norway	1978-Q1	1961-Q1	1961-Q1	1978-Q1	1961-Q1	1979-Q1	-	1964-Q1	1961-Q4	1978-Q1	1978-Q1
Poland	1995-Q1	1995-Q1	1995-Q1	1995-Q1	1995-Q1	1991-Q3	1992-Q1	1998-Q1	2001-Q1	1995-Q1	1995-Q1
Portugal	1995-Q1	1999-Q1	1999-Q1	1995-Q1	1999-Q1	1985-Q4	1985-Q4	1957Q1	1957-Q1	1995-Q1	1995-Q1
Slovak Republic	1997-Q1	1993-Q1	-	1997-Q1	2009-Q1	1995-Q3	-	2001-Q2	2000-q4	1995-Q1	-
Slovenia	1995-Q1	1995-Q1	2007-Q1	1995-Q1	2007-Q1	2002-Q1	1998-Q3	1992-Q1	1991-Q4	1995-Q1	1995-Q1
Spain	1995-Q1	1999-Q1	1999-Q1	1995-Q1	1999-Q1	1977-Q1	1979-Q1	1964-Q1	1978-Q2	1995-Q1	1995-Q1
Sweden	1960-Q1	-	1980-Q1	1960-Q1	1980-Q1	1955-Q1	1963-Q2	2002-Q3	1960-Q1	1993-Q1	1993-Q1
Switzerland	1980-Q1	1970-Q1	1970-Q1	1980-Q1	1970-Q1	1974-Q1	1980-Q1	1964-Q1	1964-Q1	1980-Q1	1970-Q1
United Kingdom	1955-Q1	1957-Q1	1957-Q1	1955-Q1	1957-Q1	1978-Q1	1964-Q1	1959-Q1	1957-Q1	1995-Q1	1957-Q1
United States	1955-Q1	1957-Q1	1957-Q1	1955-Q1	1957-Q1	1955-Q1	1957-Q1	1982-Q3	1957-Q1	1955-Q1	1957-Q1

Figure 5
Sample for VAR estimation (shaded areas indicate that Haver is the data source)

A.1 Auerbach and Gorodnichenko (2013) shocks and local projection methods

In this section we use the government spending shocks estimated by Auerbach and Gorodnichenko (2013) to calculate the interest response to fiscal stimulus. The authors regress one-period-ahead percent forecast errors for government spending from the OECD's "Outlook and Projections Database" in each country on that country's lagged macroeconomic variables (output, government spending, exchange rate, inflation, investment, and imports). The authors also consider a set of country and period fixed effects. The residuals from this regression are innovations in government spending orthogonal to professional forecasts and lags of macroeconomic variables.[21]

We take the estimated unanticipated government spending shocks from Auerbach and Gorodnichenko (2013) and use linear projection methods to measure the effect on government bond yields. The data is semi-annual. Therefore, to compare with our 4-quarter IRRF from Section 2, we regress the semi-annual government bond yield against the contemporaneous innovation to government spending and its one semester lag. In particular, for each country, we regress

$$r_t = \beta_0 + \beta_1 \hat{G}_t^{shock} + \beta_2 \hat{G}_{t-1}^{shock} + \mu_t, \tag{12}$$

where r_t is the country's government bond yield at semester t, $\hat{G}_t^{shock}$ is the Auerbach and Gorodnichenko (2013) semi-annual shock to government spending in semester t, and μ_t is the error term. We convert our quarterly data on government bond yields to the semi-annual frequency by averaging each semester's quarters. The average 4-quarter (2-semester) interest rate response to fiscal stimulus is $IRRF = \frac{1}{2}(\hat{\beta}_1 + \hat{\beta}_2)$. We use the OLS standard deviation of β_1 and β_2 to adjust for the uncertainty in the estimates (ω).

Figure 6 reports the estimated IRRFs using this approach. There are 13 countries with a negative IRRF. Surprisingly, the U.S. displays a positive IRRF. The key difference with respect to the IRRF for the U.S. obtained using the approach in Blanchard and Perotti (2002) is that in this case we have a significantly smaller amount of observations. Indeed, we only have government spending shocks identified semi-annually since 1986 semester 1, while in the Blanchard and Perotti (2002) approach we have quarterly data since 1957Q1. Greece is another country with significant differences across methods. Greece displays the most negative IRRF using the local projection method, while it has an almost zero IRRF using the Blanchard and Perotti (2002) approach. These results are also a consequence of the small sample size. With the local projection method we have Greece's shocks from 1997 semester 1 until 2003 semester 2, while for the Blanchard and Perotti (2002) approach we have quarterly data for the period 1992-2007. Greece and the U.S are indeed the top and

[21] Note that the government spending series in Auerbach and Gorodnichenko (2013) is the sum of real public consumption expenditure and real government gross capital formation.

bottom IRRF.

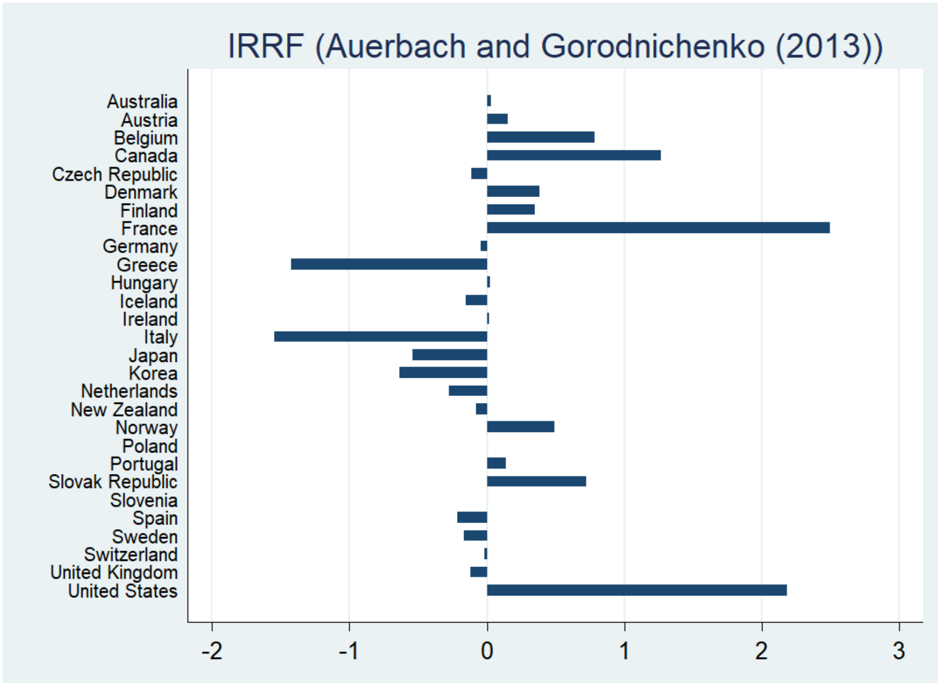

Figure 6

For each country, the figure shows the IRRF in percentage points estimated from the shocks of Auerbach and Gorodnichenko (2013).

In Figure 7, we show that the inverse relationship between the IRRF and inequality (or household debt to income ratio) still holds when we use local projection methods and semi-annual government innovations from Auerbach and Gorodnichenko (2013).

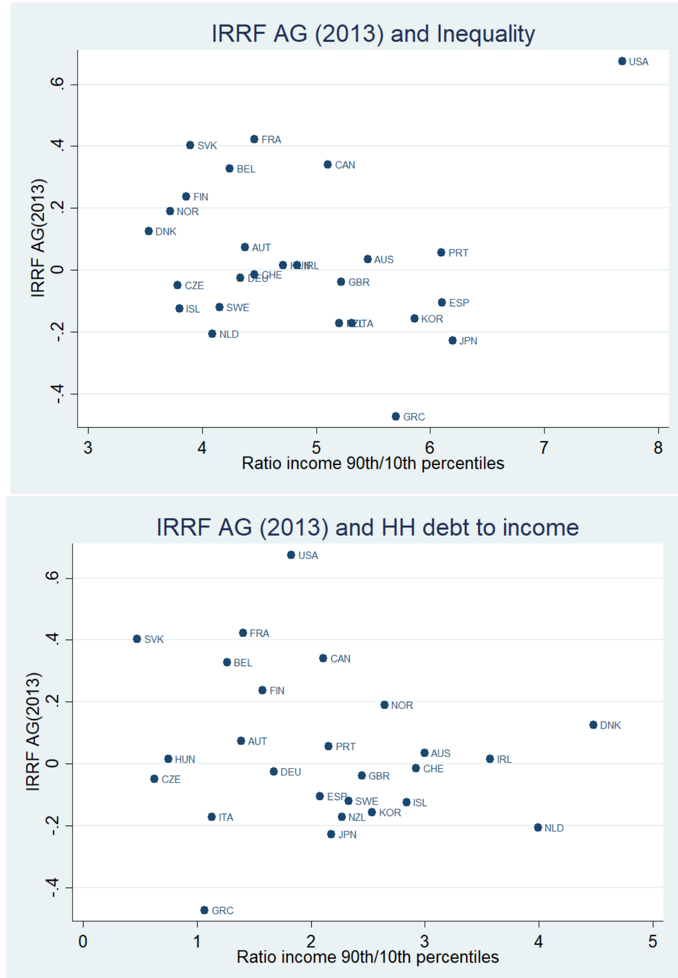

Figure 7

The figure plots $\frac{1}{w}IRRF$ in percentage points estimated from the shocks of Auerbach and Gorodnichenko (2013) against income inequality (from the OECD, averaged over 2001-2013) and household debt to income ratio (from the OECD, averaged over 2010-2016).

A.2 Policy rate response to fiscal shocks and inequality

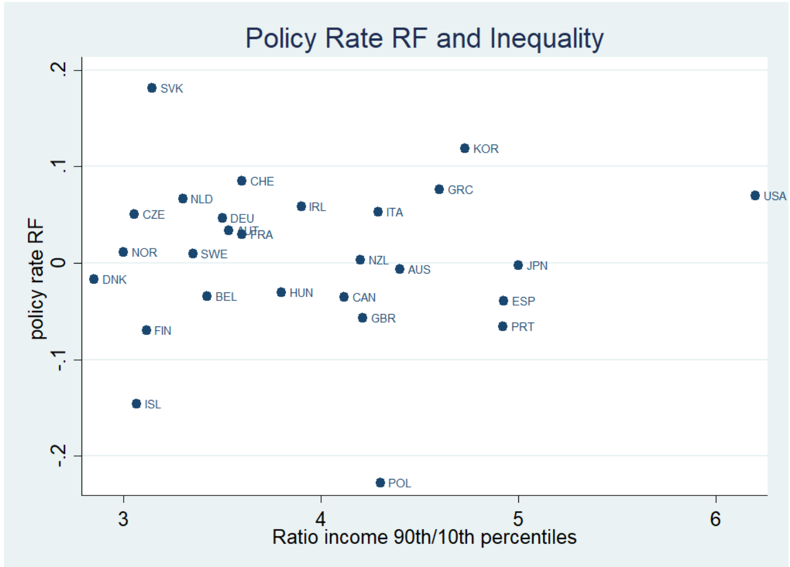

Figure 8

The figure plots $\frac{1}{\omega^{policy}}$PolicyRate$RF$ (estimated from the country-specific start date in Figure 5 through 2007Q4) against income inequality (from the OECD, averaged over 2001-2013).

A.3 Descriptive statistics cross-sectional regressions

Table 6
Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
IRRF	28	0.01	0.09	-0.15	0.28
Inequality	28	3.90	0.79	2.85	6.20
debt to income 1996-2014	28	122.53	61.08	32.96	275.92
debt to income 1996-2007	28	108.35	59.04	22.45	240.30
Financial openness ratio	28	3.05	2.80	0.87	14.50
Inflation targeting dummy	28	0.46	0.51	0.00	1.00
Fraction of G external debt	19	26.83	16.37	4.37	70.11

A.4 IRRFs and CRFs using OLS and Huber-White standard errors

Table 7
IRRF and Country Characteristics

	(1)	(2)	(3)	(4)
VARIABLES	IRRF	IRRF	IRRF	IRRF
Income ratio 90th/10th	-0.028*	-0.026	-0.029**	-0.039*
	(0.015)	(0.016)	(0.014)	(0.019)
Financial Openness		0.012		
		(0.013)		
Inflation Targeting			-0.053*	
			(0.031)	
External Government Debt/GDP				-0.006
				(0.015)
Observations	28	28	28	19
R-squared	0.106	0.125	0.204	0.197

Note: This table presents the OLS coefficients of regressing the estimated 4-quarter average response of government bond yields to government spending shocks (using Blanchard and Perotti (2002)) against income inequality (from OECD database), financial openness (from Lane and Milesi-Ferretti (2007)), inflation targeting dummy (Carare and Stone (2003)), and foreign government debt to GDP (from IMF-World Bank QPSD data). Huber-White robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 8
IRRF and Country Characteristics

VARIABLES	(1) IRRF	(2) IRRF	(3) IRRF	(4) IRRF
HH debt to income	-0.019	-0.033*	-0.019	-0.012
	(0.018)	(0.019)	(0.017)	(0.031)
Financial Openness		0.032**		
		(0.012)		
Inflation Targeting			-0.051	
			(0.031)	
External Government Debt/GDP				-0.012
				(0.019)
Observations	28	28	28	19
R-squared	0.049	0.160	0.140	0.024

Note: This table presents the OLS coefficients of regressing the estimated 4-quarter average response of government bond yields to government spending shocks (using Blanchard and Perotti (2002)) against median household debt to income ratio (from OECD database), financial openness (from Lane and Milesi-Ferretti (2007)), inflation targeting dummy (Carare and Stone (2003)), and foreign government debt to GDP (from IMF-World Bank QPSD data). Huber-White robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 9
CRF and Country Characteristics

VARIABLES	(1) CRF	(2) CRF	(3) CRF	(4) CRF
Income ratio 90th/10th	-0.002	-0.002	-0.003	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)
Inflation Targeting		-0.000		
		(0.003)		
Financial Openness			-0.002	
			(0.001)	
External Government Debt/GDP				0.001
				(0.002)
Observations	28	28	28	19
R-squared	0.063	0.063	0.113	0.070

Note: This table presents the OLS coefficients of regressing the estimated cummulative 4-quarter response of private consumption to government innovations (using Blanchard and Perotti (2002)) against income inequality (from OECD database), financial openness (from Lane and Milesi-Ferretti (2007)), inflation targeting dummy (Carare and Stone (2003)), and foreign government debt to GDP (from IMF-World Bank QPSD data). Huber-White robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 10
CRF and Country Characteristics

VARIABLES	(1) CRF	(2) CRF	(3) CRF	(4) CRF
HH debt to income	-0.005**	-0.0047**	-0.0050**	-0.0075***
	(0.002)	(0.002)	(0.002)	(0.002)
Inflation Targeting		-0.0003		
		(0.003)		
Financial Openness			0.0007	
			(0.001)	
External Government Debt/GDP				-0.0009
				(0.002)
Observations	28	28	28	19
R-squared	0.274	0.274	0.279	0.524

Note: This table presents the OLS coefficients of regressing the estimated cummulative 4-quarter response of private consumption to government innovations (using Blanchard and Perotti (2002)) against household debt (from OECD database), financial openness (from Lane and Milesi-Ferretti (2007)), inflation targeting dummy (Carare and Stone (2003)), and foreign government debt to GDP (from IMF-World Bank QPSD data). Huber-White robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

B Credit constraints

Here we demonstrate the role of credit condition for the transmission of shocks in the presence of saving-constrained households. In the baseline scenario presented in Section 3.1, there are no borrowing constraints or debt limits. Here we examine the role of tight credit conditions in the form of debt limits.

Consider a situation in which the borrowing constraint is sufficiently tight that it precludes some households from satisfying the minimum consumption level. Specifically, suppose from Section 3.1 that (1) parameters are such that non-rich agents would be borrowing in the *saving-constrained equilibrium with slack in the market*, (2) non-rich agents are unable to borrow due to tight credit conditions, and (3) in $t = 0$ non-rich agents try to consume as close as they can to the minimum level $\underline{c}$.[22]

In this case, agent optimization and the government budget constraint yield

$$\begin{aligned} c_0^p &= y^p + G \\ c_0^r &= \frac{1}{2}(1 - y^r) G + \frac{1}{2} y^r \left(1 + \frac{1}{R}\right). \end{aligned}$$

Market clearing ($\pi c_0^p + (1-\pi) c_0^r = 1$) then implies

$$\frac{1}{R} = \frac{(1-\pi) y^r - [1 + \pi - (1-\pi) y^r] G}{(1-\pi) y^r}.$$

Therefore,

$$\begin{aligned} \frac{\partial (1/R)}{\partial G} &= 1 - \frac{1+\pi}{(1-\pi) y^r} = 1 - \frac{1+\pi}{\Pi/2 + (1-\pi) w \ell^*} < 0 \implies \\ \frac{\partial R}{\partial G} &> 0, \end{aligned}$$

and

$$\begin{aligned} \frac{\partial^2 (1/R)}{\partial G \partial \pi} &< 0 \implies \\ \frac{\partial^2 R}{\partial G \partial \pi} &> 0. \end{aligned}$$

Therefore, even in a world with minimum consumption thresholds, if credit conditions become sufficiently tight, non-rich households will become borrowing-constrained (rather than saving-constrained). And in that case, the interest rate rises in response to a G shock, and the effect is amplified by inequality. In other words, the sign of the dependence of the IRRF on inequality is determined by credit conditions: with loose credit, non-rich households face

[22] This would happen if, as in Miranda-Pinto et al. (2018), there were a proportional utility cost of violating the minimum consumption level.

saving-constraints, and the IRRF declines in inequality. With tight credit, non-rich households face borrowing constraints, and the IRRF rises in inequality.