Spending Shocks and Interest Rates*

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Abstract

Most macroeconomic models imply that increases in aggregate demand due to non-monetary forces cause real interest rates to rise, but empirical evidence from the US generally fails to support this prediction. We propose a novel explanation for how increases in aggregate demand (driven either by public or private shocks) can have a zero or negative temporary effect on interest rates: when national income is demand-determined and cash is used to cover short-term needs, government or private spending shocks may generate an excess supply of loans. Our model has three key features: (1) demand-determined output, (2) portfolio heterogeneity (as we have both borrowers and lenders), and (3) asset market segmentation (different groups adjust using different asset classes). Data from the Treasury's General Account and the Survey of Consumer Finances support our premise that spending shocks are often financed with money-like assets. Evidence from the Consumer Expenditure Survey corroborates a key implication of our theory: demand shocks of rich savers *decrease* interest rates.

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1 Introduction and Related Literature

One of the most stark and consistent predictions of economic theory is that an exogenous increase in aggregate demand due to non-monetary forces causes real interest rates to rise, but empirical evidence from the US generally fails to support this relationship. In this paper, we propose an explanation for how increases in aggregate demand can have a zero or negative temporary effect on interest rates: when national income is demand-determined and cash is used to cover short-term needs, government or private spending shocks may generate an excess supply of loans.

While aggregate demand shocks can arise for a number of reasons, including a shock to the taste for current consumption relative to future consumption, one of the most commonly studied forms of an aggregate demand shock is an increase in government spending. Economic models with fundamentally different underlying assumptions, including the Keynesian IS/LM model, new-Keynesian models (e.g. Galí, López-Salido, and Valles (2007) or Devereaux, Head, and Lapham (1996)) and neoclassical models (e.g. Barro (1984, 1987)) concur that during normal times (when the economy is not at the zero lower bound), government spending causes interest rates to rise, thus crowding out investment and potentially lowering future economic output.[1] This prediction is so ingrained in economic theory that it is one of the fundamental concepts taught to undergraduate students of macroeconomics. The logic is simple: current demand shocks, whether from the private or public sector, lead to excess demand for current goods and services. For markets to clear, interest rates must rise to induce households to delay consumption or firms to delay investment.

The idea that government spending raises interest rates is also prominent in both U.S. and international public discourse. In 2003, Paul Krugman, citing Greg Mankiw's macroeconomics textbook, argued that Bush-era deficits would lead to soaring interest rates.[2] More recently, Martin Feldstein wrote that French fiscal deficits would contribute to rising interest rates in Europe.[3] Indeed, the elasticity of interest rates with respect to government spending is at the center of austerity debates in Europe. While much of the conversation revolves around risk spreads, even relatively safe debtors have expressed concern about deficits leading to high interest rates. In 2013, for example, German Chancellor Angela Merkel said, "We've seen what can happen if you accumulate too much debt ... Higher borrowing costs spur rising in-

[1] See also Blanchard (1984).

[2] Krugman, Paul (2003): "A Fiscal Train Wreck," *The New York Times*, March 11, 2003.

[3] Feldstein, Martin (2014): "An end to austerity will not boost Europe," *The Financial Times*, July 8, 2013.

terest rates, putting businesses in danger ... Then you have unemployment – and at that point you have a spiral." [4]

Surprisingly, empirical evidence fails to support the strong theoretical prediction that non-monetary aggregate demand shocks cause interest rates to rise. Works by Barro (1984, 1987) and the US Treasury (1984) were among the first to highlight the inconsistency between the theory and data. Evans (1987) documents that not only do the data fail to demonstrate a positive effect of government deficits on interest rates but also that in many instances the effect is negative and significant. Despite decades of work since then on identifying exogenous changes in government spending, the basic takeaway remains: existing evidence does not clearly show that exogenous increases in government spending are associated with higher interest rates.[5]

Rather, the evidence indicates that interest rates may instead fall temporarily following an increase in government spending. Recent influential papers on government spending shocks that have examined the effect on interest rates find a negative point estimate of the response of interest rates. Fisher and Peters (2010) find that interest rates on 3-month Treasury bills fall as government spending rises. Ramey (2011) shows that as government spending increases subsequent to an exogenous defense news shock, interest rates on Treasury bills and corporate bonds fall. The effect on corporate bonds is statistically significant.[6] In both Ramey (2011) and Fisher and Peters (2010), the negative effect of government spending on interest rates disappears within a year.

One possible explanation for the fall in interest rates is an endogenous response of monetary policy to government spending shocks. However, in Section 2 we present evidence indicating that the interest rate fall cannot be solely attributed to accommodative monetary policy. We find that the Ramey shocks are associated with a mild *decrease* in the monetary base (significantly at the 68% level), which suggests government spending does not trigger expansionary open market operations. Second, following the methodologies of Perotti (2002) and Auerbach and Gorodnichenko (2012), our VAR estimates indicate that there is no response of the Federal Funds rate target to government spending shocks. Furthermore, the auto loan rate, personal loan rate, AAA corporate rate, BAA corporate rate, and Fed Funds rate all fall, if anything, relative to the Fed Funds target following a government spending shock.

[4] Donahue, Patrick (2013): "Merkel Warns Against Debt Perils as She Begins Re-Election Bid," *Bloomberg Business*, August 14, 2013.

[5] See also Engen and Hubbard (2004) and Perotti (2004).

[6] See also Eichenbaum and Fisher (2005), Mountford and Uhlig (2009), Perotti (2004), and Edelberg, Eichenbaum, and Fisher (1999).

That is, credit markets appear to loosen relative to the policy rate. Therefore, we go beyond monetary policy in trying to understand these relationships.

Specifically, in this paper we propose a novel explanation for how aggregate demand increases (driven either by public or private shocks) can have a zero or negative effect on interest rates: when national income is demand-determined, government or private spending shocks expand output and income. Rising income increases the supply of loans (or otherwise relaxes credit markets), offsetting the rise in borrowing from the spending shock and leaving the interest rate unchanged. Moreover, if the demand increase is paid for out of money-like assets rather than though debt markets, then interest rates may *decline* from the credit market relaxation.

We illustrate this mechanism in a two-period model with three key features: (1) demand-determined output, (2) portfolio heterogeneity across agents (there are borrowers and savers), and (3) asset market segmentation[7] between money and bonds. Combining these elements, we show that a nontrivial distribution of debt and limited asset market participation predict a negative response of interest rates to particular types of aggregate demand shocks. When spending increases, the income of borrowers increases, thus reducing their demand for loans. If the increased spending itself is not associated with an increase in demand for loans (or a fall in the supply) from savers or the government, then the net effect is a fall in loan demand from borrowers and a lower equilibrium interest rate.

Spending is neutral with respect to spenders' net supply of loans whenever spenders hold cash in their portfolio which they use to pay for fluctuations in their expenditures. When cash reserves are sufficiently high, spenders need not trade in the asset market to finance current consumption. If there are costs associated with trading in the asset market, as proposed by Alvarez, Atkeson and Kehoe (2002), then current spending can have a limited or zero effect on spenders' net supply of loans. Their spending lowers aggregate demand for loans as the income of borrowers increases. Borrowers, on the other hand, have low or zero cash reserves, and frequently transact in debt markets (to, say, roll over debt positions). Therefore, their income will decrease loan demand and cause a lower equilibrium interest rate. Similar to the savers, the government in our model finances its spending in part with cash rather than borrowing. Proposition 1 establishes that as long as savers are sufficiently reluctant to adjust their bond portfolio and as long as the government uses some cash to cover deficits, then government and saver demand shocks *decrease* interest rates. However,

[7] Asset market segmentation has been recognized as important for understanding liquidity effects and exchange rates (Alvarez, Atkeson, and Kehoe (2002, 2009)).

in line with conventional wisdom, borrower demand shocks increase interest rates.[8]

After exploring the predictions of our model, we argue that the driving mechanism is based on empirically relevant assumptions. We demonstrate that the government holds a large quantity of deposits in the Treasury's General Account (TGA), which it often uses to pay for spending net of its current-period tax revenues (Figure 3). The Treasury's stated goal is to sell bonds at regularly scheduled intervals and quantities, so that shocks to expenditure need not affect current-period Treasury holdings. Our theory predicts that such spending lowers interest rates. However, as the Treasury recapitalizes the TGA in subsequent periods, we would expect increasing short-term rates following the shock. Indeed, consistent with this theory, the empirical evidence cited above shows an initial fall in short-term rates followed by an increase after about a year. And, the TGA VAR response to a government spending shock has the same pattern: an initial decline followed by a recapitalization after about a year (Figure 4).

To further corroborate our mechanism, we examine the relationship between interest rates and spending by different categories of consumers. Our theory predicts that increased spending by borrowers is associated with an increase in interest rates, while spending by wealthy, saving individuals who hold cash is associated with a fall in interest rates. Using data from the Consumer Expenditure Survey (CEX), we show that interest rates have a positive conditional dependence on expenditure by middle-income Americans and a negative conditional dependence on spending by Americans in the highest fifth of the income distribution. Of course, consumption is endogenous, so we cannot immediately interpret our estimates as representing a structural relationship. However, employing a simple structural model of consumption and interest rates and using estimates of structural parameters from the literature, we argue that the bias in our estimates is small and that the inverse relationship between interest rates and spending by the rich is not driven by reverse causation. In short, we find that the signs of our estimates support our theory and conclude that our regressions document a new fact that lacks a clear alternative explanation.[9] Furthermore, the

[8]Given that we build Keynesian elements into a heterogeneous agent model, our theory contributes to the growing literature on the role of portfolio/wealth heterogeneity in propagating macroeconomic policy. See, for example, Eggertsson and Krugman (2012), Farhi and Werning (2015), Korinek and Simsek (2015), Auclert (2016), and Kaplan, Moll, and Violante (2016).

[9]One might suspect that the conditional inverse relationship between interest rates and spending by the rich is driven by reverse causation wealth effects: rising interest rates are associated with declining bond prices, reducing the value of savers' long-term assets. However, the strength/sign of this effect depends on the maturity structure of assets and liabilities. Auclert (2016), who calls this the "exposure channel," shows that in American and Italian micro data high income households with high cash-on-hand have strong *positive* interest rate exposure and gain from rising rates. Therefore,

CEX gives us a sense of the magnitudes of households' consumption expenditure variation. Comparing the distribution of household consumption standard deviations with money holdings from the Survey of Consumer Finances (SCF), it appears that rich households are able to cover consumption variation with their cash-on-hand. This means that our assumption of asset market segmentation is consistent with the CEX and SCF.

Our findings are important for understanding the effects of aggregate demand shocks, including government spending, on the macroeconomy. When demand is directed toward sectors that have excess capacity or sticky prices, then current spending does not increase interest rates or lower private investment and consumption. This is important because a common concern with an increase in government spending is that it reduces current investment and therefore future output (as argued above in the Chancellor Merkel quotation). Also, interpreting our borrowers and savers as debtor and creditor nations, our analysis is relevant in the discussion of cross-country aid or debt relief and for the literature on the surprising negative correlation between government spending and exchange rates (see, for example, Ravn, Schmitt-Grohé, and Uribe (2012)).

To the best of our knowledge, there are only two other papers providing a theory of an inverse relationship between government purchases and interest rates. One is the study of Mankiw (1987), which employs a representative agent model with durable and nondurable consumption goods, capital that produces output, and instantaneous government purchases that deplete the resources of the representative agent but provide no utility. Thus, unlike our analysis, that of Mankiw (1987) abstracts from trade in asset markets and government borrowing. Moreover, our mechanism for falling interest rates (which we explore in the data) is much different from that of Mankiw (1987). In our model, government spending stimulates borrower demand and eases credit conditions. In Mankiw (1987), government spending *decreases* permanent income, leading to increased savings.

More recently, Galí (2014) explores the benefits of money financed fiscal stimulus in the context of a new-Keynesian model. In Galí (2014), the government finances spending by printing money, which leads to inflation and a decline in the real interest rate even though the nominal interest rate rises. This is quite different from our

empirical evidence suggests the negative relationship we document between interest rates and rich consumption is not driven by wealth effect from interest rates. Furthermore, while there are other channels through which interest rates may affect rich consumption, we show that consumer borrowing rates fall when rich consumption increases, *even when controlling for the corresponding maturity Treasury rate.*

mechanism, in which interest rates are determined by the interaction of borrowers and savers in the presence of demand-determined output.

The paper proceeds as follows: Section 2 explores the empirical evidence of the zero or negative effect of government spending on interest rates and presents evidence that the results are not driven by the endogenous response of monetary policy. Section 3 presents our model and theoretical results. Section 4 contains the CEX evidence and looks at the relationship between government spending and the TGA. Section 5 concludes.

2 Empirical Evidence on Spending Shocks and Interest Rates

The empirical literature on government spending shocks generally finds a zero or negative temporary response of interest rates to government spending shocks. A Treasury report in the 80s summarized the findings to date:

> *Probably the most important single conclusion to be drawn from this study is that there are no simple answers about the effects of Federal deficits. For example, the notion that higher deficits cause interest rates to rise and the dollar exchange rate to appreciate is not at all certain. The direction in which interest rates and exchange rates move as deficits increase depends on a complex set of factors... And, even when all of these factors are accounted for, it is still not possible to establish statistically a systematic relationship between Federal budget deficits and interest rates.* (US Treasury, 1984)

After thirty years of subsequent research, the report's general conclusion remains: there appears to be no clear evidence that government spending increases interest rates. Table 1 summarizes the published papers from the past two decades that examine the interest rate response to government spending shocks. Many studies have found statistically significant declines in real interest rates following fiscal shocks. Furthermore, we are yet to find a study reporting, above the 68% level, a significant increase in rates within a year of the government spending shock.

Table 1: Studies on the Relationship between Interest Rates and Government Spending Shocks

		Significant interest rate response to G within 4Q?			
Paper	Sample	Decrease	Increase	Identification Method	Interest Rate
Ramey (2011)	1939-2008	Yes**	No	Narrative	real baa
Fisher and Peters (2010)	1958-2007	Yes*	No[2]	Stock Market	3-month T-bill
Mountford and Uhlig (2009)[1]	1955-2000	No	No	VAR	Federal Funds
Eichenbaum and Fisher (2005)	1947-2001	Yes**	No	Narrative	real baa
Edelberg, Eichenbaum, and Fisher (1999)	1948-1996	Yes*	No[3]	Narrative	real 3-month T-bill[4]

This table shows the estimated interest rate response to a government spending shock across various studies. The columns "increase" and "decrease" ask whether the authors estimate a decrease or increase, respectively, of the interest rate within 4Q of a government spending shock. (*,**): within (68%, 95%) confidence band. The column "Identification Method" refers to how the authors estimated exogenous shocks to government spending. See the papers for the details. [1]This row describes the response to the "basic government expenditure shock" from Mountford and Uhlig (2009). [2]There is an increase significant at the 68% level within 12Q. [3]There is an increase significant at 68% level within 6Q. [4]Their results are the same with the 1-year T-bill, but there is no significant decline with 2-year T-bill.

Ramey (2011) suggests that a plausible explanation for the decline in interest rates may be accommodative monetary policy. However, there is no evidence of which we are aware demonstrating that monetary policy is systematically expansionary following a positive shock to government spending. The anecdotal evidence suggests that monetary policy was expansionary during some episode but restrictive during others, including the Korean War (Elliott, Feldberg, and Lehnert (2013)).

Here we test whether the interest rate response can be attributed to accommodative monetary policy. Our objective is not to fully disentangle the causes of interest rate fluctuations, but rather to examine whether the interest rate declines that coincided with large increases in government spending can be attributed loosening of the money supply. To do so, we examine the response of monetary policy to the exogenous government spending shocks identified in Ramey (2011). Due to the large and plausibly exogenous nature of the shocks Ramey (2011) constructs, we view her analysis as the leading example of the inverse and weak relationship between interest rates and government spending shocks.

Ramey's impulse responses are driven primarily by the large ramp-up in government spending during World War II and the Korean War. We gauge the stance of monetary policy by observing a direct tool used by the Federal Reserve to influence interest rates, the monetary base. We focus on the money base because the alternative measure of monetary policy, the Fed Funds target rate, was not used as a policy tool during the early episodes in Ramey's sample. We return to the Fed Funds target below.

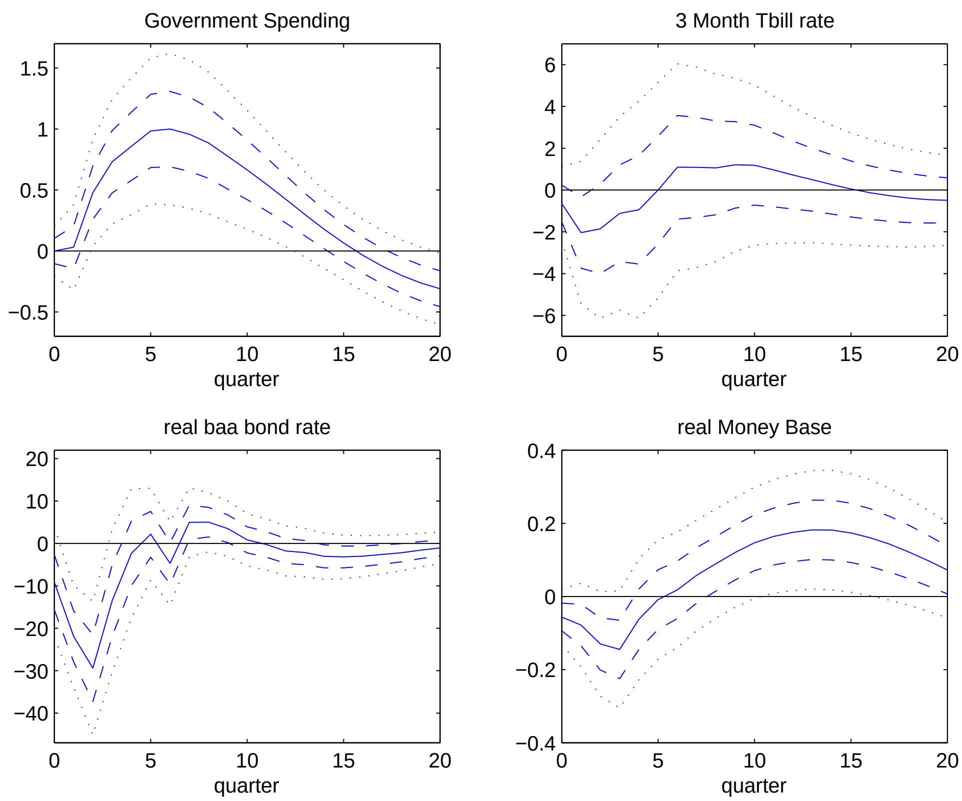
The data in Ramey's sample are quarterly from 1939Q1-2008Q4. Ramey chooses a fixed set of variables to include in a VAR along with her measure of defense news: log of real GDP per capita, government spending, the three-month T-bill rate, and the average marginal income tax rate. Additional variables of interest, including the BAA bond rate, are included one at a time to determine their response to the defense news shock. We include the real money base as one of the rotated variables in Ramey's VAR. We collect the data from the website of Valerie Ramey[10] and from FRED.[11]

Figure 1 replicates Ramey's results for the effect of a defense news shock on government spending, the BAA bond rate, and the T-bill rate. Interest rates are below their initial value for a year while government spending increases. If this decline were due to expansionary monetary policy we should observe an increase in

[10] `http://econweb.ucsd.edu/~vramey/research.html`
[11] `https://research.stlouisfed.org/fred2/`

the money base. To the contrary, the money base falls for the four quarters following the shock.

Figure 1: Impulse Responses to Ramey's Defense News Shocks.



Note: This figure shows the response of the indicated variables to the government defense spending news shocks identified in Ramey (2011). The VAR includes log real GDP per capita, per capita government spending, the 3-month T-bill rate, and the average marginal income tax rate. The BAA bond rate and real monetary base are rotated in one at a time. Dashed and dotted lines represent one and two standard error bands, respectively. The sample is 1939Q1-2008Q4. Sources: Ramey (2011) and FRED.

The decline in the money base implies that the negative interest rate response cannot be attributed to expansionary monetary policy. If anything monetary policy is slightly restrictive. Our results do not rule out that accommodative monetary policy sometimes coincides with fiscal spending increases. Indeed, both policy levers may respond to similar events over the course of the business cycle. Rather, our results suggest that a negative interest rate response cannot be fully attributed to monetary policy, even during the large war spending increases that drive the Ramey

(2011) results.

An alternative to using the money base as a gauge of monetary policy is to examine the Fed's policy rate. While the Federal Funds target rate was not a policy tool during the war episodes in Ramey's sample (and thus we cannot examine the response of the target rate to the defense news shocks), we can employ an alternative identification approach to examine the effect of government spending on credit markets in the post-war period. Building on the work of Blanchard and Perotti (2002), much of the literature on government spending shocks is based on the assumption that government spending responds contemporaneously to its own shock but not to other shocks in the economy (e.g., Bachmann and Sims (2012), Auerbach and Gorodnichenko (2012), Rossi and Zubairy (2011), and Murphy (2015a)). Here we adopt this approach to identifying government spending shocks and examine their effect on the Fed Funds target rate (in Section 4.1 we look at the how the TGA and spreads between various interest rates and the Federal Funds target respond to these spending shocks).

Specifically, we estimate a structural VAR using the specification in Blanchard and Perotti (2002) and a linear version of the specification in Auerbach and Gorodnichenko (2012):

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

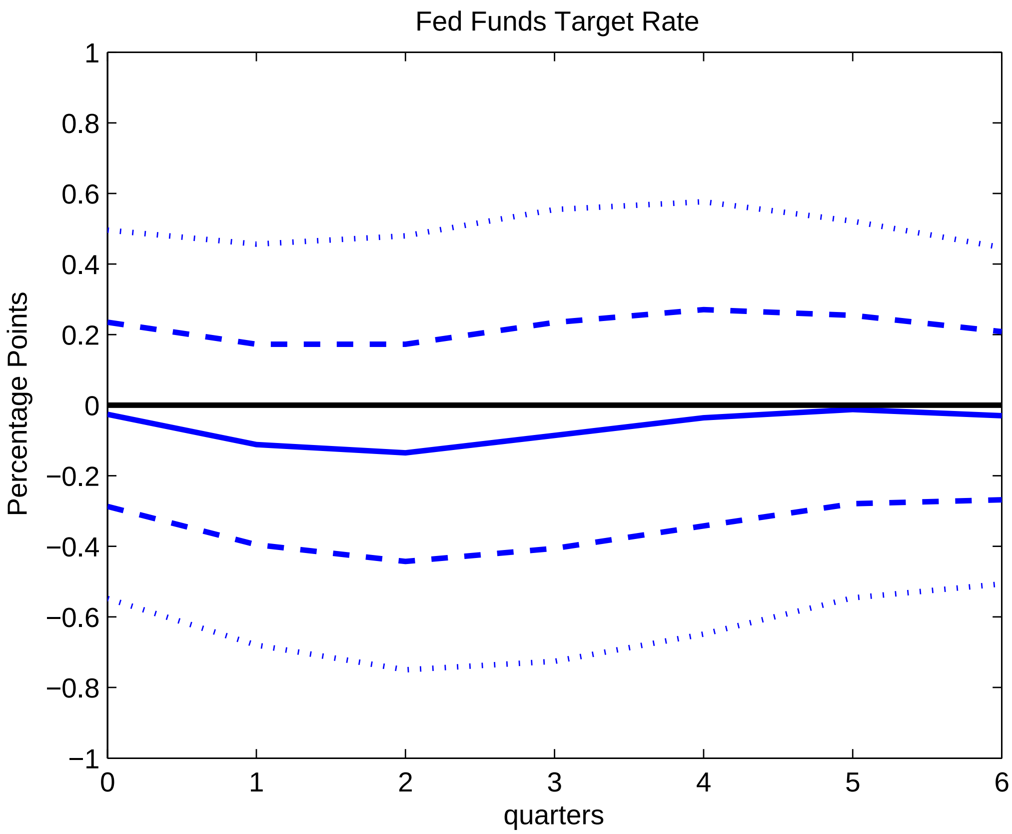
where $X_t = [G_t, T_t, Y_t]'$ consists of log real government spending G_t, log real receipts of direct and indirect taxes net of transfers to businesses and individuals, and log real GDP. $\varepsilon_t = [v_t, \varepsilon_t^2, \varepsilon_t^3]$ is a vector of structural shocks, and v_t is the shock to government spending. The identifying assumption amounts to a zero restriction on the (1,2) and (1,3) elements of A_0. We estimate the model on quarterly data from 1983Q1 (the first year in which we have data on the Fed Funds target rate) through 2007Q4. The estimates are qualitatively similar if we incorporate data from prior decades, although we choose the baseline period to coincide with the period for which we have data on the federal funds target rate.

The model yields a sequence of government spending shocks $\widehat{v}_t$. To estimate the effect of these shocks, we adapt Kilian's (2009) approach for estimating the response of macroeconomic variables to VAR-based shocks. Our specification is

$$s_t = \gamma + \sum_{h=0}^{\overline{h}} \phi_h \widehat{v}_{t-h} + u_t$$

where s_t is the federal funds target rate and u_t is a potentially serially correlated error. The impulse response coefficient at horizon h corresponds to ϕ_h and $\widehat{v}_t$ is the estimate of the structural government spending shock.

Figure 2: The Effect of Government Spending Shocks on the Federal Funds Target Rate.



Note: This figure shows the response of the Federal Funds target rate to a one standard deviation government spending shock identified by a structural VAR with real government spending, real tax receipts, and log real GDP. Dashed and dotted lines represent one and two standard error bands, respectively. The sample is 1983Q1-2007Q4. To account for the possible presence of serial correlation in the errors, confidence intervals are constructed using a block (size 4) bootstrap. Source: FRED.

Figure 2 shows the response of the Fed Funds target to a one standard deviation government spending shock. The point estimate is nearly zero at all horizons (out to 6 quarters), and the two standard deviation confidence band is well within +60 and −80 basis points. That is, our post-1983 VAR evidence indicates that the Federal Funds target rate does not systematically respond to government spending shocks.

In summary, from the perspective of existing theory, the zero/negative interest rate response to government spending shocks is a puzzle. Our results imply that the interest rate response cannot be fully attributed to accommodative monetary policy in response to (or concurrent to) government spending shocks. To resolve this puzzle, we propose a theory of spending-induced credit market relaxation. As discussed below, our theory's mechanism relies on assumptions that are supported by the data, and it has testable implications for the effects of spending shocks of savers.

3 A Model of Demand Shocks and Interest Rates

3.1 Overview

In this section we present an economy of savers and borrowers and limited asset market participation. Our objective is to establish a tractable setting that captures the mechanism responsible for the negative response of interest rates to saver and government demand shocks. In our model both government and private agents hold money (due to costs associated with financial market participation). A saver's positive demand shock generates income for the borrower, which the borrower uses to reduce his bond position.[12] Since the saver's bond supply is fixed due to his temporary non-participation in this asset market, the result is an oversupply of loans and a fall in the equilibrium interest rate. The reduction in the interest rate also stimulates demand by borrowers, which in turn generates income for savers. Cash spending by the government has a similar effect.

3.2 Model

Consider an economy consisting of three agents: savers, borrowers, and the government, indexed by S, B, and G respectively. There are two time periods, $t \in \{1, 2\}$, and there are two assets. First, there is a bond traded at $t = 1$ at price q dollars that pays 1 at $t = 2$. We denote agent i's bond holdings by b^i, $i \in \{S, B, G\}$. Second, there is money ("dollars"). Agent i is endowed with m_1^i dollars at $t = 1$, which he may either use to buy bonds, use to buy a consumption good (at price P_1), or costlessly store until $t = 2$. $m_2^i \geq 0$ is the amount of money agent i carries into $t = 2$.

[12] The assumption that borrowers deleverage in response to a positive shock to income is consistent a marginal propensity to consume (MPC) less than unity. As discussed at the end of this section, empirical estimates of the MPC are well below 1.

The representative borrower and saver each derives utility from consumption at $t = 1$ and $t = 2$. In particular, agent $i \in \{S, B\}$ has the following utility function:

$$U^i\left(c_1^i, c_2^i, b^i\right) = \log\left(c_1^i\right) + \beta^i c_2^i - \kappa^i\left(b^i - b_0^i\right),$$

where c_1^i and c_2^i are consumption at $t = 1$ and $t = 2$. The function κ^i is a fixed cost of bond portfolio adjustment and has the following form:

$$\kappa^i(x) = \begin{cases} 0 & if \quad x = 0 \\ K^i & if \quad x \neq 0 \end{cases}.$$

b_0^i, a parameter of the model determined before $t = 1$, is the bond portfolio or overhang agent i enacted before trade at $t = 1$. Deviating from this plan yields a utility loss. We think of K^i as a reduced form for trading fees, time costs, or other transaction costs. Let $\widetilde{b}^i = b^i - b_0^i$ denote net bond purchases/sales. As we will see below, overhang of debt is what distinguishes borrowers and lenders.

Besides bonds and money, an agent has two other sources of income. First, he receives share α^i of the representative firm's $t = 1$ profit Π (in dollars). Second, the government imposes a tax and transfer scheme (T^i, G^i). Government policy must satisfy the following budget constraints:

$$\begin{aligned} G^S + G^B + qb^G + m_2^G &= m_1^G \\ 0 &= T^S + T^B + b^G + m_2^G \end{aligned}$$

Combining these pieces, the optimization problem of agent i is

$$\begin{aligned} &\max_{c_1^i, c_2^i, \widetilde{b}^i, m_2^i} U^i\left(c_1^i, c_2^i, \widetilde{b}^i + b_0^i\right) \ subject\ to \\ &(i) : P_1 c_1^i + q\widetilde{b}^i + m_2^i = \alpha^i \Pi + m_1^i + G^i \\ &(ii) : P_2 c_2^i = \left(\widetilde{b}^i + b_0^i\right) + m_2^i - T^i \\ &(iii) : m_2^i \geq 0. \end{aligned}$$

Π, the firm's endogenous profit, is determined by shops that as of $t = 1$ receive income only when spending occurs. This situation may arise if, for example, prices are fixed or firms are operating in a region of zero marginal costs, as in Murphy (2015b). In short, we assume that they simply produce what is demanded of them. For simplicity, we assume throughout that $P_1 = P_2 = 1$. Therefore, profits and production are equal to $c_1^S + c_1^B$.[13] We now define equilibrium:

Definition of Competitive Equilibrium: *Competitive equilibrium consists of consumer choices* $\left(c_1^{i*}, c_2^{i*}, \widetilde{b}^{i*}, m_2^{i*}\right)_{i\in\{S,B\}}$, *government policy* $\left(T^{i*}, b^{G*}, m_2^{G^*}\right)_{i\in\{S,B\}}$, *bond price* q^*, *and shopkeeper profit* Π^* *such that:*
1. Given q^* *and* Π^*, $\left(c_1^{i*}, c_2^{i*}, \widetilde{b}^{i*}, m_2^{i*}\right)$ *solves agent* i*'s optimization problem,* $i \in \{S, B\}$,
2. Bond Markets Clear: $\widetilde{b}^{S*} + \widetilde{b}^{B*} + b^{G*} = 0$,
3. $t = 1$ *output is demand determined:* $\Pi^* = c_1^{S*} + c_1^{B*}$,
4. Government budget constraints are satisfied:

$$G^S + G^B + q^* b^{G*} + m_2^{G*} = m_1^G$$
$$0 = T^{S*} + T^{B*} + b^{G*} + m_2^{G^*}.$$

3.3 Segmented Markets Equilibrium

We analyze what we call the "segmented markets" equilibrium in which the cashless borrowers (we assume $m_1^B = 0$) adjust their bond positions but the lenders do not. To simplify our exposition, we assume that the borrowers pay no taxes and are the only beneficiaries of government spending ($T^{B*} = G^S = 0$). Also, we assume $b_0^B < 0 < b_0^S = -b_0^B$, which just says that the borrowers begin with debt overhang owed to the lenders. Finally, our analysis relies on the following parameter restrictions.

Assumption 1: $m_1^G - m_2^{G*} = \gamma^G G^B$, *where* $\gamma^G \in [0, 1]$.
Assumption 2: $\alpha^B < \left(1 - \beta^B \gamma^G G^B\right) / \left(1 + \beta^B/\beta^S\right)$.

Assumption 1 says that a fraction $\gamma^G$of government spending is done via money instead of bond issuance (we explore the empirical plausibility of this assumption in Section 4.1). Assumption 2, made for technical reasons, ensures that the interest rate is greater than zero. It says that the borrower doesn't own too much of aggregate income. If Assumption 2 is violated, the situation is similar to a liquidity trap: the interest rate is 0 ($q^* = 1$), independent of demand shocks.

In the segmented markets equilibrium, instead of dissaving, the lenders reduce their money holdings.[14] This form of equilibrium obtains, for example, when adjustment costs are low for the borrowers but relatively high for the savers (if, say, $K^B = 0$

[13] We have assumed that the government imposes a tax and transfer system on the agents. However, our results would be similar if we instead had the government buying goods from the firm.

[14] Interestingly, however, in equilibrium the savers' money holdings do not fall. To clear markets, interest rates fall and borrower consumption increases until savers hold all money. When savers

and K^S is large). Based both on introspection and the below evidence from the CEX, we feel that this is a plausible scenario. Borrowers have relatively low levels of cash and are accustomed to adjusting consumption via credit markets. Also, fixed costs of using or paying off credit cards, say, are relatively low. Wealthy savers, on the other hand, lend much in the form of long-term financial assets. Unlike credit card transactions, adjusting one's financial portfolio may involve time costs, fixed trading fees, or early withdrawal penalties, for example. Moreover, as we will see in Section 4.2, the rich in the U.S. own substantial amounts of money relative to their consumption standard deviations. Finally, in Section 3.4 we further motivate the segmented markets equilibrium by outlining a model in which savers indirectly lend to borrowers via intermediaries that transform long-term savings into short-term loans.

Proposition 1: *Suppose borrowers are willing to pay the adjustment cost. Then, under Assumptions 1-2, if K^S is sufficiently large there is a unique segmented markets equilibrium, and the bond price is*

$$q^* = \beta^B \frac{\alpha^B/\beta^S + \gamma^G G^B}{1-\alpha^B}.$$

Consequently, while borrower demand shocks raise interest rates, government and saver demand shocks decrease interest rates:

$$\frac{\partial}{\partial \beta^B} q^* > 0$$
$$\frac{\partial}{\partial G^B} q^* > 0$$
$$\frac{\partial}{\partial \beta^S} q^* < 0.$$

Proof: Suppose the interest rate is positive: $q^* < 1$ (we confirm this at the end). As the borrower is able to adjust his bond position, the solution to his optimization problem is characterized by his bond FOC and budget constraints:

$$\left(c_1^B, \widetilde{b}^B, m_2^B\right) = \left(\frac{q}{\beta^B}, \frac{\alpha^B \Pi + G^B - \frac{q}{\beta^B}}{q}, 0\right).$$

He holds no money because the interest rate is positive. As the saver does not

spend out of cash holdings, that cash is returned to savers in the form of income. The net effect of the demand stimulus is that savers' cash holdings are unchanged while net spending and income increase and interest rates decrease.

adjust, his solution is given by his money FOC and budget constraints:

$$\left(c_1^S, \widetilde{b}^S, m_2^S\right) = \left(\frac{1}{\beta^S}, 0, \alpha^S \Pi + m_1^S - \frac{1}{\beta^S}\right).$$

Because firm output is demand determined, we also have that

$$\Pi = \frac{q}{\beta^B} + \frac{1}{\beta^S},$$

which implies that the borrower bond position is

$$\widetilde{b}^B = \frac{\alpha^B}{\beta^B} - \frac{1}{\beta^B} + \frac{\alpha^B}{\beta^S q} + \frac{G^B}{q}.$$

By Assumption 1 and the government budget constraints, we have

$$b^G = \frac{-G^B\left(1-\gamma^G\right)}{q}.$$

Combining these expressions for $\widetilde{b}^B$and b^G with bond market clearing ($\widetilde{b}^S + \widetilde{b}^B + b^G = 0$), some algebra gives the bond price expression in the proposition:

$$q = \beta^B \frac{\frac{\alpha^B}{\beta^S} + G^B \gamma^G}{1-\alpha^B}.$$

Therefore, $q < 1$ if and only if

$$\beta^B \frac{\frac{\alpha^B}{\beta^S} + G^B \gamma^G}{1-\alpha^B} < 1$$

$$\Leftrightarrow$$

$$\alpha^B < \frac{1-\beta^B G^B \gamma^G}{\frac{\beta^B}{\beta^S}+1},$$

which holds by Assumption 2. Thus, the interest rate is positive, as conjectured. As the interest rate and output do not depend on K^S, it is clear that we can find K^S sufficiently large such that the saver will not adjust his bond position in equilibrium. The comparative statics of the proposition immediately follow. ■

As we have a closed form for the bond price, we are able to fully solve for the remaining endogenous variables:

Corollary 1: *In the segmented markets equilibrium of Proposition 1, consumption,* *output, and portfolio choices satisfy:*

$$\left(c_1^{B*}, c_1^{S*}\right) = \left(\frac{\alpha^B/\beta^S + \gamma^G G}{1-\alpha^B}, \frac{1}{\beta^S}\right)$$

$$\left(\widetilde{b}^{B*}, \widetilde{b}^{S*}, b^{G*}\right) = \left(\left(\frac{1-\alpha^B}{\beta^B}\right)\frac{G^B\left(1-\gamma^G\right)}{\left(\alpha^B/\beta^S + G^B\gamma^G\right)}, 0, \left(\frac{1-\alpha^B}{\beta^B}\right)\frac{-G^B\left(1-\gamma^G\right)}{\alpha^B/\beta^S + \gamma^G G^B}\right)$$

$$\left(m_2^{B*}, m_2^{S*}\right) = \left(0, m_1^S + G^B\gamma^G\right)$$

$$\Pi^* = \frac{1}{\beta^S} + \frac{\alpha^B/\beta^S + \gamma^G G}{1-\alpha^B}.$$

The intuition behind Proposition 1 is the following: due to the demand externality, government and saver spending increases firm profit, which is in part paid to the borrowers. With their new wealth, the borrowers are able to pay down some of their debt. This deleveraging of the borrowers offsets the increased spending of the savers or government, preventing a rise in the interest rate. Why does the interest fall and not just remain constant? The savers do not adjust their financial portfolio and instead spend out of cash. Therefore, there is excess bond supply as the borrowers deleverage, causing interest rates to fall.[15] The government likewise spends in part out of cash (see Section 4.1 below). That is, $\gamma^G > 0$. Government spending does lead to some new debt, but it is offset by borrower deleveraging. If $\gamma^G = 0$ and the government uses no cash, then the interest rate is independent of government spending. Loosely, spending shocks are propagating as monetary shocks (see Section 4.1 for empirical evidence related to this interpretation).

3.4 Discussion of Assumptions

Proposition 1, our main theoretical result, relies on borrowers being much less reluctant than savers to adjust their debt position. As we argued above, this situation occurs if $0 \approx K_S \ll K_B$, that is if, for example, savers have higher time costs. Alternatively, we could use the following slightly more complicated but nearly equivalent set up in which borrowers *must* pay the adjustment cost in each period. Suppose that borrowing and lending occurs via competitive intermediaries. Before the events of the model, savers make a two period loan with face value b_0^S to the intermediaries at exogenous interest rate $1/q_0^{0\to 2}$. Borrowers must borrow one period at a time via the intermediary, who engages in maturity transformation. This arrangement might

[15]Interestingly, the saver demand term, α^B/β^S, depends on the extent of inequality, α^B. The negative effect of saver demand on interest rates is largest when the borrower income share (α^B) is highest.

naturally arise when intermediaries (like credit card companies) have an advantage over saving households in monitoring debtors, who may default and have moral hazard problems. Restricting them to short-term credit may alleviate moral hazard, informational asymmetry, or default risk.[16] After borrowing $b_0^S q_0^{0\to 2}$ from savers, the intermediary makes a one period loan with face value $-b_{0\to 1}^B$ and price $q_0^{0\to 1}$ to the borrowers. With this set up, at $t = 1$ the saver budget set is as above, while the borrower's is now (for simplicity, suppose $G^B = T^S = 0$):

$$
\begin{aligned}
c_1^B + qb^B + m_2^B &= \alpha^B \Pi + b_{0\to 1}^B \\
c_2^B &= b^B + m_2^B,
\end{aligned}
$$

where $-b^B$ is a new one period loan made by the intermediary to the borrower. In equilibrium, q must clear the $t = 1$ bond market ($b^B + b_0^S = 0$), and $q_0^{0\to 1}$ must be such that intermediaries have exactly zero profits ($q_0^{0\to 1} q = q_0^{0\to 2}$). When these conditions hold, we have $-b_{0\to 1}^B = \left(b_0^S q_0^{0\to 2}\right)/q_0^{0\to 1} = qb_0^S = -qb^B$, which means that the new loan at $t = 1$ is exactly paid for by debt service $b_{0\to 1}^B$ from the $t = 0$ one period loan. Furthermore, one can show that

$$
q^* = \beta^B \frac{\alpha^B/\beta^S + b_{0\to 1}^B}{1 - \alpha^B - \beta^B b_0^S},
$$

which is qualitatively similar to the result in Proposition 1. In this framework, the borrower must service his debt and thus reevaluate his portfolio in each period, even if this frequent adjustment causes him pain. The saver, on the other hand, lends to borrowers only indirectly via intermediaries, who by assumption are better at monitoring or disciplining potentially risky debtors. Why would this situation arise at $t = 0$? Given transaction costs (or the promise of higher long-term returns as in Diamond and Dybvig (1983)), it is natural to assume that savers would prefer at least some long duration assets. Risky borrowers, in contrast, would emerge at $t = 0$ following a period of low income in a setting with strictly concave utility or a required subsistence level of consumption. In summary, fully modeling $t = 0$ decisions and the maturity transforming intermediaries might make our model more realistic but would complicate the analysis without changing the qualitative implications.

For tractability, we model demand-determined output by assuming a fixed price (as in the "Yeoman Farmer" setup in Woodford (2003)), rendering the firms passive players in the economy. We could drop this assumption by introducing many identical

[16] See, for example, Barnea, Haugen, and Senbet (1980).

price setting local monopolies, as in Murphy (2015b). In this version, sales would still be demand determined, but firms would internalize local demand curves and accordingly set prices. That is, each firm would take the economy-wide interest rate as given and solve the problem $\max_{P_1} P_1 \left(c_1^S(P) + c_1^B(P)\right)$, where $c_1^i(P)$ is the demand curve of agent i, holding fixed the interest rate.

Our log-linear utility yields convenient closed-form solutions. As we see in Corollary 1, consumption demand is independent of income. Without this property, the analysis is more complicated because income depends on consumption. However, we don't expect introducing this additional channel would change the qualitative predictions on the model. Increasing the spending multiplier might even strengthen our mechanism.

Our utility specification yields the important result that borrowers deleverage when their income increases. This deleveraging is the key element of the model that results in a negative response of interest rates to saver demand shocks. In our setting with demand-determined output, deleveraging occurs if the marginal propensity to consume (MPC) out of an income shock is less than 1: each dollar earned yields a (1-MPC) dollar decline in borrowing.

An abundance of empirical evidence confirms that the MPC is less than unity for consumers across the income distribution (see, for example, Mian, Rao, and Sufi (2013) and Kaplan and Violante (2014) and the references therein). The consensus that the MPC out of temporary income shocks is well less than 1 supports our model's prediction that borrowers deleverage in response to a demand-shock-induced increase in their income.

To summarize, our model contains a number of simplifications for tractability. The general mechanism, however, applies when (1) output is determined by demand, (2) savers spend out of cash (which we document below) and (3) borrowers' MPC is less than unity (which is confirmed by empirical estimates). Under these circumstances, saver demand shocks cause interest rates to fall.

4 Empirical Evidence

Our theory generates a zero response of interest rates when the government finances new spending through the bond market. When the government uses cash on hand for purchases the interest rate response is negative. The mechanism is driven by asset market segmentation and demand-determined output, not government spending per se. Consequently, our theory suggests that private savers' demand shocks also cause lower interest rates when they use cash for purchases. Here we demonstrate that our model's assumption that savers and the government hold large cash deposits and spend with them is consistent with the data. Impulse responses show that government spending shocks induce cash spending by the Treasury and decrease (if anything) short- and long-term interest rates relative to the Fed Funds target. We also provide evidence that spending by savers is associated with lower interest rates, consistent with our theoretical prediction.

4.1 Evidence from Treasury's General Account and Interest Rate Spreads

A key assumption for generating an inverse relationship between government spending and interest rates in our model is that deficits are at least in part paid via cash holdings instead of bond issues. A first question that arises is, can the Treasury finance deficits with cash? The answer is yes. The Treasury keeps substantial amounts of money in a checking account with the Federal Reserve System. This checking account is called the Treasury's General Account or TGA. Are fluctuations in this account quantitatively relevant relative to typical budget surpluses/deficits? The answer appears to be yes. Over the period January 1954 to January 2016, on average 16% of the monthly deficit was paid from the TGA.[17] Indeed, as we see in Figure 3, there is a strong positive correlation between the monthly budget surplus/deficit and the change in the TGA. As in our theory, shortfalls in taxes are paid both with new debt and by drawing down cash.

Figure 4 shows the response of the TGA to our VAR-identified government spending shocks from Section 2.[18] Within one year of the one standard deviation shock, the TGA declines (significantly at the 95% level), but the impact is gone within about a year. In light of our theory presented in Section 3, we would expect interest rates to fall and then return to normal during this period. And, as we showed in Section 2, this is precisely what the data indicate with respect to the real BAA bond rate and the 3-month T-bill rate. Combined with our theory, the pattern in Figures 3 and 4 explains why government spending temporarily decreases interest rates: government spending increases the supply of loans (through stimulating income) without substantially increasing the demand for loans (since TGA cash is used).

[17] $.16 \approx \frac{1}{N}\sum_{t=1}^{T}\mathbf{1}\left(T_t - G_t < 0\right)\min\left(\Delta TGA_t, 0\right) / \left(T_t - G_t\right)$, where $N = \sum_{t=1}^{T}\mathbf{1}\left(T_t - G_t < 0\right)$.

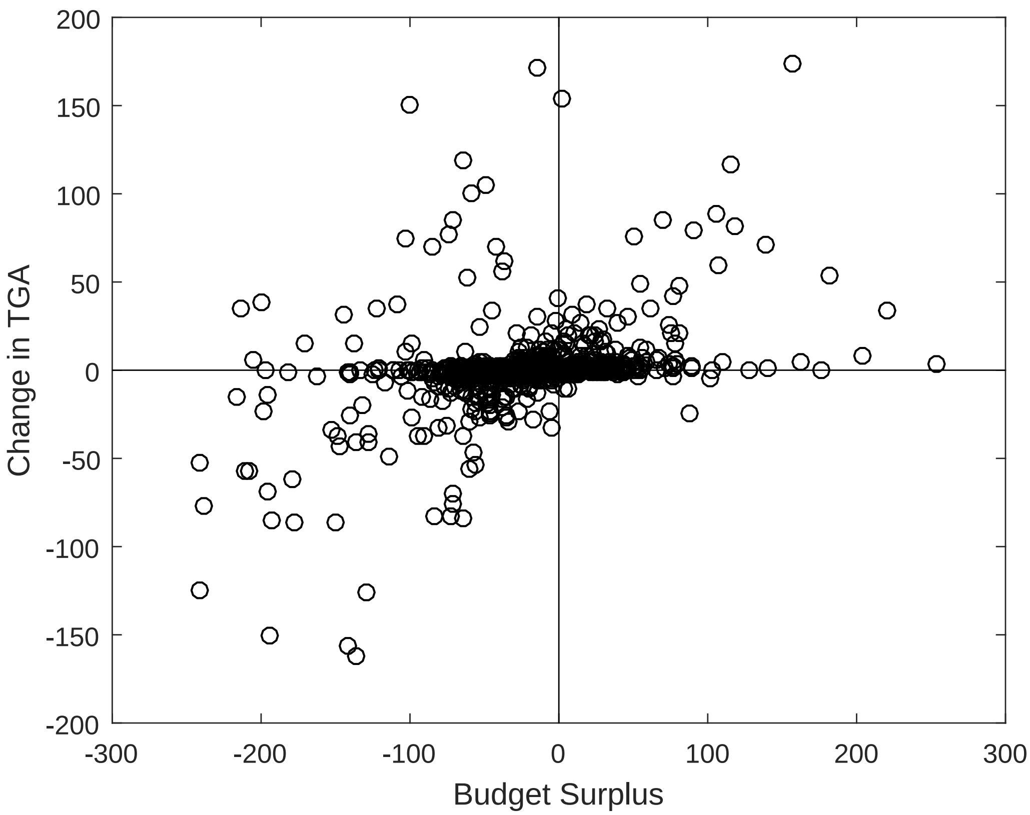
[18] Note that the Phillips-Perron test rejects a unit root in the TGA series (in real terms via the GDP deflator) for the sample 1983Q1-2007Q4.

The key implication of our theory is that government spending through the TGA should relax credit markets. While credit conditions in the post-war era are to a large extent determined by the Fed target rate, actual short-term rates can deviate from the target rate. Here we test whether government spending shocks are associated with interest rate declines relative to the target rate. Again, the government spending shocks are the VAR-identified ones from Section 2. Figure 5 displays evidence consistent with our story that TGA spending loosens credit markets beyond an endogenous response of monetary policy: while the impact is only a few basis points, we estimate that a government spending shock significantly, at the 95% level, decreases the spread between the Federal Funds rate and target. It thus seems plausible that government spending shocks induce TGA spending, which loosens the market for Federal Funds as reserves enter the banking system.[19] If spending shocks caused the Federal Funds *target* to fall, we might even (counterfactually) expect this spread to rise as the overnight market slowly reacts to the rate cut. In Figure 5, we see the same pattern with respect to the 24 month personal loan rate (from FRED)[20] and the Moody's 30–year AAA and BAA corporate rates (from FRED): these interest rates appear to fall relative to the target rate. While this effect is insignificant for the personal loan rate, the fall is significant for the corporate rates at the 68% level. Overall, the results show no evidence of tightening in credit markets relative to the desired level of credit set by the Fed Funds target rate. Instead, the spreads fall, indicating a relaxation of the overall credit market. The fact that the actual Federal Funds rate briefly falls below the target is consistent with our story that government spending (via the TGA) eases credit markets in general and puts upward pressure on the base (as checks are cashed against the TGA).

[19]TGA spending increases the monetary base. See Mishkin (2006) for further discussion.

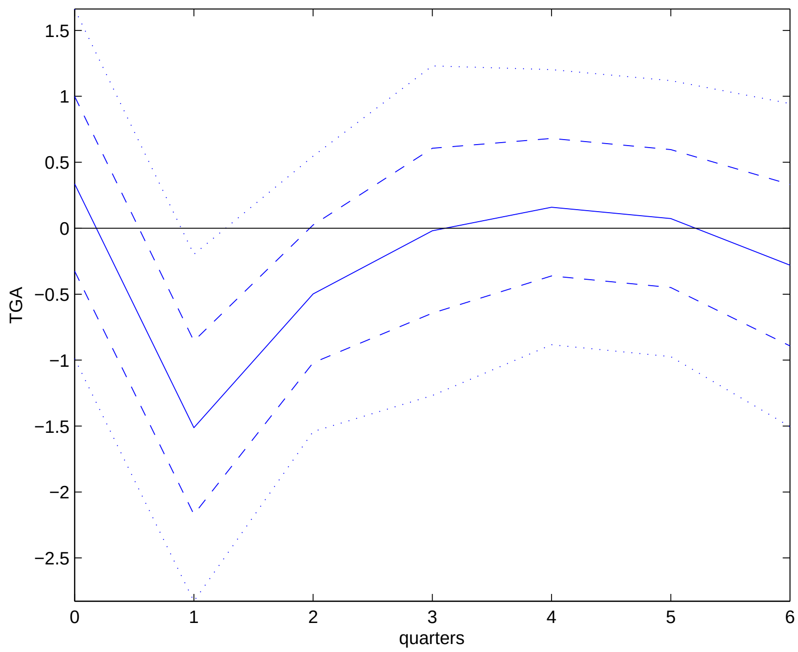
[20]The response of the 48 month auto loan rate (from FRED) is similar.

Figure 3: Change in Treasury's General Account vs. US Budget Surplus.



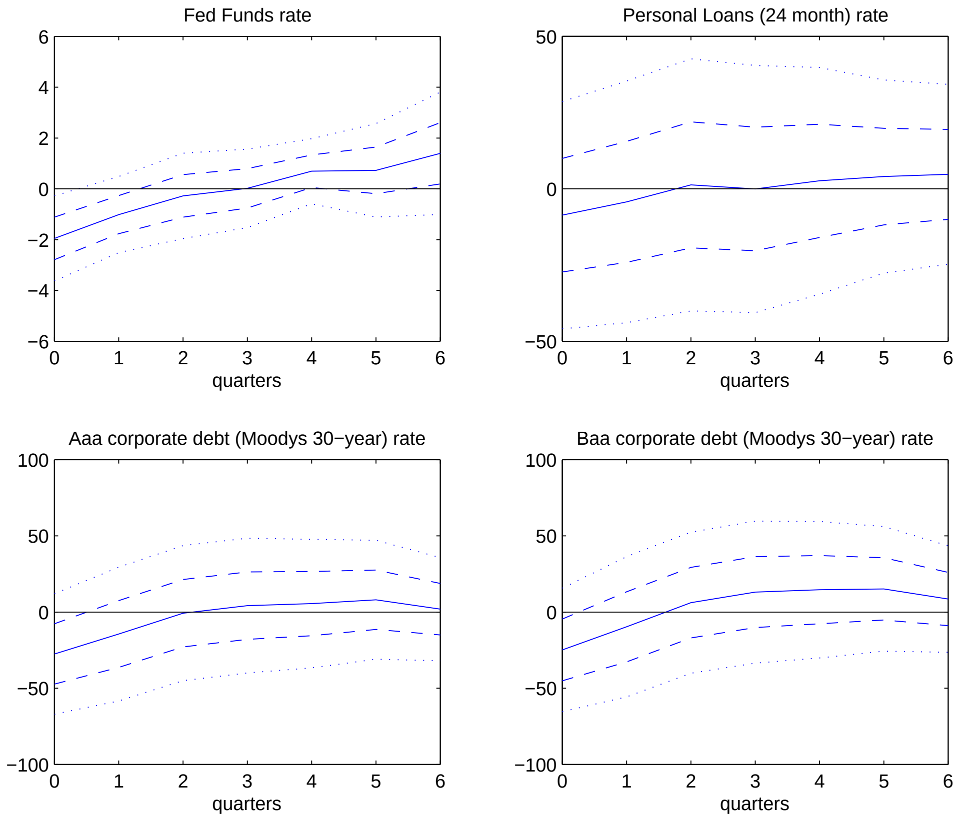
Note: This figure shows a scatter plot with the monthly US government budget surplus on the horizontal axis and the monthly change in the TGA account on the vertical axis. The TGA is the Treasury's checking account in the Federal Reserve System. The units are billions of 2015 dollars (deflated by CPI), and the sample is January 1954 - January 2016. Source: Haver.

Figure 4: The Effect of Government Spending Shocks on the Treasury's General Account.



Note: This figure shows the response of the Treasury's General Account (TGA) to a one standard deviation government spending shock identified by a structural VAR with real government spending, real tax receipts, and log real GDP. Dashed and dotted lines represent one and two standard error bands, respectively. The sample is 1983Q1-2007Q4. The TGA units are billions of 2009 dollars (GDP deflator). Sources: Haver and FRED.

Figure 5: The Effect of Government Spending Shocks on Interest Rates Relative to the Federal Funds Target Rate.



Note: This figure shows the response of the indicated variables (measured as a spread in basis points over the Federal Funds target rate) to a one standard deviation government spending shock identified by a structural VAR with real government spending, real tax receipts, and log real GDP. Dashed and dotted lines represent one and two standard error bands, respectively. The sample is 1983Q1-2007Q4. To account for the possible presence of serial correlation in the errors, confidence intervals are constructed using a block (size 4) bootstrap. Source: FRED.

4.2 Evidence from Microdata

Next, we show that evidence from microdata is consistent with our key premise that savers are less prone to bond portfolio adjustment because their cash deposits are sufficiently large to cover deviations in desired spending. The Consumer Expenditure Survey (CEX) provides us with a measure of deviations in spending across U.S. households, and the Survey of Consumer Finances (SCF) yields information on the size of households' cash deposits. Comparing the CEX and SCF data, we find that the wealthiest U.S. households (the savers) have more than sufficient cash deposits to cover spending fluctuations, while households at the bottom end of the wealth/income distribution do not.

The CEX dataset is identical to that used in Kocherlakota and Pistaferri (2009) and is available on the JPE website. The CEX contains panel data for the consumption and income of U.S. families. Its frequency is monthly, but each family is interviewed only once per quarter. Our data on asset holdings is from the 2001 Survey of Consumer Finances (SCF). The correlation between income and wealth in the SCF is sufficiently high that we refer to savers and high-income households interchangeably. For example, in 2001 the median household (by wealth) of the top decile of the income distribution had almost 6 times the net worth of the median household in the fourth quintile (60th-80th percentile by income). Therefore we equate households in the top quantiles of income with savers in our model.

First we provide a sense of the magnitude of normal consumption fluctuations for different income groups. In particular, for each household we calculate the standard deviation of consumption and the average of income over time. Table 2 shows the percentiles of consumption standard deviations across households. In adult equivalent 2000 dollars, the median standard deviation of consumption for the top 20% of households by income is about \$700. Looking at the 10th and 90th percentiles, for the richest 20% of households, the standard deviation of nondurable consumption is on the order of \$300 to \$2000.

How does this compare with the cash holdings of the rich? Table 3 shows the cross-household distribution (by income) of transaction account values from the 2001 SCF. Transaction accounts contain a number of money-like assets including checking and savings accounts. The richest 10% of households had a *median* transaction account of around $\$30,000$. Overall, comparing Table 3 with Table 2, we see that for the rich, nondurable consumption fluctuations are well below normal cash holdings. Given that money has a low return, it thus seems plausible to assume, as we do in our model, that rich savers finance consumption fluctuations in large part through money and

Table 2: Distribution of Household Consumption Standard Deviations

	Percentile*			
	10th	50th	90th	Obs.
Average Income in Top 20%**	244	734	2064	23449
Average Income in Bottom 80%	139	461	1362	85965
Average Income in Bottom 20%***	103	361	1153	19402

This table shows the distribution of household consumption standard deviations at different average income levels. *Consumption is in terms of quarterly, nondurable, adult equivalent, 2000 dollars. **This row considers households with average quarterly income in the 80th percentile, which is 14352 (2000 dollars). ***This row considers households with average quarterly income in the 20th percentile, which is 3235 (2000 dollars). Sources: CEX, Kocherlakota and Pistaferri (2009).

money-like assets (and that poorer households more frequently adjust debt levels). The bottom 20% of households by income, in contrast, had a median transaction account of only \$900. This is not much at all considering many of these households had an adult equivalent nondurable consumption standard deviation of \$400 to \$1000. For many rich households, the ratio of money to typical quarterly spending variation is on the order of $20,000/1,000 = 20$, whereas for the poor, this ratio is frequently less than $1,000/500 = 2$.

Table 3: Value of US Households' Asset in 2001

	Median Dollar Holdings within Asset Class	
Income Percentile	Transaction Accounts**	Bonds
<20	900	*
80-89.9	9400	50000
>90	26000	90000

This table shows the median dollar holdings of money and bonds at different income levels. *Fewer than 10 observations. **Checking, savings, money market, and call accounts. Source: 2001 SCF.

4.3 A Test of the Theory

Sections 4.1 and 4.2 confirm the theory's assumption that savers and the government have cash deposits to draw upon for their spending. One implication of the theory, which motivated this paper, is that positive innovations to government spending cause lower interest rates. A second implication is that a saver demand shock also lowers interest rates, which we test here using CEX data.

In bringing our theory to the data, we consider a linear interest rate equation similar to the one in Proposition 1:

$$r_t = \overline{r} + b^S \log\left(C_t^S\right) + b^B \log\left(C_t^B\right) + X_t b^X + \varepsilon_t, \tag{1}$$

where C_t^S and C_t^B are consumption of rich savers and poorer borrowers at time t, X_t is a vector of exogenous macro variables that are not impacted by the real interest rate r_t, and ε_t is an interest rate shock unrelated to the other variables. The coefficients b^S, b^B, and b^X represent interest rate elasticities. In general, as in Proposition 1, an equation like 1 will result from plugging bond supply and demand functions into the market clearing condition, solving for r_t, and performing a linear approximation.

Our theory implies that $b^S < 0$ and $b^B > 0$, and our regressions are consistent with this across specifications. While we have data on consumption, interest rates, and (potentially) X_t, a challenge in testing whether spending by savers causes lower interest rates is that consumption itself may depend on interest rates, as in the standard Euler equation:

$$\begin{aligned} \log\left(C_t^S\right) &= \overline{c}^S + \delta^S r_t + X_t \gamma^S + e_t^S \\ \log\left(C_t^B\right) &= \overline{c}^B + \delta^B r_t + X_t \gamma^B + e_t^B, \end{aligned}$$

where δ^i is the elasticity of intertemporal substitution (EIS), and e_t^S and e_t^B are consumption shocks. In this case, $E\left[\left(C_t^S, C_t^B\right)\varepsilon_t\right] \neq 0$ and OLS estimates of b^S and b^B, $\widehat{b}_{OLS}^S$ and $\widehat{b}_{OLS}^B$, are biased. However, as we show in the appendix, the degree of bias is determined by the magnitude of δ^B and δ^S. Fortunately, a large literature has already estimated the EIS δ^i. See, for example, Cashin and Unayama (2015) or Yogo (2004) or the meta-analysis of Havranek, Horvath, Irsova, and Rusnak (2015). Based on the estimates in Cashin and Unayama (2015), Yogo (2004), and Hall (1988), the EIS is around -0.2 and perhaps not statistically different from zero. If $\delta^i \approx 0$, then the OLS estimates are unbiased. In the appendix, for the case with $\delta^S = \delta^B \approx -.2$ we are able to both sign the bias and construct consistent estimates of e_t^S and e_t^B, which serve as instruments for log consumption. Both exercises suggest that our estimate $\widehat{b}_{OLS}^S < 0$ is not a result of endogeneity.

There are, however, two explanations for $\widehat{b}_{OLS}^S < 0$ other than ours. First, rising interest rates are associated with declining bond prices, which reduce the value of savers' long-term assets. Perhaps then $\widehat{b}_{OLS}^S < 0$ is the result of a negative saver wealth effect. Counter to this, Auclert (2016), who calls this the "exposure channel," shows that in American and Italian micro data high income households with high cash-on-hand have strong *positive* interest rate exposure and gain from rising rates. Therefore, this wealth effect should, if anything, bias $\widehat{b}^S_{OLS}$ towards being positive. Intuitively, the strength/sign of this effect depends on the maturity structure of assets and liabilities. The analysis of Auclert (2016) shows that the rich, who have high cash holdings (Table 3), are sufficiently maturity mismatched to give their wealth positive interest rate exposure. Second, one might argue that $\widehat{b}^S_{OLS} < 0$ reflects a large and negative *innate* saver EIS. We address this in Table 5. In particular, we show that saver consumption pushes down auto and consumer loan rates even when controlling for the equivalent maturity Treasury rate. If $\widehat{b}^S_{OLS} < 0$ were the result of reverse causation and a high saver EIS, controlling for interest rates in general (the Treasury rate) would mitigate the sign. We cannot rule out the possibility that the spread between the consumer borrowing rates and the corresponding maturity Treasury rates are the key savings vehicle for the rich, but we are not aware of evidence that suggests this.

In summary, given our theory, our bias/instrument estimates, and the existing literature, we feel the preponderance of the below evidence supports the notion that spending by the rich decreases interest rates through cash-based relaxation of credit markets.

4.3.1 Regression Results

Following the analysis in Section 4.2, we take C^S_t to be the per household, nondurable, adult equivalent consumption (in 2000 dollars) of the richest 20% of households by income. Similarly, C^B_t is the per household consumption of the poorest 80% of households.[21] C_t is per household consumption including all income groups. Our consumption data is the Kocherlakota and Pistaferri (2009) CEX dataset from January 1982 to February 2004. For the interest rate, our baseline specification uses the Cleveland Fed's 1-month ex ante real interest rate (from Haver). We also examine the 48 month nominal auto loan rate (from FRED) and the 24 month personal loan rate (from FRED). For exposition, interest rates are in percentage terms, so the coefficients in 4 and 5 below are elasticities in basis points. We assume that the other macro variables affecting consumption and interest rates are the US stock market and future income growth:

$$X_t = \left(\log\left(\frac{Y^S_{t+1}}{Y^S_t}\right), \log\left(\frac{Y^B_{t+1}}{Y^B_t}\right), \log\left(\frac{CAPE_t}{CAPE_{t-1}}\right)\right),$$

[21] Dividing the rich and poor at the 90th percentile of income produces similar results.

where Y_t^i is per household income (in 2000 dollars) of group $i \in \{S, B\}$ and $CAPE_t$ is the cyclically adjusted US stock market price-earnings ratio from the website of Robert Shiller (`http://www.econ.yale.edu/~shiller/`). In some specifications we also include a linear time trend. We include future income because it is one of the variables in the standard Euler equation. We include the stock market as a robustness check because it is a financial variable that may affect both debt markets and intertemporal consumption decisions. However, as we will see below, these three variables are not strongly correlated with interest rates in our sample. As the auto and personal loan rates are available only at the quarterly frequency, we aggregate monthly consumption, income, and 1-month interest rates via averaging over months.

Column (1) of Table 4 shows, in line with intuition and theory, that higher average consumption is associated with higher real interest rates. In particular, a 1% increase in per household nondurable consumption is associated with a significant (at the 1% level) 40 basis point increase in the 1-month real rate, controlling for the consumption of the rich and a time trend. A 1% increase in per household consumption of the rich, however, is associated with a significant (at the 5% level) 18 basis point *decline* in the real rate (controlling for average consumption). This is consistent with our theory that demand shocks of the rich loosen credit markets. In columns (2) and (3), we replace per household consumption with the average consumption of the poorest 80% of households. As predicted by theory, the coefficient for the rich is negative in both specifications, and the coefficient for the poor is positive (and significant at the 1% level). Without a time trend (column (2)), the saver coefficient is significant at the 5% level and slightly smaller in magnitude than in column (1). When including the time trend, however, the impact of saver consumption is smaller and insignificant. Columns (4) and (5) estimate Equation 1. Again, the signs of $\widehat{b}^S_{OLS}$ and $\widehat{b}^B_{OLS}$ are as predicted by theory, but the saver coefficient, $\widehat{b}^S_{OLS}$, is only significant when excluding the time trend. Comparing columns (4) and (5) to (2) and (3), we see that including the X_t controls has an only marginal impact on the coefficients and standard errors for saver and borrower consumption. As an additional robustness check, in column (6) we difference the interest rate and the log consumption series. In this regression, we have the expected signs of $\widehat{b}^S_{OLS}$ and $\widehat{b}^B_{OLS}$, and both are significant (at the 5% and 1% levels, respectively). In summary, across specifications the consumption of the rich is associated with declines in short-term real interest rates. The statistical significance of this relationship is, however, sensitive to the inclusion of a time trend (except for when we use C_t instead of C_t^B).

Table 4: The Relationship between Interest Rates and Consumption

Regressors	Dependent Variable: 1-month Real Interest Rate (1)	(2)	(3)	(4)	(5)	(6)†
$\log(C_t)$	40.22***					
	(12.42)					
$\log(C_t^S)$	−17.89**	−14.03**	−6.99	−12.12*	−6.44	
	(7.61)	(6.29)	(5.18)	(6.55)	(5.53)	
$\log(C_t^B)$		42.69***	29.15***	44.98***	32.52***	
		(10.97)	(9.07)	(11.36)	(9.69)	
$\log\left(\frac{Y_{t+1}^S}{Y_t^S}\right)$				9.15	14.64	6.33
				(12.36)	(10.34)	(7.59)
$\log\left(\frac{Y_{t+1}^B}{Y_t^B}\right)$				−14.18	−14.89	−13.44*
				(11.18)	(9.32)	(7.16)
$\log\left(\frac{CAPE_t}{CAPE_{t-1}}\right)$				8.01**	3.65	3.25*
				(3.08)	(2.66)	(1.92)
$\log\left(\frac{C_t^S}{C_{t-1}^S}\right)$						−9.20**
						(3.96)
$\log\left(\frac{C_t^B}{C_{t-1}^B}\right)$						31.77***
						(9.04)
Time Trend	Yes***	No	Yes***	No	Yes***	No
R-squared	.45	.15	.45	.22	.46	.21

This table shows regressions of the Cleveland Fed's 1–month ex ante real interest rate (unless otherwise noted) on the consumption of different groups and additional controls. ***,**,*: Significant at 1%, 5%, and 10% levels. Standard errors in parentheses. †The dependent variable in this column is the differenced real interest rate. C_t denotes average quarterly, nondurable, adult equivalent consumption in 2000 dollars. C_t^S (C_t^B) is average consumption for the richest (poorest) 20% (80%) of households by income. Y_t^S and Y_t^B are the analogously defined income measures. $CAPE_t$ is Robert Shiller's cyclically adjusted price-earnings ratio. Constants suppressed. Sources: CEX, Kocherlakota and Pistaferri (2009), Cleveland Fed, and the website of Robert Shiller.

As it is not obvious how (or perhaps even why) to detrend the real interest rate over this sample, in Table 5 we adopt a different approach in attempting to control for unmodeled determinants of real interest rates like trends. Specifically, we replace the 1-month real interest rate with either the 48 month nominal auto loan rate or the 24 month personal loan rate, which are likely better measures of credit conditions facing non-rich households. Furthermore, rather than using a measure of expected 2-year or 4-year inflation to convert to real terms, we control for inflation expectations by including the corresponding maturity nominal Treasury rate (i_t^{2-yr} or i_t^{4-yr}) as a regressor. Doing so also helps control for the stance of monetary policy, the business cycle, or secular trends in interest rates, which are potential missing variables. Note that the nominal auto rate is, roughly,

$$i_t^{auto} = r_t^{4-yr} + E_t \pi_{t+4} + (rp)_t = i_t^{4-yr} + (rp)_t \,,$$

where π_{t+4} is average 4-year inflation, and rp stands for risk premium. Therefore, by using i_t^{auto} on the left hand side and i_t^{4-yr} on the right, b^S and b^B represent the impact of demand shocks on auto loan rates, above and beyond the overall level of interest rates in the economy. As explained above, due to the Auclert (2016) evidence, the negative sign on rich consumption is not likely the result of wealth effects. However, we cannot immediately rule out a high rich EIS causing the negative sign. Including the Treasury rate as a regressor helps account for this. If the inverse relationship between borrowing rates and rich consumption were driven by intertemporal substitution, controlling for the overall level of interest rates would mitigate our findings. Instead, as we see in Table 5, controlling for the Treasury rate does not impact the rich consumption coefficient.

In column (1), we see that $\widehat{b}_{OLS}^S < 0$ and $\widehat{b}_{OLS}^B > 0$, as predicted. Here, however, while the rich coefficient $\widehat{b}_{OLS}^S$ is significant (at the 1% level), the borrower coefficient is not. In column (2) we include the X_t variables, which, again, do not have a substantial impact on the estimates and significance of the consumption coefficients. In columns (3) and (4) we replace the auto rate with the 2-year personal loan rate and i_t^{4-yr} with i_t^{2-yr}. The magnitudes of the consumption coefficients fall sightly, but the results are essentially unchanged. In short, even controlling for expected income growth, the current stock market, borrower consumption, and current Treasury rates, spending by the rich has a significant and inverse association with auto loan and personal loan rates.

Do these OLS estimates reflect the causal effect consumption shocks have on in-

Table 5: The Relationship between Interest Rates and Consumption

	Dependent Variable (Interest Rate)			
	Auto†		Personal††	
Regressors	(1)	(2)	(3)	(4)
$\log\left(C_t^S\right)$	-8.03^{***}	-8.82^{***}	-6.05^{***}	-6.56^{***}
	(2.81)	(3.05)	(1.89)	(2.06)
$\log\left(C_t^B\right)$	4.11	6.98	3.56	5.30
	(5.00)	(5.44)	(3.44)	(3.76)
$\log\left(\frac{Y_{t+1}^S}{Y_t^S}\right)$		0.46		-0.39
		(5.67)		(3.84)
$\log\left(\frac{Y_{t+1}^B}{Y_t^B}\right)$		-0.87		-1.12
		5.14		(3.47)
$\log\left(\frac{CAPE_t}{CAPE_{t-1}}\right)$		1.95		1.11
		(1.46)		(0.99)
i_t^{4-yr}	0.68^{***}	0.68^{***}		
	(0.07)	(0.07)		
i_t^{2-yr}			0.39^{***}	0.38^{***}
			(0.04)	(0.04)
Time Trend	Yes***	Yes**	Yes***	Yes***
R-squared	.91	.90	.89	.88

This table shows regressions of the (†) 4-year nominal auto loan rate and (††) 2-year nominal personal loan rate on the consumption of different groups and additional controls. ***,**,*: Significant at 1%, 5%, and 10% levels. Standard errors in parentheses. C_t denotes average quarterly, nondurable, adult equivalent consumption in 2000 dollars. C_t^S (C_t^B) is average consumption for the richest (poorest) 20% (80%) of households by income. Y_t^S and Y_t^B are the analogously defined income measures. $CAPE_t$ is Robert Shiller's cyclically adjusted price-earnings ratio. i_t^{4-yr} and i_t^{2-yr} are the 4- and 2-year nominal Treasury rates. Constants suppressed. Sources: CEX, Kocherlakota and Pistaferri (2009), Haver, FRED, and the website of Robert Shiller.

terest rates? Specifically, does our robust finding of $\widehat{b}_{OLS}^S < 0$ imply that $b^S < 0$, as predicted by our theory. We believe the answer is yes for five reasons. First, as mentioned above, a number of leading studies have not been able to reject an EIS of zero. In this case, there is no reverse causation, and $\widehat{b}_{OLS}^S$ is not biased. Second, assuming $\delta^S = \delta^B = -.2$ and $1 - b^S\delta^S - b^B\delta^B > 0$, in the appendix we estimate the bias of $\widehat{b}_{OLS}^S$ to be positive, that is, $b^S < \widehat{b}_{OLS}^S < 0$. Third, in the appendix, taking $\delta^S = \delta^B = -.2$ we construct estimates of the consumption shocks e_t^i. Using e_t^i instead of $\log\left(C_t^i\right)$, we get results similar to those in Tables 4 and 5 (see Table 6 in the appendix). Fourth, as empirical research shows the rich have high positive interest rate exposure, it is unlikely our results are driven by wealth effect reverse causation. Fifth, rich spending is associated with falling consumer borrowing rates even when including Treasury rates as regressors, which should control for intertemporal substitution reverse causation.

5 Conclusion

A range of empirical evidence demonstrates that non-monetary demand shocks cause a zero or negative response of interest rates. This fact has eluded explanation and is contrary to standard Keynesian and classical theory. Understanding the nature of this relationship is especially relevant to policy debates about the merits and consequences of austerity.

We offer a new explanation for a negative interest rate response to non-monetary aggregate demand shocks. Savers and the government often pay for current spending out of cash reserves rather than borrowing immediately from the bond market. Their spending generates higher income for debtors and allows debtors to reduce their borrowing in the bond market. The excess net supply of bonds causes a reduction in interest rates. Contrary to most existing theories, which expect a positive response, even if savers or the government spend though bond position adjustment only, the interest rate response is zero in our model.

Our mechanism is based on assumptions that are consistent with the data. Savers and the government hold large cash deposits that are more than sufficient to cover fluctuations in spending, while borrowers hold very limited amounts of cash. An implication of our theory is that higher desired spending by savers is associated with lower interest rates. We document a new empirical result that higher spending by savers (conditional on aggregate spending) is indeed associated with lower interest rates. We interpret this evidence as supportive of our theory and are unaware of existing alternative theoretical explanations.

Our theory has strong policy implications. In the presence of sufficient price rigidity or slack in the form of firms operating in a region of fixed-only costs, government spending can increase output and lower the debt service of borrowers. We expect that future work incorporating our mechanism into a model extended along a number of important dimensions (multiple time horizons, multiple countries, etc.) will be useful for policy analysis.

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7 Appendix

7.1 Signing the Bias

From Equation 1 we have

$$\begin{aligned} r_t &= \overline{r} + b^S \log\left(C_t^S\right) + b^B \log\left(C_t^B\right) + X_t b^X + \varepsilon_t \\ &= V_t b + \varepsilon_t, \end{aligned}$$

where $V_t = \begin{pmatrix} 1 & \log\left(C_t^S\right) & \log\left(C_t^B\right) & X_t \end{pmatrix}$ and $b = \begin{pmatrix} \overline{r} & b^S & b^B & b^X \end{pmatrix}'$. Letting T be the number of observations and

$$V = \begin{pmatrix} V_1 \\ \vdots \\ V_T \end{pmatrix}, \; r = \begin{pmatrix} r_1 \\ \vdots \\ r_T \end{pmatrix}, \; \varepsilon = \begin{pmatrix} \varepsilon_1 \\ \vdots \\ \varepsilon_T \end{pmatrix},$$

the OLS estimate of b is

$$\begin{aligned} \widehat{b}_{OLS} &= \left(V'V\right)^{-1} V'r = \left(V'V\right)^{-1} V' \left(Vb + \varepsilon\right) \\ &= b + \left(V'V\right)^{-1} V'\varepsilon. \end{aligned}$$

As $T \to \infty$,

$$\begin{aligned} \widehat{b}_{OLS} &\to^p b + \left(E\left[V_t'V_t\right]\right)^{-1} E\left[\begin{pmatrix} 0 \\ \log\left(C_t^S\right)\varepsilon_t \\ \log\left(C_t^B\right)\varepsilon_t \\ 0 \end{pmatrix}\right] \\ &= b + bias \end{aligned}$$

Plugging

$$\log\left(C_t^S\right) = \overline{c}^S + \delta^S r_t + X_t \gamma^S + e_t^S \tag{2}$$
$$\log\left(C_t^B\right) = \overline{c}^B + \delta^B r_t + X_t \gamma^B + e_t^B \tag{3}$$

into the interest rate equation, we get

$$\begin{aligned}r_t &= \frac{\overline{r} + b^S \overline{c}^S + b^B \overline{c}^B}{1 - b^S \delta^S - b^B \delta^B} + X_t \frac{b^S \gamma^S + b^B \gamma^B + b^X}{1 - b^S \delta^S - b^B \delta^B} \\ &+ \frac{b^S}{1 - b^S \delta^S - b^B \delta^B} e_t^S + \frac{b^B}{1 - b^S \delta^S - b^B \delta^B} e_t^B + \frac{1}{1 - b^S \delta^S - b^B \delta^B} \varepsilon_t \\ &= \Gamma^0 + X_t \Gamma^X + \Gamma^S e_t^S + \Gamma^B e_t^B + \Gamma^r \varepsilon_t.\end{aligned}$$

This implies

$$\begin{aligned}\log\left(C_t^S\right) &= \overline{c}^S + \delta^S \Gamma^0 + \left(\delta^S \Gamma^S + 1\right) e_t^S + \delta^S \Gamma^B e_t^B + \delta^S \Gamma^r \varepsilon_t + X_t \left(\gamma^S + \delta^S \Gamma^X\right) \\ \log\left(C_t^B\right) &= \overline{c}^B + \delta^B \Gamma^0 + \delta^B \Gamma^S e_t^S + \left(\delta^B \Gamma^B + 1\right) e_t^B + \delta^B \Gamma^r \varepsilon_t + X_t \left(\gamma^B + \delta^B \Gamma^X\right).\end{aligned}$$

Therefore, since $E\left[e_t^S \varepsilon_t\right] = E\left[e_t^B \varepsilon_t\right] = E\left[X_t \varepsilon_t\right] = 0$, we have

$$\begin{aligned}E\left[\log\left(C_t^S\right)\varepsilon_t\right] &= \delta^S \Gamma^r Var\left[\varepsilon_t\right] = \frac{\delta^S}{1 - b^S \delta^S - b^B \delta^B} Var\left[\varepsilon_t\right] \\ E\left[\log\left(C_t^B\right)\varepsilon_t\right] &= \delta^B \Gamma^r Var\left[\varepsilon_t\right] = \frac{\delta^B}{1 - b^S \delta^S - b^B \delta^B} Var\left[\varepsilon_t\right].\end{aligned}$$

Thus, the OLS bias is

$$bias = \frac{\left(E\left[V_t' V_t\right]\right)^{-1} Var\left[\varepsilon_t\right]}{1 - b^S \delta^S - b^B \delta^B} \begin{pmatrix} 0 & \delta^S & \delta^B & 0 \end{pmatrix}'.$$

This means that when the EIS is close to zero, the bias is as well.

Furthermore, the term $\left(E\left[V_t' V_t\right]\right)^{-1} \begin{pmatrix} 0 & \delta^S & \delta^B & 0 \end{pmatrix}'$ does not depend on the OLS estimates. Assuming $\delta^S = \delta^B = -.2$,[22] for columns (3) and (5) of Table 4, we estimate the $\left(b^S, b^B\right)'$ rows of this quantity to be $(0.14, -5.24)'$ and $(0.13, -5.41)'$. For columns (2) and (4) of Table 5, we estimate these rows to be $(0.20, -5.71)'$ and $(0.23, -6.10)'$. That is, provided $1 - b^S \delta^S - b^B \delta^B > 0$, $\widehat{b}^S_{OLS}$ appears to overestimate b^S. The premise $1 - b^S \delta^S - b^B \delta^B > 0$ seems reasonable since across our specifications $.9 < 1 - b^S \delta^S - b^B \delta^B < 1.1$.

[22] In the regressions, we take the interest rate to be $r * 100$ for presentation. Thus, in estimating the bias, we use $\delta/100 = -.002$ as the EIS.

7.2 Construction of Consumption Shocks

An alternate approach to investigating the role of endogeneity is to directly estimate the consumption shocks in Equations 2 and 3. Because

$$\widetilde{\log\left(C_t^S\right)} = \log\left(C_t^S\right) - \delta^S r_t = \bar{c}^S + X_t \gamma^S + e_t^S \tag{4}$$

$$\widetilde{\log\left(C_t^B\right)} = \log\left(C_t^B\right) - \delta^B r_t = \bar{c}^B + X_t \gamma^B + e_t^B \tag{5}$$

$$E\left[X_t\left(e_t^S, e_t^B\right)\right] = 0,$$

assuming we know $\delta^S = \delta^B = -.2$,[23] we can calculate $\widetilde{\log\left(C_t^S\right)}$ and $\widetilde{\log\left(C_t^B\right)}$ and form consistent shock estimates $\widehat{e}_t^S$ and $\widehat{e}_t^B$ by running regressions 4 and 5. For Table 6, we take

$$\widetilde{\log\left(C_t^i\right)} = \log\left(C_t^i\right) - \delta^i\left(1 - month\ real\ rate\right)$$

$$X_t = \left(\log\left(\frac{Y_{t+1}^S}{Y_t^S}\right), \log\left(\frac{Y_{t+1}^B}{Y_t^B}\right), \log\left(\frac{CAPE_t}{CAPE_{t-1}}\right), t\right)$$

and repeat the main specifications from Tables 4 and 5 , using $\widehat{e}_t^i$ instead of $\log\left(C_t^i\right)$. As before, across specifications $\widehat{b}_{OLS}^S < 0$, and the coefficient is significant at least at the 10% level, except in column (1).

[23] Again, because we take the interest rate to be $r * 100$ for presentation, we use $\delta/100 = -.002$ as the EIS for calculations.

Table 6: The Relationship between Interest Rates and Consumption Shocks

	Dependent Variable: Interest Rate			
	1 month real	Δ 1 month real	Auto	Personal
Regressors	(1)	(2)	(3)	(4)
$\widehat{e}_t^S$	-6.22	-8.18^{*}	-8.89^{***}	-6.59^{***}
	(5.21)	(4.35)	(3.05)	(2.06)
$\widehat{e}_t^B$	39.15^{***}	21.96^{***}	8.84^{*}	6.04
	(8.71)	(7.28)	(5.28)	(3.69)
$\log\left(\frac{Y_{t+1}^S}{Y_t^S}\right)$	13.83		4.08	2.28
	(9.50)		(5.53)	(3.74)
$\log\left(\frac{Y_{t+1}^B}{Y_t^B}\right)$	-13.70		-1.68	-1.70
	(8.76)		(5.14)	(3.47)
$\log\left(\frac{CAPE_t}{CAPE_{t-1}}\right)$	2.06		1.41	0.74
	(2.47)		(1.41)	(0.98)
i_t^{4-yr}			0.68^{***}	
			(0.08)	
i_t^{2-yr}				0.38^{***}
				(0.04)
Time Trend	Yes***	No	Yes***	Yes***
R-squared	.52	.10	.90	.88

This table shows regressions of the Cleveland Fed's 1–month ex ante real interest rate, 4-year nominal auto loan rate, and 2-year nominal personal loan rate on the estimated consumption shocks of different groups and additional controls. ***,**,*: Significant at 1%, 5%, and 10% levels. Standard errors in parentheses. C_t denotes average quarterly, nondurable, adult equivalent consumption in 2000 dollars. C_t^S (C_t^B) is average consumption for the richest (poorest) 20% (80%) of households by income. Y_t^S and Y_t^B are the analogously defined income measures. $\widehat{e}_t^S$ and $\widehat{e}_t^B$ are estimates of the shocks to rich and poor consumption (see Appendix 6.2 for details). $CAPE_t$ is Robert Shiller's cyclically adjusted price-earnings ratio. i_t^{4-yr} and i_t^{2-yr} are the 4- and 2-year nominal Treasury rates. Constants suppressed. Sources: CEX, Kocherlakota and Pistaferri (2009), Haver, FRED, and the website of Robert Shiller.