Fiscal Policy and Durable Goods*

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Abstract

This paper shows that the fiscal multiplier for purchases of durable and investment goods is often very small — much smaller than the multiplier for nondurable goods. Standard models predict small durables multipliers because private sector purchases of durable goods are highly intertemporally substitutable and therefore easily crowded out. Empirical estimates based on U.S. data confirm this result. In aggregate time series data output rises by about 50 cents less if the government purchases 1$ of durable rather than nondurable goods. At the industry level, spending on durable goods leads to smaller sectoral expansions than spending on nondurable goods. There is also evidence for state-dependence: While the durables multiplier is small on average, it appears to be larger in economic slumps.

JEL Codes: E21, E32, E62, E63

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1 Introduction

When the government raises spending by one dollar, GDP changes by an amount that is generally *not* one dollar. The difference arises from the fact that households and firms change their behavior when the government intervenes — a phenomenon known as crowding in or out. It is well understood that the private sector response depends on whether the fiscal intervention is temporary or permanent (Baxter and King, 1993). Recent research has shown that the response also depends on whether the economy's factors of production are underutilized (e.g. Auerbach and Gorodnichenko, 2012, Michaillat, 2014) and whether the central bank accommodates the change in spending (e.g. Christiano, Eichenbaum, and Rebelo, 2011, Woodford, 2011).

In this paper I argue that the composition of government spending matters for the size of the fiscal multiplier. I show that in a two sector model purchases of durable goods have a much smaller multiplier than purchases of nondurable goods. I then estimate multipliers separately for spending in durables and nondurables industries. While, on average, a dollar of spending on durable goods raises industry gross output by less than 30 cents, gross output rises more than one-for-one if the government buys nondurable goods. Yet, as I explain below, these estimates do not imply that purchases of durable goods are always ineffective.

The demand for nondurable goods differs fundamentally from the demand for new durables. Whereas nondurable goods and services are immediately consumed, durable goods such as cars, appliances or structures have service lives of many years. If the price of a durable good rises temporarily, households can rely on the existing stock and postpone new purchases until prices revert to lower levels. All else equal, a longer service life leads to a greater intertemporal substitutability of purchases.

Intertemporal substitutability is key for the fiscal multiplier because it determines how much private sector spending is crowded out. If the government temporarily raises spending and drives up prices, households delay new purchases until the fiscal expansion ends. The higher the intertemporal elasticity of substitution the larger the degree of crowding out. It follows that multipliers for durable goods with high intertemporal elasticities of substitution are smaller than multipliers for nondurable goods with low intertemporal elasticities of substitution.

In standard models the difference between durable and nondurable multipliers is large. When the service life is calibrated to realistic levels, the durables multiplier is often less than one third of

the nondurables multiplier. I also show that the durables multiplier approaches zero as the service life of the durable good becomes large. The prediction that durables multipliers are smaller than nondurables multipliers holds for both New Keynesian and neoclassical models.

Research by Woodford (2011), Christiano, Eichenbaum, and Rebelo (2011), Werning (2011), and Farhi and Werning (2012), among others, has emphasized that the size of the fiscal multiplier is highly sensitive to the monetary policy response. Interestingly, the durables multiplier depends substantially less on monetary policy than the nondurables multiplier. Because purchases of durables crowd out private sector spending, equilibrium quantities and prices move little relative to the case in which the government purchases nondurable goods. With output and prices barely changed, the monetary policy response matters less. In the special case in which the service life of durables becomes large, the allocation is independent of monetary policy for a large class of rules.

I estimate fiscal multipliers separately for durable and nondurable goods, beginning with evidence based on U.S. national accounts data. In simple regressions which take U.S. military spending as exogenous (Hall, 2009, Barro and Redlick 2011) the nondurables multiplier exceeds the durables multiplier by about 0.5. Consistent with theory government purchases of durable goods are associated with declines in private sector investment and purchases of durable goods.

I subsequently turn to an analysis at the industry level. In particular, I assemble a new dataset from the NBER-CES Manufacturing Industry Database and two databases covering the universe of U.S. military prime contracts. The merged dataset contains industry-level outcomes such as gross output, value added, and employment together with military spending on goods in each 4-digit SIC manufacturing industry.

As predicted by the theory, industries that produce durable goods respond much less to fiscal expansions than industries that produce nondurable goods. Using an identification strategy closely related to Ramey and Shapiro (1998) and Nakamura and Steinsson (2014), I first estimate impulse response functions. I then construct industry-level multipliers from the estimated impulse response functions separately for durable and nondurable goods. The multipliers for all five measures of economic activity I consider—gross output, value added, cost of materials, energy expenditures, and employment—are smaller if spending takes place in durable goods industries.

While the durables multiplier is low on average, I find that it is higher during recessions. Durable goods industries exhibit high volatility over the business cycle resulting in substantial underutiliza-

tion of factors in economic slumps. As, for example, Auerbach and Gorodnichenko (2012, 2013), Bachmann and Sims (2012), and Michaillat (2014) show, multipliers can be larger in such environments. Indeed, when estimating state-dependent multipliers in durable goods industries, I find that spending in recessions is quite effective. After a fiscal shock that occurs in recessions, the gross output multiplier rises gradually and eventually exceeds unity. In contrast, the multiplier becomes negative if the government raises spending in expansions.[1]

This paper is related to a large literature on the effects of government spending. Hall (2009) shows in a simple static model with a single nondurable good that the fiscal multiplier is decreasing in the intertemporal elasticity of substitution. In his model the multiplier tends to zero as the intertemporal elasticity of substitution approaches infinity. I show that the same result holds approximately for short-run multipliers of long-lived durable goods. Consistent with this result, House (2009) argues that among the options that households face in response to greater government spending, reducing investment is more attractive than reducing consumption or raising the supply of labor.

Most of the literature on fiscal multipliers does not distinguish between purchases of durable and nondurable goods. Exceptions include Perotti (2004) and Pappa (2009a, 2009b) who study the effects of government consumption and investment using structural VARs. Their findings are broadly consistent with the hypothesis that government consumption is associated with greater multipliers than government investment.[2] Paying particular attention to anticipation effects and timing Leduc and Wilson (2013) study the effects of public infrastructure spending. They find a very large short-term multiplier in recessions and an insignificant short-term multiplier in expansions.[3]

Although I cast my analysis largely in terms of consumer durables, I note that the demand for investment goods such as machines, ships or structures is also highly elastic (House and Shapiro, 2008). In the empirical part of this paper, I will refer to all long-lived goods as durable goods, regardless of whether they are consumer durables or investment goods. Because services are immediately consumed, they are best understood as nondurable goods in the context of this paper.

The remainder of the paper is structured as follows. In the next section, I lay out a simple

[1]The evidence on state dependence of fiscal multipliers is not uncontroversial. Owyang, Ramey, and Zubairy (2013) find that the multiplier in recessions is large in Canada, but not in the U.S.

[2]See in particular tables 4 to 6 in Perotti (2004), the "typical" state-level employment responses in figure 3 in Pappa (2009b) and table 1 in Pappa (2009a).

[3]Other papers that distinguish different government interventions include Finn (1998), and Pereira (2000). Aschauer (1989) studies the effect of public expenditure on productivity.

theory predicting that the multiplier for durables is small relative to that of nondurable goods. I then turn to the empirical analysis in Section 3. In Section 4 I discuss state dependence of the fiscal multipliers. I first estimate durables multipliers in recessions and expansions and then analyze an extension of the model in which the interest rate is pinned at the zero lower bound. Section 5 concludes.

2 Theoretical analysis

I next present a New Keynesian two sector model to study the effectiveness of government spending on durable and nondurable goods. After describing the model, I demonstrate that the intertemporal elasticity of substitution of durable goods purchases is much larger than that of nondurable goods purchases. I then show that their high intertemporal substitutability renders the durable goods multiplier small.

2.1 Model description

The model is designed to mirror the empirical setting I face below: There is a large number of (4-digit SIC) industries. Some of these industries produce durable goods, others produce nondurable goods. I am interested in the effect on GDP when the government increases spending in a typical durable or a typical nondurable goods industry.

To keep the framework tractable, I only model two sectors, a small sector X and a large sector Z. The small sector represents a typical 4-digit SIC manufacturing industry that is subjected to a government spending shock. Depending on the choice of the depreciation rate δ_D, the small sector produces either durable or nondurable goods for final consumption. The large sector Z represents the aggregate of all remaining industries. It produces goods which can alternately be used for final nondurable consumption C, for investment into capital of the two sectors, I_Z and I_X, or for intermediate goods M_X used in the production of good X. For simplicity, there is no government spending on goods in the Z sector. Notice that Z is a hybrid sector, producing both nondurable goods (C and M_X) and durable investment goods (I_Z and I_X).

2.1.1 Representative household

The representative household maximizes life-time utility

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[u\left(C_t, D_{H,t}\right) + \Gamma_t - v\left(N_{X,t}, N_{Z,t}\right) \right]$$

subject to the nominal budget constraint

$$\begin{aligned} &P_{X,t}X_{H,t} + P_{Z,t}\left(C_t + I_{X,t} + I_{Z,t}\right) + B_t + T_t \\ &\qquad = W_{X,t}N_{X,t} + W_{Z,t}N_{Z,t} + R_{X,t}K_{X,t-1} + R_{Z,t}K_{Z,t-1} + B_{t-1}\left(1 + i_{t-1}\right) + \Pi_t, \end{aligned} \quad (1)$$

the accumulation equations

$$D_{H,t} = X_{H,t} + \left(1 - \delta_D\right) D_{H,t-1}, \quad K_{j,t} = I_{j,t} + \left(1 - \delta_K\right) K_{j,t-1},\ j \in \{Z, X\}, \quad (2)$$

and a no-Ponzi game condition.

Utility is derived from three components. The first component, u, reflects the benefit derived from the consumption of the nondurable good C_t and the good $D_{H,t}$. When $\delta_D = 1$, $D_{H,t} = X_{H,t}$ is a nondurable good. For $\delta_D < 1$, $D_{H,t}$ is the household's stock of durable goods, while $X_{H,t}$ are new purchases. The second component, Γ_t, represents the household's utility derived from government purchases. I assume that Γ enters additively separable so that government spending is neither a substitute nor a complement for private sector spending. Finally, the third term is the household's disutility from supplying labor to the two sectors. Letting subscripts denote partial derivatives, I assume that 1) $u_C, u_D, v_X, v_Z > 0$, 2) $u_{CC}, u_{DD} < 0$, 3) $v_{XX}, v_{ZZ} > 0$, and 4) that Inada-type conditions hold.

The remaining notation is chosen as follows. $P_{X,t}$ and $P_{Z,t}$ denote the prices in the X and the Z sector. Wages are analogously denoted by $W_{X,t}$ and $W_{Z,t}$. Each sector has its own capital stock $K_{X,t}$ and $K_{Z,t}$, earning rental rates $R_{X,t}$ and $R_{Z,t}$. The representative household can hold risk-free nominal bonds, B_t, paying interest rate i_t. Π_t are profits and T_t is a lump-sum tax.

2.1.2 Firms

Both sectors have a representative aggregating firm and a unit continuum of differentiated firms. The aggregating firms assemble the differentiated varieties into CES bundles

$$X_t = \left[\int_0^1 x_t(s)^{\frac{\varepsilon-1}{\varepsilon}} ds\right]^{\frac{\varepsilon}{\varepsilon-1}}, \quad Z_t = \left[\int_0^1 z_t(s)^{\frac{\varepsilon-1}{\varepsilon}} ds\right]^{\frac{\varepsilon}{\varepsilon-1}}. \tag{3}$$

Optimal behavior in competitive markets implies the demand functions

$$x_t(s) = X_t\left(\frac{p_{x,t}(s)}{P_{X,t}}\right)^{-\varepsilon}, \quad z_t(s) = Z_t\left(\frac{p_{z,t}(s)}{P_{Z,t}}\right)^{-\varepsilon} \tag{4}$$

where $p_{x,t}(s)$ and $p_{z,t}(s)$ denote the prices of a generic variety s in each sector and $P_{X,t}$ and $P_{Z,t}$ are given by

$$P_{X,t} = \left(\int_0^1 (p_{x,t}(s))^{1-\varepsilon} ds\right)^{\frac{1}{1-\varepsilon}}, \quad P_{Z,t} = \left(\int_0^1 (p_{z,t}(s))^{1-\varepsilon} ds\right)^{\frac{1}{1-\varepsilon}}. \tag{5}$$

A differentiated firm in sector X produces variety s using production function

$$x_t(s) = \left[(k_{x,t}(s))^{\alpha} (n_{x,t}(s))^{1-\alpha}\right]^{\chi} [m_{x,t}(s)]^{1-\chi}. \tag{6}$$

The firm rents capital $k_{x,t}(s)$ at rate $R_{X,t}$ and employs labor $n_{x,t}(s)$ at wage $W_{X,t}$. Additionally, production requires an intermediate $m_{x,t}(s)$ from the large sector. Parameter χ is the cost share of capital and labor and $(1-\chi)$ is that of intermediates. Cost minimization in competitive factor markets yields the firm's conditional factor demand functions and an expression for its marginal costs $MC_{X,t}$.

Firms set prices as in Calvo (1983). Let θ_X denote the probability that a firm in sector X cannot adjust its price. Let further λ denote the Lagrange multiplier on the budget constraint (1). Then the monopolistically competitive firm chooses the reset price $p^*_{X,t}$ to maximize objective

$$\mathbb{E}_t \sum_{j=0}^{\infty} (\theta_X \beta)^j \frac{\lambda_{t+j}}{\lambda_t} \left[p^*_{X,t} x_{t+j} - MC_{X,t+j} x_{t+j}\right]$$

subject to the sequence of demand functions (the first equation in 4) and its marginal costs $MC_{X,t+j}$.

The optimal reset price is

$$p_{X,t}^{*}=\frac{\varepsilon}{\varepsilon-1}\frac{\mathbb{E}_t\sum_{j=0}^{\infty}\left(\theta_X\beta\right)^j\lambda_{t+j}X_{t+j}\left(P_{X,t+j}\right)^{\varepsilon}MC_{X,t+j}}{\mathbb{E}_t\sum_{j=0}^{\infty}\left(\theta_X\beta\right)^j\lambda_{t+j}X_{t+j}\left(P_{X,t+j}\right)^{\varepsilon}}.$$

Monopolistic competitors in the large sector behave similarly. The only difference is that they do not require an intermediate input. Their production function is simply $z_t(s)=\left(k_{z,t}(s)\right)^{\alpha}\left(n_{z,t}(s)\right)^{1-\alpha}$, and capital and labor are paid the rental rate $R_{Z,t}$ and the wage $W_{Z,t}$. Price rigidity in sector Z is parameterized by θ_Z. Notice that I assume that productivity in both sectors is unaffected by government spending.

2.1.3 Market clearing, government, accounting, and monetary policy

Market clearing in sectors Z and X requires

$$Z_t=C_t+I_{X,t}+I_{Z,t}+M_{X,t}\ \text{ and }\ X_t=X_{H,t}+X_{G,t} \tag{7}$$

where $M_{X,t}=\int_0^1 m_{x,t}(s)\,ds$ is the total of intermediates demanded by the X sector and X_G is government spending on good X. The labor and capital market clearing conditions are given by

$$N_{X,t}=\int_0^1 n_{x,t}(s)\,ds,\quad N_{Z,t}=\int_0^1 n_{z,t}(s)\,ds \tag{8}$$

and

$$K_{X,t-1}=\int_0^1 k_{x,t}(s)\,ds,\quad K_{Z,t-1}=\int_0^1 k_{z,t}(s)\,ds. \tag{9}$$

Since the economy is closed and the government always balances its budget ($T_t=P_{X,t}X_{G,t}$), bonds are in zero net supply, $B_t=0$.[4] I assume that government purchases in sector X follow the AR(1) process

$$X_{G,t}=\left(1-\varrho_X\right)X_G+\varrho_X X_{G,t-1}+\varepsilon_{G,t}. \tag{10}$$

Variables without time subscripts, such as X_G, denote steady state values.

GDP in constant prices is

$$Y_t=P_X X_t-P_Z M_{X,t}+P_Z Z_t. \tag{11}$$

[4]Since Ricardian equivalence holds in this model, the balanced budget assumption is not restrictive.

The GDP deflator and inflation are then

$$P_t = \frac{P_{X,t}X_t + P_{Z,t}Z_t - P_{Z,t}M_{X,t}}{P_X X_t + P_Z Z_t - P_Z M_{X,t}} \text{ and } \pi_t = \left(P_t - P_{t-1}\right)/P_{t-1}. \tag{12}$$

I initially assume that the monetary authority follows a fairly general rule of the form

$$i_t = \iota\left(\{i_{t-s-1}, P_{t-s}, P_{X,t-s}, P_{Z,t-s}, Y_{t-s}, X_{t-s}, Z_{t-s}\}_{s=0}^{\infty}\right). \tag{13}$$

where ι is any function of the given arguments. This completes the description of the model. I summarize all equations in Appendix A.1.

2.2 The demand for durable and nondurable goods

I next compare the demand for durable and nondurable goods. I first demonstrate that the low intertemporal elasticity of substitution of nondurables implies a very inelastic demand curve at a given point in time. I then show that the demand for durables has a much higher demand elasticity, reflecting the high substitutability of durables purchases over time.

Denote by γ the Lagrange multiplier on the accumulation equation of durable goods (the first equation in 2) and recall that λ is the Lagrange multiplier on the nominal budget constraint (1). Hence, γ is the shadow value of good X, expressed in utils, and λ represents the marginal utility of one dollar. Optimal behavior of the representative household (section 2.1.1) then implies that

$$\gamma_t = u_D\left(C_t, D_{H,t}\right) + \beta\left(1-\delta_D\right)\mathbb{E}_t\left[\gamma_{t+1}\right] \tag{14}$$

and

$$P_{X,t} = \lambda_t^{-1}\gamma_t. \tag{15}$$

As equation (14) shows, the shadow value of good X equals a flow component u_D plus a continuation value. Solving this equation forward and combining the result with (15) yields

$$P_{X,t} = \lambda_t^{-1}\mathbb{E}_t\sum_{s=0}^{\infty}\left[\beta\left(1-\delta_D\right)\right]^s u_D\left(C_{t+s}, D_{H,t+s}\right). \tag{16}$$

This expression can be interpreted as the household's (inverse) demand function for X. It is helpful

to first discuss the special case in which $\delta_D = 1$.

2.2.1 Nondurable goods

If $\delta_D = 1$, the small sector produces a nondurable good, $D_{H,t} = X_{H,t}$, and equation (16) reduces to the familiar expression

$$P_{X,t} = \lambda_t^{-1} u_D \left(C_t, X_{H,t} \right). \tag{17}$$

Next, define the intertemporal elasticity of substitution of D_H as $\sigma_D = -\frac{u_D(C,D_H)}{D_H u_{DD}(C,D_H)}$. The linear approximation of equation (17) then implies that, ceteris paribus, a one percent change in $X_{H,t}$ reduces $P_{X,t}$ by σ_D^{-1} percent. Hence, a low intertemporal elasticity of substitution σ_D implies that the demand curve for nondurable goods is inelastic.

Estimates of elasticity σ_D vary and are somewhat controversial. A recent study by Cashin and Unayama (2012) which explicitly distinguishes nondurable from storable and durable goods estimates a value 0.21, similar to Hall's (1988) estimates. Such a low value suggests that consumption barely responds to changes in intertemporal prices or, equivalently, that the demand curve for nondurables is very steep. Even if σ_D is set to unity, a popular choice in the literature, the demand for nondurables is much less elastic than that for durables.

2.2.2 Durable goods

Due to the dynamic nature of the model, an analogous elasticity for durable goods ($\delta_D < 1$) is difficult to obtain. Instead, I will argue on the basis of equation (16) that in a limiting case the shadow value of the durable good γ_t is approximately constant. If γ_t is constant, the demand for X_t is perfectly elastic (see equation 15). The limiting approximation assumes that β approaches unity, δ_D approaches zero and that all disturbances are short-lived — a reasonable assumption for temporary fiscal expansions. Of course, many durable goods do not have depreciation rates near zero. For instance, the Bureau of Economic Analysis (BEA) estimates the service life of furniture at 14 years.[5] Yet, the approximation provides the correct intuition that the demand elasticity rises with greater durability and it remains quite accurate for realistic calibrations of δ_D. I provide details on the numerical accuracy of this approximation below.

To see why γ_t is approximately constant for long-lived durables, first notice that the consumer

[5]For the BEA's estimates of service lives, see Bureau of Economic Analysis (undated).

derives utility from the stock of the durable good $D_{H,t}$, not current purchases $X_{H,t}$. Because durables with long service lives have large stock to flow ratios (in steady state $D_H/X_H = 1/\delta_D$), even large changes in $X_{H,t}$ cause only relatively small percentage changes in $D_{H,t}$.

Second, if the household is sufficiently patient (β close to unity) and the durable long-lived (δ_D close to zero), the shadow value γ_t depends on utility flows far in the future. In stationary environments with short-lived shocks these future terms are barely affected since the economy quickly reverts back to its steady state. Any changes to the first few terms in the sum of equation (16) are dwarfed by the future terms which remain approximately unchanged. Hence, as β approaches unity and δ_D approaches zero, the shadow value γ_t becomes unresponsive to temporary shocks and the demand for $X_{H,t}$ perfectly elastic.[6]

Intuitively, the household smoothes consumption of both nondurable and durable goods. But since utility is derived from the stock the consumer is willing to tolerate much larger variation in durables purchases than in nondurables purchases. It is optimal to purchase durables only at favorable prices and to draw down the stock whenever prices are temporarily high. Mankiw (1985), Adda and Cooper (2000), Erceg and Levin (2006), Mian and Sufi (2012) and Hausman (2015) all provide evidence for large intertemporal substitutability of durable goods purchases.

2.3 Implications for fiscal policy

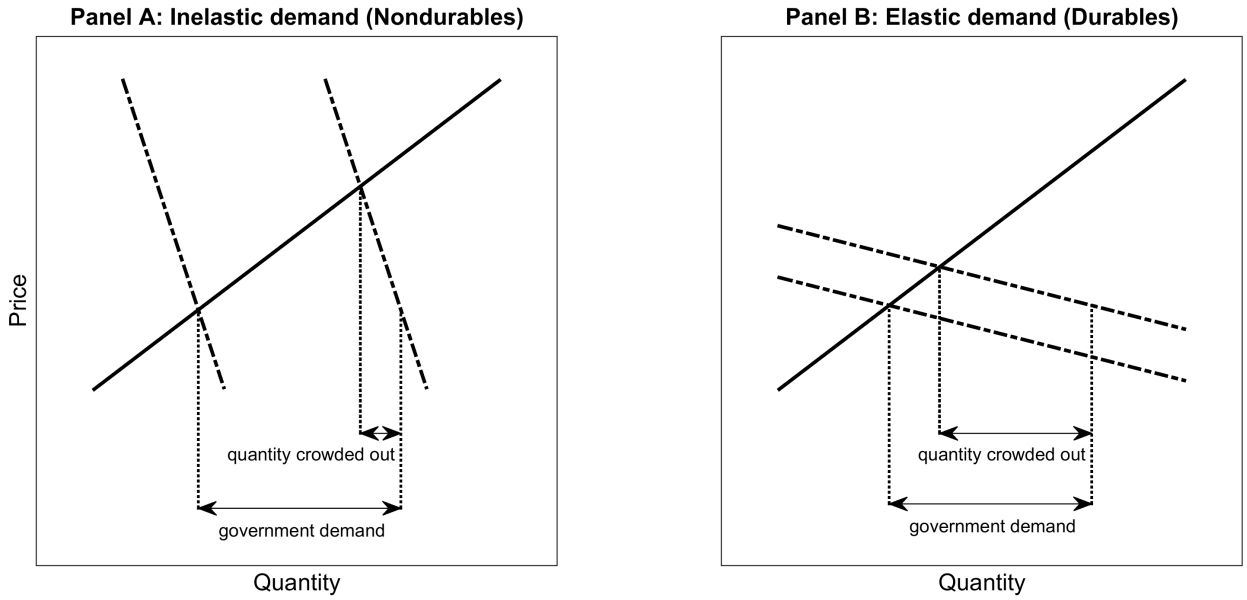
The demand elasticity is crucial for the size of the fiscal multiplier because it determines the degree to which private sector spending is crowded out. The basic intuition can then be illustrated in a demand and supply diagram.

Suppose the government raises spending and shifts out the demand curve. If the supply curve is upward-sloping, the resulting price increase reduces private sector spending. Greater demand elasticities lead to greater crowding-out. In the limiting case with horizontal demand curve, all private sector spending is crowded out and the fiscal expansion has no effect. Figure 1 illustrates the effect of government spending in a sector with inelastic demand (Panel A) and elastic demand (Panel B). The supply curve and the fiscal expansion are the same in both sectors.

Before turning to a more formal analysis of fiscal policy I briefly define sector-level analogues of the aggregate fiscal multiplier $\mathrm{d}Y/\,\mathrm{d}G$. These sectoral multipliers help link the theoretical analysis

[6] A similar argument is made in Barsky, House, and Kimball (2007).

Figure 1: Crowding out of private sector spending.



that follows to the empirical evidence in Section 3.

In the model described above, gross output in constant prices in sector X is $GO_{X,t} = P_X X_t$ and value added is $VA_{X,t} = P_X X_t - P_Z M_{X,t}$. Also denote government purchases of good X in constant prices by $G_{X,t} = P_X X_{G,t}$. Then the gross output and value added multipliers for sector X are defined as $\mathrm{d}GO_{X,t}/\,\mathrm{d}G_{X,t}$ and $\mathrm{d}VA_{X,t}/\,\mathrm{d}G_{X,t}$. Since I will estimate these multipliers in Section 3, it is of interest how these sector-level multipliers map into the policy relevant aggregate multiplier. When discussing the results below I pay particular attention to this relationship.

I next turn to two limiting approximations which allow me to solve for durable and nondurable multipliers analytically. The approximations require assumptions similar to those made above: I assume that β approaches unity and that the depreciation rate of capital δ_K tends to zero. The economy is then shocked with a short-lived increase in government purchases, X_G, in the small sector. To preserve space I limit myself to the discussion of these results and provide details on the derivations in Appendix A.2.

2.3.1 Spending on durable goods

I first consider the case in which the small sector produces highly durable goods.

Approximation result 1. *Suppose δ_K and δ_D are arbitrarily close to zero and β is arbitrarily close to* 1*. Then, for a short-lived increase in spending, it is approximately true that (1) $\Delta X_{H,t} \approx -\Delta X_{G,t}$, (2) the price $P_{X,t}$ remains unchanged, (3) the sectoral multipliers for gross output and value added are zero, $\frac{\mathrm{d}GO_{X,t}}{\mathrm{d}G_{X,t}} \approx \frac{\mathrm{d}VA_{X,t}}{\mathrm{d}G_{X,t}} \approx 0$, and (4) the aggregate multiplier is zero, $\frac{\mathrm{d}Y_t}{\mathrm{d}G_{X,t}} \approx 0$.*

Here Δ denotes the absolute deviation of a variable from steady state. Notice first that this result only requires the stated parametric assumptions. In particular, the result holds regardless of the functional forms of u and v and regardless of whether the small sector requires intermediates for production. The result is also independent of the degree of price stickiness (as long as prices are not perfectly sticky) and the precise specification of the monetary policy rule (equation 13).

Part (1) of the result states that every dollar spent by the government crowds out one dollar of private sector spending. If prices are not perfectly sticky, the small sector's supply curve is upward-sloping. Hence, a greater quantity would lead to a higher equilibrium price. In this limiting approximation, however, the private sector's demand for durable goods is perfectly elastic and any price increase would result in complete withdrawal from the market. Clearly, this cannot be an equilibrium outcome. Instead, the equilibrium quantity and price in the small sector both remain unchanged. This requires that private sector demand contracts dollar for dollar with greater government spending.

Since the equilibrium quantity in the small sector is unaffected by the fiscal expansion, the sectoral multipliers must be zero. It turns out that in this limiting case the aggregate multiplier is zero as well. The explanation of this result has three components. First, as noted above, the fiscal expansion has no effect on the small sector's output and therefore leaves factor demands unchanged. It follows that the household's factor income remains the same and that there are no spillovers to the large sector through the demand for intermediate inputs. The second effect concerns the government's financing of the rise in spending. Because the expansion is by assumption brief, its effect on life-time income through taxation is very small. In fact, the approximation procedure treats the change in life-time income as negligible. It then follows that households neither change their labor supply nor their overall consumption demand. Finally, notice that both prices P_X and P_Z remain unchanged. Hence greater government spending does not raise inflation or output and no adjustment is required for the nominal interest rate.

An important corollary of this approximation result is that fiscal multipliers need not be large

at the zero lower bound (ZLB). As, among others, Christiano, Eichenbaum, and Rebelo (2011) and Woodford (2011) show, the multiplier is large whenever the fiscal expansion leads to inflation, and these inflationary forces are not offset by a higher policy rate. At the ZLB, higher inflation reduces the real rate, stimulating private consumption and therefore resulting in a large fiscal multiplier. However, when the government purchases highly durable goods, private spending is crowded out and inflation barely rises. The mechanism of greater demand leading to greater inflation and greater inflation leading to even greater demand is therefore not triggered. As a result, the durables multiplier remains low.

While the multipliers for long-lived durable goods are small at the ZLB, this is not always true for durable goods with intermediate service lives. I return to this issue in Section 4.2 in which I provide a quantitative analysis of durables multipliers at the ZLB.

2.3.2 Spending on nondurable goods

I next turn to the case in which the small sector produces a nondurable good.

Approximation result 2. *Suppose $\delta_D = 1$, δ_K is arbitrarily close to zero and β is arbitrarily close to 1. Suppose further that prices are fully flexible, and that $u_{CD} = v_{XZ} = 0$. Lastly, there is an additional technical assumption of little economic relevance which I discuss in Appendix A.2. Then a short-lived increase in spending yields a gross output sectoral multiplier equal to*

$$\frac{\mathrm{d}GO_{X,t}}{\mathrm{d}G_{X,t}} \approx \frac{\left(1+\eta_X^{-1}\right)\chi^{-1} - \left(\alpha+\eta_X^{-1}\right)}{\sigma_D\left(\alpha+\eta_X^{-1}\right)\frac{X_H}{X} + \left(1+\eta_X^{-1}\right)\chi^{-1} - \left(\alpha+\eta_X^{-1}\right)}$$

and approximately equal sectoral value added and aggregate multipliers

$$\frac{\mathrm{d}VA_{X,t}}{\mathrm{d}G_{X,t}} \approx \frac{\mathrm{d}Y_t}{\mathrm{d}G_{X,t}} \approx \frac{1-\alpha}{\sigma_D\left(\alpha+\eta_X^{-1}\right)\frac{X_H}{X} + \left(1+\eta_X^{-1}\right)\chi^{-1} - \left(\alpha+\eta_X^{-1}\right)}.$$

Here, $\eta_X = \frac{v_X(N_Z,N_X)}{N_X v_{XX}(N_Z,N_X)}$. The relative price $P_{X,t}/P_{Z,t}$ rises in response to greater spending.

When the small sector produces a nondurable good, all three multipliers are positive. More precisely, they are bounded between zero and one — a feature common to neoclassical environments. Additionally, the sectoral value added multiplier and the aggregate multiplier are again approximately equal, implying that sectoral multipliers are of direct policy interest.

I next discuss how various parameters affect the multipliers. The main property that this paper emphasizes is the multipliers' dependence on the intertemporal elasticity of substitution σ_D. The greater σ_D the smaller the multipliers. As σ_D approaches infinity all three multipliers tend to zero — the same value that multipliers of highly durable goods take.

To understand the role of the remaining parameters, I consider two polar cases. Suppose first that no intermediates are required for production ($\chi = 1$). Then it is easy to show that all three multipliers approximately equal

$$\frac{1-\alpha}{1-\alpha+\sigma_D\left(\alpha+\eta_X^{-1}\right)\frac{X_H}{X}}.$$

This formula is identical to that in Hall (2009, p. 199). It illustrates clearly that the multiplier is increasing in the labor supply elasticity, η_X, and decreasing in the capital share, α, reflecting the fact that capital is a fixed factor in the short run.

I next turn to the opposite case in which $\chi \to 0$ so that the small sector almost exclusively uses intermediates in production. It then follows that the sectoral multiplier for gross output, $\frac{\mathrm{d}GO_{X,t}}{\mathrm{d}G_{X,t}}$, approaches unity while the sectoral multiplier for value added and the aggregate multiplier tend to zero. What is the intuition behind these results?

A gross output multiplier of unity implies that the small sector expands one-for-one with greater government demand. Since additional output is almost exclusively produced from intermediates, it is clear that value added in the small sector remains close to zero. It can also be shown that

$$\Delta M_{X,t} \approx -\left(\Delta I_{X,t} + \Delta I_{Z,t}\right),$$

so that purchases of intermediates crowd out investment in the large hybrid sector dollar for dollar. Hence, while the small sector expands one-for-one, this expansion has no effect on production in the large sector and total value added (GDP) remains unchanged. We therefore encounter a second instance in which the crowding out of durable goods with large intertemporal elasticity of substitution—in this case investment goods—implies a low multiplier.

Although this finding is certainly extreme and crucially relies on the assumption that the large sector's output can be used for investment, the approximation clearly illustrates how sectoral linkages affect fiscal multipliers: If government purchases, either directly or indirectly through inter-

mediate input linkages, raise the demand for durable goods, they largely crowd out private sector demand. If, in contrast, government purchases are targeted at nondurable goods, there is less crowding out and the multipliers are larger.

2.4 Numerical results

I next use an exact (linear) solution of the model to confirm that the durables multiplier is relatively small. Before proceeding, however, I modify the model slightly. In order to avoid the extreme crowding out effects that greater intermediate purchases cause in the large hybrid sector, I introduce investment adjustment costs. These adjustment costs reflect the fact that some intermediates are nondurable in nature and therefore have a less elastic demand function than those intermediates that are durable.

2.4.1 Calibration

The length of a period is a quarter and households discount the future with discount factor $\beta = 0.99$. The flow utility function is given by

$$u\left(C_t, D_{H,t}\right) = \left(1 - \frac{1}{\sigma}\right)^{-1} \left(\left[\omega \left(C_t\right)^{\frac{\rho-1}{\rho}} + \left(1-\omega\right)\left(D_{H,t}\right)^{\frac{\rho-1}{\rho}}\right]^{\frac{\rho}{\rho-1}}\right)^{1-\frac{1}{\sigma}}. \tag{18}$$

Consistent with the estimates in Hall (1988) and Cashin and Unayama (2012), I select an intertemporal elasticity of substitution σ of 0.25. In the baseline calibration, I further assume that the elasticity of substitution ρ between C and D_H is (arbitrarily close) to 1. I explore alternative values in robustness exercises. The preference weight ω is chosen so that value added in the small sector is one hundredth of total value added.

I assume that the disutility of labor is given by

$$v\left(N_{X,t}, N_{Z,t}\right) = \varphi_X \frac{\left(N_{X,t}\right)^{1+\frac{1}{\eta}}}{1+\frac{1}{\eta}} + \varphi_Z \frac{\left(N_{Z,t}\right)^{1+\frac{1}{\eta}}}{1+\frac{1}{\eta}}.$$

This specification implies that labor is immobile across sectors, an assumption I also relax in robustness exercises. I set the labor supply elasticity η to unity. This value is broadly consistent with recent suggestions in the literature (Kimball and Shapiro, 2008, Hall, 2009, Chetty et al.,

2011).[7]

Turning to the production side of the model, I choose $\alpha = 1/3$ as is standard in the literature. Consistent with an intermediate input share of roughly 55 percent in the 2007 Make and Use Tables, I calibrate χ to 0.45. Further, I set ε to 6, implying a steady state mark-up of 20 percent. In my choice of the the price stickiness parameters θ_X and θ_Z, I follow Gali (2008) and assume that both equal 2/3. The depreciation rates of both types of capital are set to 0.025, implying approximately a 10 percent annual depreciation rate. I show results for various alternative values of δ_D, including $\delta_D = 1$ so that the small sector produces a nondurable good.

In steady state, the government purchases one fifth of the output in the small sector. I calibrate the persistence ϱ_X of the spending process (10) to 0.75. This value implies that the fiscal expansion largely dissipates after eight quarters, mimicking the spending trajectory of the American Recovery and Reinvestment Act.[8] The monetary authority follows a simple Taylor rule, that is, I replace the general rule (13) by $i_t = \beta^{-1} - 1 + \phi_\pi \pi_t + \phi_Y \tilde{Y}_t$. Here, the tilde denotes percent deviation from steady state. In the baseline calibration I set $\phi_\pi = 1.1$ and $\phi_Y = 0$. Notice that this policy rule satisfies the Taylor principle, ensuring equilibrium determinacy as shown in Bullard and Mitra (2002). I consider a more hawkish parameterization of the Taylor rule in Appendix A.3.

Finally, I assume that capital investment at time t is subject to adjustment costs of the form

$$K_{j,t-1} \frac{\zeta_K}{2} \left(\frac{I_{j,t}}{K_{j,t-1}} - \delta_K \right)^2, \quad j \in \{X, Z\}.$$

In the baseline calibration, summarized in Table 1, ζ_K is set to 20. This value is slightly higher than the 17 chosen by Christiano, Eichenbaum, and Rebelo (2011) who base their calibration on Eberly, Rebelo, and Vincent (2008).

2.4.2 Simulation results

I next turn to the question how the economy's reaction to a government spending shock depends on the depreciation rate δ_D. I consider four different cases. First, I set $\delta_D = 1$ so that the small sector produces nondurables. Second, I set $\delta_D = 0.083$ — a value consistent with a 3 year service life. The Bureau of Economic Analysis (undated) estimates for example the service lives of tires

[7] Once ω and the remaining parameters are fixed, the values of φ_X and φ_Z do not affect equilibrium dynamics.

[8] The Congressional Budget Office estimates that 78 percent of total spending had occurred by September 2011 (see `https://www.cbo.gov/publication/42682`).

Table 1: Baseline calibration

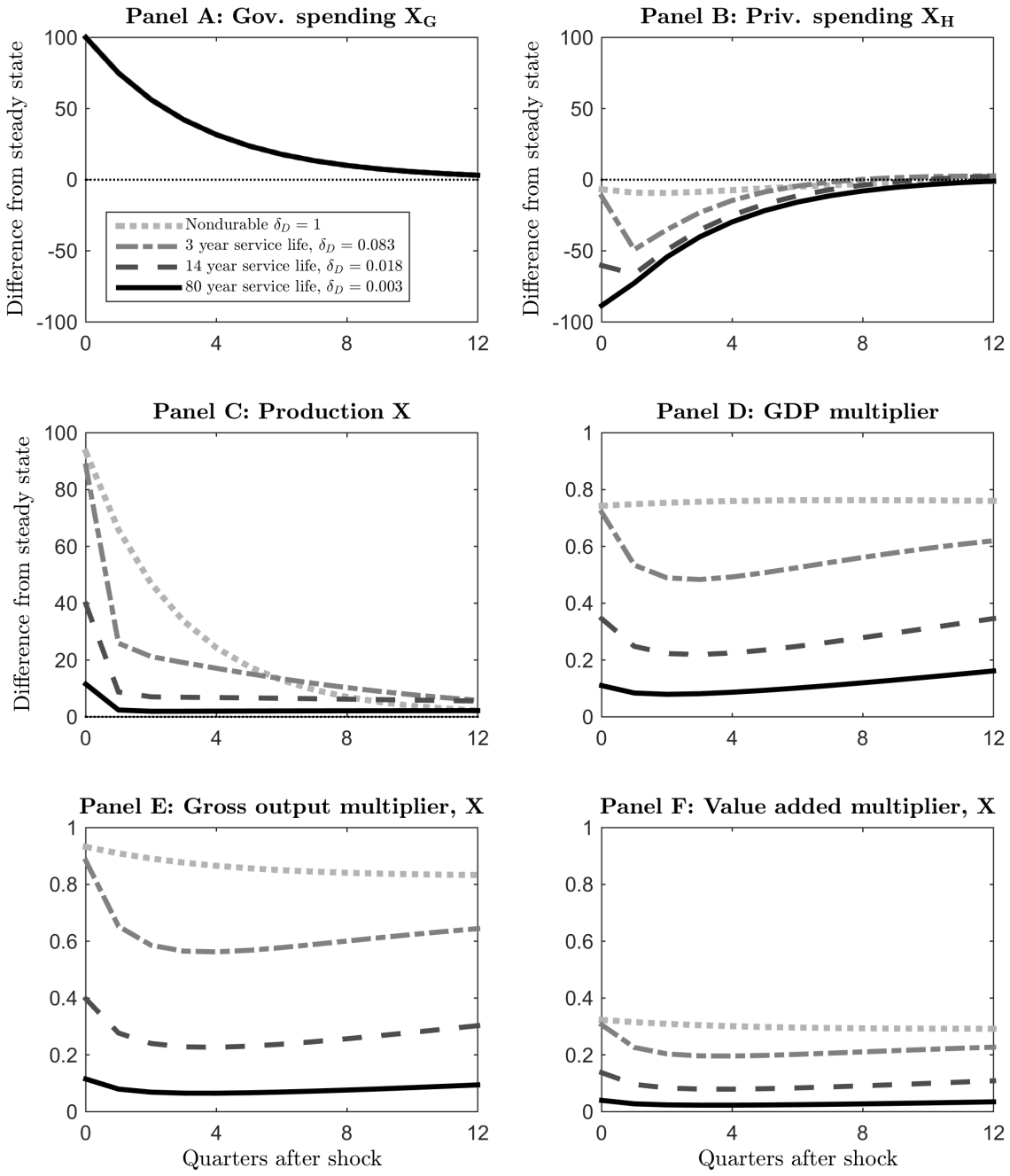
Parameter	Value	Description
β	0.99	Discount factor
η	1	Labor supply elasticity
σ	0.25	Intertemporal elasticity of substitution
ρ	0.9999	Elasticity of substitution between goods in the X and the Z sector
α	1/3	Capital share
χ	0.45	$1-\chi$ is the cost share of intermediates
ε	6	Elasticity of substitution in aggregator
θ_X, θ_Z	2/3	Price stickiness
δ_K	0.025	Depreciation rate of capital
X_H/X	0.80	Fraction of private sector spending in steady state
ω	0.9693	Preference weight on consumption of Z sector goods
ϱ_X	0.75	Persistence of fiscal policy shock
ϕ_π	1.1	Taylor rule response coefficient on inflation
ϕ_Y	0	Taylor rule response coefficient on output
ζ_K	20	Capital adjustment costs

and software at 3 years. Third, I select a value of $\delta_D = 0.018$. This value corresponds to a service life of 14 years (e.g. furniture). Lastly, I consider a very long-lived durable. According to the BEA, new 1-to-4-unit structures have service lives of 80 years, implying a quarterly depreciation rate of approximately $\delta_D = 0.003$. Figure 2 shows the impulse response functions of a 100 unit increase of government spending in the X sector.

Panel A displays the fiscal expansion in the public sector and Panel B shows the private sector response. If the small sector produces a nondurable good, private sector spending barely changes. Since there is very little crowding out, production expands almost one-for-one with public spending. This is shown in Panel C. The aggregate multiplier is near 0.75 (Panel D) and the gross multiplier in the X sector is close to unity (Panel E). If, in contrast, the small sector produces durable goods, the multipliers are much smaller.

The lower the depreciation rate the more private sector spending is crowded out. When the X sector produces a moderately durable good with a 3 year service life ($\delta_D = 0.083$), private sector spending falls substantially more after the spending shock. All multipliers — gross output, value added, and aggregate — fall to roughly two thirds of the nondurable goods multiplier. For a service life of 14 years, the multipliers fall to about 1/3 of the nondurables multiplier. As the depreciation

Figure 2: Impulse response functions for a government spending shock



Notes: The figure plots impulse response functions for various calibrations. Panels A to C are expressed in absolute deviations from steady state. The impulse is a 100 unit increase of government spending in sector X.

rate further approaches zero the multipliers gradually shrink to zero. The model therefore predicts that infrastructure investment that crowds out private sector construction has a very small fiscal multiplier of roughly 0.1.

These impulse response functions corroborate the results presented earlier: The demand for durable goods is highly elastic and easily crowded out. However, they yield one additional insight. Because all real variables of the model are stationary, they return to their steady state values in the long run. This model feature implies that any demand that is temporarily crowded out has to be made up in the long run as households replenish their stock of durables. In fact, Panel B shows that households' purchases of the durable goods rise above zero roughly 10 quarters after the shock.

An implication of this delayed demand boost is that the multipliers of durable goods begin to rise about 4 quarters after the shock. From the viewpoint of stabilization policy, it is an unfortunate fact that private demand picks up only after the fiscal expansion ends and the pressure on prices recedes. For short-lived spending shocks the economy will never enjoy increased government and private sector demand at the same time. I report the impulse response functions of the price in sector X and the nominal interest rate in Figure A1 in Appendix A.4.

I finally turn to the question of what sectoral multipliers teach us about aggregate multipliers. In the limiting approximations above, crowding out of capital investment was perfect and, as a result, the aggregate multipliers were equal to the sectoral value-added multipliers. However, when the depreciation rate of capital is higher and investment is subject to adjustment costs, as in the calibrations shown here, crowding out is imperfect. The aggregate multiplier is now greater than the sectoral value added multiplier. In fact, for all four calibrations shown in Figure 2, the aggregate multipliers lie above the sectoral value added multipliers and are quite similar to or somewhat below the gross output multipliers. As I show in Appendix A.3, the rule of thumb that the aggregate multipliers are slightly smaller than the sectoral gross output multipliers is robust for a number of alternative calibrations.

3 Empirical evidence

The main objective in this section is to test whether the data support the hypothesis that the durables multiplier is smaller than the nondurables multiplier. I begin the analysis using national

accounts data and find that the evidence supports the hypothesis. I then turn to an analysis at the industry level and again find evidence for smaller multipliers of durable goods purchases.

3.1 Evidence based on aggregate data

For the analysis of aggregate data, I adopt a specification similar to Hall (2009) and Barro and Redlick (2011), namely

$$\frac{Y_t - Y_{t-1}}{Y^T_{t-1}} = \alpha + \mu_X \frac{G_{X,t} - G_{X,t-1}}{Y^T_{t-1}} + \mu_C \frac{G_{C,t} - G_{C,t-1}}{Y^T_{t-1}} + \nu RN_t + \varepsilon_{t+1}. \tag{19}$$

In this equation Y_t is GDP, Y^T_t is trend GDP, $G_{X,t}$ is military spending on durable goods, $G_{C,t}$ is military spending on nondurable goods, and RN_t is Ramey's (2011) defense news variable. Ramey's news variable is constructed from narrative records and measures the present value of new military spending at the time of announcement. The variable mostly captures defense spending 3 to 5 years into the future and is expressed as a fraction of GDP.

I control for the announcement of future spending to isolate the effect of actual spending on durable and nondurable goods. According to standard theory, the announcement of greater future spending reduces households' life-time wealth and increases their labor supply. ν is therefore expected to be positive. The main reason for including this control is that announcements of future spending could be correlated with one of the spending variables but not the other. If, for example, the public learns about a military buildup at the same time as first investments into equipment are made, the estimate of μ_X would be biased upward without the control for news on future spending. Note that when μ_X and μ_C are estimated based on specification (19), the multipliers are purged of announcement effects and thus understate the total effect of military spending.[9]

Consistent estimation of the multipliers μ_X and μ_C requires the commonly made assumption that the state of the business cycle does not affect whether or not the U.S. engages in military conflict (e.g. Ramey and Shapiro, 1998, Hall, 2009, Nakamura and Steinsson, 2014). I use annual national accounts data for the estimation. Details are available in Appendix B.1.

Table 2 shows the results. The output multipliers are quite different for durable and nondurable goods. For the sample from 1929 to 2014 the estimate of μ_C is 0.49. When World War II is excluded,

[9] Based on the argument in Barro and Redlick (2011) the total size of the durables and nondurables multipliers should roughly be $\mu_X + 4 \cdot \nu$ and $\mu_C + 4 \cdot \nu$.

Table 2: Estimates of durable and nondurable goods multipliers

	Sample					
	1929-2014			1947-2014		
Dependent variable	μ_X	μ_C	ν	μ_X	μ_C	ν
Output	0.04	0.49	0.065	-1.19	0.83	0.041
	(0.32)	(0.08)	(0.011)	(2.24)	(0.43)	(0.007)
Private consumption	-0.63	0.02	0.024	-1.13	0.14	0.012
	(0.20)	(0.04)	(0.008)	(1.03)	(0.20)	(0.003)
Private investment	-0.89	0.00	0.032	-1.12	0.09	0.028
	(0.26)	(0.05)	(0.004)	(0.93)	(0.18)	(0.003)
Private consumption of	-0.54	0.03	0.022	-0.95	0.17	0.009
nondurables and services	(0.16)	(0.04)	(0.006)	(0.95)	(0.19)	(0.003)
Private investment plus	-0.98	0.00	0.034	-1.30	0.07	0.030
private durables consumption	(0.33)	(0.06)	(0.005)	(1.01)	(0.20)	(0.003)
Net exports	0.00	-0.05	-0.002	-0.23	0.01	-0.007
	(0.08)	(0.01)	(0.003)	(0.32)	(0.08)	(0.001)

Notes: The table reports the coefficient estimates of μ_X, μ_C, and ν as defined in equation (19). Newey-West standard errors are reported in parentheses.

the multiplier rises to 0.83. In contrast, the estimates of μ_X are close to zero or negative, supporting the theoretical predictions that durables multipliers are smaller than nondurables multipliers. Yet, the standard errors are too large to reject the null hypothesis that μ_C equals μ_X. As expected, the estimates of ν are positive.

I next replace GDP in the numerator on the left hand side of equation (19) with a number of other variables to estimate how government spending on durable and nondurable goods crowds out private sector spending. These are consumption, investment, consumption of nondurables and services, investment plus durable goods consumption, and net exports. It is striking how consistently the coefficient on nondurables is estimated to be essentially zero. Hence, there is little, if any, crowding out when the government purchases nondurable goods. There is, however, crowding out when the government purchases durable goods. For the sample from 1929 to 2014 the

estimate of μ_X is significantly negative for all four measures of private consumption and investment. The coefficients are near negative one for investment and investment plus durables consumption, suggesting that there is almost perfect crowding out. It is less clear how the negative coefficient on durables spending in the consumption equation should be interpreted. When consumption is limited to nondurables and services, the estimates of μ_X move slightly towards zero. Although this suggests that there is indeed more crowding out of durables consumption, the estimates of μ_X remain negative.

The model in section 2 suggests that the durables multiplier is small because the private sector substitutes intertemporally when the government raises spending. An alternative explanation is that the private sector substitutes towards imported goods. If this was the case, greater government spending should be accompanied by lower net exports and a smaller drop in investment. The last line in table 2 shows that the response of net exports is negligibly small. Hence, the data do not support the alternative hypothesis that the durables multiplier is small because of substitution towards foreign goods.

From 1972 onwards, the BEA provides a more detailed breakdown of military spending. Evidence based on this data again suggests that fiscal policy is less effective when the government purchases durable goods. I discuss data, estimation strategy and results in Appendix B.2 and next turn to evidence based on industry-level data.

3.2 Evidence based on industry-level data

In this section I estimate fiscal multipliers at the industry level: How much does industry output rise if the government spends 1$ on goods in this industry? Moving towards less aggregate data has the benefit of substantially raising the available data and therefore statistical power. As I will discuss below, this analysis has the additional advantage of relaxing the identifying assumption slightly. Yet, there is a mild cost: The policy relevant aggregate multipliers generally differ somewhat from the estimated industry-level multipliers. Since I established a close connection between these two types of multipliers in section 2, I view these costs as relatively small.

3.2.1 Data

The empirical analysis at the industry level is based primarily on two data sources, the NBER-CES Manufacturing Industry Database and the military prime contract files. The NBER-CES database contains annual data on, among other things, gross output, value added, cost of materials, expenditures on energy, and employment, along with various deflators. It ranges from 1958 to 2009 and covers all manufacturing industries. The database is constructed mainly from the Annual Survey of Manufactures and the Census of Manufactures, but complemented with additional information from the Bureau of Economic Analysis, the Bureau of Labor Statistics, and the Federal Reserve Board. A detailed description of this database is provided by Bartelsman and Gray (1996) and Becker, Gray, and Marvakov (2013).

The military prime contract files include information on all military prime contracts with values above the minimum threshold of $10,000 up to 1983 and $25,000 thereafter. They can be downloaded for the period from 1966 to 2003 from the U.S. National Archives. I complement the prime contract files with data from USAspending.gov, a government website dedicated to promoting transparency of federal spending. The data from USAspending.gov is available from 2000 onwards. A comparison of the two data sources for the overlapping years from 2000 to 2003 reveals only negligible differences. The analysis below is based on all contracts that are awarded to firms in the United States.

Unfortunately, the data on defense spending is not easily matched to different industries. While the NBER-CES database is available for both SIC- and NAICS-based industry definitions, the military prime contract files contain SIC codes only for the relatively brief period from 1989 to 2000 and NAICS codes from 2000 onwards. Instead, military purchases are classified according to the Federal Procurement Data System which assigns a unique Product Service Code (PSC) or Federal Supply Code (FSC) to each contract since 1966.

To obtain military spending at the industry level I construct a concordance from the FSC/PSC classification to 4-digit SIC codes. The concordance is based on the military prime contract files from 1989 to 2000 which contain both, FSC/PSC and SIC codes. Details on the construction of this concordance as well as further information on the data and the FSC/PSC classification system are available in Appendix C.1. Because the FSC/PSC system underwent a major revision in 1979, the concordance is only valid thereafter. This leaves me with a sample of annual data from 1979

to 2009. I adopt the SIC classification of durable and nondurable goods.[10]

3.2.2 Empirical strategy

Specification

I first estimate impulse response functions using Jordà's (2005) local projection method and then construct multipliers from the estimated impulse response functions. The baseline specification is

$$\frac{Y_{i,t+h} - Y^T_{i,t-1}}{VA^T_{i,t-1}} = \alpha_h \frac{G_{i,t} - G^T_{i,t-1}}{VA^T_{i,t-1}} + \beta_h \frac{Y_{i,t-1} - Y^T_{i,t-2}}{VA^T_{i,t-2}} + \gamma_h \frac{G_{i,t-1} - G^T_{i,t-2}}{VA^T_{i,t-2}} + \delta_{i,h} + \zeta_{t,h} + \varepsilon_{i,t+h}, \qquad (20)$$

for $h = 0, 1, ..., 4$. In this equation $Y_{i,t}$ is a generic variable of interest of industry i at time t, $G_{i,t}$ is defense spending, and $VA_{i,t}$ is value added. The superscript T indicates that the variable in question is an HP-filtered trend.

I estimate equation (20) separately for durable and nondurable goods industries to obtain the objects of interest $\{\alpha_h\}_{h=0}^4$. These parameters represent the impulse response coefficients for the impact year, $h = 0$, and four subsequent years. The specification controls for the deviations of the dependent variable and defense spending from trend, lagged once, as well as time and industry fixed effects $\delta_{i,h}$ and $\zeta_{t,h}$.

The time fixed effect plays a key role in specification (20). It soaks up disturbances that affect all industries symmetrically, notably monetary policy shocks and certain tax policy changes. Additionally, the time fixed effect controls for announcements of greater future spending, at least to the extend that all sectors are affected equally. Notice that since I estimate equation (20) separately for durable and nondurable goods industries all coefficients are allowed to differ by type of industry.

One concern with specification (20) is that the impulse response coefficients $\{\alpha_h\}_{h=0}^4$ depend on the smoothness of the trends required for constructing the left and right-hand side variables. To err on the safe side I extract very smooth trends with a smoothing parameter of 1600 for annual data. I also test the robustness of my results for alternative values of this parameter.

As Nekarda and Ramey (2011) discuss in detail, an industry-level analysis of government spending may suffer from an endogeneity problem. Technological progress in a particular industry can lead both to greater sales to the private sector and to increased defense spending as the military upgrades its equipment. The bias resulting from the estimation of (20) by OLS would inflate the

[10] For a detailed discussion of the military prime contract data see Nakamura and Steinsson (2014).

impulse response coefficients above their true levels.

On the other hand, measurement error in defense spending may bias the coefficients towards zero. Measurement error is a concern for the following reason. In the military prime contract files, every contract is assigned a single FSC/PSC code. The documentation of the files reveals occasional difficulties of the procurement staff to select a single code, as some contracts include purchases of different types of goods.[11] Although the staff is instructed to assign the FSC/PSC code whose description best fits the contract, it is likely that the limitation to one code per contract induces measurement error. A second source of error is the use of the concordance to map FSC/PSC codes to SIC industry definitions.

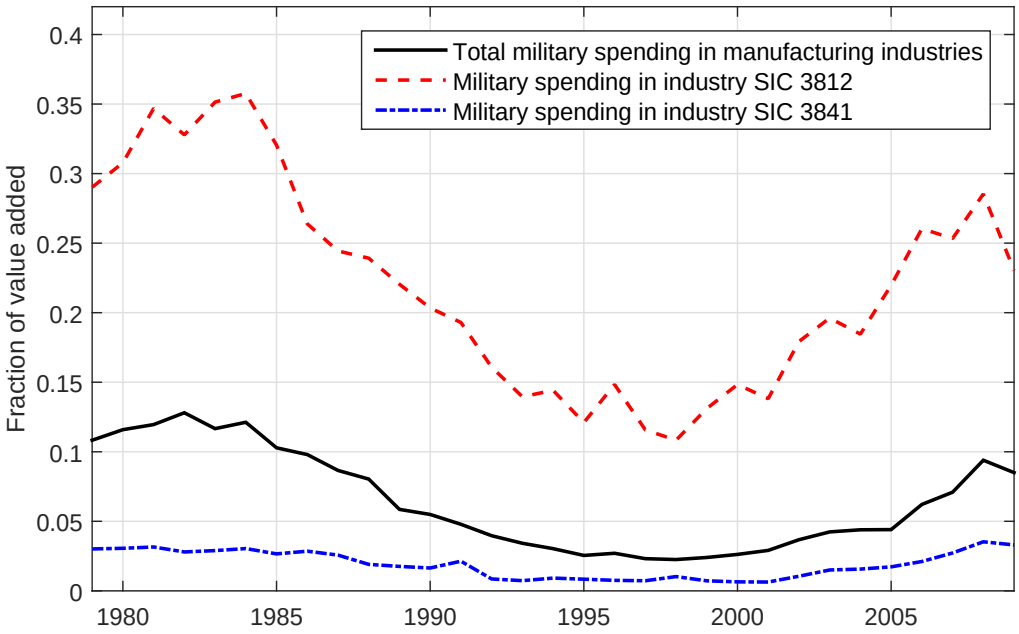
Identification strategy

To avoid or reduce these biases I construct instruments from total defense spending (spending summed over all manufacturing industries) similar to Nakamura and Steinsson (2014). More precisely, the identification strategy is based on the fact that industries experience different increases in demand when aggregate military spending expands. For example, when aggregate defense spending as a fraction of value added rises one percentage point above its trend, spending in SIC industry 3812 (Search, Detection, Navigation, Guidance, Aeronautical, and Nautical Systems and Instruments) rises, on average, by 2.98 percentage points. In contrast, spending in industry 3841 (Surgical and Medical Instruments and Apparatus) increases only by 0.29 percentage points. This is illustrated in Figure 3.

The observation that military buildups raise spending differentially across industries suggests to construct instruments by interacting the deviation of aggregate spending from trend with a dummy for each industry. When using the two-stage least squares (2SLS) estimator, aggregate spending can then affect industry-level spending differentially in the first stage. Of course, both, $\left(G_{i,t} - G^T_{i,t-1}\right)/VA^T_{i,t-1}$ and $\left(G_{i,t-1} - G^T_{i,t-2}\right)/VA^T_{i,t-2}$ in equation (20) are potentially endogenous. Letting G_t and VA^T_t denote military spending and the trend of value added summed over all manufacturing industries I therefore use $\left(G_t - G^T_{t-1}\right)/VA^T_{t-1}$ and its lag, both interacted with industry dummies, as instruments. The identifying assumption is then that the relative performance of industries does not affect whether the U.S. government engages in an aggregate military buildup.

[11] For example, guns, up to 30mm (FSC 1005) and guns, over 30mm up to 75mm (FSC 1010) are two separate categories. It is conceivable that purchases of both types of guns were part of the same contract.

Figure 3: Industry-level responses to a military buildup.



Notes: SIC industry 3812 produces search, detection, navigation, guidance, aeronautical, and nautical systems and instruments while industry 3841 produces surgical and medical instruments and apparatus.

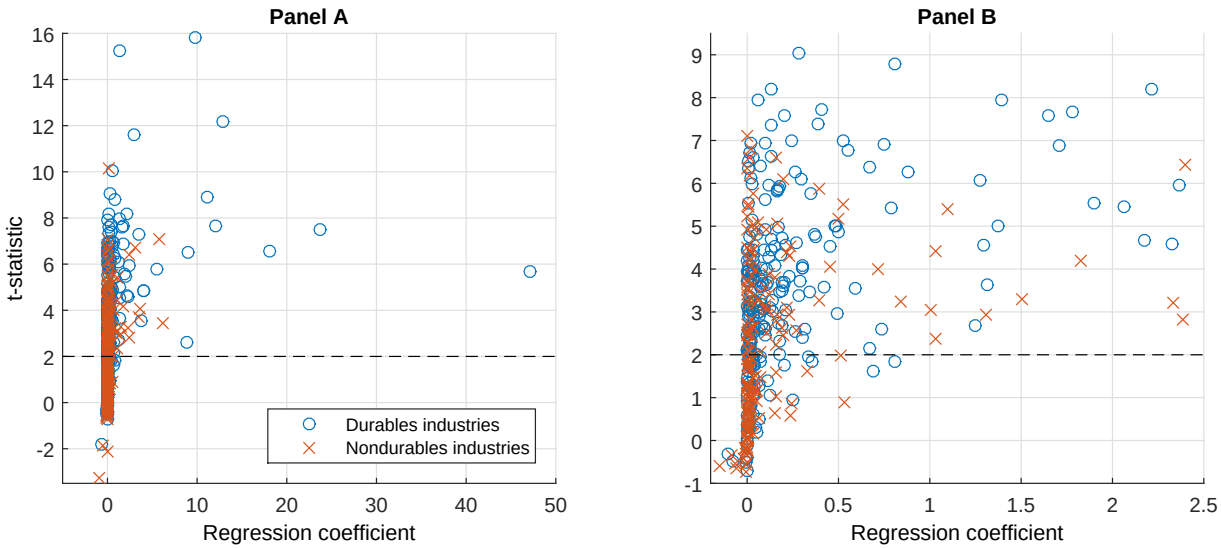
To illustrate the instruments' predictive power, I estimate the regression

$$\frac{G_{i,t} - G^T_{i,t-1}}{VA^T_{i,t-1}} = \alpha_i + \beta_i \frac{G_t - G^T_{t-1}}{VA^T_{t-1}} + u_{i,t}, \tag{21}$$

for each industry i. Figure 4 plots the estimates of β_i and their t-statistics. Blue circles represent durable goods industries and red crosses represent nondurable goods industries. While Panel A shows the full range of slope estimates and t-statistics, Panel B limits the range of the axes and zooms in on the dense cloud of points. In 296 out of 444 industries with strictly positive defense spending in all years, the t-statistic is greater than 2. Among these 296 industries are 200 durable goods industries and 96 nondurable goods industries. 91 out of the 148 industries with t-statistics smaller than 2 produce nondurable goods.

Figure 4 confirms the presence of substantial identifying variation for the impulse response coefficients in durable goods industries. Two sectors, Tanks and Tank Components (SIC 3795) and

Figure 4: Sensitivity to and explanatory power of the instrument



Notes: The figure plots the estimates of β_i in equation (21) and their t-statistic. Each circle or cross represents one industry. While Panel A shows the full range of estimates and t-statistics, Panel B zooms in on the denser part of the distribution.

Ammunition, except for Small Arms (SIC 3483), have slope coefficients greater than 20. Additionally, 46 industries have t-statistics greater than 2 and slope coefficients greater than 1. On the other hand, identifying variation is somewhat less plentiful for nondurable goods industries. The largest slope coefficient is 6.21 (SIC 2385, Waterproof Outerwear). A total of 15 nondurable goods industries have t-statistics greater than 2 and slope coefficients greater than 1.

When constructing the baseline sample, I am confronted with a trade-off between strong instruments and a representative sample. When including all industries, the sample is representative for all of U.S. manufacturing. However, the instrument is weak for about one third of all industries. Alternatively, I can construct the baseline sample only from industries with t-statistics greater than, say, 2. This ensures strong instruments, but the sample is no longer representative for all of U.S. manufacturing. In the baseline analysis I choose to drop industries with t-statistics smaller than 2. Examples of dropped industries include women's clothing, toys, greeting cards, dog and cat food, jewelery, and intermediate inputs such as fertilizers. Table C5 in Appendix C provides details. To show that my findings do not depend on the exact value of this threshold, I conduct a number of robustness checks.

I limit the sample further by excluding industries with little private sector demand. These industries are problematic for testing the hypothesis of smaller multipliers for spending on durable goods because with little private sector demand to begin with, there is little room for crowding out. In the complete absence of private sector demand, the theory discussed above does not apply and the sectoral multiplier should be unity regardless of whether the sector produces durable or nondurable goods. For the baseline sample, I therefore drop industries with average values of military purchases per industry gross output of greater than 0.35. Imposing this threshold and dropping industries for which data is incomplete over the sample period leaves the number of nondurable goods industries unchanged at 96, but reduces the number of durable goods industries to 188. For instance SIC industry 3795 (Tanks and Tank Components) is excluded due to little private sector demand. I provide more information on the sample in Appendix C.2.

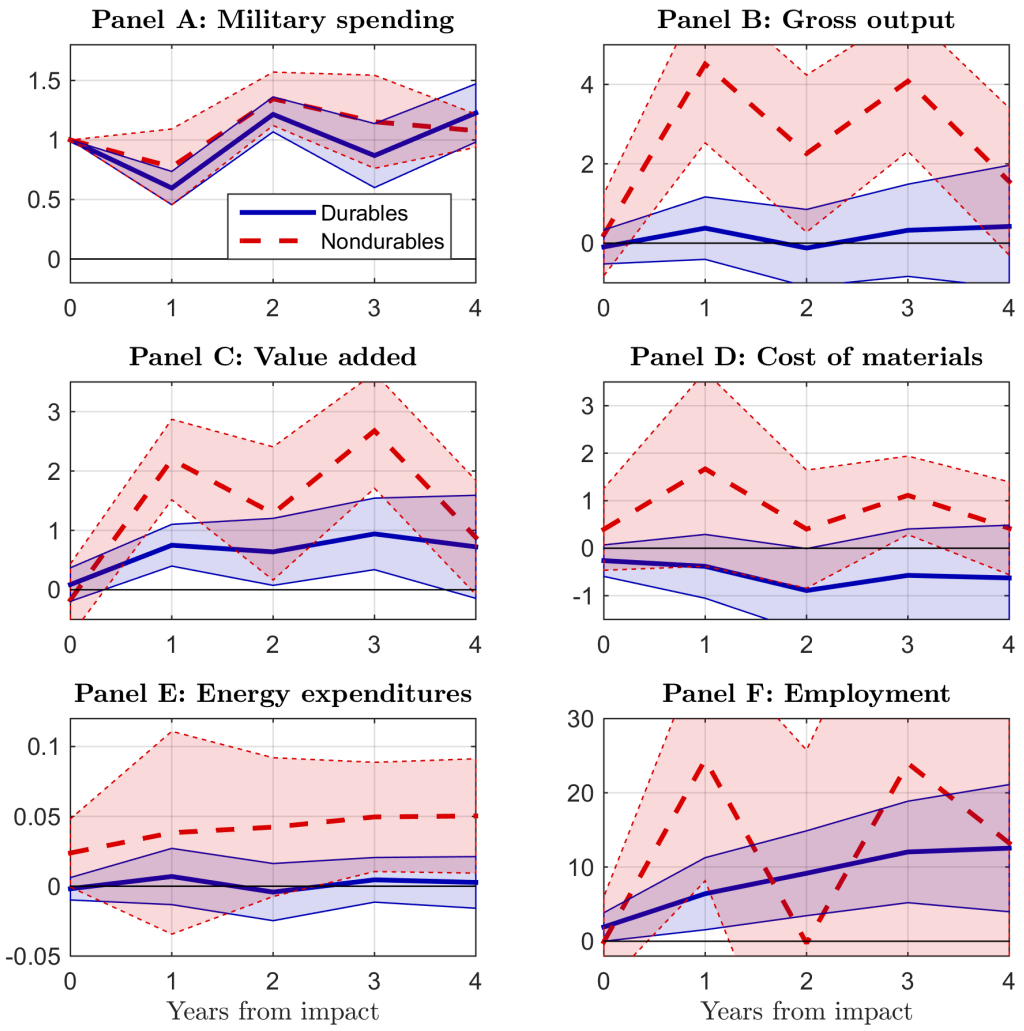
3.2.3 Results

Figure 5 shows the estimated impulse response functions for the baseline sample. A unit increase in military spending leads to additional spending in subsequent years (Panel A). The impulse response functions for both types of industries begin to fall in year five and return to zero 7 years after the shock (see Figure C2, Appendix C.3). Hence, the spending increase is more persistent than a typical stimulus program such as the ARRA. I show in Appendix A.3 that the model predicts a difference of factor two between the nondurables and the durables multiplier for shocks with this persistence.

Panel B shows the dynamic responses of gross output associated with these spending paths. Consistent with the hypothesis of greater crowding out in durable goods industries, gross output is barely affected and insignificantly different from zero. In contrast, nondurables industries expand substantially in response to greater spending.

Panel C shows the responses of value added. In both types of industries value added rises significantly above zero and, again, the dynamic response for durables industries lies below that for nondurables industries. Additionally, in nondurables industries the rise in valued added is accompanied by increased purchases of materials and energy (Panels D and E), although the standard errors are fairly large. By contrast, material and energy expenditures change little in durables in-

Figure 5: Impulse response functions for durable and nondurable goods



Notes: The figure plots impulse response functions for the baseline sample estimated using specification (20). See text for a description of the baseline sample. The shock is a unit increase of government spending above trend, normalized by the industry's value added. For production employment the impulse is a $1 million increase in military spending and the response is expressed as the number of additional employees. Shaded regions mark 90 percent confidence bands based on standard errors that are clustered at the industry level.

dustries.[12] Finally, Panel F shows the employment responses. While the impulse response function for nondurables industries exceeds, on average, that for durables industries, the standard errors are too large to allow for a conclusive statistical comparison.[13]

[12] Value added and cost of materials roughly sum to the gross output.

[13] I report estimates of impulse response functions for prices in Appendix C.3.1.

For the interpretation of the impulse responses in the impact period note that military spending by industry is constructed by aggregating the value of all contracts in a given year. I use the date on which the contract is signed for this aggregation. My dataset has no information on the date of actual payments. Panels B to F all suggest that there is little effect at the time the contract is signed, but only in subsequent years.

Taken together, nondurable goods industries respond strongly to increased defense spending while the reaction of durable goods industries is quite moderate. These findings are consistent with the theory described above, suggesting that indeed there is little crowding out in nondurable goods industries but substantial crowding out in durables industries.

I next compute the sectoral multipliers as the cumulative change in the outcome variable divided by the cumulative change in spending. Based on the model from the previous section and taking into account that military buildups typically have greater persistence than stabilizing interventions, I expect that the durables multiplier has about half the size of the nondurables multiplier.

Table 3 summarizes the estimated multipliers for time horizons of 1 to 3 years after the shock. The table confirms that multipliers for all five variables, gross output, value added, cost of materials, energy expenditures, and employment are uniformly larger in nondurable goods sectors. Notice that the employment multiplier is expressed as employees per year per $1 million dollar of spending.

The finding that multipliers are larger in nondurable goods industries is consistent with the simple theory presented above. However, the theory also implies that sectoral multipliers should lie between zero and one. In particular, the large multipliers for gross output in nondurables industries are inconsistent with this prediction. I examine several possible explanations for these large estimates.[14]

One possibility is that anticipation of future spending leads industries to expand prior to actual spending. To address this concern I add Ramey's (2011) defense news variable interacted with industry indicators to specification (20). Since the results, shown in Appendix C.4.1 Table C6, are similar to those from the baseline specification, anticipation effects do not explain the large multipliers. A second possibility is that the time fixed effects do not fully control for monetary policy. The reason is that the interest sensitivity increases with the length of the service lives of

[14]Unlike the multipliers for gross output, value added, and cost of materials, the employment multiplier is fairly small relative to other estimates in the literature. Chodorow-Reich et al. (2012), for instance, estimate employment multipliers that are roughly three times as large.

Table 3: Sectoral multipliers in durable and nondurable goods industries

	Durable goods			Nondurable goods		
Years after shock	1	2	3	1	2	3
Gross output	0.18	0.06	0.13	2.66	2.24	2.59
	(0.61)	(0.58)	(0.60)	(0.69)	(0.76)	(0.84)
Value added	0.52	0.52	0.66	1.14	1.06	1.40
	(0.34)	(0.31)	(0.33)	(0.33)	(0.35)	(0.37)
Cost of materials	-0.40	-0.55	-0.57	1.17	0.79	0.84
	(0.38)	(0.36)	(0.37)	(0.47)	(0.51)	(0.54)
Energy expenditures	0.003	0.000	0.001	0.035	0.033	0.036
	(0.021)	(0.018)	(0.019)	(0.024)	(0.026)	(0.027)
Employment	5.21	6.22	8.02	13.75	7.73	11.26
(employees per year per $1m)	(4.13)	(3.77)	(3.78)	(6.71)	(7.53)	(8.34)

Notes: The table reports the cumulative multipliers for various outcome variables. Multipliers for gross output, value added, cost of materials, and energy expenditures have the usual interpretation of one additional dollar in the outcome variable per additional dollar of military spending. The multiplier for production employment is expressed as the number of employees per year per $1 million of military spending. Standard errors for durable and nondurable goods multipliers are obtained via bootstrapping with 500 (1000) bootstrap samples and reported in parentheses.

goods, and service lives vary across industries. When controlling for the real interest rate interacted with industry indicators, however, the results barely change (Table C7).

An additional concern is that the two stage least squares (2SLS) estimator can be biased when many instruments are used.[15] To test whether my analysis suffers from this many-instruments problem, I perform two additional robustness exercises. First, I estimate the impulse response functions on a much more restrictive sample for which the instruments are surely strong. Second, I use a Bartik-type instrument (Bartik, 1991). In both cases the estimates are similar in magnitude. Hence, neither the conclusion that durables multipliers are smaller than nondurables multipliers changes, nor does a many-instruments bias explain the large nondurable goods multipliers. I report the results and further details on these robustness exercises in Appendix C.5.[16]

[15] Accessible discussions of many instruments problems can be found in Imbens (2010) and Angrist and Pischke (2008).

[16] In light of the findings of Judson and Owen (1997), the problems arising from dynamic panel estimation with

A third possibility is that input-output linkages of industries lead to a bias. If firms in a particular industry use inputs from other firms in the same industry, shipments and cost of materials will be counted multiple times. The Use Tables of various years suggest that 10 percent is a conservative estimate of the share of intra-industry shipments. Under this assumption, one dollar of final sales is counted $1/(1-0.1) \approx 1.11$ times. Although this bias is surely present, it is too small to explain multipliers of 2 and above.[17] Furthermore, intra-industry shipments cannot explain the large multipliers for value added.[18] My estimates therefore strongly suggest that durable goods multipliers are substantially smaller than nondurable goods multipliers. Additional robustness exercises are available in Appendix C.6.

4 Durable goods and state dependence

Recent research on fiscal policy has emphasized that rather than a constant, the multiplier is a function that depends on the state of the economy. Two forms of state dependence have received particular attention. First, the multiplier may depend on the state of the business cycle, that is, it depends on whether economic activity is above or below trend (e.g. Auerbach and Gorodnichenko, 2012, 2013). Second, the fiscal multiplier may be larger when the nominal interest rate is pinned at the zero lower bound (e.g. Christiano et al., 2011, Woodford, 2011, Werning, 2011, and Farhi and Werning, 2012). In this section I explore how the durable goods multiplier depends on the state of the economy.

4.1 The state of the business cycle

One form of the state dependence hypothesis holds that the multiplier is greater in economic slumps than in booms. Since factors of production are underutilized in slumps, firms can raise

fixed effects are also unlikely to give rise to a bias of this size.

[17] A similar problem arises from intra-firm, inter-plant shipments. Atalay, Hortacsu, and Syverson (2014) report that 16 percent of shipments occur within the firm.

[18] The large multipliers could also be explained if actual defense spending was greater than that recorded in the data. As noted above, the minimum threshold for contracts to be recorded in the data is 25 thousand dollars for the majority of the sample. Since I have data on contracts between 10 and 25 thousand dollars prior to 1983 and after 2005, I impute the value of these contracts by linearly interpolating the share of contracts with values between 10 and 25 thousand dollars. Hence, I am only systematically missing contracts below 10 thousand dollars. In the most recent years, the data from USAspending.gov contain these small contracts as well. However, their value is very small relative to the larger contracts — around 2.5 percent of total spending for both durable and nondurable goods industries in the sample.

inputs without substantially driving up marginal costs. Supply curves are therefore more elastic in slumps, mitigating crowding out of private sector spending. A version of this idea has recently been formalized by Michaillat (2014).

Applying the rationale of state dependence to an environment with multiple sectors suggests that those sectors with greater output variation over the business cycle should experience greater state dependence. As is well-known, the most cyclical sectors are those producing durable goods. Based on a sample from 1953 to 1996, Stock and Watson (1999) report standard deviations of 0.64 for service consumption, 1.11 for nondurables consumption, 4.66 for durables consumption, and 10.04 for residential investment. Hence, one would expect that the durables multiplier is particularly dependent on the state of the business cycle.

I next test this form of state dependence by estimating impulse response functions separately for recessions and expansions. Because insufficient variation of spending in nondurable goods sectors prohibits accurate inference, I estimate impulse response functions for durable goods industries only. The sample consists of the same 188 durables industries that were used in the estimation above.

I adopt a specification similar to Auerbach and Gorodnichenko (2013),

$$\begin{aligned}\frac{Y_{i,t+h}-Y^T_{i,t-1}}{VA^T_{i,t-1}} &= \alpha^R_h F_{i,t-1}\frac{G_{i,t}-G^T_{i,t-1}}{VA^T_{i,t-1}}+\alpha^E_h\left(1-F_{i,t-1}\right)\frac{G_{i,t}-G^T_{i,t-1}}{VA^T_{i,t-1}}+\beta^R_h F_{i,t-1}\frac{Y_{i,t-1}-Y^T_{i,t-2}}{VA^T_{i,t-2}}\\ &+\beta^E_h\left(1-F_{i,t-1}\right)\frac{Y_{i,t-1}-Y^T_{i,t-2}}{VA^T_{i,t-2}}+\gamma^R_h F_{i,t-1}\frac{G_{i,t-1}-G^T_{i,t-2}}{VA^T_{i,t-2}}\\ &+\gamma^E_h\left(1-F_{i,t-1}\right)\frac{G_{i,t-1}-G^T_{i,t-2}}{VA^T_{i,t-2}}+\eta_h F_{i,t-1}+\delta_{i,h}+\zeta_{t,h}+\varepsilon_{i,t+h}. \qquad (22)\end{aligned}$$

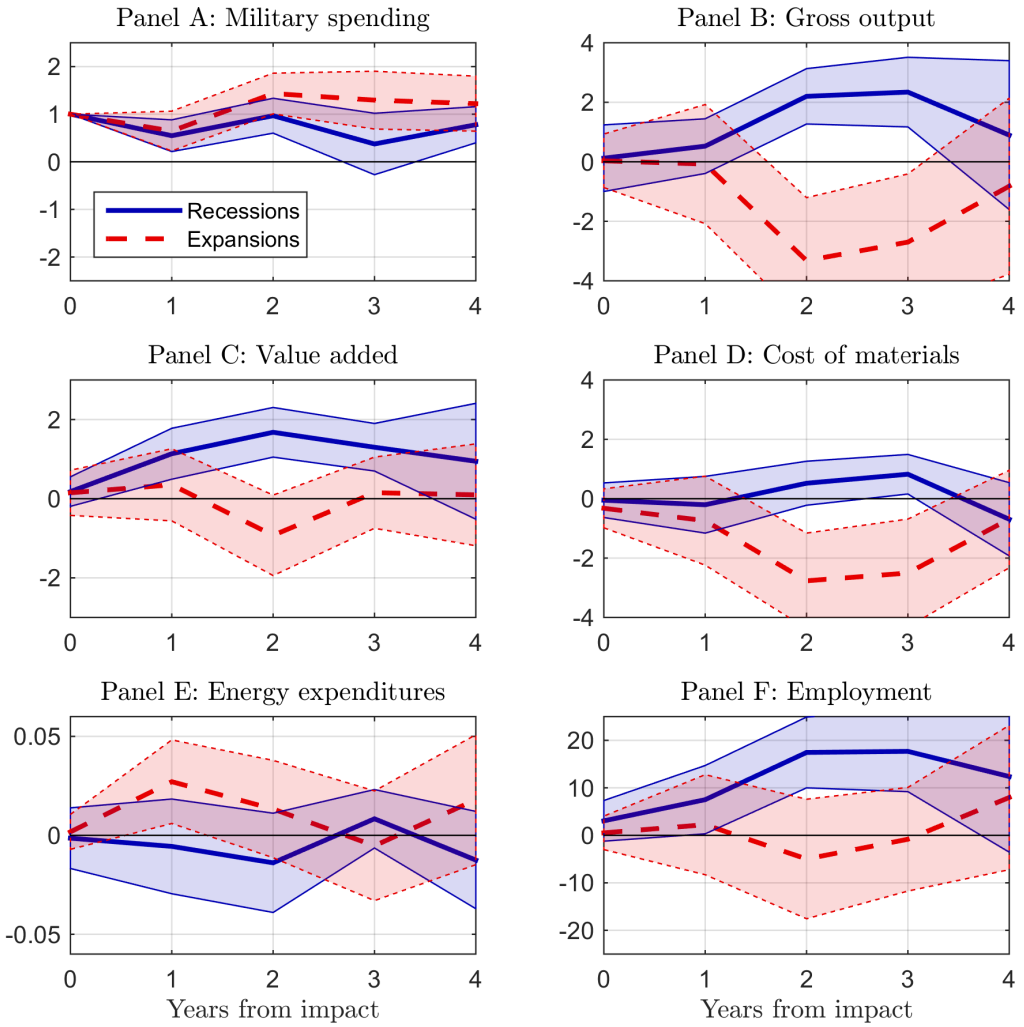
In this equation

$$F_{i,t}=\frac{\exp\left(-\kappa\cdot VA^C_{i,t}\right)}{1+\exp\left(-\kappa\cdot VA^C_{i,t}\right)},\ \kappa>0,$$

and $VA^C_{i,t}$ denotes the demeaned and standardized cycle component of HP-filtered value added in sector i.[19] $F_{i,t}$ measures the "degree" to which industry i's value added is below trend (in recession). It varies between zero and one and takes greater values whenever the industry's value added is low. Hence, the empirical model (22) permits estimation of impulse response functions separately for recessions ($F_{i,t}=1$) and expansions ($F_{i,t}=0$). These impulse response functions are given by $\{\alpha^R_h\}^4_{h=0}$ and $\{\alpha^E_h\}^4_{h=0}$. Parameter κ is set to 1.5 which implies that the economy spends

[19] I use a smoothing parameter of 1600.

Figure 6: Impulse response functions for durable goods in recessions and expansions



Notes: The figure plots impulse response functions for the durable goods industries of the baseline sample estimated using specification (22). See Section 3 for a description of the baseline sample. The shock is a unit increase of government spending above trend, normalized by the sector's value added. For employment the impulse is a $1 million increase in military spending and the response is expressed as the number of additional employees. Shaded regions mark 90 percent confidence bands based on standard errors that are clustered at the industry level.

about 20 percent of the time in recessions — a value consistent with U.S. business cycle facts. For more details see Auerbach and Gorodnichenko (2012, 2013). Notice finally, that I include $F_{i,t-1}$ as a control variable. By doing so, I allow the left-hand side variable to directly depend on the state of the economy.

Figure 6 shows the impulse response functions starting with military spending in Panel A. A

spending shock in recessions is followed by somewhat lower subsequent spending than a spending shock in expansions. There is remarkably strong evidence for greater multipliers in recessions. The impulse response functions for gross output (Panel B) and cost of materials (Panel D) rise in recessions and *fall* in expansions. Additionally, value added (Panel C) and employment (Panel F) increase in recessions but show no significant reaction in expansions. Notice that the dynamic responses diverge only 2 years after the shock. This delay is likely due to the long latency period between signing of the contract and its implementation. Energy expenditures display no clearly distinct pattern in recessions and expansions (Panel E).

Table 4 shows the associated multipliers. It confirms large differences in the effectiveness of fiscal policy in recessions and expansions. Two years after the shock the value added and gross output multipliers both exceed unity when the increase in spending occurs in recessions. In contrast, their estimates in expansions become negative. Although imprecisely estimated, the employment multipliers also indicate greater effectiveness of fiscal policy in recessions. Taken together, this evidence suggests that spending on durable goods is much more effective in recessions.[20] I discuss the robustness of these results in Appendix C.5.1.

4.2 The zero lower bound

I next analyze the sizes of durables and nondurables multipliers in an economy in which the zero lower bound (ZLB) on the nominal interest rate binds. As I showed in Section 2.3.1, for very low depreciation rates the multiplier for durable goods is small regardless of the monetary policy response. For moderate depreciation rates, however, the multiplier can be larger when the ZLB binds.

To study fiscal policy at the ZLB, I modify the model from Section 2 in two ways. First, I replace the monetary policy rule (13) with

$$i_t = \max\{0, \beta^{-1} - 1 + \phi_\pi \pi_t + \phi_Y \tilde{Y}_t\},$$

where $\phi_\pi = 1.1$ and $\phi_Y = 0$. Second, I assume that the discount factor follows the AR(1) process

$$\beta_t = (1 - \varrho_\beta)\,\beta + \varrho_\beta \beta_{t-1} + \varepsilon_{\beta,t}. \tag{23}$$

[20] These findings differ markedly from Berger and Vavra (2014).

Table 4: Sectoral multipliers for durable goods in recessions and expansions

	Recessions			Expansions		
Years after shock	1	2	3	1	2	3
Gross output	0.42	1.13	1.80	-0.03	-1.09	-1.39
	(0.59)	(0.59)	(0.71)	(0.97)	(1.04)	(1.04)
Value added	0.85	1.19	1.49	0.30	-0.14	-0.06
	(0.31)	(0.29)	(0.36)	(0.49)	(0.53)	(0.54)
Cost of materials	-0.16	0.11	0.38	-0.65	-1.24	-1.45
	(0.40)	(0.36)	(0.40)	(0.59)	(0.63)	(0.62)
Energy expenditures	-0.005	-0.008	-0.004	0.018	0.014	0.008
	(0.020)	(0.019)	(0.021)	(0.034)	(0.032)	(0.029)
Employment	6.82	11.13	15.81	1.68	-0.72	-0.70
(employees per year per $1m)	(4.15)	(3.88)	(4.38)	(6.43)	(6.35)	(6.04)

Notes: The table reports the cumulative multipliers for various outcome variables. Multipliers for gross output, value added, cost of materials, and energy expenditures have the usual interpretation of one additional dollar in the outcome variable per additional dollar of military spending. The multiplier for production employment is expressed as the number of employees per year per $1 million of military spending. Standard errors are bootstrapped with 200 bootstrap iterations.

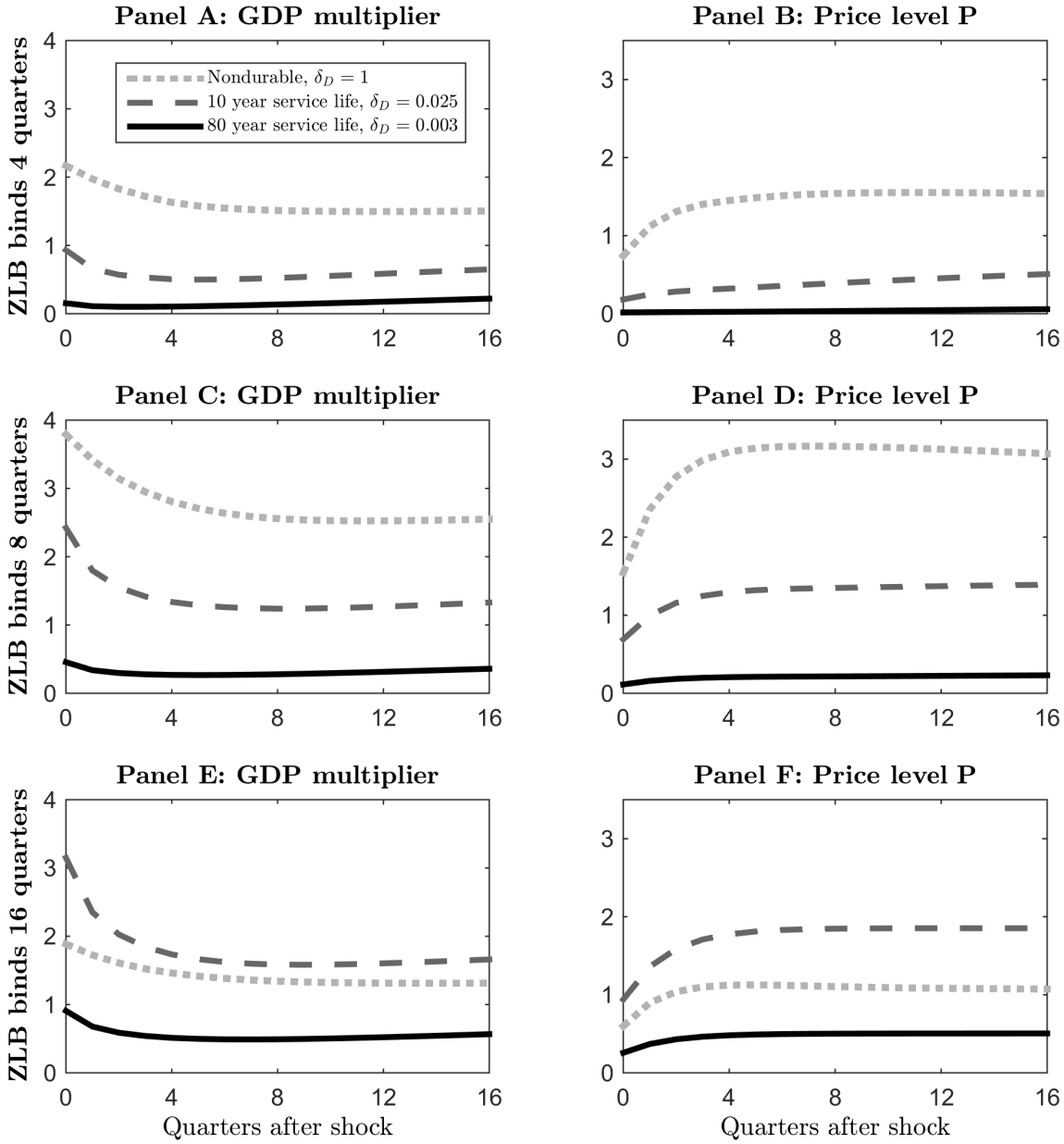
The remaining model equations and the calibration remain unchanged.

I consider the following scenario. Prior to time 0, the economy is subject to a positive discount factor shock so that the ZLB begins to bind. The government then raises spending on X by 100 basis points at time 0. I choose the persistence of the discount factor shock ϱ_β to imply that the ZLB continues to bind for 4, 8, and 16 quarters beginning at time 0. The persistence of the spending shock is as in the baseline calibration, $\varrho_X = 0.75$. I assume that the government spending shock is sufficiently small to never lift the economy out of the ZLB regime. The fiscal multiplier is then computed from the incremental output response to the shock in government spending.[21]

Figure 7 shows the multipliers together with the impulse response functions of the price level P. When the ZLB binds for 4 quarters (Panels A and B), the multiplier for nondurable goods

[21] More precisely, the impulse response functions are computed as the difference between the response with the fiscal policy shock and that without the fiscal policy shock. The resulting price dynamics are therefore entirely caused by the spending and not the discount factor shock.

Figure 7: Model impulse response functions



Notes: The figure fiscal multipliers and impulse response functions for various depreciation rates. Prior to time 0, the household's discount factor is first shocked so that the ZLB begins to bind. The persistence of the shock is chosen to imply that the ZLB binds for 4, 8, and 16 quarters beginning at time 0. At time 0 the government raises spending on X by 100 basis points. The impulse response functions for prices are expressed in relative deviations from steady state and the units are basis points.

is slightly below 2. The multiplier is smaller when the government purchases goods with greater durability. For durables with 10 year service lives the multiplier is below unity and for durables with 80 year service lives the multiplier is below 0.3. Hence, for a short period of 4 quarters at the ZLB the ordering of multipliers remains unchanged, but they are larger than when the central bank offsets the expansion by raising the interest rate.

At the ZLB greater government spending raises inflation and thereby lowers real interest rates. Lower real rates, in turn, crowd in private sector spending. Hence, to understand the size of the fiscal multiplier at the ZLB, it is crucial to understand the inflation response to government spending — and this inflation response is quite different for durable and nondurable goods. As can be seen in Panel B, government spending on nondurable goods raises inflation substantially more than spending on durable goods. Additionally, the impulse response for nondurable goods displays a slightly hump-shaped pattern with initial inflation and subsequent mild deflation as the government reduces spending. When good X is durable, inflation continues to rise for much longer, reflecting the fact that households rebuild their durables stock as soon as government demand falls.

For the fiscal multiplier to be large, inflation must be high when the interest rate is fixed at the ZLB. Conversely, deflation at the ZLB has strong contractionary effects. Panels C and D show the multiplier and the price path when the ZLB binds for 8 quarters. The multiplier for the moderately durable good with a service life of 10 years is now above one and the nondurables multiplier is near 3.

The multiplier for nondurables falls when the ZLB binds for 16 quarters (Panel E). The reason is that prices are falling while the economy is at the ZLB. In fact, when the ZLB binds for 16 quarters, the multiplier for nondurables falls below that for moderately durable goods with $\delta_D = 0.025$. The catch-up of private sector spending prevents inflation from falling as much as it does when the government purchases nondurable goods. For the long-lived durable the multiplier remains below one.

In summary, the multiplier remains relatively small at the ZLB when the good in question is sufficiently durable. Yet, for goods with intermediate durability the multiplier can be above one.

5 Conclusion

Both neoclassical and New Keynesian models predict that the fiscal multiplier for temporary increases in spending is much smaller when the government buys durable rather than nondurable goods. I show that evidence based on aggregate and industry-level data is consistent with this prediction. Yet, this does not imply that the government should avoid spending on infrastructure and other durable goods when the economy suffers from weak demand. While the estimates for durables multipliers are small *on average*, they vary substantially with the state of the business cycle and appear to be large in recessions.

Given the government's role in the provision of public infrastructure, my results suggest that the timing of new construction is important. The recent suggestion to assemble a pool of "shovel-ready projects" to be implemented when the economy next plunges into recession appears promising in light of the findings of this paper.

This paper also provides guidance for future research on fiscal policy. The large difference in the sizes of durables and nondurables multipliers imply that future work should distinguish between these types of spending. Since the composition of spending matters estimates of multipliers for total spending suffer from an external validity problem. If the composition of spending changes, the multiplier changes as well.

Finally, it is likely that other product dimensions matter. As a general rule, industries with more elastic supply curves and less elastic demand curves should have larger fiscal multipliers. Price stickiness, factor mobility, and tradability are just three properties likely to be associated with the elasticities of demand or supply.

References

Adda, Jerome and Russell Cooper. 2000. "Balladurette and Juppette: A Discrete Analysis of Scrapping Subsidies." *Journal of Political Economy* 108 (4):778–806.

Angrist, Joshua and Joern-Steffen Pischke. 2008. *Mostly harmless econometrics: An empiricist's companion*. Princeton University Press, Princeton NJ.

Aschauer, David Alan. 1989. "Is public expenditure productive?" *Journal of Monetary Economics* 23 (2):177–200.

Atalay, Enghin, Ali Hortacsu, and Chad Syverson. 2014. "Vertical Integration and Input Flows." *American Economic Review* 104 (4):1120–48.

Auerbach, Alan J. and Yuriy Gorodnichenko. 2012. "Measuring the Output Responses to Fiscal Policy." *American Economic Journal: Economic Policy* 4 (2):1–27.

———. 2013. "Output Spillovers from Fiscal Policy." *American Economic Review* 103 (3):141–46.

Bachmann, Ruediger and Eric R. Sims. 2012. "Confidence and the transmission of government spending shocks." *Journal of Monetary Economics* 59 (3):235–249.

Barro, Robert J. and Charles J. Redlick. 2011. "Macroeconomic Effects From Government Purchases and Taxes." *The Quarterly Journal of Economics* 126 (1):51–102.

Barsky, Robert, Christopher L. House, and Miles Kimball. 2003. "Do Flexible Durable Goods Prices Undermine Sticky Price Models?" NBER Working Papers, National Bureau of Economic Research, Inc.

Barsky, Robert B., Christopher L. House, and Miles S. Kimball. 2007. "Sticky-Price Models and Durable Goods." *American Economic Review* 97 (3):984–998.

Bartelsman, Eric J. and Wayne Gray. 1996. "The NBER Manufacturing Productivity Database." NBER Technical Working Papers, National Bureau of Economic Research, Inc.

Bartik, Timothy J. 1991. "Who Benefits from State and Local Economic Development Policies?" Kalamazoo, MI W.E., Upjohn Institute for Employment Research.

Baxter, Marianne and Robert G King. 1993. "Fiscal Policy in General Equilibrium." *American Economic Review* 83 (3):315–34.

Becker, Randy, Wayne Gray, and Jordan Marvakov. 2013. "NBER-CES Manufacturing Industry Database: Technical Notes." Technical Working Paper, .

Berger, David and Joseph Vavra. 2014. "Measuring How Fiscal Shocks Affect Durable Spending in Recessions and Expansions." *American Economic Review* 104 (5):112–15.

Bullard, James and Kaushik Mitra. 2002. "Learning about monetary policy rules." *Journal of Monetary Economics* 49 (6):1105–1129.

Bureau of Economic Analysis. undated. "BEA Depreciation Esimates." , Bureau of Economic Analysis. URL `http://www.bea.gov/national/pdf/BEA_depreciation_rates.pdf`.

Calvo, Guillermo A. 1983. "Staggered prices in a utility-maximizing framework." *Journal of Monetary Economics* 12 (3):383–398.

Cashin, David and Takashi Unayama. 2012. "Short-run Distributional Effects of VAT Rate Change: Evidence from a consumption tax rate increase in Japan." Discussion papers, Research Institute of Economy, Trade and Industry (RIETI).

Chetty, Raj, Adam Guren, Day Manoli, and Andrea Weber. 2011. "Are Micro and Macro Labor Supply Elasticities Consistent? A Review of Evidence on the Intensive and Extensive Margins." *American Economic Review* 101 (3):471–75.

Chodorow-Reich, Gabriel, Laura Feiveson, Zachary Liscow, and William Gui Woolston. 2012. "Does State Fiscal Relief during Recessions Increase Employment? Evidence from the American Recovery and Reinvestment Act." *American Economic Journal: Economic Policy* 4 (3):118–45.

Christiano, Lawrence, Martin Eichenbaum, and Sergio Rebelo. 2011. "When Is the Government Spending Multiplier Large?" *Journal of Political Economy* 119 (1):78 – 121.

Cragg, John G. and Stephen G. Donald. 1993. "Testing Identifiability and Specification in Instrumental Variable Models." *Econometric Theory* 9 (02):222–240.

Davidson, Russell and James G MacKinnon. 1993. *Estimation and inference in econometrics*. Oxford University Press.

Eberly, Janice, Sergio Rebelo, and Nicolas Vincent. 2008. "Investment and Value: A Neoclassical Benchmark." NBER Working Papers, National Bureau of Economic Research, Inc.

Erceg, Christopher and Andrew Levin. 2006. "Optimal monetary policy with durable consumption goods." *Journal of Monetary Economics* 53 (7):1341–1359.

Farhi, Emmanuel and Ivan Werning. 2012. "Fiscal Multipliers: Liquidity Traps and Currency Unions." NBER Working Papers, National Bureau of Economic Research, Inc.

Finn, Mary G. 1998. "Cyclical Effects of Government's Employment and Goods Purchases." *International Economic Review* 39 (3):635–57.

Gali, Jordi. 2008. *Monetary Policy, Inflation and the Business Cycle: An Introduction to the New Keynesian Framework*. Princeton University Press, Princeton NJ.

Hall, Robert E. 1988. "Intertemporal Substitution in Consumption." *Journal of Political Economy* 96 (2):339–57.

Hall, Robert E. 2009. "By How Much Does GDP Rise If the Government Buys More Output?" *Brookings Papers on Economic Activity* 40 (2 (Fall)):183–249.

Hansen, Christian, Jerry Hausman, and Whitney Newey. 2008. "Estimation With Many Instrumental Variables." *Journal of Business & Economic Statistics* 26:398–422.

Hausman, Joshua. 2015. "What was Bad for GM was Bad for America: The Auto Industry and the 1937-38 Recession." Working paper, University of Michigan.

House, Christopher L. 2009. "Comment on: By How Much Does GDP Rise If the Government Buys More Output?" *Brookings Papers on Economic Activity* 40 (2 (Fall)):236–244.

House, Christopher L. and Matthew D. Shapiro. 2008. "Temporary Investment Tax Incentives: Theory with Evidence from Bonus Depreciation." *American Economic Review* 98 (3):737–68.

Imbens, Guido. 2010. "Weak Instruments and Many Instruments." Lectures on Evaluation Methods, .

Judson, Ruth A. and Ann L. Owen. 1997. "Estimating dynamic panel data models: a practical guide for macroeconomists." Finance and Economics Discussion Series, Board of Governors of the Federal Reserve System.

Kimball, Miles S. and Matthew D. Shapiro. 2008. "Labor Supply: Are the Income and Substitution Effects Both Large or Both Small?" Nber working papers, National Bureau of Economic Research, Inc.

Leduc, Sylvain and Daniel Wilson. 2013. "Roads to Prosperity or Bridges to Nowhere? Theory and Evidence on the Impact of Public Infrastructure Investment." *NBER Macroeconomics Annual* 27 (1):89 – 142.

Mankiw, N Gregory. 1985. "Consumer Durables and the Real Interest Rate." *The Review of Economics and Statistics* 67 (3):353–62.

Mian, Atif and Amir Sufi. 2012. "The Effects of Fiscal Stimulus: Evidence from the 2009 Cash for Clunkers Program." *The Quarterly Journal of Economics* 127 (3):1107–1142.

Michaillat, Pascal. 2014. "A Theory of Countercyclical Government Multiplier." *American Economic Journal: Macroeconomics* 6 (1):190–217.

Nakamura, Emi and Jon Steinsson. 2014. "Fiscal Stimulus in a Monetary Union: Evidence from US Regions." *American Economic Review* 104 (3):753–92.

Nekarda, Christopher J. and Valerie A. Ramey. 2011. "Industry Evidence on the Effects of Government Spending." *American Economic Journal: Macroeconomics* 3 (1):36–59.

Òscar Jordà. 2005. "Estimation and Inference of Impulse Responses by Local Projections." *American Economic Review* 95 (1):161–182.

Owyang, Michael T., Valerie A. Ramey, and Sarah Zubairy. 2013. "Are Government Spending Multipliers Greater during Periods of Slack? Evidence from Twentieth-Century Historical Data." *American Economic Review* 103 (3):129–34.

Pappa, Evi. 2009a. "The effects of fiscal expansions: an international comparison." Working Paper, Barcelona Graduate School of Economics.

———. 2009b. "The Effects Of Fiscal Shocks On Employment And The Real Wage." *International Economic Review* 50 (1):217–244.

Pereira, Alfredo M. 2000. "Is All Public Capital Created Equal?" *The Review of Economics and Statistics* 82 (3):513–518.

Perotti, Roberto. 2004. "Public investment: another (different) look." Working Paper, Bocconi University.

Ramey, Valerie A. 2011. "Identifying Government Spending Shocks: It's all in the Timing." *The Quarterly Journal of Economics* 126 (1):1–50.

Ramey, Valerie A. and Matthew D. Shapiro. 1998. "Costly capital reallocation and the effects of government spending." *Carnegie-Rochester Conference Series on Public Policy* 48 (1):145–194.

Ravn, Morten O. and Harald Uhlig. 2002. "On adjusting the Hodrick-Prescott filter for the frequency of observations." *The Review of Economics and Statistics* 84 (2):371–375.

Stock, James H. and Mark W. Watson. 1999. "Business cycle fluctuations in us macroeconomic time series." In *Handbook of Macroeconomics*, *Handbook of Macroeconomics*, vol. 1, edited by J. B. Taylor and M. Woodford, chap. 1. Elsevier, 3–64.

Stock, James H. and Motohiro Yogo. 2002. "Testing for Weak Instruments in Linear IV Regression." Nber technical working papers, National Bureau of Economic Research, Inc.

Werning, Ivan. 2011. "Managing a Liquidity Trap: Monetary and Fiscal Policy." NBER Working Papers, National Bureau of Economic Research, Inc.

Woodford, Michael. 2011. "Simple Analytics of the Government Expenditure Multiplier." *American Economic Journal: Macroeconomics* 3 (1):1–35.

A Model appendix

A.1 Summary of equations

In this part of the Appendix I summarize the equations of the most general model with adjustment costs and time-varying discount factor. $q_{X,t}$ and $q_{Z,t}$ denote the shadow values of one unit of capital in the two sectors. To obtain the model in Section 2 set $\beta_t = \beta$ and $\zeta_K = 0$.

The household's behavior is summarized the following equations:

$$\lambda_t = (1 + i_t)\,\mathbb{E}_t\left[\beta_{t+1}\lambda_{t+1}\right] \tag{A1}$$

$$\frac{\partial v\left(N_{Z,t}, N_{X,t}\right)}{\partial N_{j,t}} = \lambda_t W_{j,t},\ j \in \{X, Z\} \tag{A2}$$

$$\frac{\partial u\left(C_t, D_{H,t}\right)}{\partial C_t} = \lambda_t P_{Z,t} \tag{A3}$$

$$q_{j,t} = \lambda_t P_{Z,t}\left(1 + \zeta_K\left(\frac{I_{j,t}}{K_{j,t-1}} - \delta_K\right)\right),\ j \in \{X, Z\} \tag{A4}$$

$$q_{j,t} = \mathbb{E}_t\left[\beta_{t+1}\lambda_{t+1}R_{j,t+1} + \beta_{t+1}\lambda_{t+1}P_{j,t+1}\frac{\zeta_K}{2}\left(\left(\frac{I_{j,t+1}}{K_{j,t}}\right)^2 - \left(\delta_K\right)^2\right) + \beta_{t+1}\left(1 - \delta_K\right)q_{j,t+1}\right],\ j \in \{X, Z\} \tag{A5}$$

$$\gamma_t = \frac{\partial u\left(C_t, D_{H,t}\right)}{\partial D_{H,t}} + \left(1 - \delta_D\right)\mathbb{E}_t\left[\beta_{t+1}\gamma_{t+1}\right]. \tag{A6}$$

The accumulation equations (2) and equation (15) in the text continue to hold.

Firms' reset their prices according to

$$p^*_{j,t} = \frac{\varepsilon}{\varepsilon - 1}\frac{\mathbb{E}_t\sum_{k=0}^{\infty}\left(\theta_j\right)^k\lambda_{t+k}\prod_{s=1}^{k}\beta_{t+s}\left(P_{j,t+k}\right)^{\varepsilon}j_{t+k}MC_{j,t+k}}{\mathbb{E}_t\sum_{k=0}^{\infty}\left(\theta_j\right)^k\lambda_{t+k}\prod_{s=1}^{k}\beta_{t+s}\left(P_{j,t+k}\right)^{\varepsilon}j_{t+k}},\ j \in \{X, Z\} \tag{A7}$$

and prices in both sectors evolve according to

$$P_{j,t} = \left(\theta_j\left(P_{j,t-1}\right)^{1-\varepsilon} + \left(1 - \theta_j\right)\left(p^*_{j,t}\right)^{1-\varepsilon}\right)^{\frac{1}{1-\varepsilon}},\ j \in \{X, Z\}. \tag{A8}$$

Nominal marginal costs in the two sectors are

$$MC_{X,t}\left(s\right) = \left(\frac{P_{Z,t}}{1-\chi}\right)^{1-\chi}\left(\frac{R_{X,t}}{\alpha\chi}\right)^{\chi\alpha}\left(\frac{W_{X,t}}{\left(1-\alpha\right)\chi}\right)^{\chi(1-\alpha)}, \tag{A9}$$

$$MC_{Z,t}\left(s\right) = \left(\frac{R_{Z,t}}{\alpha}\right)^{\alpha}\left(\frac{W_{Z,t}}{1-\alpha}\right)^{1-\alpha}. \tag{A10}$$

The conditional factor demand functions are

$$M_{X,t} = \left(\frac{P_{Z,t}}{1-\chi}\right)^{-\chi} \left(\frac{R_{X,t}}{\alpha\chi}\right)^{\chi\alpha} \left(\frac{W_{X,t}}{(1-\alpha)\,\chi}\right)^{\chi(1-\alpha)} X_t, \tag{A11}$$

$$K_{X,t-1} = \left(\frac{P_{Z,t}}{1-\chi}\right)^{1-\chi} \left(\frac{R_{X,t}}{\alpha\chi}\right)^{\chi\alpha-1} \left(\frac{W_{X,t}}{(1-\alpha)\,\chi}\right)^{\chi(1-\alpha)} X_t, \tag{A12}$$

$$N_{X,t} = \left(\frac{P_{Z,t}}{1-\chi}\right)^{1-\chi} \left(\frac{R_{X,t}}{\alpha\chi}\right)^{\chi\alpha} \left(\frac{W_{X,t}}{(1-\alpha)\,\chi}\right)^{\chi(1-\alpha)-1} X_t, \tag{A13}$$

$$K_{Z,t-1} = \left(\frac{R_{Z,t}}{\alpha}\right)^{\alpha-1} \left(\frac{W_{Z,t}}{1-\alpha}\right)^{1-\alpha} Z_t, \tag{A14}$$

$$N_{Z,t} = \left(\frac{R_{Z,t}}{\alpha}\right)^{\alpha} \left(\frac{W_{Z,t}}{1-\alpha}\right)^{-\alpha} Z_t. \tag{A15}$$

The market clearing condition in the Z sector with capital adjustment costs is

$$Z_t = C_t + I_{X,t} + I_{Z,t} + M_{X,t} + K_{X,t-1}\frac{\zeta_K}{2}\left(\frac{I_{X,t}}{K_{X,t-1}} - \delta_K\right)^2 + K_{Z,t-1}\frac{\zeta_K}{2}\left(\frac{I_{Z,t}}{K_{Z,t-1}} - \delta_K\right)^2. \tag{A16}$$

Market clearing for the X sector, accounting, government spending, and the monetary policy rule are as described in the text (equations 7 to 13).

A.2 Proofs of approximation results

In what follows the notation $\tilde{X}_t = \frac{X_t - X}{X}$ denotes the percentage deviation of variable X_t from its steady state value. I prove the results for the case in which the fiscal policy shock has no persistence, $\varrho_X = 0$, although they can be generalized to cases with mild persistence. I assume that prior to the shock the economy is in the steady state. Notice that the references in Appendix A.1 correspond to the baseline model in the text when there are no adjustment costs, $\zeta_K = 0$, and the discount factor β is constant.

A.2.1 Spending on durable goods

Approximation result 1. *Suppose δ_K and δ_D are arbitrarily close to zero and β is arbitrarily close to* 1*. Then, for a short-lived increase in spending, it is approximately true that (1) $\Delta X_{H,t} \approx -\Delta X_{G,t}$, (2) the price $P_{X,t}$ remains unchanged, (3) the sectoral multipliers for gross output and value added are zero, $\frac{\mathrm{d}GO_{X,t}}{\mathrm{d}G_{X,t}} \approx \frac{\mathrm{d}VA_{X,t}}{\mathrm{d}G_{X,t}} \approx 0$, and (4) the aggregate multiplier is zero, $\frac{\mathrm{d}Y_t}{\mathrm{d}G_{X,t}} \approx 0$.*

Proof I first show that these assumptions imply that the stocks $K_{X,t}, K_{Z,t}$ and $D_{H,t}$ are approximately constant. The linear approximation of the accumulation equation for

durables (equation 2) is

$$\tilde{D}_{H,t} = \delta_D \tilde{X}_{H,t} + (1 - \delta_D)\, \tilde{D}_{H,t-1}$$

It then follows from the assumptions $\delta_D \to 0$ and $\tilde{D}_{H,t-1} = 0$ that $\tilde{D}_{H,t} \approx 0$. Similarly, $\tilde{K}_{X,t} \approx \tilde{K}_{Z,t} \approx 0$.

The respective shadow values γ_t, $q_{X,t}$, $q_{Z,t}$ are also approximately constant under these assumptions. This can be seen using the linear approximation of equation (A6),

$$\tilde{\gamma}_t = -\frac{(1 - (1 - \delta_D)\,\beta)}{\sigma_D} \tilde{D}_{H,t} + \frac{(1 - (1 - \delta_D)\,\beta)}{\sigma_{DC}} \tilde{C}_t + (1 - \delta_D)\,\beta \mathbb{E}_t\left[\tilde{\gamma}_{t+1}\right]$$

Here, σ_D and σ_{DC} are constants. Clearly, under the assumptions $\delta_D \to 0$ and $\beta \to 1$ it follows that $\tilde{\gamma}_t \approx \mathbb{E}_t\left[\tilde{\gamma}_{t+1}\right]$. Since this variable is stationary and returns to its steady state value eventually it must be that $\tilde{\gamma}_t \approx 0$. Similarly, $q_{X,t} \approx q_{Z,t} \approx 0$.

I next guess that $\tilde{P}_{X,t} = 0$. It then follows from equations (15) and (A4) that $\tilde{\lambda}_t = 0$ and $\tilde{P}_{Z,t} = 0$. This guess, together with $\tilde{D}_{H,t} \approx \tilde{K}_{X,t} \approx \tilde{K}_{Z,t} \approx 0$ and the assumption that $\varrho_X = 0$ implies that all state variables from period $t+1$ onwards are zero. Hence all other variables from period $t+1$ onwards are zero.

With these results in hand it is easy to show that

$$\Delta X_{H,t} = -\Delta X_{G,t},$$

$\Delta I_{X,t} + \Delta I_{Z,t} = 0$ and that no other variable at time t responds to the fiscal policy shock. Notice that since neither of the prices adjust nor the quantities X_t, Z_t or Y_t change, the monetary policy rule (13) implies that the nominal interest rate remains unchanged. The claims on the multipliers now follow immediately.

A.2.2 Spending on nondurable goods

Approximation result 2. *Suppose $\delta_D = 1$, δ_K is arbitrarily close to zero and β is arbitrarily close to 1. Suppose further that $\theta_X = \theta_Z = 0$, that is, prices are fully flexible, and that $u_{CD} = v_{XZ} = 0$. Lastly, assume that the government subsidizes monopolistic firms such that $\frac{P_Z M_X}{P_X X} = 1 - \chi$. Next, define*

$$\sigma_D = -\frac{u_D\left(C, D_H\right)}{D_H u_{DD}\left(C, D_H\right)} \text{ and } \eta_X = \frac{v_X\left(N_Z, N_X\right)}{N_X v_{XX}\left(N_Z, N_X\right)}.$$

Then a short-lived increase in spending yields a gross output sectoral multiplier equal to

$$\frac{\mathrm{d}GO_{X,t}}{\mathrm{d}G_{X,t}} \approx \frac{\left(1 + \eta_X^{-1}\right)\chi^{-1} - \left(\alpha + \eta_X^{-1}\right)}{\sigma_D\left(\alpha + \eta_X^{-1}\right)\frac{X_H}{X} + \left(1 + \eta_X^{-1}\right)\chi^{-1} - \left(\alpha + \eta_X^{-1}\right)}$$

and approximately equal sectoral value added and aggregate multipliers

$$\frac{\mathrm{d}VA_{X,t}}{\mathrm{d}G_{X,t}} \approx \frac{\mathrm{d}Y_t}{\mathrm{d}G_{X,t}} \approx \frac{1-\alpha}{\sigma_D\left(\alpha+\eta_X^{-1}\right)\frac{X_H}{X}+\left(1+\eta_X^{-1}\right)\chi^{-1}-\left(\alpha+\eta_X^{-1}\right)}.$$

The relative price $P_{X,t}/P_{Z,t}$ rises in response to greater spending.

Proof Similar to the proof in A.2.1, the assumptions that $\beta \to 1$ and $\delta_K \to 0$ implies that $\tilde{K}_{X,t} \approx \tilde{K}_{Z,t} \approx \tilde{q}_{Z,t} \approx \tilde{q}_{X,t} \approx 0$. It then immediately follows from (A4) that $\tilde{\lambda}_t = -\tilde{P}_{Z,t}$. Additionally, equation (15) implies that $\tilde{\gamma}_t = \tilde{P}_{X,t} - \tilde{P}_{Z,t}$, and (A3) implies that $\tilde{C}_t = 0$. Using these relationships in the labor supply functions (A2) yields

$$\frac{1}{\eta_Z}\tilde{N}_{Z,t} = \tilde{W}_{Z,t} - \tilde{P}_{Z,t} \text{ and } \frac{1}{\eta_X}\tilde{N}_{X,t} = \tilde{W}_{X,t} - \tilde{P}_{Z,t}.$$

Additionally, the household's demand for good X (equation A6) becomes

$$\tilde{P}_{X,t} - \tilde{P}_{Z,t} = -\frac{1}{\sigma_D}\tilde{X}_{H,t} \tag{A17}$$

With these results in hand, it is straightforward but tedious to show that $\tilde{Z}_t = 0$ and that

$$\tilde{X}_t = \frac{\left(1+\eta_X^{-1}\right)\chi^{-1}-\left(\alpha+\eta_X^{-1}\right)}{\left(1-\chi\alpha+(1-\chi)\eta_X^{-1}\right)\chi^{-1}+\left(\alpha+\eta_X^{-1}\right)\sigma_D\frac{X_H}{X}}\frac{X_G}{X}\tilde{X}_{G,t}$$

and

$$\tilde{M}_{X,t} = \frac{\left(1+\eta_X^{-1}\right)\chi^{-1}}{\left(1-\chi\alpha+(1-\chi)\eta_X^{-1}\right)\chi^{-1}+\left(\alpha+\eta_X^{-1}\right)\sigma_D\frac{X_H}{X}}\frac{X_G}{X}\tilde{X}_{G,t}$$

Recall the assumption that there is a subsidy that implies that $\frac{P_Z M_X}{P_X X} = 1-\chi$. An ad-valorem subsidy of $\frac{1}{\varepsilon}$ on purchases of the intermediate is one way to ensure this relationship. Using the definitions of gross output, value added, and GDP, and the fact that $\frac{P_Z M_X}{P_X X} = 1-\chi$ the results for the multipliers are now easily shown. Notice finally that $\tilde{P}_{X,t} - \tilde{P}_{Z,t}$ rises as $\tilde{X}_{H,t}$ falls (equation A17).

A.3 Robustness of fiscal multipliers to alternative calibrations

In this part of the appendix I check the robustness of the fiscal multipliers to alternative calibrations. The first three rows in Table A1 illustrate the role of capital adjustment costs. Whereas neither gross output nor value added sectoral multipliers change substantially with adjustment costs, aggregate multipliers do. Higher adjustment costs imply less crowding out of investment through purchases of intermediates. When adjustment costs are high, aggregate multipliers are quite close to the gross output multipliers.

I next relax the assumption that labor is immobile across sectors. Specifically, I assume

that

$$v\left(N_{X,t}, N_{Z,t}\right) = \left(1+\frac{1}{\eta}\right)^{-1}\left[\left(\phi\left(N_{Z,t}\right)^{\frac{\eta+\mu}{\eta}} + (1-\phi)\left(N_{X,t}\right)^{\frac{\eta+\mu}{\eta}}\right)^{\frac{\eta}{\eta+\mu}}\right]^{\left(1+\frac{1}{\eta}\right)},$$

Here, η is the Frisch labor supply elasticity and μ parameterizes labor mobility across sectors. If $\mu = 0$, labor is perfectly mobile across sectors. If $\mu = 1$, labor is completely immobile. Intermediate values imply partial labor mobility.[22]

Since greater labor mobility raises the elasticity of both sectors' supply curves, the sectoral multipliers increase slightly. Of course, more workers in one sector imply fewer in the other so the effect on the aggregate multiplier is small. In order to mimic severe slack in labor markets in recessions, I also compute multipliers for a calibration with greater labor supply elasticity ($\eta = 2$). This parameterization also implies more elastic sectoral supply curves but now additional hires in one sector do not draw labor away from the other. As a result all multipliers increase relative to the baseline.

An additional determinant of the short-run elasticity of supply curves are sticky prices. If prices are sticky, as in the baseline calibration, a fraction of firms must serve increased demand at fixed prices. When I assume that prices are flexible, the case $\theta_X = \theta_Z = 0$, it is therefore unsurprising that multipliers fall. Naturally, this decline in multipliers relative to the baseline calibration is larger in the more price sensitive durable goods sectors.

Next, I consider an alternative Taylor rule in which the monetary authority responds stronger to both inflation and deviations of output from trend ($\phi_\pi = 1.5$, $\phi_Y = 0.5/4$). As the open economy relative multiplier in Nakamura and Steinsson (2014), sectoral multipliers are less sensitive to alternative monetary policy rules than aggregate multipliers. Of course, aggregate multipliers fall when the monetary authority "leans against the wind" with increasing strength.

I next assume that the persistence of the government spending shock is higher and takes a value of 0.90. This value corresponds to the persistence estimated in section 3.2.3 ($0.9^{4.7} \approx 0.05$). Longer lived shocks raise the multipliers for durable goods and reduces those for nondurables. Yet, the aggregate nondurables multiplier with a value of 0.70 remains more than twice the size of the durables multiplier which takes a value of 0.32. For the empirical analysis in this paper, it is important that the industry-level multipliers also remain very different.

Finally, I explore the impact on fiscal multipliers when D_H and C are complements or substitutes (the last two lines of Table A1). The more complementary D_H and C are, the larger are the durable goods multipliers. However, the difference between nondurables and durable's multipliers remains large.

Across all calibrations, a good rule of thumb is that the aggregate multipliers lie between sectoral value added and gross output multipliers. In the simple model presented here, this rule suggests that the aggregate multiplier is between 0.1 and 0.35 for durable goods and around 0.75 for nondurables goods.

[22] This specification is taken from Barsky, House, and Kimball (2003).

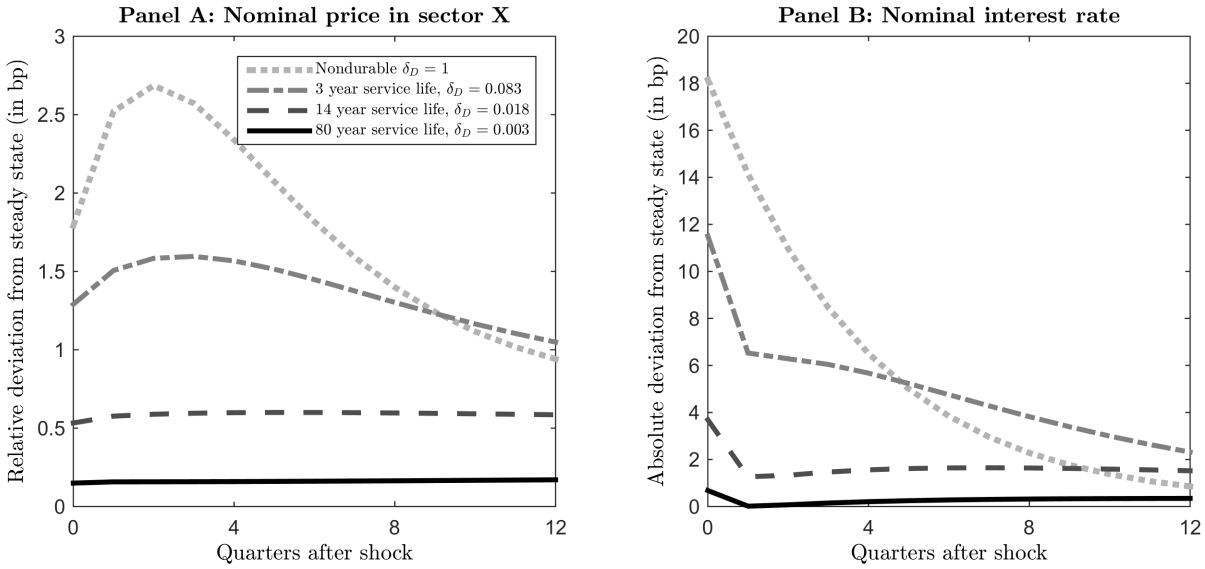
Table A1: Multipliers for alternative calibrations

Small sector	15 year service life, $\delta_D = 0.017$			Nondurable $\delta_D = 1$		
	Sectoral multiplier			Sectoral multiplier		
Calibration	Gross output	Value added	Aggregate multiplier	Gross output	Value added	Aggregate multiplier
Baseline (baseline calibration)	0.22	0.08	0.21	0.88	0.30	0.76
High adjustment costs $\zeta_K = 100$	0.22	0.08	0.22	0.88	0.30	0.83
Low adjustment costs $\zeta_K = 1$	0.20	0.08	0.18	0.88	0.32	0.43
High labor mobility $\mu = 0.5$	0.25	0.10	0.23	0.90	0.35	0.75
High labor supply elasticity $\eta = 2$	0.25	0.10	0.26	0.90	0.35	0.85
Flexible prices $\theta_X = \theta_Z = 0$	0.10	0.04	0.13	0.75	0.26	0.60
More aggressive Taylor rule $\phi_\pi = 1.5,\ \phi_Y = 0.5/4$	0.22	0.08	0.20	0.87	0.30	0.63
Greater shock persistence $\varrho_X = 0.90$	0.34	0.12	0.32	0.86	0.30	0.70
D_H and C complements $\rho = 0.5$	0.33	0.11	0.29	0.93	0.32	0.76
D_H and C substitutes $\rho = 2$	0.13	0.05	0.15	0.79	0.27	0.75

Notes: The table reports the multipliers at a time horizon of one year after the shock as generated by the model.

A.4 Additional impulse response functions

Figure A1: Impulse response functions for a government spending shock



Notes: The figure plots impulse response functions for various calibrations. The impulse is a 100 basis point increase of government spending in sector X relative to its steady state value.

B Appendix for aggregate empirical analysis

B.1 Data used in aggregate analysis

The data are annual and come from the Bureau of Economic Analysis. GDP, the consumption series and investment in current dollars are taken from Table 1.1.5 and the corresponding price indexes are taken from Table 1.1.4. For $G_{X,t}$ I use national defense gross investment, and for $G_{C,t}$ I use national defense consumption expenditures. These series in current dollars are obtained from Table 3.9.5 and the price indexes from Table 3.9.4. Note that consumption expenditures include consumption of fixed capital. Additionally, roughly 5 to 10 percent of defense consumption expenditures are purchases of durable goods which cannot be separated out until 1972 because the Bureau of Economic Analysis begins to report a detailed breakdown of military spending only in 1972, Table 3.11.5. Hence, a small component of durable goods spending remains in the series $G_{C,t}$. Valerie Ramey's news series can be downloaded from her website (`http://econweb.ucsd.edu/~vramey/research.html#data`). I obtain the trend of GDP Y_t^T using an HP-filter with a smoothing parameter of 6.25 as recommended by Ravn and Uhlig (2002).

B.2 Additional evidence from national accounts data

From 1972 onwards, the BEA provides a more detailed breakdown of military spending in Table 3.11.5. This table contains time series of defense spending separately for services, nondurable goods, durable goods, equipment, and structures, among others.[23] I can use this data to test whether spending on these five categories leads to crowding out in the corresponding spending category for the private sector. To do so, I group services and nondurable goods together into a nondurables group, denoted C, and durable goods, equipment and structures into a durables group X. The data are now quarterly.

Let $Y_{P,i,t}$ denote private sector spending on category i. I estimate the specification

$$\frac{Y_{P,i,t} - Y_{P,i,t-1}}{Y^T_{P,i,t-4}} = \sum_{s=1}^{4} \gamma_{X,s} \frac{G_{X,i,t-s+1} - G_{X,i,t-s}}{Y^T_{P,i,t-4}} + \sum_{s=1}^{4} \gamma_{C,s} \frac{G_{C,i,t-s+1} - G_{C,i,t-s}}{Y^T_{P,i,t-4}} + \delta_t + \zeta_i + \varepsilon_{i,t}. \tag{A18}$$

This empirical model is closely related to equation (19), but adjusted for quarterly data. Instead of Ramey's news variable, I now include a time fixed effect, δ_t, which also soaks up the common component of other shocks such as monetary and tax policy. ζ_i is a fixed effect for each spending category. $G_{X,i,t}$ ($G_{C,i,t}$) denotes defense spending on category i interacted with a dummy variable that takes the value one if and only if industry i belongs to the durables group (the nondurables group). The multipliers are simply $\sum_{s=1}^{4} \gamma_{j,s}$, $j = C, X$.

Table B1 shows the results. In the baseline specification, column (1), the point estimate is -1.12, suggesting that one dollar of spending in a durables category (durable goods, equip-

[23] The deflators are in Table 3.11.4.

Table B1: Estimates from disaggregated national accounts data

Specification	(1)	(2)	(3)
Durable goods multiplier	-1.12	-1.04	-1.17
	(0.46)	(0.47)	(0.47)
Nondurable goods multiplier	3.99	4.34	4.32
	(2.88)	(2.86)	(2.94)
Controls in addition to those in equation (A18)	none	interest rate interacted with category dummy	Ramey news variable interacted with category dummy
Observations	845	845	845

Note: Standard errors in parentheses.

ment, and structures) crowds out 1.12 dollars of private sector spending. The estimate is significantly different from zero at the 5 percent level. In contrast, the estimate for nondurable goods is positive and insignificantly different from zero. Unfortunately, the standard errors are fairly large.

In columns (2) and (3) of the table I report two estimates from specifications that include additional control variables. Column (2) reports the estimates when I include the real interest rate interacted with a category dummy. This control variable would allow monetary policy to affect the spending categories differently. The results in column (3) are obtained when I additionally control for Ramey's news variable interacted with category dummies. As can be seen from the table, the results are not sensitive to the inclusion of these additional controls. Although I do not report the estimates here, the findings are also robust to the inclusion of additional lags in specification (A18) so that the time horizon over which the multipliers are computed is greater than four quarters.

C Appendix for industry-level empirical analysis

C.1 Industry-level data

C.1.1 Original data sources for sectoral analysis

The NBER-CES manufacturing database can be downloaded from `http://www.nber.org/nberces/`. This page also provides summary statistics of the dataset and a documentation. As noted in the text, a detailed description of the database is provided by Bartelsman and Gray (1996) and Becker, Gray, and Marvakov (2013).

The military prime contract files were downloaded from the U.S. National Archives, `https://research.archives.gov/`. After entering the website, search for the key words "military prime contracts" and "defense contract action data system". There is a separate set of files, i.e. the dataset and documentation, for each fiscal year from 1966 to 2003. There is also a separate file for the 3-month period between the old and the new fiscal year in 1975.

The remaining data on military spending were obtained from `www.usaspending.gov`. More precisely, the data can be downloaded from `https://www.usaspending.gov/DownloadCenter/Pages/DataDownload.aspx` for the years from 2000 onwards. When downloading the data be sure to select "prime award" as type of data and "contracts" as spending type. The agency is the Department of Defense.

C.1.2 Product Service Codes and Federal Supply Codes

U.S. military procurement is categorized according to Product Service Codes (PSCs) and Federal Supply Codes (FSCs). Several examples are given in table C1. Individual categories can be looked up here: `http://support.outreachsystems.com/resources/tables/pscs/`. A summary of all FSC and PSC codes as used after 1979 is available here: `https://www.fpds.gov/downloads/psc_data_Oct012011.xls`. Both websites were last accessed on 06/16/2015.

Table C1: Selected examples of PSC and FSC codes

PSC/FSC	Description
1010	Guns, over 30mm up to 75mm
1560	Airframe structural components
1615	Helicopter rotor blades, drive mechanisms and components
3820	Mining, rock drilling, earth boring, and related equipment
AR32	R&D-Space: Flight (applied research/exploratory development)
M1GC	Operation of fuel storage buildings
R702	Data collection services

C.1.3 Concordance between FSC/PSC and SIC codes

The military prime contract files contain both FSC/PSC codes and 4-digit SIC codes for the period from 1989 to 2000. I use these 12 years to construct a concordance and then apply the concordance to spending on FSC/PSC categories which are available over the entire sample from 1979 to 2009.

The concordance is a matrix that describes for each FSC and PSC code what fraction of a dollar spend on the FSC/PSC code is purchased from each SIC industry. For instance, if one dollar is spent on the FSC code 1010 (Guns, over 30mm up to 75mm) about 45 cents are purchased from SIC industry 3484 (Small Arms). The next most important SIC industry is 3489 (Ordnance and Accessories, NEC) with 25 cents. Table C2 provides a summary of all SIC industries that receive more than 1 cent when one dollar is spent on FSC code 1010. A second example is given in table C3 for the FSC code 1560 (Airframe Structural Components).

Table C2: Spending shares for FSC code 1010 (Guns, over 30mm up to 75mm)

SIC code	Description	Spending share
3484	Small Arms	0.448
3489	Ordnance and Accessories, NEC	0.254
3499	Fabricated Metal Products, NEC	0.166
8711	Engineering Services	0.086
3728	Aircraft Parts and Auxiliary Equipment, NEC	0.021

Table C3: Spending shares for FSC code 1560 (Airframe Structural Components)

SIC code	Description	Spending share
3728	Aircraft Parts and Auxiliary Equipment, NEC	0.815
3721	Aircraft	0.069
8711	Engineering Services	0.033
3724	Aircraft Engines and Engine Parts	0.023
8731	Commercial Physical and Biological Research	0.022

C.2 Industries in the baseline sample

In this appendix I discuss the construction of the baseline sample. Out of 456 industries, I exclude 12 because they do not have strictly positive military spending in each year, and an additional 3 because they do not exist over the full 31 year sample period. Next, 148 industries are dropped because the instrument has little predictive power. More precisely, these industries have a t-statistic of the estimate of β_i in specification (21) below 2. Finally, I drop 9 industries, because defense spending as a fraction of gross output exceeds, on average, 0.35.

Table C4 provides a summary of the sample status of 4-digit SIC industries. The table shows that the baseline sample does not include industries manufacturing tobacco products and underrepresents petroleum and coal product industries. A detailed summary is shown in Table C5.

Table C4: Industries and sample status

2-digit SIC code	Durable	Fraction of 4-digit SIC industries in baseline sample	Fraction of 4-digit SIC industries in restricted sample	2-digit SIC description
20	no	21 / 46	18 / 46	Food and kindred products
21	no	0 / 4	3 / 4	Tobacco products
22	no	14 / 23	0 / 23	Textile mill products
23	no	22 / 31	1 / 31	Apparel and other textile products
24	yes	11 / 16	1 / 17	Lumber and wood products
25	yes	8 / 13	1 / 13	Furniture and fixtures
26	no	9 / 17	1 / 17	Paper and allied products
27	no	5 / 14	1 / 14	Printing and publishing
28	no	11 / 29	3 / 29	Chemicals and allied products
29	no	1 / 5	0 / 5	Petroleum and coal products
30	no	8 / 15	3 / 15	Rubber and miscellaneous plastics products
31	no	5 / 11	1 / 11	Leather and leather products
32	yes	21 / 25	2 / 26	Stone, clay, glass, and concrete products
33	yes	13 / 26	1 / 26	Primary metal industries
34	yes	30 / 38	7 / 38	Fabricated metal products
35	yes	37 / 51	11 / 51	Industrial machinery and equipment
36	yes	28 / 37	15 / 37	Electronic and other electric equipment
37	yes	12 / 17	10 / 18	Transportation equipment
38	yes	17 / 17	10 / 17	Instruments and related products
39	yes	11 / 18	2 / 18	Miscellaneous manufacturing industries
Total		284 / 456	91 / 456	

Table C5: Industries and sample status

SIC code	Durable	In baseline sample	t-stat.	Avg. def. spending share (in %)	Description
2011	no	yes	2.2	0.4	Meat Packing Plants
2013	no	no	0.4	0.5	Sausages and Other Prepared Meat Products
2015	no	no	0.9	0.2	Poultry Slaughtering and Processing
2021	no	no	-0.6	0.5	Creamery Butter
2022	no	no	-0.5	0.3	Natural, Processed, and Imitation Cheese
2023	no	no	-0.3	0.1	Dry, Condensed and Evaporated Dairy Products
2024	no	no	-0.3	0.1	Ice Cream and Frozen Desserts
2026	no	no	-0.6	0.3	Fluid Milk
2032	no	no	0.6	1.8	Canned Specialties
2033	no	yes	4.5	0.7	Canned Fruits, Vegetables, Preserves, Jams, and Jellies
2034	no	yes	4.3	0.8	Dried and Dehydrated Fruits, Vegetables and Soup Mixes
2035	no	yes	2.5	0.4	Pickled Fruits and Vegetables, Vegetable Sauces and Seasonings, and Salad Dressings
2037	no	yes	4.4	0.7	Frozen Fruits, Fruit Juices, and Vegetables
2038	no	no	0.1	0.1	Frozen Specialties, NEC
2041	no	yes	2.9	0.3	Flour and Other Grain Mill Products
2043	no	yes	3.8	0.5	Cereal Breakfast Foods
2044	no	yes	3.1	0.2	Rice Milling
2045	no	yes	2.6	0.1	Prepared Flour Mixes and Doughs
2046	no	yes	4.9	0.0	Wet Corn Milling
2047	no	no	1.0	0.1	Dog and Cat Food
2051	no	yes	3.6	0.1	Bread and Other Bakery Products, Except Cookies and Crackers
2052	no	yes	3.3	0.2	Cookies and Crackers
2053	no	yes	2.1	0.0	Frozen Bakery Products, Except Bread
2061	no	no	1.1	0.2	Cane Sugar, Except Refining
2062	no	no	1.6	0.4	Cane Sugar Refining
2063	no	yes	2.5	0.0	Beet Sugar
2064	no	no	0.2	0.2	Candy and Other Confectionery Products
2066	no	no	1.5	0.3	Chocolate and Cocoa Products
2067	no	no	0.7	0.1	Chewing Gum
2068	no	no	0.5	0.3	Salted and Roasted Nuts and Seeds
2074	no	yes	4.1	0.1	Cottonseed Oil Mills
2076	no	yes	4.2	0.6	Vegetable Oil Mills, Except Corn, Cottonseed, and Soybean
2077	no	no	1.3	0.0	Animal and Marine Fats and Oils
2079	no	yes	4.1	0.7	Shortening, Table Oils, Margarine, and Other Edible Fats and Oils, NEC
2083	no	yes	3.5	0.0	Malt
2086	no	no	-1.9	2.0	Bottled and Canned Soft Drinks and Carbonated Water
2087	no	yes	3.4	0.1	Flavoring Extracts and Flavoring Syrups, NEC
2091	no	yes	3.1	0.7	Canned and Cured Fish and Seafoods
2092	no	no	0.9	0.6	Prepared Fresh or Frozen Fish and Seafoods
2095	no	no	1.1	0.3	Roasted Coffee
2096	no	no	0.2	0.1	Potato Chips, Corn Chips, and Similar Snacks
2097	no	no	1.5	1.0	Manufactured Ice
2098	no	yes	3.6	0.3	Macaroni, Spaghetti, Vermicelli and Noodles
2099	no	no	0.5	1.2	Food Preparations, NEC
2111	no	no	1.2	0.2	Cigarettes
2121	no	no	0.6	0.0	Cigars
2141	no	no	1.9	0.0	Tobacco Stemming and Redrying
2211	no	yes	5.1	0.7	Broadwoven Fabric Mills, Cotton
2221	no	yes	3.9	0.1	Broadwoven Fabric Mills, Manmade Fiber and Silk
2231	no	yes	3.3	5.7	Broadwoven Fabric Mills, Wool

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Table C5 – *Continued from previous page*

SIC code	Durable	In baseline sample	t-stat.	Avg. def. spending share (in %)	Description
2241	no	yes	3.9	0.6	Narrow Fabric and Other Smallware Mills: Cotton, Wool, Silk and Manmade Fiber
2251	no	no	1.0	0.0	Womens Full-Length and Knee-Length Hosiery, Except Socks
2252	no	yes	3.2	0.6	Hosiery, NEC
2253	no	yes	2.9	0.8	Knit Outerwear Mills
2254	no	no	0.9	3.1	Knit Underwear and Nightwear Mills
2258	no	yes	3.7	0.0	Lace and Warp Knit Fabric Mills
2259	no	yes	4.4	0.1	Knitting Mills, NEC
2261	no	yes	2.6	0.0	Finishers of Broadwoven Fabrics of Cotton
2262	no	yes	4.2	0.0	Finishers of Broadwoven Fabrics of Manmade Fiber and Silk
2269	no	yes	2.8	0.1	Finishers of Textiles, NEC
2273	no	no	0.7	0.1	Carpets and Rugs
2281	no	no	1.2	0.0	Yarn Spinning Mills
2295	no	yes	3.4	0.4	Coated Fabrics, Not Rubberized
2296	no	no	1.9	0.1	Tire Cord and Fabrics
2297	no	no	1.7	0.0	Nonwoven Fabrics
2298	no	yes	3.3	2.2	Cordage and Twine
2299	no	yes	5.4	2.7	Textile Goods, NEC
2311	no	yes	2.9	9.0	Mens and Boys Suits, Coats, and Overcoats
2321	no	yes	2.6	1.9	Mens and Boys Shirts, Except Work Shirts
2322	no	yes	2.4	10.9	Mens and Boys Underwear and Nightwear
2323	no	yes	3.1	0.5	Men's and Boys' Neckwear
2325	no	yes	3.3	7.3	Mens and Boys Separate Trousers and Slacks
2326	no	yes	4.0	3.8	Mens and Boys Work Clothing
2329	no	yes	3.0	6.8	Mens and Boys Clothing, NEC
2331	no	no	0.8	0.2	Womens, Misses, and Juniors Blouses and Shirts
2335	no	no	1.0	0.0	Womens, Misses, and Juniors Dresses
2337	no	no	1.3	0.5	Womens, Misses, and Juniors Suits, Skirts, and Coats
2339	no	yes	2.8	0.2	Womens, Misses, and Juniors Outerwear, NEC
2341	no	no	1.1	0.0	Womens, Misses, Childrens, and Infants Underwear and Nightwear
2342	no	yes	3.3	0.0	Brassieres, Girdles, and Allied Garments
2353	no	yes	4.4	6.1	Hats, Caps, and Millinery
2369	no	yes	4.5	0.1	Girls, Childrens, and Infants Outerwear, NEC
2371	no	no	-3.3	2.8	Fur Goods
2384	no	yes	6.1	0.7	Robes and Dressing Gowns
2386	no	no	0.3	0.0	Leather and Sheep-Lined Clothing
2387	no	yes	5.5	1.5	Apparel Belts
2389	no	yes	5.2	2.6	Apparel and Accessories, NEC
2391	no	no	2.0	0.2	Curtains and Draperies
2392	no	yes	4.0	0.3	Housefurnishings, Except Curtains and Draperies
2393	no	yes	6.4	5.9	Textile Bags
2394	no	yes	3.2	8.7	Canvas and Related Products
2395	no	yes	2.7	0.0	Pleating, Decorative and Novelty Stitching, and Tucking for the Trade
2396	no	no	1.7	0.1	Automotive Trimmings, Apparel Findings, and Related Products
2397	no	yes	2.5	0.0	Schiffli Machine Embroideries
2399	no	yes	6.7	8.7	Fabricated Textile Products, NEC
2411	yes	yes	2.1	0.0	Logging
2421	yes	no	2.0	0.0	Sawmills and Planing Mills, General
2426	yes	no	1.9	0.1	Hardwood Dimension and Flooring Mills
2429	yes	yes	2.9	0.1	Special Product Sawmills, NEC
2431	yes	yes	3.7	0.0	Millwork
2434	yes	yes	2.1	0.0	Wood Kitchen Cabinets
2435	yes	yes	5.5	0.0	Hardwood Veneer and Plywood

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Table C5 – *Continued from previous page*

SIC code	Durable	In baseline sample	t-stat.	Avg. def. spending share (in %)	Description
2436	yes	yes	4.6	0.2	Softwood Veneer and Plywood
2439	yes	yes	2.2	0.0	Structural Wood Members, NEC
2441	yes	no	1.9	0.4	Nailed and Lock Corner Wood Boxes and Shook
2448	yes	yes	3.1	0.3	Wood Pallets and Skids
2449	yes	yes	2.7	0.4	Wood Containers, NEC
2451	yes	yes	6.0	0.1	Mobile Homes
2452	yes	yes	4.9	0.3	Prefabricated Wood Buildings and Components
2491	yes	no	1.9	0.2	Wood Preserving
2493	yes	no	0.6	0.0	Reconstituted Wood Products
2499	yes	yes	4.0	0.4	Wood Products, NEC
2511	yes	no	1.8	0.4	Wood Household Furniture, Except Upholstered
2512	yes	yes	2.1	0.2	Wood Household Furniture, Upholstered
2514	yes	no	1.2	0.5	Metal Household Furniture
2515	yes	no	1.9	0.1	Mattresses, Foundations, and Convertible Beds
2517	yes	no	1.4	0.0	Wood Television, Radio, Phonograph, and Sewing Machine Cabinets
2519	yes	no	1.3	1.1	Household Furniture, NEC
2521	yes	yes	2.3	2.4	Wood Office Furniture
2522	yes	yes	2.7	2.0	Office Furniture, Except Wood
2531	yes	yes	3.7	0.3	Public Building and Related Furniture
2541	yes	yes	3.9	0.2	Wood Office and Store Fixtures, Partitions, Shelving, and Lockers
2542	yes	yes	6.6	0.8	Office and Store Fixtures, Partitions, Shelving, and Lockers, Except Wood
2591	yes	yes	2.3	0.1	Drapery Hardware and Window Blinds and Shades
2599	yes	yes	4.3	1.5	Furniture and Fixtures, NEC
2611	no	yes	3.2	0.0	Pulp Mills
2621	no	yes	5.4	0.0	Paper Mills
2631	no	no	0.1	0.0	Paperboard Mills
2652	no	no	0.0	0.0	Setup Paperboard Boxes
2653	no	no	1.7	0.0	Corrugated and Solid Fiber Boxes
2655	no	yes	4.9	0.4	Fiber Cans, Tubes, Drums, and Similar Products
2656	no	no	0.4	0.0	Sanitary Food Containers, Except Folding
2657	no	no	0.0	0.0	Folding Paperboard Boxes, Including Sanitary
2671	no	no	1.7	0.0	Packaging Paper and Plastics Film, Coated and Laminated
2672	no	yes	6.8	0.1	Coated and Laminated Paper, NEC
2673	no	no	1.7	0.1	Plastics, Foil, and Coated Paper Bags
2674	no	yes	2.1	0.3	Uncoated Paper and Multiwall Bags
2675	no	yes	4.0	0.1	Die-Cut Paper and Paperboard and Cardboard
2676	no	no	-0.2	0.2	Sanitary Paper Products
2677	no	yes	6.2	0.0	Envelopes
2678	no	yes	6.6	0.4	Stationery, Tablets, and Related Products
2679	no	yes	5.0	0.1	Converted Paper and Paperboard Products, NEC
2711	no	no	-2.1	0.0	Newspapers: Publishing, or Publishing and Printing
2721	no	no	0.7	0.0	Periodicals: Publishing, or Publishing and Printing
2731	no	no	-0.2	0.1	Books: Publishing, or Publishing and Printing
2732	no	no	1.3	0.0	Book Printing
2741	no	no	2.0	2.1	Miscellaneous Publishing
2752	no	no	-0.6	0.0	Commercial Printing, Lithographic
2754	no	yes	3.4	0.0	Commercial Printing, Gravure
2759	no	yes	5.2	0.0	Commercial Printing, NEC
2761	no	yes	3.7	0.0	Manifold Business Forms
2771	no	no	1.7	0.0	Greeting Cards
2782	no	yes	4.2	0.0	Blankbooks, Looseleaf Binders and Devices
2789	no	no	-0.2	0.0	Bookbinding and Related Work

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Table C5 – *Continued from previous page*

SIC code	Durable	In baseline sample	t-stat.	Avg. def. spending share (in %)	Description
2791	no	yes	3.6	0.0	Typesetting
2796	no	no	-0.5	0.1	Platemaking and Related Services
2812	no	no	0.1	0.3	Alkalies and Chlorine
2813	no	no	0.1	2.4	Industrial Gases
2816	no	no	1.2	0.0	Inorganic Pigments
2819	no	no	0.2	0.3	Industrial Inorganic Chemicals, NEC
2821	no	yes	6.6	0.0	Plastics Materials, Synthetic and Resins, and Nonvulcanizable Elastomers
2823	no	yes	2.5	0.0	Cellulosic Manmade Fibers
2824	no	yes	6.3	0.0	Manmade Organic Fibers, Except Cellulosic
2833	no	no	1.8	0.1	Medicinal Chemicals and Botanical Products
2834	no	no	1.0	0.5	Pharmaceutical Preparations
2835	no	yes	10.1	0.4	In Vitro and In Vivo Diagnostic Substances
2836	no	yes	2.5	1.4	Biological Products, Except Diagnostic Substances
2841	no	no	-0.2	0.2	Soaps and Other Detergents, Except Specialty Cleaners
2842	no	no	0.3	0.2	Specialty Cleaning, Polishing, and Sanitation Preparations
2843	no	yes	2.5	0.0	Surface Active Agents, Finishing Agents, Sulfonated Oils, and Assistants
2844	no	no	0.7	0.1	Perfumes, Cosmetics, and Other Toilet Preparations
2851	no	yes	4.4	0.1	Paints, Varnishes, Lacquers, Enamels and Allied Products
2861	no	no	1.5	0.2	Gum and Wood Chemicals
2865	no	no	0.7	0.0	Cyclic Organic Crudes and Intermediates, and Organic Dyes and Pigments
2869	no	no	-0.4	0.1	Industrial Organic Chemicals, NEC
2873	no	no	1.3	0.0	Nitrogenous Fertilizers
2874	no	no	-0.7	0.0	Phosphatic Fertilizers
2875	no	no	1.0	0.0	Fertilizers, Mixing Only
2879	no	no	0.8	0.2	Pesticides and Agricultural Chemicals, NEC
2891	no	yes	2.3	0.0	Adhesives and Sealants
2892	no	yes	7.1	22.2	Explosives
2893	no	yes	4.9	0.1	Printing Ink
2895	no	no	0.5	0.0	Carbon Black
2899	no	yes	2.8	1.0	Chemicals and Chemical Preparations, NEC
2911	no	no	1.6	1.6	Petroleum Refining
2951	no	no	0.3	0.0	Asphalt Paving Mixtures and Blocks
2952	no	no	1.3	0.0	Asphalt Felts and Coatings
2992	no	no	-0.3	1.7	Lubricating Oils and Greases
2999	no	yes	2.4	0.2	Products of Petroleum and Coal, NEC
3011	no	no	1.2	0.7	Tires and Inner Tubes
3021	no	no	1.0	2.5	Rubber and Plastics Footwear
3052	no	no	1.2	0.4	Rubber and Plastics Hose and Belting
3053	no	yes	2.6	1.3	Gaskets, Packing, and Sealing Devices
3061	no	yes	5.5	0.0	Molded, Extruded, and Lathe-Cut Mechanical Rubber Goods
3069	no	yes	5.9	1.4	Fabricated Rubber Products, NEC
3081	no	yes	3.2	0.2	Unsupported Plastics Film and Sheet
3082	no	yes	7.1	0.0	Unsupported Plastics Profile Shapes
3083	no	no	0.2	0.5	Laminated Plastics Plate, Sheet, and Profile Shapes
3084	no	no	0.5	0.0	Plastics Pipe
3085	no	yes	2.3	0.0	Plastics Bottles
3086	no	yes	2.1	0.0	Plastics Foam Products
3087	no	no	1.0	0.0	Custom Compounding of Purchased Plastics Resins
3088	no	no	2.0	0.1	Plastics Plumbing Fixtures
3089	no	yes	4.7	0.1	Plastics Products, NEC
3111	no	yes	4.5	0.0	Leather Tanning and Finishing

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Table C5 – *Continued from previous page*

SIC code	Durable	In baseline sample	t-stat.	Avg. def. spending share (in %)	Description
3131	no	no	0.3	0.1	Boot and Shoe Cut Stock and Findings
3142	no	yes	5.1	0.2	House Slippers
3143	no	no	0.9	6.9	Mens Footwear, Except Athletic
3144	no	no	-0.2	0.8	Womens Footwear, Except Athletic
3149	no	no	0.6	5.5	Footwear, Except Rubber, NEC
3151	no	yes	2.8	12.1	Leather Gloves and Mittens
3161	no	no	0.5	0.3	Luggage
3171	no	no	-0.1	0.2	Womens Handbags and Purses
3172	no	yes	2.7	0.1	Personal Leather Goods, Except Womens Handbags and Purses
3199	no	yes	5.8	0.1	Leather Goods, NEC
3211	yes	no	1.2	0.1	Flat Glass
3221	yes	yes	2.1	0.0	Glass Containers
3229	yes	no	1.6	0.0	Pressed and Blown Glass and Glassware, NEC
3231	yes	yes	2.4	0.1	Glass Products Made of Purchased Glass
3241	yes	yes	3.1	0.0	Cement, Hydraulic
3251	yes	yes	4.5	0.0	Brick and Structural Clay Tile
3253	yes	yes	4.5	0.0	Ceramic Wall and Floor Tile
3255	yes	yes	4.3	0.1	Clay Refractories
3259	yes	yes	6.7	0.1	Structural Clay Products, NEC
3261	yes	no	1.0	2.3	Vitreous China Plumbing Fixtures and China and Earthenware Fittings and Bathroom Accessories
3262	yes	yes	2.9	0.1	Vitreous China Table and Kitchen Articles
3263	yes	no	1.9	0.2	Fine Earthenware
3264	yes	yes	3.4	0.1	Porcelain Electrical Supplies
3269	yes	yes	2.1	0.0	Pottery Products, NEC
3271	yes	yes	6.9	0.1	Concrete Block and Brick
3272	yes	yes	4.5	0.4	Concrete Products, Except Block and Brick
3273	yes	yes	3.9	0.0	Ready-Mixed Concrete
3274	yes	yes	2.5	0.2	Lime
3275	yes	yes	3.0	0.0	Gypsum Products
3281	yes	yes	2.6	0.2	Cut Stone and Stone Products
3291	yes	yes	2.3	0.1	Abrasive Products
3292	yes	yes	2.9	0.3	Asbestos Products
3295	yes	yes	4.6	5.3	Minerals and Earths, Ground or Otherwise Treated
3296	yes	yes	3.7	0.1	Mineral Wool
3297	yes	yes	3.2	0.1	Nonclay Refractories
3299	yes	yes	3.1	1.1	Nonmetallic Mineral Products, NEC
3312	yes	yes	2.1	0.0	Steel Works, Blast Furnaces
3313	yes	no	0.2	0.9	Electrometallurgical Products, Except Steel
3315	yes	yes	4.1	1.1	Steel Wiredrawing and Steel Nails and Spikes
3316	yes	no	1.4	0.3	Cold-Rolled Steel Sheet, Strip, and Bars
3317	yes	no	0.7	0.2	Steel Pipe and Tubes
3321	yes	no	1.9	0.0	Gray and Ductile Iron Foundries
3324	yes	yes	6.5	0.0	Steel Investment Foundries
3325	yes	yes	4.9	0.1	Steel Foundries, NEC
3331	yes	no	1.4	0.0	Primary Smelting and Refining of Copper
3334	yes	no	1.0	0.0	Primary Production of Aluminum
3339	yes	no	-0.5	0.3	Primary Smelting and Refining of Nonferrous Metals, Except Copper and Aluminum
3341	yes	no	-0.5	0.1	Secondary Smelting and Refining of Nonferrous Metals
3351	yes	no	0.3	0.1	Rolling, Drawing, and Extruding of Copper
3353	yes	no	1.5	0.1	Aluminum Sheet, Plate, and Foil
3354	yes	yes	4.8	0.1	Aluminum Extruded Products
3355	yes	yes	3.2	0.1	Aluminum Rolling and Drawing, NEC

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Table C5 – *Continued from previous page*

SIC code	Durable	In baseline sample	t-stat.	Avg. def. spending share (in %)	Description
3356	yes	yes	2.5	0.2	Rolling, Drawing, and Extruding of Nonferrous Metals, Except Copper and Aluminum
3357	yes	no	1.1	0.5	Drawing and Insulating of Nonferrous Wire
3363	yes	yes	4.1	0.0	Aluminum Die-Castings
3364	yes	yes	3.7	0.0	Nonferrous Die-Castings, Except Aluminum
3365	yes	yes	3.1	0.0	Aluminum Foundries
3369	yes	yes	3.9	0.2	Nonferrous Foundries, Except Aluminum and Copper
3398	yes	yes	2.6	0.3	Metal Heat Treating
3399	yes	yes	5.0	1.4	Primary Metal Products, NEC
3411	yes	yes	2.3	0.1	Metal Cans
3412	yes	yes	4.9	1.6	Metal Shipping Barrels, Drums, Kegs, and Pails
3421	yes	no	0.3	1.0	Cutlery
3423	yes	yes	5.0	0.5	Hand and Edge Tools, Except Machine Tools and Handsaws
3425	yes	no	1.9	0.1	Saw Blades and Handsaws
3429	yes	yes	6.0	6.2	Hardware, NEC
3431	yes	yes	3.8	0.5	Enameled Iron and Metal Sanitary Ware
3432	yes	yes	4.4	0.1	Plumbing Fixture Fittings and Trim
3433	yes	yes	3.5	0.7	Heating Equipment, Except Electric and Warm Air Furnaces
3441	yes	yes	8.2	0.4	Fabricated Structural Metal
3442	yes	yes	5.2	0.1	Metal Doors, Sash, Frames, Molding, and Trim
3443	yes	no	1.6	6.1	Fabricated Plate Work
3444	yes	yes	6.6	0.1	Sheet Metal Work
3446	yes	yes	3.8	0.1	Architectural and Ornamental Metal Work
3448	yes	yes	5.4	1.9	Prefabricated Metal Buildings and Components
3449	yes	yes	6.0	0.4	Miscellaneous Structural Metal Work
3451	yes	yes	6.4	0.1	Screw Machine Products
3452	yes	yes	2.5	1.6	Bolts, Nuts, Screws, Rivets, and Washers
3462	yes	yes	5.9	0.8	Iron and Steel Forgings
3463	yes	yes	6.4	0.3	Nonferrous Forgings
3465	yes	yes	2.6	0.0	Automotive Stampings
3466	yes	yes	3.8	0.1	Crowns and Closures
3469	yes	yes	4.8	0.1	Metal Stampings, NEC
3471	yes	no	0.9	0.0	Electroplating, Plating, Polishing, Anodizing, and Coloring
3479	yes	yes	3.1	0.1	Coating, Engraving, and Allied Services, NEC
3482	yes	no	6.5	41.3	Small Arms Ammunition
3484	yes	yes	7.3	16.3	Small Arms
3489	yes	no	7.7	53.3	Ordnance and Accessories, NEC
3491	yes	yes	3.0	0.3	Industrial Valves
3492	yes	yes	2.7	0.4	Fluid Power Valves and Hose Fittings
3493	yes	yes	3.7	0.7	Steel Springs, Except Wire
3494	yes	yes	2.2	6.4	Valves and Pipe Fittings, NEC
3495	yes	yes	3.7	0.3	Wire Springs
3496	yes	yes	3.1	0.7	Miscellaneous Fabricated Wire Products
3497	yes	yes	2.5	0.0	Metal Foil and Leaf
3498	yes	no	1.7	0.2	Fabricated Pipe and Pipe Fittings
3499	yes	yes	15.3	4.3	Fabricated Metal Products, NEC
3511	yes	yes	5.4	8.6	Steam, Gas, and Hydraulic Turbines, and Turbine Generator Set Units
3519	yes	yes	5.0	1.6	Internal Combustion Engines, NEC
3523	yes	yes	3.9	0.0	Farm Machinery and Equipment
3524	yes	no	0.3	0.1	Lawn and Garden Tractors and Home Lawn and Garden Equipment
3531	yes	yes	7.4	0.9	Construction Machinery and Equipment
3532	yes	yes	2.5	0.3	Mining Machinery and Equipment, Except Oil and Gas Field Machinery and Equipment

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Table C5 – *Continued from previous page*

SIC code	Durable	In baseline sample	t-stat.	Avg. def. spending share (in %)	Description
3533	yes	yes	4.0	0.0	Oil and Gas Field Machinery and Equipment
3534	yes	yes	3.3	0.7	Elevators and Moving Stairways
3535	yes	yes	3.7	0.6	Conveyors and Conveying Equipment
3536	yes	yes	2.6	3.8	Overhead Traveling Cranes, Hoists, and Monorail Systems
3537	yes	yes	5.0	5.7	Industrial Trucks, Tractors, Trailers, and Stackers
3541	yes	yes	3.5	1.6	Machine Tools, Metal Cutting Types
3542	yes	yes	4.6	1.2	Machine Tools, Metal Forming Type
3543	yes	yes	4.3	0.1	Industrial Patterns
3544	yes	yes	3.2	0.1	Special Dies and Tools, Die Sets, Jigs and Fixtures, and Industrial Molds
3545	yes	yes	5.6	0.4	Cutting Tools, Machine Tool Accessories, and Machinist Precision Measuring Devices
3546	yes	yes	4.5	0.7	Power-Driven Handtools
3547	yes	no	0.8	0.1	Rolling Mill Machinery and Equipment
3552	yes	no	1.7	0.1	Textile Machinery
3553	yes	no	1.3	0.3	Woodworking Machinery
3554	yes	no	0.2	0.1	Paper Industries Machinery
3555	yes	no	0.1	0.3	Printing Trades Machinery and Equipment
3556	yes	yes	3.2	0.3	Food Products Machinery
3559	yes	yes	2.7	4.8	Special Industry Machinery, NEC
3561	yes	yes	4.7	1.6	Pumps and Pumping Equipment
3562	yes	yes	3.1	1.7	Ball and Roller Bearings
3563	yes	yes	4.7	0.7	Air and Gas Compressors
3564	yes	no	1.7	1.2	Industrial and Commercial Fans and Blowers and Air Purification Equipment
3565	yes	yes	3.1	0.1	Packaging Machinery
3566	yes	yes	6.1	6.5	Speed Changers, Industrial High-Speed Drives, and Gears
3567	yes	yes	3.0	0.8	Industrial Process Furnaces and Ovens
3568	yes	yes	3.5	2.9	Mechanical Power Transmission Equipment, NEC
3569	yes	yes	8.8	2.7	General Industrial Machinery and Equipment, NEC
3571	yes	yes	7.6	4.2	Electronic Computers
3572	yes	yes	3.7	1.3	Computer Storage Devices
3575	yes	no	-1.8	11.2	Computer Terminals
3577	yes	no	1.9	3.1	Computer Peripheral Equipment, NEC
3578	yes	yes	2.7	1.1	Calculating and Accounting Machinery, Except Electronic Computers
3579	yes	no	-0.3	2.1	Office Machines, NEC
3581	yes	no	0.6	0.3	Automatic Vending Machines
3582	yes	no	1.8	1.5	Commercial Laundry, Drycleaning, and Pressing Machines
3585	yes	yes	3.0	0.4	Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment
3586	yes	yes	2.6	1.3	Measuring and Dispensing Pumps
3589	yes	yes	3.4	1.2	Service Industry Machinery, NEC
3592	yes	yes	3.0	0.4	Carburetors, Pistons, Piston Rings, and Valves
3593	yes	yes	4.0	0.2	Fluid Power Cylinders and Actuators
3594	yes	yes	2.6	0.9	Fluid Power Pumps and Motors
3596	yes	yes	3.1	0.7	Scales and Balances, Except Laboratory
3599	yes	yes	6.9	0.6	Industrial and Commercial Machinery and Equipment, NEC
3612	yes	yes	3.0	3.7	Power, Distribution, and Specialty Transformers
3613	yes	yes	5.8	1.0	Switchgear and Switchboard Apparatus
3621	yes	yes	6.4	3.5	Motors and Generators
3624	yes	yes	2.7	0.6	Carbon and Graphite Products
3625	yes	no	0.8	0.4	Relays and Industrial Controls
3629	yes	yes	3.8	1.8	Electrical Industrial Apparatus, NEC

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Table C5 – *Continued from previous page*

SIC code	Durable	In baseline sample	t-stat.	Avg. def. spending share (in %)	Description
3631	yes	no	1.4	0.1	Household Cooking Equipment
3632	yes	yes	2.5	0.1	Household Refrigerators and Home and Farm Freezers
3633	yes	yes	3.5	0.1	Household Laundry Equipment
3634	yes	yes	3.1	0.1	Electric Housewares and Fans
3635	yes	no	-0.7	0.0	Household Vacuum Cleaners
3639	yes	yes	3.2	0.2	Household Appliances, NEC
3641	yes	yes	4.2	0.2	Electric Lamp Bulbs and Tubes
3643	yes	yes	3.7	1.6	Current-Carrying Wiring Devices
3644	yes	no	0.3	1.7	Noncurrent-Carrying Wiring Devices
3645	yes	no	1.8	0.2	Residential Electric Lighting Fixtures
3646	yes	yes	3.9	0.1	Commercial, Industrial, and Institutional Electric Lighting Fixtures
3647	yes	yes	4.0	1.7	Vehicular Lighting Equipment
3648	yes	yes	4.8	1.3	Lighting Equipment, NEC
3651	yes	yes	7.0	0.8	Household Audio and Video Equipment
3652	yes	no	-0.4	0.2	Phonograph Records and Prerecorded Audio Tapes and Disks
3661	yes	yes	7.7	2.0	Telephone and Telegraph Apparatus
3663	yes	yes	8.2	11.6	Radio and Television Broadcasting and Communications Equipment
3671	yes	yes	3.6	23.1	Electron Tubes
3672	yes	yes	5.8	2.7	Printed Circuit Boards
3674	yes	yes	2.0	0.4	Semiconductors and Related Devices
3675	yes	yes	7.4	0.7	Electronic Capacitors
3676	yes	yes	4.5	3.0	Electronic Resistors
3677	yes	yes	3.6	1.5	Electronic Coils, Transformers, and Other Inductors
3678	yes	yes	3.7	0.5	Electronic Connectors
3679	yes	yes	7.9	6.6	Electronic Components, NEC
3691	yes	no	0.5	1.5	Storage Batteries
3692	yes	no	1.8	4.4	Primary Batteries, Dry and Wet
3694	yes	yes	4.5	0.8	Electrical Equipment for Internal Combustion Engines
3695	yes	yes	4.7	2.8	Magnetic and Optical Recording Media
3699	yes	yes	6.9	10.8	Electrical Machinery, Equipment, and Supplies, NEC
3711	yes	yes	6.3	0.9	Motor Vehicles and Passenger Car Bodies
3713	yes	yes	5.9	0.5	Truck and Bus Bodies
3714	yes	yes	5.8	0.5	Motor Vehicle Parts and Accessories
3715	yes	yes	5.6	4.3	Truck Trailers
3716	yes	yes	3.6	0.2	Motor Homes
3721	yes	yes	5.8	29.4	Aircraft
3724	yes	yes	4.8	27.6	Aircraft Engines and Engine Parts
3728	yes	no	15.8	52.3	Aircraft Parts and Auxiliary Equipment, NEC
3732	yes	yes	2.0	1.2	Boat Building and Repairing
3743	yes	yes	2.4	0.2	Railroad Equipment
3751	yes	yes	4.3	0.5	Motorcycles, Bicycles, and Parts
3761	yes	no	8.9	56.6	Guided Missiles and Space Vehicles
3764	yes	yes	3.6	12.5	Guided Missile and Space Vehicle Propulsion Units and Propulsion Unit Parts
3792	yes	yes	6.1	0.1	Travel Trailers and Campers
3799	yes	yes	10.1	1.5	Transportation Equipment, NEC
3812	yes	yes	11.6	15.1	Search, Detection, Navigation, Guidance, Aeronautical, and Nautical Systems and Instruments
3821	yes	yes	6.1	1.9	Laboratory Apparatus and Furniture
3822	yes	yes	4.0	0.8	Automatic Controls for Regulating Residential and Commercial Environments and Appliances
3823	yes	yes	7.0	1.2	Industrial Instruments for Measurement, Display, and Control of Process Variables; and Related Products

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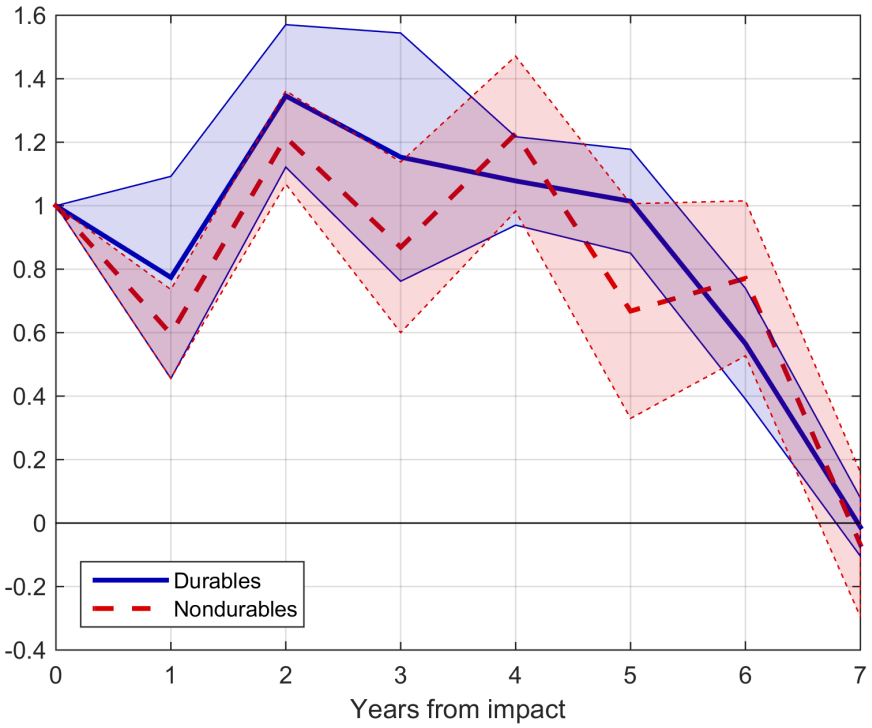
Table C5 – *Continued from previous page*

SIC code	Durable	In baseline sample	t-stat.	Avg. def. spending share (in %)	Description
3824	yes	yes	4.1	0.9	Totalizing Fluid Meters and Counting Devices
3825	yes	yes	6.9	4.2	Instruments for Measuring and Testing of Electricity and Electrical Signals
3826	yes	yes	6.3	1.6	Laboratory Analytical Instruments
3827	yes	yes	4.8	10.0	Optical Instruments and Lenses
3829	yes	yes	7.7	7.2	Measuring and Controlling Devices, NEC
3841	yes	yes	9.0	1.3	Surgical and Medical Instruments and Apparatus
3842	yes	yes	6.8	2.1	Orthopedic, Prosthetic, and Surgical Appliances and Supplies
3843	yes	yes	3.6	2.1	Dental Equipment and Supplies
3844	yes	yes	4.7	1.3	X-Ray Apparatus and Tubes and Related Irradiation Apparatus
3845	yes	yes	7.9	0.3	Electromedical and Electrotherapeutic Apparatus
3851	yes	yes	7.6	0.6	Ophthalmic Goods
3861	yes	yes	4.4	0.7	Photographic Equipment and Supplies
3873	yes	yes	3.5	0.7	Watches, Clocks, Clockwork Operated Devices, and Parts
3911	yes	no	0.0	0.0	Jewelry, Precious Metal
3914	yes	no	-0.4	0.0	Silverware, Plated Ware, and Stainless Steel Ware
3915	yes	no	1.8	0.2	Jewelers Findings and Materials and Lapidary Work
3931	yes	yes	2.6	0.1	Musical Instruments
3942	yes	yes	2.9	0.1	Dolls and Stuffed Toys
3944	yes	no	-0.1	0.0	Games, Toys, and Childrens Vehicles, Except Dolls and Bicycles
3949	yes	yes	3.6	0.5	Sporting and Athletic Goods, NEC
3951	yes	yes	3.6	0.2	Pens, Mechanical Pencils, and Parts
3952	yes	yes	3.9	0.0	Lead Pencils and Art Goods
3953	yes	yes	2.2	0.1	Marking Devices
3955	yes	yes	4.0	0.4	Carbon Paper and Inked Ribbons
3961	yes	no	1.1	0.5	Costume Jewelry and Costume Novelties, Except Precious Metal
3965	yes	yes	3.3	0.4	Fasteners, Buttons, Needles, and Pins
3991	yes	no	0.5	0.2	Brooms and Brushes
3993	yes	yes	3.2	0.4	Signs and Advertising Specialties
3995	yes	yes	4.0	0.1	Burial Caskets
3996	yes	yes	4.2	0.0	Linoleum, Asphalted-Felt-Base, and Other Hard Surface Floor Coverings, NEC
3999	yes	no	1.1	2.1	Manufacturing Industries, NEC

C.3 Additional results

Figure C2: Spending response for durable and nondurable goods



Notes: The figure plots impulse response functions of military spending for the baseline sample estimated using specification (20). Shaded regions mark 90 percent confidence bands based on standard errors that are clustered at the industry level.

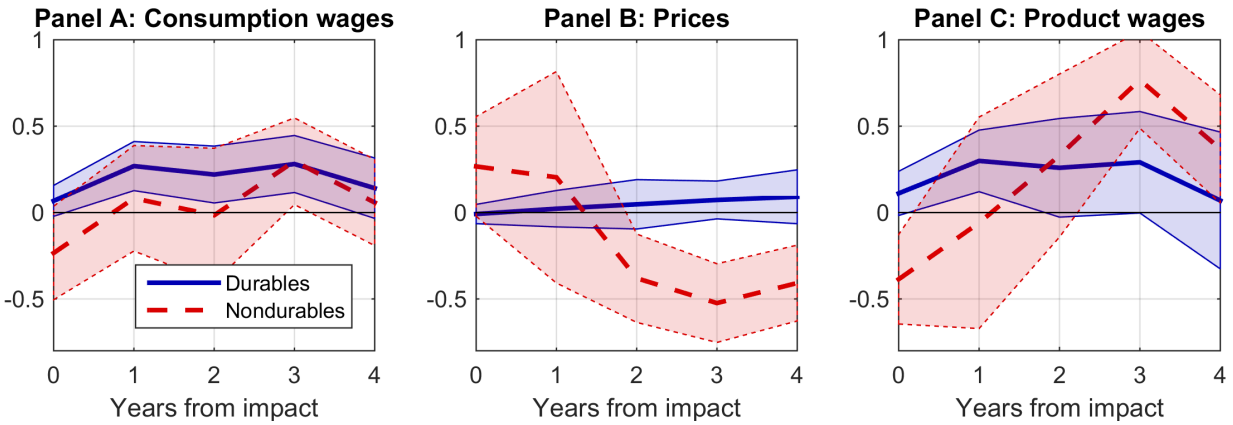
C.3.1 Impulse response functions of prices

I estimate the specification

$$\frac{P_{i,t+h} - P^T_{i,t-1}}{P^T_{i,t-1}} = \alpha_h \frac{G_{i,t} - G^T_{i,t-1}}{VA^T_{i,t-1}} + \beta_h \frac{P_{i,t-1} - P^T_{i,t-2}}{P^T_{i,t-2}} + \gamma_h \frac{G_{i,t-1} - G^T_{i,t-2}}{VA^T_{i,t-2}} + \delta_{i,h} + \zeta_{t,h} + \varepsilon_{i,t+h}, \quad \text{(A19)}$$

where $P_{i,t}$ denotes the industry's consumption wage, price, or product wage. The coefficients $\{\alpha_h\}_{h=0}^4$ are now akin to semi-elasticities and interpreted as follows. When the difference between government spending and its trend, normalized by the sector's value added, rises by one, the government engages, on average, in further spending in subsequent periods as shown in Panel A of Figure 5. This spending path is associated with a price response, expressed as a percentage deviation from trend, given by $\{\alpha_h\}_{h=0}^4$. As before, spending at the sector level is instrumented with interactions of aggregate spending and sector dummies.

Figure C3: Impulse response functions of prices



Notes: The figure plots impulse response functions estimated from specification (A19) for the baseline sample as described in the text. The shock is a unit increase of government spending above trend, normalized by the sector's value added. Shaded regions mark 90 percent confidence bands based on standard errors that are clustered at the industry level.

Figure C3 displays the results. As Panel A shows, consumption wages in both types of sectors rise about 25 basis points above trend. There is no meaningful difference between nondurable and durable goods sectors.

Prices in durable goods sectors increase slightly and only insignificantly so (Panel B). In contrast, prices in nondurable goods sectors fall by about 50 basis points. The response of durable goods prices is roughly in line with the theory. Due to their high price sensitivity, fluctuations of durable goods prices should generally be small and hard to detect.[24] However, the price decline in nondurable goods sectors is surprising and inconsistent with the theory. One possible explanation is a composition effect. The military likely purchases a different basket of goods from a particular sector than the private sector. If the basket purchased by the military has a lower price than that purchased by the private sector, then a price decline as that in Panel B would be observed. Another possible explanation is that the government purchases goods in bulk and receives greater discounts than the private sector. Given that many nondurable goods sectors in the sample produce food, this explanation seems plausible. Yet, the decline of prices in response to greater government spending remains puzzling. For completeness, Panel C displays the impulse response functions of product wages.

[24] See, for example, House and Shapiro (2008).

C.4 Robustness

C.4.1 Robustness of durables and nondurables multipliers

Table C6: Sectoral multipliers when controlling for Ramey's news variable

	Durable goods			Nondurable goods		
Years after shock	1	2	3	1	2	3
Gross output	0.26	0.12	0.33	3.47	1.97	3.10
Value added	0.60	0.52	0.75	1.53	0.97	1.85
Cost of materials	-0.32	-0.45	-0.47	1.41	0.38	0.74
Energy expenditures	0.007	0.001	0.005	0.041	0.025	0.038
Employment (employees per year per $1m)	6.68	7.08	9.80	23.81	9.15	19.92

Notes: See notes of Table 3. The estimates are based on specification (20), augmented by Ramey's news variable interacted with industry indicators.

Table C7: Sectoral multipliers when allowing for industry-specific effects of monetary policy

	Durable goods			Nondurable goods		
Years after shock	1	2	3	1	2	3
Gross output	0.20	-0.03	0.01	2.97	2.22	2.52
Value added	0.55	0.49	0.62	1.33	1.08	1.38
Cost of materials	-0.46	-0.66	-0.71	1.34	0.82	0.91
Energy expenditures	0.005	-0.001	0.000	0.035	0.030	0.031
Employment (employees per year per $1m)	5.73	6.27	7.92	14.44	6.43	9.71

Notes: See notes of Table 3. The estimates are based on specification (20), augmented by interactions of the real interest rate with industry indicators.

C.5 Alternative sample construction

Intuitively, many instruments lead to an overfitting in the first stage. The predicted values then carry some of the undesired variation, which the instrumentation was designed to eliminate, into the second stage. The 2SLS estimator is biased towards OLS in the presence of a many instruments problem. I therefore limit the sample to industries for which aggregate military spending has very strong predictive power.[25]

This restricted sample is constructed as follows. I estimate the first stage of specification (20) (without the time fixed effect) industry by industry. From the results, I compute the Cragg and Donald (1993) statistic — again for every industry. The Cragg-Donald (C-D) statistic summarizes the strength of the first stage in a single number with greater values indicating stronger instruments.[26] It can therefore be viewed as an analogue of the F-statistic when there are multiple endogenous regressors.

Figure (C4) Panel A shows a histogram of the C-D statistics of all industries. I construct this restricted sample from all industries with C-D statistics greater than 2. The sample is now much smaller. It contains 31 nondurable goods industries and 60 durable goods industries. The sample composition is shown in Table C4.

Table C8 shows the multipliers based on this restricted sample. Although the sample has been reduced to about one third of its size, the results are very similar to those in the baseline sample (Table 3).

As an additional robustness exercise, I construct a Bartik-type instrument (Bartik, 1991) as the average of $\frac{G_{i,t}/VA_{i,t}}{G_t/VA_t}$ over the sample period times $\left(G_t - G_{t-1}^T\right)/VA_{t-1}^T$. This alternative strategy results in exact identification and there is no risk of a many instrument problem. The Cragg-Donald statistic is now over 136 for the estimation of specification (20) on nondurables and over 210 for durable goods. The results are quite similar to the earlier ones and shown in Table C9.

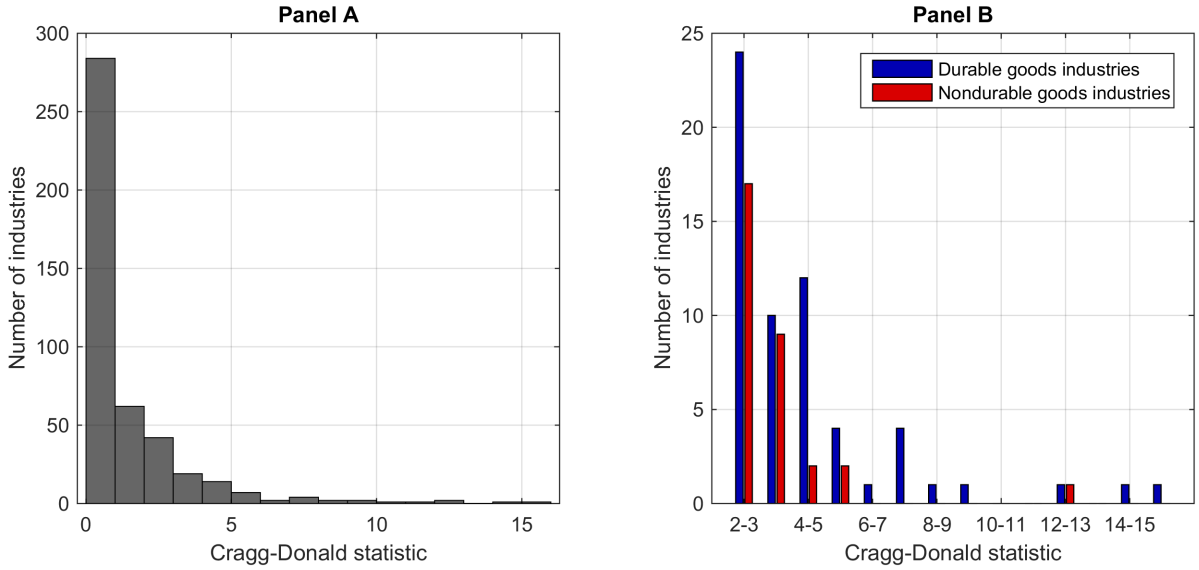
I have also estimated specification (20) on the baseline sample, using the Bartik instrument. Unfortunately, the standard errors are so large that the results are not informative.

C.5.1 Robustness of state-dependent multipliers

[25] Among others, Hansen, Hausman, and Newey (2008), suggest to use the limited information maximum likelihood (LIML) estimator when there is a concern for weak instruments, since it is less biased than 2SLS. Unfortunately, the LIML estimator's limiting distribution has no finite moments, as discussed in Davidson and MacKinnon (1993, pp. 649-650), and can give rise to extreme estimates. When I use the LIML estimator, I obtain very similar results for several estimates, but a number extreme values as well.

[26] Stock and Yogo (2002) show that the Cragg-Donald statistic can be used to test whether a set of instruments is weak.

Figure C4: Predictive power of the instrument by industry



Notes: The Cragg-Donald statistics are obtained from the first stage of the 2SLS estimator of equation (20), estimated sector by sector and without the time fixed effect.

Table C8: Estimates based on the restricted sample

	Durable goods			Nondurable goods		
Years after shock	1	2	3	1	2	3
Gross output	0.15	0.12	0.34	2.81	2.64	2.65
Value added	0.40	0.46	0.68	1.86	1.75	1.75
Cost of materials	-0.21	-0.29	-0.22	0.89	0.75	0.71
Energy expenditures	-0.003	-0.002	0.000	0.055	0.052	0.051
Employment (employees per year per $1m)	3.79	5.01	7.00	8.33	8.68	11.34

Notes: See notes of Table 3. The results in this table are obtained using the restricted sample.

Table C9: Estimates of sectoral multipliers using the Bartik instrument

	Durable goods			Nondurable goods		
Years after shock	1	2	3	1	2	3
Gross output	0.44	0.35	0.59	2.50	2.40	2.47
Value added	0.56	0.61	0.84	1.73	1.63	1.66
Cost of materials	0.10	-0.03	0.03	0.75	0.65	0.65
Energy expenditures	-0.005	-0.004	-0.002	0.047	0.049	0.051
Employment (employees per year per $1m)	5.26	5.98	7.73	7.07	7.96	10.98

Notes: See notes of Table 3. The results in this table are obtained using the Bartik instrument.

Table C10: State dependent multipliers using restricted sample

	Recessions			Expansions		
Years after shock	1	2	3	1	2	3
Gross output	0.69	1.53	2.53	-0.41	-1.41	-1.63
Value added	1.08	1.44	1.87	0.03	-0.34	-0.21
Cost of materials	-0.03	0.31	0.77	-0.53	-1.05	-1.22
Energy expenditures	-0.003	-0.006	-0.002	0.001	0.002	-0.001
Employment (employees per year per $1m)	6.41	11.55	17.54	-1.72	-4.95	-5.43

Notes: See notes of Table 3. The results are based on specification (22), using the restricted sample as described in Appendix C.5.

Table C11: State dependent multipliers with Bartik-type instrument

	Recessions			Expansions		
Years after shock	1	2	3	1	2	3
Gross output	-0.10	1.10	2.18	1.19	-0.42	-0.55
Value added	0.71	1.36	1.97	0.46	-0.08	0.08
Cost of materials	-0.55	-0.05	0.42	0.97	-0.12	-0.34
Energy expenditures	-0.005	-0.005	0.002	-0.006	-0.003	-0.007
Employment (employees per year per $1m)	2.93	10.65	17.54	7.73	0.48	-0.28

Notes: See notes of Table 3. The results are based on specification (22), using the Bartik-type instrument and the restricted sample as described in Appendix C.5.

C.6 Additional robustness exercises

In this part of the Appendix I report results of additional robustness tests.

One question that arises is that firms (or their establishments) produce goods for the military that are categorized differently than goods for the private sector. An example of this phenomenon is that a car manufacturer produces tanks rather than passenger automobiles in war times. To address this concern I repeat the analysis after collapsing the industries to the 3-digit level. The multipliers for nondurable goods industries should be interpreted with care since the sample size is small and the standard errors are extremely large. The results are shown in Table C12.

Table C12: Sectoral multipliers estimated from 3-digit SIC industries

	Durable goods			Nondurable goods		
Years after shock	1	2	3	1	2	3
Gross output	0.35	0.22	0.32	6.66	4.73	6.98
Value added	0.31	0.27	0.34	2.95	1.52	3.38
Cost of materials	0.12	0.00	-0.02	3.33	1.08	-1.60
Energy expenditures	0.006	0.001	0.002	-0.181	-0.105	-0.096
Employment (employees per year per $1m)	0.47	0.50	1.59	3.52	-118.57	-217.61

Notes: See notes of Table 3. The estimates are based on specification (20) and the data is collapsed to the 3-digit SIC level, resulting in 32 nondurable goods industries and 61 durable goods industries.

Tables C13 and show the multipliers when the trends of all variables are obtained using smoothing parameters of 400 and 5000. The estimates are barely affected.

Table C13: Sectoral multipliers for a smoothing parameter of 400

	Durable goods			Nondurable goods		
Years after shock	1	2	3	1	2	3
Gross output	0.42	0.17	0.22	1.65	1.29	1.85
Value added	0.50	0.43	0.57	0.75	0.57	0.91
Cost of materials	-0.08	-0.26	-0.25	0.63	0.34	0.55
Energy expenditures	0.014	0.011	0.013	0.015	0.015	0.023
Employment (employees per year per $1m)	6.46	7.57	10.08	9.62	3.70	6.48

Notes: See notes of Table 3. The results in this table are obtained when the trends for all variables are extracted with a smoothing parameter of 400.

Table C14: Sectoral multipliers for a smoothing parameter of 5000

	Durable goods			Nondurable goods		
Years after shock	1	2	3	1	2	3
Gross output	-0.04	-0.10	-0.05	3.36	2.85	3.11
Value added	0.48	0.50	0.61	1.40	1.30	1.57
Cost of materials	-0.54	-0.64	-0.66	1.60	1.16	1.18
Energy expenditures	-0.003	-0.006	-0.006	0.053	0.050	0.051
Employment (employees per year per $1m)	3.90	4.82	6.35	12.09	6.88	9.39

Notes: See notes of Table 3. The results in this table are obtained when the trends for all variables are extracted with a smoothing parameter of 5000.