Fiscal Stimulus in a Monetary Union: Evidence from U.S. Regions

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Abstract

We use rich historical data on military procurement spending across U.S. regions to estimate the effects of government spending in a monetary union. Aggregate military build-ups and draw-downs have differential effects across regions. We use this variation to estimate an open economy relative government spending multiplier of approximately 1.5. We develop a framework for interpreting this estimate and relating it to estimates of closed economy aggregate multipliers. The closed economy aggregate multiplier is highly sensitive to how strongly aggregate monetary and tax policy "leans against the wind." In contrast, our estimate "differences out" these effects because different regions in the union share a common monetary and tax policy. Our estimate provides evidence in favor of models in which demand shocks can have large effects on output.

Keywords: Fiscal stimulus, Government Spending, Multiplier, Monetary Union.

JEL Classification: E62, E32

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1 Introduction

The effect of government spending on output is often summarized by a multiplier—the percentage increase in output that results when government spending is increased by 1% of GDP. There is a wide range of views about this statistic in the literature. On the one hand, the recent American Recovery and Reinvestment Act (ARRA)—perhaps the largest fiscal stimulus plan in U.S. history—was motivated by a relatively high estimate of the multiplier of 1.6 (Romer and Bernstein, 2009). Other studies argue that the multiplier is substantially less than one and potentially close to zero. In particular, if the determination of output is dominated by supply-side factors, an increase in government purchases to a large extent "crowds out" private sector consumption and investment.

The wide range of views on the multiplier arises in part from the difficulty of measuring it. Changes in government spending are rarely exogenous, leading to a range of estimates depending on the estimation approach.[1] Two main approaches have been used to estimate the multiplier in the academic literature. The first is to study the output effects of increases in military spending associated with wars, which are plausibly unrelated to prevailing macroeconomic conditions (Ramey and Shapiro, 1998; Edelberg, Eichenbaum and Fisher, 1999; Burnside, Eichenbaum and Fisher, 2004; Ramey, 2010; Barro and Redlick, 2011; Fisher and Peters, 2010). The main obstacle faced by this approach is the relative infrequency of large wars.[2] The second main approach used to identify the multiplier is the structural VAR approach (Blanchard and Perotti, 2002; Perotti, 2007; Mountford and Uhlig, 2008; Ilzetzki, Mendoza and Vegh, 2010). This approach relies on structural assumptions about output and fiscal policy dynamics to estimate the multiplier.

The wide range of views on the multiplier also results from a lack of clear predictions in the theoretical literature. The government spending multiplier is not a deep structural parameter like the elasticity of labor supply or the intertemporal elasticity of substitution. Different models, therefore, differ in their implications about the multiplier depending on what is assumed about preferences, technology, government policy and various "frictions." Simple versions of the Neoclassical model generally imply a small multiplier, typically smaller than 0.5 (see, e.g., Baxter and King, 1993).

[1] For surveys of the existing evidence, see for example Perotti (2007), Hall (2009), Alesina and Ardagna (2009) and Cogan et al. (2010).

[2] Most of the evidence from this approach derives from the U.S. experience during WWII and the Korean War, when changes in U.S. military spending were largest and most abrupt as a fraction of total output. However, confounding variation associated with wartime price controls, patriotism, tax increases, and other macroeconomic shocks remain sources of intense debate regarding the evidence from these episodes. Hall (2009) and Barro and Redlick (2011) emphasize that it is not possible to draw meaningful inference using aggregate data on military spending after 1955 because there is insufficient variation in military spending in this period.

The multiplier is sensitive to how the spending is financed—smaller if it is financed by distortionary taxes than lump sum taxes.[3] In New Keynesian models, the size of the multiplier depends critically on the extent to which monetary policy "leans against the wind." Strongly counter-cyclical monetary policy—such as that commonly estimated for the Volcker-Greenspan period—can generate quite low multipliers—comparable to those for the Neoclassical model. However, when monetary policy is less responsive—e.g., at the zero lower bound—the multiplier can exceed two.[4] Clearly, there is no "single" government spending multiplier. All estimates of the government spending multiplier depend on the policy regime in place. This is likely one contributing factor for the wide range of empirical estimates of the multiplier discussed above.

We analyze the effects of government spending in a monetary and fiscal union—the United States. In this setting, we estimate the effect that an increase in government spending in one region of the union relative to another has on relative output and employment. We refer to this as the "open economy relative multiplier." Studying a monetary union has the unique advantage that the relative monetary policy is pinned down by the fact that the nominal interest rate is common across the entire region (and the exchange rate is fixed). This implies that increased spending in one region relative to another cannot lead to tighter monetary policy in that region relative to the other. Also, federal spending is financed by federal taxes levied in the same way across regions. An increase in federal spending in one region relative another, therefore, does not increase current or future tax rates in that region relative to other regions. We show that an important advantage of being able to precisely specify relative policy across regions is that we can more easily distinguish between different models of the economy.

We use regional variation in military spending to estimate the multiplier. When national military procurement rises by 1 percentage point of GDP, it rises on average by more than 3 percentage points in defense-intensive states such as California and Connecticut, but by less than one-half of one percent in defense-insensitive states such as Illinois. This heterogeneity in sensitivity to aggregate military build-ups and draw-downs across regions is the source of variation we use to estimate the effects of government spending shocks on output, employment and prices.[5]

[3]See, e.g., Baxter and King (1993), Ohanian (1997), Corsetti et al., 2009, and Drautzburg and Uhlig (2011).

[4]Intuitively, at the zero lower bound, monetary policy is rendered impotent and a fiscal expansion is particularly effective since it lowers real interest rates by raising inflation (Eggertsson, 2010; Christiano, Eichenbaum, and Rebelo, 2010).

[5]Since regional variations in military procurement is much larger than aggregate variation, this approach allows us to overturn the conclusion from the literature that focuses on aggregate data that little can be learned about fiscal multipliers from the post-1960 data. Data from this period may be more informative about the size of the fiscal multiplier for "normal times" and "normal purchases" than data from WWII and the Korean war. Several authors

A common identifying assumption in the empirical literature on the effects of military spending is that variation in military spending is exogenous to the U.S. business cycle. Our key identifying assumption is similar but weaker. We assume that the U.S. does not embark on military buildups—such as those associated with the Vietnam war and the Soviet invasion of Afghanistan—because defense oriented states are doing poorly relative to other states. We do not require that idiosyncratic variations in military procurement—such as the increase in procurement spending in Texas during the presidency of George W. Bush—are exogenous to local economic conditions.[6] By including time fixed effects, we control for aggregate shocks that affect all states at a particular point in time—such as changes in distortionary taxes and aggregate monetary policy.

We estimate the "open economy relative multiplier" to be 1.5. In other words, when relative per-capita government purchases in a region rises by 1% of regional output, relative per-capita output in that region rises by 1.5%. As we emphasize above, our open economy relative multiplier differs from a "closed economy aggregate multiplier" one might estimate using aggregate U.S. data. We develop a theoretical framework to help us interpret our multiplier estimate and assess how it relates to the closed economy aggregate multiplier for the United States. Our main conclusion is that our estimate favors models in which demand shocks can have large effects on output. Our estimate lines up well with the multiplier implied by an open economy New Keynesian model in which consumption and work are complements.[7] Benchmark New Keynesian and Neoclassical models, however, yield lower open economy relative multipliers.

Our estimate of 1.5 for the open economy relative multiplier is perfectly consistent with much lower existing estimates of the closed economy aggregate multiplier. A likely reason for the difference is that the relative monetary policy across regions—fixed relative nominal rate and exchange rate—is less counter-cyclical than aggregate monetary policy in the U.S.—which raises the real interest rate substantially in response to inflationary shocks. Our open economy relative multiplier is thus akin to an aggregate multiplier for a more accommodative monetary policy than the one seen in the United States.

The logic for why the open economy relative multiplier is higher than the closed economy

suggest that the multiplier may be different for military versus non-military spending, but these findings rely heavily on the WWII and Korean War experiences when aggregate variation in military spending was largest (e.g., Perotti 2007; Auerbach and Gorodnichenko, 2010).

[6]The allocation of defense spending across U.S. regions is well-known to be influenced by political factors. See Mintz (1992) for a discussion of political issues related to the allocation of military procurement spending.

[7]Another potential approach to matching our multiplier estimate would be to consider a model with "hand-to-mouth" consumers as in Gali, Lopez-Salido, and Valles (2007).

aggregate multiplier for normal monetary policy is the same as the logic for why the fiscal multiplier is larger under a fixed exchange rate than a flexible exchange rate in the Mundell-Fleming model. In fact, we show theoretically that the open economy relative multiplier is exactly the same as the aggregate multiplier in a small open economy with a fixed exchange rate. This lines up well with existing empirical evidence. Based on data from 44 countries, Ilzetzki, Mendoza, and Vegh (2010) estimate a multiplier of 1.5 for countries that operate a fixed exchange rate regime, but a much lower multiplier for countries operating a flexible exchange rate regime.[8]

Since the nominal interest rate cannot offset any changes in relative output or inflation across regions in our setting, one might infer that our setting resembles that of a closed economy in which the nominal interest rate is at its zero lower bound and New Keynesian models generate large multipliers. However, this simple intuition ignores a crucial dynamic aspect of price responses in a monetary union. Since purchasing power parity holds in the long run and the exchange rate is fixed within the monetary union, any increase in prices in the short run in one region relative to the other must eventually be reversed in the long run. This implies that even though relative short-term real interest rates fall in response to government spending shocks in our model, relative *long-term* real interest rates don't (in contrast to the zero lower bound setting). Consumption (and thus output) is determined by the behavior of the long-term real interest rate via the Euler equation.

An important difference between our open economy relative multiplier and the closed economy aggregate multiplier is that the regions that receive spending don't have to pay for it. Could this perhaps explain the "large" relative multiplier we estimate? To the contrary, both Neoclassical and New Keynesian business cycle models imply that negative wealth effects *raise* the fiscal multiplier (since leisure is a normal good). The absence of a negative wealth effect in our setting should thus lower the multiplier we estimate relative to a setting in which current and future taxes rise in proportion to spending. Also, the multiplier that we estimate is not a "windfall" or "manna from heaven" multiplier. Agents in our setting are getting paid for producing goods and services that are used for defense of the union as a whole. If labor and product markets are competitive, they are indifferent at the margin as to whether they get more or less such work.

The theoretical framework we describe may be used to interpret recent and ongoing research on the effects of other forms of local government spending (Acconcia et al., 2011; Clemens and Miran, 2010; Cohen et al., 2010; Fishback and Kachanovskaya, 2010; Serrato and Wingender, 2010;

[8] Kraay (2011) estimates a government spending multiplier or about 0.5 for 29 aid-dependent developing countries using variation in World Bank lending.

Shoag, 2010; Wilson, 2011). There are some potentially important differences between our study and these. Some of these studies focus on windfall transfers rather than purchases. Also, military spending represents government purchases that are much less substitutable for private spending than most other government purchases. With these caveats in mind, several of these papers also find large effects of regional government spending which can potentially be explained by similar factors to those we emphasize in our theoretical model.

Our empirical approach builds on previous work by Davis, Loungani, and Mahidhara (1997), who study several drivers of regional economic fluctuations, including military procurement.[9] Several other studies of the impact of defense spending on regional economic fluctuations are surveyed in Braddon (1995). The most important difference in our empirical methodology relative to these studies is our use of variation in aggregate military spending in creating instruments to account for potential endogeneity of local procurement spending. Our work is also related to Canova and Pappa (2007), who study the price effects of fiscal shocks in a monetary union. Our theoretical analysis is related to earlier work on monetary and fiscal policy in a monetary union by Benigno and Benigno (2003) and Gali and Monacelli (2008).

The remainder of the paper is organized as follows. Section 2 described the data we use. Section 3 presents our empirical results. Section 4 presents the model we use to interpret these empirical results. Section 5 presents our theoretical results. Section 6 concludes.

2 Data

Our main source for military procurement data is the electronic database of DD-350 military procurement forms available from the US Department of Defense. These forms document military purchases of everything from repairs of military facilities to the purchase of aircraft carriers. They cover purchases greater than $10,000 up to 1983 and greater than $25,000 thereafter.[10] Relative to other forms of federal government spending, the geographical distribution of military spending is remarkably well-documented, perhaps because of the intense political scrutiny surrounding these purchases. We have used the DD-350 database to compile data on total military procurement by

[9]Similarly, Hooker and Knetter (1997) estimate the effects of military procurement on subsequent employment growth using a somewhat different specification. Blanchard and Katz (1992) also study the relationship between movements in military procurement variables and subsequent employment growth.

[10]Purchases reported on DD-350 forms account for 90% of military purchases. Furthermore, our analysis of census shipment data in section 3 suggests DD-350 purchases account for almost all of the time-series variation in total military procurement. DD-1057 forms are used to summarize smaller transactions but do not give the identity of individual sellers.

state and year for 1966-2006.[11] DD-350 forms provide detailed information on individual military procurement contracts, including the amount (and in some cases projected duration) of the contract, and the location where the majority of the work was performed.[12]

We have also compiled data on shipments to the government from defense oriented industries. The source of these data are the *Annual Survey of Shipments by Defense-Oriented Industries* conducted by the US Census Bureau from 1963 through 1983. Since there is no electronic version of these data, we digitized the data from microfilm. This source provides direct evidence on the timing and location of production associated with military procurement. They allow us to assess the extent to which some fraction of the prime military contracts reported on DD-350 forms may have been subcontracted to manufacturers in other states. These data also provide information on value-added for these manufacturers that we use to calibrate our theoretical model.

Our primary measure of state output is the GDP by state measure constructed by the U.S. Bureau of Economic Analysis (BEA), which is available since 1963.[13] We also make use of analogous data by major SIC/NAICS grouping.[14] We use the BLS payroll survey from the Current Employment Statistics (CES) program to measure state-level employment. We also present results for the BEA measure of state employment which is available since 1969. We obtain state population data from the Census Bureau.[15]

Finally, to analyze price effects, we construct state and regional inflation measures from several sources. Before 1995, we rely on state-level inflation series constructed by Marco Del Negro (1998) for the period 1969-1995 using a combination of BLS regional inflation data and cost of living estimates from the American Chamber of Commerce Realtors Association (ACCRA).[16] After 1995, we construct state-level price indexes by multiplying a population-weighted average of cost of living

[11] The electronic military prime contract data file was created in the mid-1960's and records military prime contracts since 1966. This occurred around the time Robert McNamara was making sweeping changes to the procurement process of the U.S. Department of Defense. While aggregate statistics are available before this point, they appear not to be a reliable source of information on military purchases since large discrepancies arise between actual outlays and procurement for the earlier period, particularly at the time of the Korean war. See the Department of Defense *Greenbook* for aggregate historical series of procurement and outlays.

[12] These data are for the federal government fiscal year. Since 1976, this has been from October 1st to September 30th. Prior to 1976, it was from July 1st to June 30th.

[13] As an alternative measure of output, we have analyzed BEA State Personal Income data. These data yield similar results to our baseline measure.

[14] The data are organized by SIC code before 1997 and NAICS code after 1997. BEA publishes the data for both systems in 1997, allowing the growth rate series to be smoothly pasted together.

[15] Between census years, these data are estimated using a variety of administrative data sources. Since 1970, we are also able to obtain population by age group, which allows us to adjust our estimates for the working age population as opposed to the population as a whole.

[16] See Appendix A of Del Negro (1998) for the details of this procedure.

indexes from the American Chamber of Commerce Realtors Association (ACCRA) for each region with the US aggregate Consumer Price Index. Reliable annual consumption data are unfortunately not available at the state level for most of the time period or regions we consider.[17]

3 Government Spending Multiplier: Measurement

3.1 Empirical Specification and Identification

We use variation in military procurement spending across states and regions to identify the effects of government spending on output. Our empirical specification is

$$\frac{Y_{it} - Y_{it-2}}{Y_{it-2}} = \alpha_i + \gamma_t + \beta \frac{G_{it} - G_{it-2}}{Y_{it-2}} + \epsilon_{it}, \quad (1)$$

where Y_{it} is per-capita output in region i in year t, G_{it} is per-capita military procurement spending in region i in year t, and α_i and γ_t represent state and year fixed effects.[18] We use panel data on state and regional output and spending for 1966-2006. The regional data are constructed by aggregating state-level data within Census divisions. We make one adjustment to the Census divisions. This is to divide the "South Atlantic" division into two parts because of its large size.[19] This yields ten regions made up of contiguous states.

Our interest focuses on the coefficient β in regression (1), which we refer to as the "open economy relative multiplier." The inclusion of state fixed effects implies that we are allowing for state specific time trends in output and military procurement spending. The inclusion of time fixed effects allows us to control for aggregate shocks that affect all states at a particular point in time—such as changes in distortionary taxes and aggregate monetary policy. All variables in the regression are measured in per capita terms. We run the regression on biannual data. This is a crude way to capture dynamics in the relationship between government spending and output.[20]

Military procurement is notoriously political, suggesting that endogeneity in the timing of pro-

[17] Retail sales estimates from *Sales and Marketing Management Survey of Buying Power* have sometimes been used as a proxy for state-level annual consumption. However, these data are constructed by using employment data to impute retail sales between census years, rendering them inappropriate for our purposes. Fishback, Horrace, and Kantor (2004) study the longer run effects of New Deal spending on retail sales using Census data.

[18] We deflate both regional output and military procurement spending using the national CPI for the U.S..

[19] We place Delaware, Maryland, Washington DC, Virginia and West Virginia in one region, and North Carolina, South Carolina, Georgia and Florida in the other.

[20] An alternative approach would be to run the regression on annual data and include lags (and possibly also leads) of government spending on the right hand side. We have explored this and found that our biannual regression captures the bulk of the dynamics in a parsimonious way. We find small positive coefficients on further leads and lags. This suggests that we are likely slightly underestimating the multiplier.

curement spending is an important concern.[21] We therefore estimate equation (1) using an instrumental variables approach. To account for endogeneity in state military procurement spending, the source of variation we exploit is variation in state military procurement spending associated with variation in national military procurement spending. This approach has the additional benefit that it eliminates attenuation bias associated with measurement error in state procurement spending.

Figure 1 plots the evolution of military procurement spending relative to output for California and Illinois as well as for the U.S. as a whole. First, notice that most of the variation in national military spending is driven by geopolitical events—such as the Vietnam war, Soviet invasion of Afghanistan and 9/11. It is also clear from the figure that military spending in California is systematically much more sensitive to movements in national military spending than military spending in Illinois. The 1966-1971 Vietnam war draw-down illustrates this. Over this period, military procurement in California fell by 2.5 percentage points (almost twice the national average), while military procurement in Illinois fell by only about 1 percentage point (about 2/3 the national average). We use this variation in the sensitivity of military spending across regions to national military build-ups and draw-downs to identify the effects of government spending on output.

The "first stage" in the two-stage least squares interpretation of our procedure is to regress regional procurement spending for each state on aggregate military procurement and fixed effects. This yields scaled versions of national spending as fitted values for each state to be used in the second stage. Table 1 lists the states for which state procurement spending is most sensitive to variation in national procurement spending. The differential sensitivity to national military spending implies that, whenever there is a military buildup in the U.S., military spending in defense-oriented states increases by more than in other states. We ask whether this differential increase in government spending in defense-oriented states translates into a differential increase in output. The variation in $G_{i,t}$ we use to identify β is thus correlated in the time series with national government spending and correlated in the cross section with the sensitivity of state spending to national spending. Any potential confounding effect must satisfy both of these conditions.

It is common in the literature on fiscal stimulus to assume that national military spending is exogenous to the U.S. business cycle. Our identifying assumption is related to this but weaker. What we assume is that when the U.S. embarks on a military build-up it is not doing so because defense-oriented states are doing poorly relative to other states. Specifically, we instrument for state or region military procurement using total national procurement interacted with a state or

[21] See Mintz (1992) for a discussion of political issues related to the allocation of military procurement spending.

region dummy.[22] We estimate the effects of military spending on employment and inflation using an analogous approach. For employment, the regression is analogous to equation (1) except that the left-hand side variable is the two year percentage change in the employment rate—$(L_{it} - L_{it-2})/L_{it-2}$—where L_{it} is the employment rate (employment divided by population). For the inflation regression, the left-hand side variable is the two-year inflation rate, $(P_{it} - P_{it-2})/P_{it-2}$, where P_{it} is the price level.

3.2 Effects of Government Spending Shocks

The results of these regressions are presented in the first row of table 2. For each specification, the table reports the open economy relative multiplier β. Standard errors are in parentheses and are clustered by regions or states.[23] In the second row of Table 2, we present an analogous set of results using a broader measure of military spending that combines military procurement spending with compensation of military employees for each state or region. We present results for output both deflated by national CPI and our measure of state CPI.

The point estimates of β for the output regression range from 1.4 to 1.9, while the point estimates of β for the employment regression range from 1.3 to 1.8. The estimates using regional data are, in general, slightly larger than those based on state data, though the differences are small and statistically insignificant. The point estimates of the effects of military spending on consumer prices are statistically insignificantly different from zero, ranging from small positive to small negative numbers.[24]

The regressions above control for short-term movements in population associated with government spending by looking for relationships among variables in per-capita terms. The last column of Table 2 characterizes the nature of these population movements. The regression we estimate is again analogous to equation (1) except that the left-hand side variable is the two year percentage

[22] Nekarda and Ramey (2010) use a similar approach to purge government purchases for particular industries of potentially endogenous responses to industry productivity. They use data at 5 year intervals to estimate the share of aggregate government spending from different industries, as opposed to the responsiveness of industry output to aggregate spending.

[23] Our standard errors thus allow for arbitrary correlation over time in the error term for a given state. They also allow for heteroskedasticity. As we describe below, we have carried out an extensive Monte Carlo analysis of our estimator to judge the robustness of our results. The Monte Carlo analysis indicates that while the standard error for the state-level regressions is unbiased, the standard errors for the region regressions are slightly downward-biased: the standard 95% confidence interval based on the standard errors reported in table 2 is in fact a 90% confidence interval. This adjustment arises from the well-known small-sample bias in clustered standard errors in the presence of a small number of clusters.

[24] The difficulty in obtaining a precise estimate of the effect of military spending on inflation no doubt arises in part from the paucity of the data involved—state and regional inflation data are likely to suffer from a large amount of measurement error. See section 2 for a discussion of the inflation data.

change in population—$(Pop_{it} - Pop_{it-2})/Pop_{it-2}$—and the right-hand side government spending variable as well as the instruments are constructed using the level of government spending and output rather than per-capita versions of these variables. We find government spending shocks to have small and statistically insignificant effects on population over the time horizon we consider.[25]

Figure 3 gives a visual representation of our main specification for output. The figure shows averages of changes in output and predicted military spending (based on our first-stage regression), grouped by 30 quantiles of the predicted military spending variable. Both variables are demeaned by year and state fixed effects. The vast majority of points in the figure are located in the NE and SW quadrants, leading to a positive coefficient in our IV regression. To assess the robustness of our result, we have experimented with dropping states and regions with especially large estimated sensitivity of spending to national spending and this slightly raises the estimated multiplier.[26]

Table 3 presents a number of alternative specifications for the effects of military procurement on output and employment. We report the output multiplier when per-capita output is constructed using a measure of the working age population as opposed to the total population.[27] We add the price of oil interacted with state dummies as controls to our baseline regression. We add the real interest rate interacted with state dummies as controls to our baseline regression. We estimate the employment regression using the BEA's employment series (available from 1969) instead of BLS payroll employment. This series includes estimated values of self-employment and other non-payroll employment. The table shows that these specifications all yield similar results to our baseline estimates.

An alternative way to construct instruments for state spending based on national spending is to scale national spending by the average level of spending in each state relative to state output, an approach sometimes referred to as constructing "Bartik instruments" (Bartik, 1991; Blanchard and Katz, 1992). To construct these estimates, we use the average level of spending in the first five years of our sample, implying that the fraction of military spending is pre-determined relative to the majority of our sample period. Results for output and employment using this instrument instead of our baseline instruments are presented in Table 3. For output, this approach yields a

[25] Blanchard and Katz (1992) show that population dynamics are important in determining the dynamics of unemployment over longer horizons.

[26] MO and CT have substantially higher estimated sensitivity of spending to national spending than other states and ND has a substantially negative estimated sensitivity (alone among the states). Dropping any combination of these states from our baseline regression slightly raises the our multiplier estimate. Dropping all three yields 1.88 (0.57).

[27] State-level measures of population by age-group are available from the Census Bureau starting in 1970. We define the working age population as the population between the ages of 19 and 64.

multiplier of roughly 2.5 with a standard error of 0.9 for the states and 2.8 with a standard error of 0.7 for the regions. For employment, this approach also yields larger multipliers than our baseline specification.

Table 3 also presents OLS estimates of our baseline specification for output. The OLS estimates are substantially lower than our instrumental variables estimates. A natural explanation of this is that states' elected officials may find it easier to argue for spending at times when their states are having trouble economically. There is a substantial literature in politics and political economy supporting this notion (see, e.g. Mintz, 1992). Our instruments also likely correct for measurement error in the data on state-level prime military contracts that does not arise at the national level. Such measurement error causes an "attenuation bias" in the OLS coefficient toward zero that is corrected for in our instrumental variables specifications.[28]

Table 4 presents the results for equation (1) estimated separately by major SIC/NAICS groupings. Statistically significant output responses occur in the construction, manufacturing, retail and services sectors. The largest output response is in the construction sector, where an increase in military procurement equal to 1% of state GDP is associated with a 5.4% increase in relative sectoral output. Given the difficulties of measuring output in the government sector, one might be concerned that our results on the effects of government spending shocks are driven in part by increases in output in this sector.[29] Table 4 shows that this is not the case; increases in government sector output contribute negligibly to the overall effects we estimate. Table 4 also shows that increases in relative procurement spending are not associated with increases in non-procurement military output.

We have extensively investigated the small-sample properties of our estimation approach using Monte Carlo simulations. Our analysis suggests no bias in the level of the region-level multiplier. However, it suggests that our estimates of the state regressions are likely to be slightly conservative in the sense of underestimating the fiscal multiplier for states by roughly 10% (implying that the true state-level multiplier is 1.65 rather than 1.43). Intuitively, this downward bias arises because instrumental variables does not fully correct for endogeneity in small samples, leading IV

[28]In section 3.3 below, we describe an alternative source of data on military procurement based on shipments to the government from defense oriented industries. Notice that, despite the close correspondence between the prime military contract data and the shipments data, differences remain in the growth rates for the two series. Viewing these as independent (but noisy) measures on the magnitude of spending, we can adjust for measurement error by using one variable as an instrument for the other. We find that this significantly raises the multiplier relative to the OLS estimates.

[29]The measurement difficulties imply that output in the government sector is typically measured using input costs.

to be biased in the direction of OLS.[30] The LIML estimator avoids this downward bias in the IV estimator but yields larger standard errors in both the data (see Table 3) and our Monte Carlo analysis.[31]

Our results show that output in defense oriented states and regions is differentially affected by national military build-ups and draw-downs. A potential concern with interpreting this as evidence for a large open economy relative multiplier is that defense oriented regions might just happen to be generally more cyclically sensitive. As it turns out, this is not the case. The standard deviation of output growth is the same for states and regions with above-median defense orientation as below median (4.7% for regions and 6.1% for states). Furthermore, suppose we regress state output growth ΔY_{it} on scaled national output growth $s_i \Delta Y_t$, where the scaling factor s_i is the average level of military spending in each state relative to state output, as well as state and time fixed effects. If state with high s_i are more cyclically sensitive, this regression should yield a positive coefficient on $s_i \Delta Y_t$. In fact, the coefficient is slightly negative in our data. In contrast, when $s_i \Delta Y_t$ is replaced with $s_i \Delta G_t$, this regression yields a large positive coefficient.

Ramey (2011) argues that news about military spending leads actual spending by several quarters and that this has important implications for the estimation of fiscal multipliers. When we add future spending as a regressor in regression (1), the coefficient on this variable is positive and the sum of the coefficients on the government spending rises somewhat. This suggests that our baseline specification somewhat underestimates the multiplier by ignoring output effects associated with anticipated future spending.

[30]See Stock, Wright, and Yogo (2002) for an overview of this issue. The concern is that the first-stage of the IV procedure may pick up some of the endogenous variation in the explanatory variable in the presence of a large number of instruments. In contrast to the canonical examples discussed in Stock, Wright, and Yogo (2002), this actually biases us *away* from finding a statistically significant result in small samples, since the OLS estimates in our case are close to zero. Our Monte Carlo analysis is roughly consistent with the asymptotic results reported in Stock and Yogo (2005). The partial R-squared of the excluded instruments, a statistic frequently used to gauge the "strength" of instruments is 12% for the state regressions and 18% for the region regressions. However, because we use a large number of instruments in our baseline case—one for each state or region—the Cragg-Donald (1993) first stage F-statistic suggested by Stock and Yogo (2005) is roughly 5 for our baseline specification of the state-level regressions and 8 for the region-level regressions. (This statistic is, of course, much higher for the simpler Bartik specification discussed above, since it includes only a single instrument.) Our Monte Carlo analysis indicates that while the large number of instruments in the state-level specification leads to a slight downward-bias in the coefficient on government spending, the standard error on this coefficient is unbiased because of the high R-squared of our instruments taken as a whole. We thank Marcelo Moreira and Motohiro Yogo for generous advice on this issue.

[31]See, e.g.,Stock and Yogo (2005) for a discussion of the LIML estimator.

3.3 Subcontracting of Prime Military Contracts

An important question with regard to the use of military procurement data is to what extent the interpretation of these data might be affected by subcontracting of prime military contracts to surrounding states. To investigate this issue, we use Census Bureau data on shipments to the government from defense oriented industries. To our knowledge, these data have previously been used only infrequently in studying the geographical distribution of military spending. They were not previously available in digital form.[32] The Census shipments data are available for the period 1963-1983. Figure 2 illustrates the close relationship between the state-level military procurement data and the shipments data for several states over this period. To summarize this relationship, we estimate the following relationship between shipments from a particular state and our measure of military procurement spending,

$$MS_{it} = \alpha_i + \beta MPS_{it} + \epsilon_{it}, \tag{2}$$

where MS_t is the value of shipments from the Census Bureau data and MPS_{it} is our measure of military procurement spending. Estimating this regression yields a point estimate of $\beta = 0.96$, indicating that our measure of military procurement moves almost one for one with the value of shipments from the Census Bureau.

3.4 Government Spending at High Versus Low Unemployment Rates

We next investigate whether the effects of government spending on the economy are larger in periods when the unemployment rate is already high.[33] There are a variety of reasons why this could be the case. Most often cited is the idea that in an economy with greater slack, expansionary government spending is less likely to crowd out private consumption or investment.[34] In a closed economy, a second potential source of such differences is the differential response of monetary policy—central bankers may have less incentive to "lean against the wind" to counteract the effects of government spending increases if unemployment is already high. This latter effect does not, however, influence

[32] We digitized these data from microfilm. See section 2 for a discussion of the shipments data.

[33] Gordon and Krenn (2010) estimate substantially larger fiscal multiplier for 1940:Q2-1941:Q2 than for 1940:Q2-1941:Q4. They attribute the fall in the estimated multiplier in the second half of 1941 to increasingly tight capacity constraints associated with the large military buildup that was underway at that time.

[34] This might arise, for example, if unemployment leads to a higher labor supply elasticity (Hall, 2009). Such effects might also occur in an economy with downwardly-rigid wages. During a recession, wages lie above their market-clearing level in such a model, making output more sensitive to variation in government spending. These effects are beyond the scope of the model we present in section 4.

the results we report below, since the open economy relative multipliers we consider "difference out" aggregate monetary and tax policy shocks.

To investigate these issues, we estimate the following regression,

$$\frac{Y_{it} - Y_{it-2}}{Y_{it-2}} = \alpha_i + \gamma_t + \beta_h \frac{G_{it} - G_{it-2}}{Y_{it-2}} + (\beta_l - \beta_h) I_l \frac{G_{it} - G_{it-2}}{Y_{it-2}} + \epsilon_{it}, \tag{3}$$

where I_l is an indicator for a period of low economic slack, and the effects of government spending in high and low slack periods are given by β_h and β_l respectively. We define high and low slack periods in terms of the unemployment rate at the start of the interval over which the government spending occurs. Specifically, period t is defined as a high slack period if U_{t-2} is above its median value over our sample period.[35]

Table 5 presents our estimates of equation (3). The point estimates support the view that the effects of government spending are larger when unemployment is high: depending on the specification, the government spending multiplier lies between 2 and 3.5 in the high slackness periods, substantially above our estimates for the time period as a whole. Given the limited number of business cycles in our sample, we are not, however, able to estimate these effects with much statistical precision. The difference in the multiplier in the high and low spending periods is moderately statistically significant (with a P-value of 0.06) only in the case of the state-level output regression.

4 A New Keynesian Model of a Monetary Union

To aid interpretation of the open economy relative multiplier we estimate in section 3 and relate it to the more conventional closed economy aggregate multiplier, we consider a model economy that consists of two regions belonging to a monetary and fiscal union. Our model is a relatively standard New Keynesian model that builds on the framework developed in, e.g., Obstfeld and Rogoff (1995), Chari, Kehoe, and McGrattan (2002), Benigno and Benigno (2003), Woodford (2003), Benigno and Woodford (2005) and Gali and Monacelli (2008).

We refer to the regions as "home" and "foreign." The population of the entire economy is normalized to one. The population of the home region is denoted by n. Household preferences, market structure and firm behavior take the same form in both regions. Below, we describe the economy of the home region.

[35]The high slack years t according to this measure are: 1966, 1967, 1972-1974, 1976-1988, 1993, 1994, 2004 and 2005.

4.1 Households

The home region has a continuum of household types indexed by x. A household's type indicates the type of labor supplied by that household. Home households of type x seek to maximize their utility given by

$$E_0 \sum_{t=0}^{\infty} \beta^t u(C_t, L_t(x)), \tag{4}$$

where β denotes the household's subjective discount factor, C_t denotes household consumption of a composite consumption good, $L_t(x)$ denotes household supply of differentiated labor input x. There are an equal (large) number of households of each type.

The composite consumption good in expression (4) is an index given by

$$C_t = \left[\phi_H^{\frac{1}{\eta}} C_{Ht}^{\frac{\eta-1}{\eta}} + \phi_F^{\frac{1}{\eta}} C_{Ft}^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}, \tag{5}$$

where C_{Ht} and C_{Ft} denote the consumption of composites of home and foreign produced goods, respectively. The parameter $\eta > 0$ denotes the elasticity of substitution between home and foreign goods and ϕ_H and ϕ_F are preference parameters that determine the household's relative preference for home and foreign goods. It is analytically convenient to normalize $\phi_H + \phi_F = 1$. If $\phi_H > n$, household preferences are biased toward home produced goods.

The subindices, C_{Ht} and C_{Ft}, are given by

$$C_{Ht} = \left[\int_0^1 c_{ht}(z)^{\frac{\theta-1}{\theta}} dz \right]^{\frac{\theta}{\theta-1}} \quad \text{and} \quad C_{Ft} = \left[\int_0^1 c_{ft}(z)^{\frac{\theta-1}{\theta}} dz \right]^{\frac{\theta}{\theta-1}} \tag{6}$$

where $c_{ht}(z)$ and $c_{ft}(z)$ denote consumption of variety z of home and foreign produced goods, respectively. There is a continuum of measure one of varieties in each region. The parameter $\theta > 1$ denotes the elasticity of substitution between different varieties.

Goods markets are completely integrated across regions. Home and foreign households thus face the same prices for each of the differentiated goods produced in the economy. We denote these prices by $p_{ht}(z)$ for home produced goods and $p_{ft}(z)$ for foreign produced goods. All prices are denominated in a common currency called "dollars".

Households have access to complete financial markets. There are no impediments to trade in financial securities across regions. Home households of type x face a flow budget constraint given by

$$P_t C_t + E_t[M_{t,t+1} B_{t+1}(x)] \leq B_t(x) + W_t(x) L_t(x) + \int_0^1 \Xi_{ht}(z) dz - T_t, \tag{7}$$

where P_t is a price index that gives the minimum price of a unit of the consumption good C_t, $B_{t+1}(x)$ is a random variable that denotes the state contingent payoff of the portfolio of financial securities held by households of type x at the beginning of period $t+1$, $M_{t,t+1}$ is the stochastic discount factor that prices these payoffs in period t, $W_t(x)$ denotes the wage rate received by home households of type x in period t, $\Xi_{ht}(z)$ is the profit of home firm z in period t and T_t denotes lump sum taxes.[36] To rule out Ponzi schemes, household debt cannot exceed the present value of future income in any state of the world.

Households face a decision in each period about how much to spend on consumption, how many hours of labor to supply, how much to consume of each differentiated good produced in the economy and what portfolio of assets to purchase. Optimal choice regarding the trade-off between current consumption and consumption in different states in the future yields the following consumption Euler equation:

$$\frac{u_c(C_{t+j}, L_{t+j}(x))}{u_c(C_t, L_t(x))} = \frac{M_{t,t+j}}{\beta^j}\frac{P_{t+j}}{P_t} \tag{8}$$

as well as a standard transversality condition. Subscripts on the function u denote partial derivatives. Equation (8) holds state-by-state for all $j > 0$. Optimal choice regarding the intratemporal trade-off between current consumption and current labor supply yields a labor supply equation:

$$\frac{u_\ell(C_t, L_t(x))}{u_c(C_t, L_t(x))} = \frac{W_t(x)}{P_t}. \tag{9}$$

Households optimally choose to minimize the cost of attaining the level of consumption C_t. This implies the following demand curves for home and foreign goods and for each of the differentiated products produced in the economy:

$$C_{H,t} = \phi_H C_t \left(\frac{P_{Ht}}{P_t}\right)^{-\eta} \quad \text{and} \quad C_{F,t} = \phi_F C_t \left(\frac{P_{Ft}}{P_t}\right)^{-\eta}, \tag{10}$$

$$c_{ht}(z) = C_{Ht} \left(\frac{p_t(z)}{P_{Ht}}\right)^{-\theta} \quad \text{and} \quad c_{ft}(z) = C_{Ft} \left(\frac{p_t(z)}{P_{Ft}}\right)^{-\theta}, \tag{11}$$

where

$$P_{Ht} = \left[\int_0^1 p_t(z)^{1-\theta} dz\right]^{\frac{1}{1-\theta}} \quad \text{and} \quad P^*_{Ft} = \left[\int_0^1 p^*_t(z)^{1-\theta} dz\right]^{\frac{1}{1-\theta}}, \tag{12}$$

and

$$P_t = \left[\phi_H P_{Ht}^{1-\eta} + \phi_F P_{Ft}^{1-\eta}\right]^{\frac{1}{1-\eta}}. \tag{13}$$

As we noted above, the problem of the foreign household is analogous. We therefore refrain from describing it in detail here. It is, however, useful to note that combining the home and foreign

[36] The stochastic discount factor $M_{t,t+1}$ is a random variable over states in period $t+1$. For each such state it equals the price of the Arrow-Debreu asset that pays off in that state divided by the conditional probability of that state. See Cochrane (2005) for a detailed discussion.

consumption Euler equations to eliminate the common stochastic discount factor yields

$$\frac{u_c(C_t^*, L_t^*(x))}{u_c(C_t, L_t(x))} = Q_t, \tag{14}$$

where $Q_t = P_t^*/P_t$ is the real exchange rate. This is the "Backus-Smith" condition that describes optimal risk-sharing between home and foreign households (Backus and Smith, 1993). For simplicity, we assume that all households—in both regions—initially have an equal amount of financial wealth.

4.2 The Government

The economy has a federal government that conducts fiscal and monetary policy. Total government spending in the home and foreign region follow an exogenous AR(1) process. Let G_{Ht} denote government spending per capita in the home region. Total government spending in the home region is then nG_{Ht}. For simplicity, we assume that government demand for the differentiated products produced in each region takes the same CES form as private demand. In other words, we assume that

$$g_{ht}(z) = G_{Ht}\left(\frac{p_{ht}(z)}{P_{Ht}}\right)^{-\theta} \quad \text{and} \quad g_{ft}(z) = G_{Ft}\left(\frac{p_{ft}(z)}{P_{Ft}}\right)^{-\theta}. \tag{15}$$

The government levies lump-sum taxes to pay for its purchases of goods. Our assumption of perfect financial markets implies that any risk associated with variation in taxes and transfers across the two regions is undone through risk-sharing. Ricardian equivalence holds in our model. Windfall government transfers from one region to the other and lump-sum taxes to finance government spending in one region, therefore, have no effect on equilibrium allocations in our model. Also, we need not specify the time-path or regional incidence of taxes.

The federal government operates a common monetary policy for the two regions. This policy consists of the following augmented Taylor-rule for the economy-wide nominal interest rate:

$$\hat{r}_t^n = \rho_r \hat{r}_{t-1}^n + (1-\rho_i)(\phi_\pi \hat{\pi}_t^{ag} + \phi_y \hat{y}_t^{ag} + \phi_g \hat{g}_t^{ag}), \tag{16}$$

where hatted variables denote percentage deviations from steady state. The nominal interest rate is denoted $\hat{r}_t^n$. It responds to variation in the weighted average of consumer price inflation in the two regions $\hat{\pi}_t^{ag} = n\hat{\pi}_t + (1-n)\hat{\pi}_t^*$, where $\hat{\pi}_t$ is consumer price inflation in the home region and $\hat{\pi}_t^*$ is consumer price inflation in the foreign region. It also responds to variation in the weighted average of output in the two regions $\hat{y}_t^{ag} = n\hat{y}_t + (1-n)\hat{y}_t^*$. Finally, it may respond directly to the weighted average of the government spending shock in the two regions $\hat{g}_t^{ag} = n\hat{g}_t + (1-n)\hat{g}_t^*$.

4.3 Firms

There is a continuum of firms indexed by z in the home region. Firm z specializes in the production of differentiated good z, the output of which we denote $y_t(z)$. In our baseline model, labor is the only variable factor of production used by firms.[37] Each firm is endowed with a fixed, non-depreciating stock of capital. Labor is immobile across regions.[38] We follow Woodford (2003) in assuming that each firm belongs to an industry x and that there are many firms in each industry. The goods in industry x are produced using labor of type x and all firms in industry x change prices at the same time.

The production function of firm z is

$$y_t(z) = f(L_t(z)). \tag{17}$$

The function f is increasing and concave. It is concave because there are diminishing marginal returns to labor given the fixed amount of other inputs employed at the firm.

Firm z acts to maximize its value,

$$E_t \sum_{j=0}^{\infty} M_{t,t+j}[p_{t+j}(z)y_{t+j}(z) - W_{t+j}(x)L_{t+j}(z)]. \tag{18}$$

Firm z must satisfy demand for its product. The demand for firm z's product comes from three sources: home consumers, foreign consumers and the government. It is given by

$$y_t(z) = (nC_{Ht} + (1-n)C^*_{Ht} + nG_{Ht}) \left(\frac{p_{ht}(z)}{P_{Ht}}\right)^{-\theta}. \tag{19}$$

Firm z is therefore subject to the following constraint:

$$(nC_{Ht} + (1-n)C^*_{Ht} + nG_{Ht}) \left(\frac{p_{ht}(z)}{P_{Ht}}\right)^{-\theta} \leq f(L_t(z)). \tag{20}$$

Firm z takes its industry wage $W_t(x)$ as given. Optimal choice of labor demand by the firm is given by

$$W_t(x) = f_\ell(L_t(z))S_t(z), \tag{21}$$

where $S_t(z)$ denotes the firm's nominal marginal cost (the Lagrange multiplier on equation (20) in the firm's constrained optimization problem).

[37] Appendix B develops an extension of our baseline model with capital.

[38] Our results in section 3, suggest that this is a reasonable assumption over the horizons we focus on. An extension of our model that allows for an equal amount of labor and capital mobility yields virtually identical results for output as long as all variables (output, employment, government spending, etc.) are defined in per-capita terms. Blanchard and Katz (1992) emphasize that labor mobility plays an important role in the adjustment to regional shocks over longer horizons.

Firm z can reoptimize its price with probability $1-\alpha$ as in Calvo (1983). With probability α it must keep its price unchanged. Optimal price setting by firm z in periods when it can change its price implies

$$E_t \sum_{j=0}^{\infty} \alpha^j M_{t,t+j}(nC_{Ht+j} + (1-n)C_{Ft+j} + nG_{Ht+j})P_{Ht+j}^{\theta}(1-\theta)[p_t(z) - \frac{\theta}{\theta-1}S_{t+j}(z)] = 0. \quad (22)$$

4.4 Calibration

We analyze the behavior of the economy for several specific sets of assumptions about the utility function, production function, monetary policy and parameters of the model. We consider the following two forms for the utility function:

$$u(C_t, L_t(x)) = \frac{C_t^{1-\sigma^{-1}}}{1-\sigma^{-1}} - \chi \frac{L_t(x)^{1+\nu^{-1}}}{1+\nu^{-1}}, \quad (23)$$

$$u(C_t, L_t(x)) = \frac{(C_t - \chi L_t(x)^{1-\nu^{-1}}/(1-\nu^{-1}))^{1-\sigma^{-1}}}{1-\sigma^{-1}}. \quad (24)$$

In the first utility specification, consumption and labor enter separably. They are therefore neither complements nor substitutes. The second utility function is adopted from Greenwood, Hercowitz, and Huffman (1988). We refer to this utility function as GHH preferences. Consumption and labor are complements for households with GHH preferences. Recently, Monacelli and Perotti (2008), Bilbiie (2009), and Hall (2009) have emphasized the implications of consumption-labor complementarities for the government spending multiplier.

For both specifications for utility, we must specify values for σ and ν (χ is irrelevant when utility is separable and determined by other parameters in the GHH case). In both cases, ν is the Frisch elasticity of labor supply. There is little agreement on the appropriate value for this parameter in the literature. We set $\nu = 1$. This value is somewhat higher than values estimated for employed workers. The higher value is meant to capture variation in labor on the extensive margin—such as variation in unemployment and retirement (Hall, 2009). We set $\sigma = 1$. For the separable utility specification, σ denotes the intertemporal elasticity of substitution (IES). There is little agreement within the macroeconomics literature on the appropriate values for the IES. Hall (1988) estimates the IES to be close to zero, while Bansal and Yaron (2004), Gruber (2006) and Nakamura, et al. (2011) argue for values above 1. For the model with separable preferences, $\sigma = 1$ yields balanced growth.

We set the subjective discount factor equal to $\beta = 0.99$, the elasticity of substitution across varieties equal to $\theta = 7$ and the elasticity of substitution between home and foreign goods to $\eta = 2$.

We assume the production function $f(L_t(z)) = L_t(z)^a$ and we set $a = 2/3$. We set $\alpha = 0.75$. This implies that firms reoptimize there prices on average once a year.

We set the size of the home region to $n = 0.1$. This roughly corresponds to the size of the average region in our regional regressions (where we divide the U.S. into 10 regions). We use data from the U.S. Commodity Flow Survey (CFS) and the U.S. National Income and Product Accounts (NIPA) to set the home-bias parameter ϕ_H. The CFS reports data on shipments of goods within and between states in the U.S. It covers shipments between establishments in the mining, manufacturing, wholesale and retail sectors. For the average state in 2002, 38% of shipments were within state and 50% of shipments were within region. However, roughly 40% of all shipments in the CFS are from wholesalers to retailers and the results of Hillberry and Hummels (2003) suggest that a large majority of these are likely to be within region. Since the relevant shipments for our model are those from manufacturers to wholesalers, we assume that 83% of these are from another region (50 of the remaining 60 percent of shipments).

NIPA data indicate that goods represent roughly 30% of U.S. GDP. If all inter-region trade were in goods—i.e., all services were local—imports from other regions would amount to 25% of total consumption ($30*0.83 = 25$). However, for the U.S. as a whole, services represent roughly 20% of international trade. Assuming that services represent the same fraction of cross-border trade for regions, total inter-region trade is 31% of region GDP ($25/0.8 = 31$). We therefore set $\phi_H = 0.69$. This makes our regions slightly more open than Spain and slightly less open than Portugal. We set ϕ_H* so that overall demand for home products as a fraction of overall demand for all products is equal to the size of the home population relative to the total population of the economy. This implies that $\phi_H* = (n/(1-n))\phi_F$.

We consider three specifications of monetary policy. First, we consider a specification that is meant to mimic the policy of the U.S. Federal Reserve during the Volcker-Greenspan period. Many recent papers have estimated monetary rules similar to the one we adopt for the Volcker-Greenspan period (see, e.g., Taylor, 1993 and 1999; Clarida, Gali and Gertler, 2000). Guided by this literature we refer to $\rho = 0.8$, $\phi_\pi = 1.5$, $\phi_y = 0.5$ and $\phi_g = 0$ as the Volcker-Greenspan policy. Notice that the Volcker-Greenspan policy is one in which the monetary authority "leans against the wind" in the sense that it raises the real interest rate in response to inflationary shocks.

The second monetary policy we consider is one that responds directly to the fiscal policy shock in such a way as to neutralize the effect that such shocks have on the real interest rate. In other words, this policy maintains a constant real interest rate when fiscal policy shocks occur. We refer to this policy as the constant real interest rate policy. This policy does not lean against the wind in response to government spending shocks. To guarantee price level determinacy, we must rule out self-fulfilling variation in inflation that is not driven by fundamental shocks (i.e., sunspot equilibria). We do this by setting $\phi_\pi = 1.5$. This implies that the real interest rate will react to any variation in inflation that is not caused by government spending shocks. Along the equilibrium path, no such variation occurs in our model.

The third policy specification we consider is one that maintains a constant nominal interest rate when fiscal policy shocks occur. We refer to this policy as the constant nominal interest rate policy. This policy is meant to mimic monetary policy at the zero lower bound. Again, to guarantee price level determinacy, the constant nominal interest rate policy has $\phi_\pi = 1.5$.

We set the steady state value of government purchases as a fraction of output to 0.2. We set the AR(1) coefficient on the government spending shock such that the half-life of the government spending shock is 2 years (i.e. an AR(1) coefficient of $0.5^{1/8} \approx 0.917$) to roughly match the persistence of aggregate military procurement spending in the data. We log-linearize the equilibrium conditions of the model and use the methods of Sims (2001) to find the unique bounded equilibrium.

5 Government Spending in a New Keynesian Model

In this section, we analyze the effects of fiscal policy shocks in the model presented in section 4.

5.1 The Closed Economy Aggregate Multiplier

Consider first the standard closed economy aggregate multiplier, calculated as the response of total output (combining home and foreign production) to total government spending. To estimate the closed economy aggregate multiplier, we simulate data from the model described in section 4 and estimate a closed economy version of equation (1). Specifically, we use aggregate output and aggregate government spending to construct the dependent and independent variables and we no longer include fixed effects in the regression. To compute the same objects in the data and model, we time-aggregate quarterly data from the model to an annual frequency to estimate equation (1).

The first panel of table 6 reports results for the model in section 4 for the standard case of household preferences that are additively separable between consumption and labor. The first column reports results on the closed economy aggregate multiplier. We present results for three different monetary policies that differ in the degree to which movements in the interest rate are used to “lean against the wind” in response to the government spending shock—a Volcker-Greenspan monetary policy in which real interest rates are assumed to rise in response to increasing output or inflation, a fixed real interest rate rule, and a fixed nominal interest rate rule meant to mimic monetary policy at the zero lower bound.

The model with a Volcker-Greenspan monetary policy yields a closed economy aggregate output multiplier of only 0.22. With the constant real interest rate monetary policy, the closed economy multiplier is one. The multiplier is higher because monetary policy leans less against the wind—the real interest rate remains constant rather than rising when spending increases. Woodford (2010) shows that for a constant real interest rate monetary policy, the closed economy multiplier is one for a broad set of parameter values in models without capital. Intuitively, consumption doesn’t change since the real interest rate is constant. Output must therefore rise one-for-one with government spending.

Finally, we report results for constant nominal interest rate monetary policy. This is a close cousin of monetary policy at the zero-lower bound, a scenario analyzed in detail by Eggertsson (2010), Christiano, Eichenbaum, and Rebelo (2010), and Mertens and Ravn (2010). This policy has the potential to generate extremely large multipliers since expansionary fiscal policy, by raising inflationary expectations, drives down real interest rates, leading to further increases in consumption and output. In our framework, the closed economy aggregate multiplier is 1.70 if the nominal interest rate is fixed and the government spending shock has a half-life of one year (i.e., $\rho_g = 0.85$). This result is, however, sensitive to the persistence of the government spending shock. For our baseline parameters, where government spending is slightly more persistent ($\rho_g = 0.917$), the closed economy aggregate multiplier falls to -0.39.[39]

Needless to say, the rise in aggregate GDP that arises if the government buys more output is highly sensitive to the stance of monetary policy. This sensitivity carries over to other variables. Much recent work on the effects of fiscal policy has focused on consumption, real wages and markups (Ramey, 2010; Perotti, 2007). Our closed economy New Keynesian model with Volcker-Greenspan monetary policy generates a fall in all three of these variables in response to positive government spending shocks, while the same exercise with the constant real interest rate monetary policy yields

[39]The sensitivity of the fixed nominal interest rate multiplier to the persistence of government spending is closely related to issues discussed in Mertens and Ravn (2010). Intuitively, the government spending shock has both deflationary effects (for a given level of output, it increases labor supply and thus reduces marginal costs by reducing consumption) and inflationary effects (it increases demand at a given interest rate since households would like to smooth consumption). Which effect is bigger depends on the persistence of the government spending shock. With highly persistent government spending shocks, the deflationary effect dominates (demand does not increase by much because the shock has a large effect on permanent income).

an increase in real wages and markups, and leaves consumption unchanged.

This sensitivity of the multiplier to the stance of monetary policy may help to explain some of the wide range of estimates of the multiplier in the empirical literature. Most economists agree that the extent to which the Federal Reserve has "leaned against the wind" has varied substantially over the last century. Many economists believe, for example, that monetary policy was far more expansionary during the 2007-2009 financial crisis than in earlier financial crises such as the Great Depression.

The sensitivity of the closed economy aggregate multiplier to the stance of monetary policy makes it difficult to distinguish between alternative models of the economy. The last row in Panel A Table 6 presents results for a version of our model with flexible prices. The closed economy aggregate multiplier in this case is 0.39, which lies well within the range of multipliers for the New Keynesian model for alternative monetary policies. While the Neoclassical and New Keynesian models may yield similar government spending multipliers under responsive monetary policies such as the Volcker-Greenspan policy, their implications can differ greatly when nominal interest rates are fixed—such as when interest rates hit the zero lower bound. The Neoclassical model continues to yield a small multiplier in this case, whereas the New Keynesian multiplier is potentially very large. Thus, while the predictions of New Keynesian and Neoclassical models for the effects of government spending may be difficult to tell apart in normal times, the distinction may be crucially important in times of crisis.

5.2 The Open Economy Relative Multiplier

Contrast the wide range of different closed economy aggregate multipliers produced by our model for different monetary policies with the complete stability of the open economy relative multiplier reported in the second data column of Table 6. This open economy relative multiplier is calculated by estimating equation (1) using the regional data from the model. For all three specifications of monetary policy we consider, this open economy relative output multiplier is 0.85. In other words, the open economy relative multiplier in our model is completely insensitive to the specification of monetary policy.[40]

The intuition for this result rests on the fact that in estimating the open economy relative multiplier we "difference out" aggregate shocks affecting the economy by including time fixed

[40] The open economy relative multiplier is, of course, not completely insensitive to other parameters of the model, such as the persistence of the government spending shock, as can be seen from the fourth row of the table.

effects in the regression. Since the different regions share the same monetary policy, this procedure differences out the aggregate effects of monetary policy. What we measure is the differential effect of government spending on output across regions. Since the two regions belong to a monetary union, monetary policy in one region cannot differentially respond to regions spending shocks. This implies that the open economy relative multiplier is akin to a closed economy aggregate multiplier for a relatively accommodating aggregate monetary policy. Readers familiar with the Mundell-Fleming model will recall that the fiscal multiplier in that model is larger under a fixed exchange rate than a flexible exchange rate for the same reason.

The open economy relative multiplier we estimate turns out the be equal to the aggregate multiplier in a small open economy with a fixed exchange rate. We have verified this by letting the size of the home country go to zero and calculating the aggregate multiplier for that country in the limit. Intuitively, if the home country is sufficiently small, it has a negligible effect on the currency union as a whole. As a consequence, the "relative" effect of government spending will be the same as the aggregate effect on the home region—i.e., the time dummies will be zero in equation (1).

Since the relative nominal interest rate is constant in response to a government spending shock in one region—i.e., the monetary authority cannot respond to the shock by making monetary policy tighter in that region alone—it is tempting to assume that this situation is analogous to the response of a close economy to a government spending shock at the zero lower bound. In fact, an increase in government spending in the home region leads to a rise in expected inflation, lowering real interest rates—just as in the closed economy case at the zero lower bound.

This logic turns out to ignore a crucial aspect of our setting. The crucial difference versus the closed economy zero lower bound setting is that in our setting, the *long-term* real interest rate does not fall in response to the fiscal shock, even though the short-term real interest rate does. The fiscal shock leads to an immediate rise in prices and expectations of further rises in prices in the short term. This lowers the short term real interest rate. However, since purchasing power parity must hold in the long run, any short term increase in prices in one region relative to the other region must be undone by a fall in prices in that region later on. This means that the long term real interest rate does not fall in our setting. In fact, the initial jump up in prices implies that going forward prices are anticipated to fall more in the long run than they are anticipated to rise further in the short run. This implies that the relative long-term real interest rate actually rises slightly in the home region in response to an increase in government spending.[41]

[41] Corsetti et al. (2011) explore this effect for the case of a small open economy with a fixed exchange rate.

Since the relevant interest rate—the long-term real interest rate—actually rises slightly in response to an increase in government spending irrespective of the persistence of the shock and other parameters, the fixed relative nominal interest rate policy in a monetary union is fundamentally different from a fixed nominal interest rate policy in a closed economy setting with a Taylor rule monetary policy. The response of long-term real interest rates in our setting is closest to the fixed *real* interest rate case in the closed economy setting, where the output multiplier equals 1.0. Policy in our case is slightly more contractionary (since long-term real interest rates actually rise a slight bit). Table 6 shows that the open economy relative multiplier is, in fact, 0.85 for our baseline parameter values—far below the fixed nominal rate multipliers emphasized by Eggertsson (2010) and Christiano, Eichenbaum, and Rebelo (2010) and just slightly lower than the closed economy aggregate multiplier for a fixed real rate monetary policy.

To more clearly see the intuition for this result, Figure 4 presents the impulse response of the price level and the real interest rate in the home region relative to the foreign region after a government spending shock in our model. The home price level rises for several periods, but then falls back to its original level of purchasing power parity. This movement in prices implies that the real interest rate in the home region initially falls, but then rises above its steady state level for a prolonged period. Figure 5 shows what happens to consumption in the home region relative to the foreign region after a government spending shock in our model. Despite the short-run fall in the real interest rate, consumption falls. This is because households anticipate high real rates in the future—equivalently, they face a high current long-term real interest rate—and therefore cut their consumption.

5.3 GHH Preferences

The results discussed above show that both the Neoclassical model and the benchmark New Keynesian model yield open economy relative multiplier that are quite a bit smaller than our empirical estimate. To bring our models better in line with the empirical evidence, we allow for complementarities between consumption and work. In particular, panel B of Table 6 reports results for a model with consumption-labor complementarities in the form of GHH preferences. Recent work by Monacelli and Perotti (2008), Bilbiie (2009), and Hall (2009) has shown that such complementarities have the potential to raise the government spending multiplier. Aguiar and Hurst (2005) present empirical evidence for such complementarities.[42]

With GHH preferences, the closed economy aggregate multipliers are even more sensitive to monetary policy: ranging from -1 to almost 9. The table makes clear, furthermore, that GHH preferences can either raise or lower the closed economy aggregate multiplier in comparison to the model with separable preferences. If monetary policy is relatively unresponsive to increases in output as in the constant real rate case, we find that incorporating GHH preferences raises the closed economy aggregate multiplier. However, if monetary policy is highly responsive to output as in the Volcker-Greenspan policy, GHH preferences lead to lower multipliers. The Neoclassical (flexible price) model yields a multiplier of zero since the wealth effect on labor supply is absent.[43] This is well within the range of multipliers implied by the New Keynesian model for alternative monetary policies as in the separable utility case.

The second data column of Panel B of Table 6 reports results for the open economy relative multiplier. It is 1.48 for all three specifications of our benchmark model ($\rho_g = 0.917$) and 2.09 for the case of more transitory government spending shocks ($\rho_g = 0.5$). Incorporating GHH preferences unambiguously raises our open economy relative multiplier. This arises because, as we describe above, real interest rates rise only slightly to offset higher output in a particular region in the monetary union. Since the monetary policy is effectively quite unresponsive to local shocks, the complementarity between consumption and work embodied in GHH preferences raises the multiplier. Intuitively, since households are working more and consumption is complementary to labor, their demand for consumption is larger than in the model with separable preferences. But to be able to consume more, still more production must take place. Firms with rigid prices meet this demand and bid up real wages in the process. This shifts the trade-off between more work and less consumption further towards more work and thus increases the output multiplier—so long as real interest rates do not rise too much in response to the increase in output.

Figure 6 plots relative output and consumption in our open economy model with GHH preferences after a positive shock to home government spending. Both output and consumption rise on impact by a little more than twice the amount of the shock. They then both fall more rapidly than the shock. The fact that the initial rise in consumption is as large as the rise in output implies that the home region responds to the shock by running a trade deficit in the short run.

[42]Schmitt-Grohe and Uribe (2009) estimate a rich business cycle model with Jaimovich and Rebelo (2009) preferences—which nests GHH and King and Rebelo (1988) preferences as special cases. Their estimates show that the data strongly prefers parameters that give GHH preferences.

[43]With sticky prices government spending shocks affect the markup of prices over marginal costs and therefore affect output by shifting labor demand.

Consumption eventually falls below its steady state level for a period of time. During this time the home region is running a trade surplus. Intuitively, the complementarity between consumption and labor implies that home households want to shift their consumption towards periods of high work effort associated with positive government spending shocks.

Summing up our results thus far, our estimates of equation (1) based on the military procurement data yield an open economy relative multiplier of roughly 1.5. This lies far above the open economy relative multipliers for the Neoclassical model—which are roughly 0.5 for both separable preferences and GHH preferences. Our empirical estimate of 1.5 is also substantially higher than the open economy relative multiplier of 0.85 implied by the New Keynesian model with separable preferences. The New Keynesian model with GHH preferences, however, is able to match the open economy relative multiplier we estimate in the data.[44] The fact that the open economy relative multiplier is not sensitive to aggregate monetary (or tax) policy implies that it is a powerful statistic for distinguishing between different models of the economy. In contrast, the closed economy aggregate multiplier is highly sensitive to aggregate policy and thus less easily used to distinguish between models.

5.4 Model with Capital

Appendix B develops an extension of the model presented in section 4 that includes investment, capital accumulation and variable capital utilization. The specification for these features that we adopt mirrors closely that of Christiano, Eichenbaum, and Evans (2005). Open economy relative multipliers for several calibrations of this model with GHH preferences are presented in Table 7. The main conclusion is that introducing capital into the model lowers the multiplier somewhat. Intuitively, in this model, government spending "crowds out" investment. One way to match the multiplier in the data for this model is to raise the elasticity of labor substantially (to 25). Table 7 also presents open economy relative multiplier for employment and prices. The Neoclassical model implies much larger movements in relative prices than does the New Keynesian model. We find little evidence for large movements in relative prices in the data. This is thus another empirical prediction that favors the New Keynesian model over the Neoclassical model.

[44]Models with hand-to-mouth consumers of the type studied by Gali, Lopez-Salido, and Valles (2007) may also have the potential to generate large open economy relative multipliers.

6 Conclusion

We study the effects of government spending on output in a monetary union. Our empirical analysis makes use of historical data on military procurement spending across U.S. regions. We measure the consequences of a differential increase in government spending in a particular region on output, employment, and prices in that region relative to other regions in the union. Since regional procurement spending potentially responds to underlying economic conditions in the region, we focus only on the effects of relative changes in government spending that arise from aggregate military build-ups or draw-downs. We use time fixed effects to control for aggregate shocks that affect all regions. Our estimates imply an open economy relative output multiplier of approximately 1.5.

We develop a framework for interpreting this open economy relative multiplier and relating it to estimates of closed economy aggregate multipliers. The closed economy aggregate multiplier is highly sensitive to how strongly aggregate monetary and tax policy "leans against the wind." In contrast, the open economy relative multiplier "differences out" these effects because different regions in the union share a common monetary and tax policy. Since the monetary authority cannot raise interest rates differentially in one region relative to other regions in response to a regions spending shock, our open economy relative multiplier is akin to an aggregate multiplier for a more accommodative monetary policy than the monetary policy seen in the United States. This implies that our open economy relative multiplier of 1.5 is not inconsistent with lower aggregate multipliers found in the literature.

Our estimate provides evidence in favor of models in which demand shocks can have large effects on output. We show that a New Keynesian model with complementarities between consumption and work in the form of GHH preferences yields an open economy relative multiplier that matches our empirical estimate. Baseline New Keynesian and Neoclassical models, however, yield lower open economy relative multipliers.

A Constant Real Rate Monetary Policy

The paper considers specifications of monetary policy that hold the real or nominal interest rate constant in response to a government spending shock. Here, we illustrate the method used to solve for these monetary policy specifications. We do this for the case of separable preference and a monetary policy that holds the real interest rate constant. The GHH preference case and the case of holding the nominal interest rate constant are similar.

Consider the closed economy limit of our model. A log-linear approximation of the key equilibrium conditions of this model are

$$\hat{c}_t = E_t\hat{c}_{t+1} - \sigma(\hat{r}_t^n - E_t\hat{\pi}_{t+1}), \tag{25}$$

$$\hat{\pi}_t = \beta E_t\hat{\pi}_{t+1} + \kappa\zeta\sigma^{-1}\hat{c}_t + \kappa\zeta\psi_\nu\hat{y}_t, \tag{26}$$

$$\hat{y}_t = \left(\frac{C}{Y}\right)\hat{c}_t + \hat{g}_t, \tag{27}$$

where $\zeta = 1/(1+\psi_\nu\theta)$ and $\psi_\nu = (1-\nu^{-1})/a - 1$.

Using equation (27) to eliminate $\hat{c}_t$ from equations (25) and (26) yields

$$\hat{y}_t = E_t\hat{y}_{t+1} - \left(\frac{C}{Y}\right)\sigma(\hat{r}_t^n - E_t\hat{\pi}_{t+1}) + (\hat{g}_t - E_t\hat{g}_{t+1}), \tag{28}$$

$$\hat{\pi}_t = \beta E_t\hat{\pi}_{t+1} + \kappa\zeta_y\hat{y}_t - \kappa\zeta_g\hat{g}_t, \tag{29}$$

where $\zeta_y = \zeta(\psi_\nu + (C/Y)^{-1}\sigma^{-1})$ and $\zeta_g = \zeta(C/Y)^{-1}\sigma^{-1}$.

An equilibrium with a fixed real interest rate must satisfy

$$\hat{y}_t = E_t\hat{y}_{t+1} + (\hat{g}_t - E_t\hat{g}_{t+1}), \tag{30}$$

$$\hat{\pi}_t = \beta E_t\hat{\pi}_{t+1} + \kappa\zeta_y\hat{y}_t - \kappa\zeta_g\hat{g}_t. \tag{31}$$

We conjecture a solution of the form $\hat{y}_t^* = a_y\hat{g}_t$, $\hat{\pi}_t^* = a_\pi\hat{g}_t$. Using the method of undetermined coefficients, it is easy to verify that such an equilibrium exists with

$$a_y = 1, \quad a_\pi = \kappa\tfrac{\zeta_y - \zeta_g}{1-\beta\rho_g},$$

where ρ_g is the autoregressive coefficient of the AR(1) process for $\hat{g}_t$.

This equilibrium can be implemented with the following policy rule

$$\begin{aligned} \hat{r}_t^n &= E_t\hat{\pi}_{t+1} + \phi_\pi(\hat{\pi}_t - \hat{\pi}_t^*) \\ &= a_\pi\rho_g\hat{g}_t + \phi_\pi\hat{\pi}_t - a_\pi\phi_\pi\hat{g}_t \\ &= \phi_\pi\hat{\pi}_t - a_\pi(\phi_\pi - \rho_g)\hat{g}_t. \end{aligned} \tag{32}$$

B Model with Capital

This appendix presents the an extension of the model presented in section 4 that incorporates investment, capital accumulation and variable capital utilization. We adopt a specification for these features that mirrors closely the specification in Christiano, Eichenbaum, and Evans (2005).

B.1 Households

Household preferences in the home region are given by equations (4)-(6) as before. Household decisions regarding consumption, saving and labor supply are thus the same as before. However, in addition to these choices, households own the capital stock, they choose how much to invest and they choose the rate of utilization of the capital stock. Let $\bar{K}_t$ denote the physical stock capital of capital available for use in period t and I_t the amount of investment chosen by the household in period t. For simplicity, assume that I_t is a composite investment good given by an index of all the products produced in the economy analogous to equations (5)-(6) for consumption. The capital stock evolves according to

$$\bar{K}_{t+1} = (1-\delta)\bar{K}_t + \Phi(I_t, I_{t-1}), \tag{33}$$

where δ denotes the physical depreciation of capital and Φ summarizes the technology for transforming current and past investment into capital. Households choose the utilization rate u_t of the capital cost. The amount of capital services provided by the capital cost in period t is then given by $K_t = u_t \bar{K}_t$.

The budget constrain of households' in the home region is given by

$$\begin{aligned} &P_t C_t + P_t I_t + P_t A(u_t)\bar{K}_t + E_t[M_{t,t+1} B_{t+1}(x)] \\ &\quad \leq B_t(x) + W_t(x) L_t(x) + R_t^k u_t \bar{K}_t + \int_0^1 \Xi_{ht}(z) dz - T_t. \end{aligned} \tag{34}$$

The differences relative to the model presented in section 4 are: First, households spend $P_t I_t$ on investment. Second, they incur a cost $P_t A(u_t)\bar{K}_t$ associated with utilizing the capital stock. Here $A(u_t)$ denotes a convex cost function. Third, they receive rental income equal to $R_t^k u_t \bar{K}_t$ for supplying $u_t \bar{K}_t$ in capital services. Here R_t^k denotes the rental rate for a unit of capital services.

In addition to equations (8)-(11), (14) and a standard transversality condition, household optimization yields the following relevant optimality conditions. Optimal capital utilization sets the marginal cost of additional utilization equal to the rental rate on capital,

$$A'(u_t) = \frac{R_t^k}{P_t}. \tag{35}$$

Optimal investment and capital accumulation imply

$$D_t\Phi_1(I_t, I_{t-1}) + \beta E_t[D_{t+1}\Phi_2(I_{t+1}, I_t)] = u_c(C_t, L_t(x)), \tag{36}$$

$$D_t = \beta(1-\delta)E_t D_{t+1} + \beta E_t[(A'(u_{t+1})u_{t+1} - A(u_{t+1}))u_c(C_{t+1}, L_{t+1}(x))], \tag{37}$$

where D_t is the Lagrange multiplier on equation (33) and $\Phi_j(\cdot,\cdot)$ denotes the derivative of Φ with respect to its jth argument.

B.2 Firms

The production function for firm z is

$$y_t(z) = f(L_t(z), K_t(z)). \tag{38}$$

The demand for firm z's product is given by

$$y_t(z) = (nC_{Ht} + (1-n)C^*_{Ht} + nI_{H,t} + (1-n)I^*_{H,t} + nG_{Ht})\left(\frac{p_{ht}(z)}{P_{Ht}}\right)^{-\theta}. \tag{39}$$

Firm optimization then yields

$$W_t(x) = f_\ell(L_t(z), K_t(z))S_t(z), \tag{40}$$

$$R^k_t = f_k(L_t(z), K_t(z))S_t(z), \tag{41}$$

and a firm price setting equation given by equation (22).

B.3 Calibration

We set the rate of depreciation of capital to $\delta = 0.025$, which implies an annual depreciation rate of 10 percent. The investment adjustment cost function is given by

$$\Phi(I_t, I_{t-1}) = \left[1 - \phi\left(\frac{I_t}{I_{t-1}}\right)\right] I_t, \tag{42}$$

where $\phi(1) = \phi'(1) = 0$ and $\kappa_I = \phi''(1) > 0$. We set $\kappa_I = 2.5$. This is the value estimated by Christiano et al. (2005). We require that capital utilization $u_t = 1$ in steady state, assume that the cost of utilization function $A_1 = 0$ and set $\sigma_a = A''(1)/A'(1) = 0.01$. Again, this is the value estimated by Christiano et al. (2005). We assume that the production function is Cobb-Douglas with a capital share of 1/3.

References

Acconcia, A., G. Corsetti, and S. Simonelli (2011): "Mafia and Public Spending: Evidence on the Fiscal Multiplier from a Quasi-Experiment," CEPR Discussion Paper No. 8305.

Aguiar, M., and E. Hurst (2005): "Consumption versus Expenditure," *Journal of Political Economy*, 113(5), 919–948.

Alesina, A., and S. Ardagna (2009): "Large Changes in Fiscal Policy: Taxes versus Spending," in *Tax Policy and the Economy, Volume 24*, ed. by J. R. Brown, pp. 35–68, Chicago IL. University of Chicago Press.

Auerbach, A. J., and Y. Gorodnichenko (2010): "Measuring the Output Responses to Fiscal Policy," NBER Working Paper No. 16311.

Backus, D. K., and G. W. Smith (1993): "Consumption and Real Exchange Rates in Dynamic Economies with Non-Traded Goods," *Journal of International Economics*, 35(3–4), 297–316.

Bansal, R., and A. Yaron (2004): "Risks for the Long Run: A Potential Resolution of Asset Pricing Puzzles," *Journal of Finance*, 59(4), 1481–1509.

Barro, R. J., and C. J. Redlick (2011): "Macroeconomic Effects from Government Purchases and Taxes," *Quarterly Journal of Economics*, 126, Forthcoming.

Bartik, T. J. (1991): *Who Benefits from State and Local Economic Development Policies?* W.E. Upjohn Institute for Employment Research, Kalamazoo, MI.

Baxter, M., and R. G. King (1993): "Fiscal Policy in General Equilibrium," *American Economic Review*, 83(3), 315–334.

Benigno, G., and P. Benigno (2003): "Price Stability in Open Economies," *Review of Economic Studies*, 70(4), 743–764.

Benigno, P., and M. Woodford (2005): "Inflation Stabilization and Welfare: The Case of a Distorted Steady State," *Journal of the European Economic Association*, 3, 1185–1236.

Bilbiie, F. O. (2009): "Non-Separable Preferences, Frisch Labor Supply and the Consumption Multiplier of Government Spending: One Solution to a Fiscal Policy Puzzle," Working Paper, Paris School of Economics.

Blanchard, O., and R. Perotti (2002): "An Empirical Characterization of the Dynamic Effects of Changes in Government Spending," *Quarterly Journal of Economics*, 117(4), 1329–1368.

Blanchard, O. J., and L. Katz (1992): "Regional Evolutions," *Brookings Papers on Economic Activity*, 1992(1), 1–75.

Braddon, D. (1995): "The Regional Impact of Defense Expenditure," in *Handbook of Defense Economics*, ed. by K. Hartley, and T. Sandler, pp. 491–521, Amsterdam. Elsevier Science.

Burnside, C., M. Eichenbaum, and J. Fisher (2004): "Fiscal Shocks and their Consequences," *Journal of Economic Theory*, 115, 89–117.

Calvo, G. A. (1983): "Staggered Prices in a Utility-Maximizing Framework," *Journal of Monetary Economics*, 12, 383–398.

Canova, F., and E. Pappa (2007): "Price Differentials in Monetary Unions: The Role of Fiscal Shocks," *The Economic Journal*, 117(520), 713–737.

Chari, V., P. J. Kehoe, and E. R. McGrattan (2002): "Can Sticky Price Models Generate Volatile and Persistent Real Exchange Rates," *Review of Economic Studies*, 69, 533–563.

Christiano, L., M. Eichenbaum, and S. Rebelo (2010): "When is the Government Spending Multiplier Large?," Working Paper, Northwestern University.

Christiano, L. J., M. Eichenbaum, and C. L. Evans (2005): "Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy," *Journal of Political Economy*, 113(1), 1–45.

Clarida, R., J. Gali, and M. Gertler (2000): "Monetary Policy Rules and Macroeconomic Stability: Evidence and Some Theory," *Quarterly Journal of Economics*, 115, 147–180.

Clemens, J., and S. Miran (2010): "The Effects of State Budget Cuts on Employment and Income," Working Paper, Harvard University.

Cochrane, J. H. (2005): *Asset Pricing*. Princeton University Press, Princeton, NJ, second edn.

Cogan, J. F., T. Cwik, J. B. Taylor, and V. Wieland (2010): "New Keynesian Versus Old Keynesian Government Spending Multipliers," *Journal of Economic Dynamics and Control*, 34(3), 281–295.

Cohen, L., J. Coval, and C. Mallow (2010): "Do Powerful Politicians Cause Corporate Downsizing?," Working Paper, Harvard Business School.

Corsetti, G., K. Kuester, and G. Muller (2011): "Floats, Pegs and the Transmission of Fiscal Policy," CEPR Working Paper No. 8180.

Corsetti, G., A. Meier, and G. J. Muller (2009): "Fiscal Stimulus With Spending Reversals," CEPR Discussion Paper No. 7302.

Cragg, J. G., and S. G. Donald (1993): "Testing Identifiability and Specification in Instrumental Variable Models," *Econometric Theory*, 9(2), 222–240.

Davis, S. J., P. Loungani, and R. Mahidhara (1997): "Regional Labor Fluctuations: Oil Shocks, Military Spending, and Other Driving Forces," Working Paper, University of Chicago.

Del Negro, M. (1998): "Aggregate Risk Sharing Across US States and Across European Countries," Working Paper, Yale University.

Drautzburg, T., and H. Uhlig (2011): "Fiscal Stimulus and Distortionary Taxation," Working Paper, University of Chicago.

Edelberg, W., M. Eichenbaum, and J. D. Fisher (1999): "Understanding the Effects of a Shock to Government Purchases," *Review of Economic Dynamics*, 2, 166–206.

Eggertsson, G. B. (2010): "What Fiscal Policy Is Effective at Zero Interest Rates?," in *NBER Macroeconomics Annual 2010*, ed. by D. Acemoglu, and M. Woodford, Chicago IL. University of Chicago Press.

Fishback, P., and V. Kachanovskaya (2010): "In Search of the Multiplier for Federal Spending in the States During the New Deal," NBER Working Paper No. 16561.

Fishback, P. V., W. C. Horrace, and S. Kantor (2004): "Did New Deal Grant Programs Stimulate Local Economies? A Study of Federal Grants and Retail Sales During the Great Depression," Working Paper, University of Arizona.

Fisher, J. D. M., and R. Peters (2010): "Using Stock Returns to Identify Government Spending Shocks," *Economic Journal*, 120(544), 414–436.

Gali, J., D. Lopez-Salido, and J. Valles (2007): “Understanding the Effects of Government Spending on Consumption,” *Journal of the European Economic Association*, 5(1), 227–270.

Gali, J., and T. Monacelli (2008): “Optimal Monetary and Fiscal Policy in a Currency Union,” *Journal of International Economics*, 76(1), 116–132.

Gordon, R. J., and R. Krenn (2010): “The End of the Great Depression 1939-41: Policy Contributions and Fiscal Multipliers,” NBER Working Paper No. 16380.

Greenwood, J., Z. Hercowitz, and G. W. Huffman (1988): “Investment, Capacity Utilization and the Real Business Cycle,” *American Economic Review*, 78(3), 402–417.

Gruber, J. (2006): “A Tax-Based Estimate of the Elasticity of Intertemporal Substitution,” NBER Working Paper No. 11945.

Hall, R. E. (1988): “Intertemporal Substitution in Consumption,” *Journal of Political Economy*, 96(2), 339–357.

——— (2009): “By How Much Does GDP Rise if the Government Buys More Output?,” *Brookings Papers on Economic Activity*, 2, 183–249.

Hillberry, R., and D. Hummels (2003): “Intranational Home Bias: Some Explanations,” *Review of Economics and Statistics*, 85(4), 1089–1092.

Hooker, M. A., and M. M. Knetter (1997): “The Effects of Military Spending on Economic Activity: Evidence from State Procurement Spending,” *Journal of Money, Credit and Banking*, 28(3), 400–421.

Ilzetzki, E., E. Mendoza, and C. Vegh (2010): “How Big (Small?) are Fiscal Multipliers?,” NBER Working Paper No. 16479.

Jaimovich, N., and S. Rebelo (2009): “Can News about the Future Drive the Business Cycle?,” *American Economic Review*, 99(4), 1097–1118.

King, R. G., and C. I. P. S. Rebelo (1988): “Production, Growth and Business Cycles: I. The Basic Neoclassical Model,” *Journal of Monetary Economics*, 21((2/3)), 195–232.

Kraay, A. (2011): “How Large is the Government Spending Multiplier? Evidence from World Bank Lending,” Working Paper, World Bank.

Mertens, K., and M. Ravn (2010): “Fiscal Policy in an Expectations Driven Liquidity Trap,” Working Paper, Cornell University.

Mintz, A. (ed.) (1992): *The Political Economy of Military Spending in the United States*. Routledge, New York.

Monacelli, T., and R. Perotti (2008): “Fiscal Policy, Wealth Effects, and Markups,” NBER Working Paper No. 14584.

Mountford, A., and H. Uhlig (2009): “What are the Effects of Fiscal Policy Shocks?,” *Journal of Applied Econometrics*, 24(6), 960–992.

Nakamura, E., J. Steinsson, R. Barro, and J. Ursua (2011): “Crises and Recoveries in an Empirical Model of Consumption Disasters,” Working Paper, Columbia University.

Nekarda, C. J., and V. A. Ramey (2010): “Industry Evidence on the Effects of Government Spending,” Working Paper, University of California, San Diego.

Obstfeld, M., and K. Rogoff (1995): “Exchange Rate Dynamics Redux,” *Journal of Political Economy*, 103(3), 624–660.

Ohanian, L. E. (1997): "The Macroeconomic Effects of War Finance in the United States: World War II and the Korean War," *American Economic Review*, 87(1), 23–40.

Perotti, R. (2007): "In Search of the Transmission Mechanism of Fiscal Policy," in *NBER macroeconomics Annual 2007*, ed. by D. Acemoglu, K. Rogoff, and M. Woodford, pp. 169–226, Chicago IL. University of Chicago Press.

Ramey, V. A. (2011): "Identifying Government Spending Shocks: It's All in the Timing," *Quarterly Journal of Economics*, 126, Forthcoming.

Ramey, V. A., and M. D. Shapiro (1998): "Costly Capital Reallocation and the Effects of Government Spending," *Carnegie-Rochester Conference Series on Public Policy*, 48(1), 145–194.

Romer, C., and J. Bernstein (2009): "The Job Impact of the American Recovery and Reinvestment Plan," Council of Economic Advisers.

Schmitt-Grohe, S., and M. Uribe (2009): "What's News in Business Cycles," Working Paper, Columbia University.

Serrato, J. C. S., and P. Wingender (2010): "Estimating Local Fiscal Multipliers," Working Paper, University of California at Berkeley.

Shoag, D. (2010): "The Impact of Government Spending Shocks: Evidence on the Multiplier from State Pension Plan Returns," Working Paper, Harvard University.

Sims, C. A. (2001): "Solving Linear Rational Expectations Model," *Journal of Computational Economics*, 20, 1–20.

Stock, J. H., J. H. Wright, and M. Yogo (2002): "A Survey of Weak Instruments and Weak Identification in Generalized Method of Moments," *Journal of Business and Economic Statistics*, 20(4), 518–529.

Stock, J. H., and M. Yogo (2005): "Testing for Weak Instruments in Linear IV Regression," in *Identification and Inference for Econometric Models: Essays in Honor of Thomas Rothemberg*, ed. by D. W. K. Andrews, and J. H. Stock, pp. 80–108, Cambridge, U.K. Cambridge University Press.

Taylor, J. B. (1993): "Discretion Versus Policy Rules in Practice," *Carnegie-Rochester Conference Series*, 39, 195–214.

——— (1999): "Staggered Price and Wage Setting in Macroeconomics," in *Handbook of Macroeconomics*, ed. by J. B. Taylor, and M. Woodford, pp. 1009–1050, Amsterdam, Holland. Elsevier.

Wilson, D. J. (2011): "Fiscal Spending Jobs Multipliers: Evidence from the 2009 American Recovery and Reinvestment Act," Working Paper, Federal Reserve Bank of San Francisco.

Woodford, M. (2003): *Interest and Prices*. Princton University Press, Princeton, NJ.

——— (2010): "Simple Analytics of the Government Expenditure Multiplier," *American Economic Journal: Macroeconomics*, Forthcoming.

TABLE I
States Most Sensitive to Aggregate Military Buildups

Missouri
Connecticut
Texas
Vermont
New Hampshire
Massachusetts
Kansas
California
Georgia
Louisiana

The table lists the 10 states for which state military procurement spending is most sensitive to national military procurement spending in descending order.

TABLE II
The Effects of Military Spending

	Output		Output defl. State CPI		Employment		CPI		Population
	States	Regions	States	Regions	States	Regions	States	Regions	States
Prime Military Contracts	1.43	1.85	1.35	1.85	1.28	1.76	0.03	-0.14	-0.12
	(0.36)	(0.58)	(0.36)	(0.71)	(0.29)	(0.62)	(0.18)	(0.65)	(0.17)
Prime Contracts plus Military Compensation	1.61	1.62	1.36	1.45	1.39	1.51	0.19	0.06	0.07
	(0.40)	(0.84)	(0.39)	(0.88)	(0.32)	(0.90)	(0.16)	(0.41)	(0.21)
Num. Obs.	1989	390	1989	390	1989	390	1785	350	1989

The dependent variable is stated at top of each column. Each cell in the table reports results for a different regression with the main regressor of interest listed in the far left column. Standard errors are in parentheses. Military spending variables are per capita except in Population regression. All regressions include region and time fixed effects, and are estimated by two stage least squares. The sample period is 1966-2006 for output, employment and population, and 1969-2006 for the CPI. Output is state GDP, first deflated by the national CPI and then by our state CPI measures. Employment is from the BLS payroll survey. The CPI measure is described in the text. Standard errors are clustered by state or region.

TABLE III

Alternative Specifications for Effects of Military Spending

	Output per Working Age		Output w/ Oil Controls		Output w/ Real Int. Contr.		Output OLS	
	States	Regions	States	Regions	States	Regions	States	Regions
Prime Military Contracts	1.46 (0.58)	1.94 (1.21)	1.32 (0.36)	1.89 (0.53)	1.40 (0.34)	1.76 (0.78)	0.16 (0.14)	0.56 (0.32)
Prime Contracts plus Military Comp.	1.79 (0.60)	1.74 (1.00)	1.43 (0.39)	1.72 (0.66)	1.52 (0.37)	1.38 (1.05)	0.19 (0.19)	0.64 (0.31)
Num Obs.	1785	350	1785	350	1938	380	1989	390

	Output Level Instr.		Employment Level Instr.		Output LIML		BEA Employment	
	States	Regions	States	Regions	States	Regions	States	Regions
Prime Military Contracts	2.48 (0.94)	2.75 (0.69)	1.81 (0.41)	2.51 (0.31)	1.95 (0.62)	2.07 (0.66)	1.52 (0.37)	1.64 (0.98)
Prime Contracts plus Military Comp.	4.79 (2.65)	2.60 (1.18)	2.07 (0.67)	1.97 (0.98)	2.21 (0.67)	1.90 (1.02)	1.62 (0.42)	1.28 (1.16)
Num Obs.	1989	390	1989	390	1989	390	1836	360

The dependent variable is stated at top of each column. Each cell in the table reports results for a different regression with the main regressor of interest listed in the far left column. Standard errors are in parentheses. Specifications: 1) Constructs per-capita output using the working age population, which is available starting in 1970; 2) Adds the price of oil interacted with state dummies as controls; 3) Adds the real interest rate interacted with state dummies as controls; 4) OLS estimates of the benchmark specification; 5) and 6) Use national military spending scaled by fraction of military spending in the state in 1966-1971 relative to the average fraction as the instrument for state spending; 7) LIML estimate of baseline specification; 8) Estimates the employment regression using the BEA employment series, which starts in 1969. All specifications include time and regions fixed effects in addition to the main regressor of interest. Standard errors are clustered by state or region depending on the specification.

TABLE IV
Effect of Military Spending on Sectoral Output

	Weight	States	Regions
Construction	0.05	5.43*	5.51*
		(1.24)	(1.33)
Manufacturing	0.20	2.83*	3.45*
		(0.95)	(1.50)
Retail	0.09	1.36*	1.78*
		(0.28)	(0.51)
Services	0.18	0.99*	0.84*
		(0.39)	(0.41)
Wholesale	0.07	0.44	0.80
		(0.35)	(0.63)
Mining	0.02	-0.48	12.88
		(3.03)	(6.89)
Agriculture	0.02	1.85	0.72
		(1.13)	(3.81)
Transportation and Utilities	0.08	-0.05	0.03
		(0.41)	(0.67)
Finance, insurance, rental, estate	0.17	0.22	1.93
		(0.71)	(1.39)
Government	0.13	0.15	0.30
		(0.34)	(0.64)
Federal Military	0.01	0.23	-1.37
		(0.82)	(1.87)

The table reports results of regressions of the change in sectoral state output on the change in state military spending. All regressions include region and time fixed effects, and are estimated by two stage least squares. The sample period is 1966-2006. The first data column reports the weight of each sector in total output over our sample period. All variables are in per capita terms. A star indicates statistical significance at the 5% level.

TABLE V

Effects of Military Spending in High Versus Low Unemployment Periods

	Output		Employment	
	States	Regions	States	Regions
β_h	3.54	3.27	1.85	2.20
	(1.51)	(1.60)	(0.85)	(1.53)
$\beta_l - \beta_h$	-2.80	-1.85	-0.75	-0.57
	(1.49)	(1.91)	(0.89)	(1.61)

The dependent variable is stated at top of each column. Standard errors are in parentheses. The two regressors are 1) change in military spending and 2) change in military spending interacted with a dummy indicating whether the national unemployment rate is below its median value over the sample period. This yields the effect of spending during high unemployment periods (β_h) and the difference between the effect of spending during low and high unemployment periods ($\beta_l - \beta_h$). All regressions include region and time fixed effects, and are estimated by two stage least squares. The sample period is 1966-2006. Output is state GDP. Employment is from the BLS payroll survey. All variables are per capita.

TABLE VI

Government Spending Multiplier in Business Cycle Models

	Closed Economy Agg. Multiplier	Open Economy Rel. Multiplier
Panel A: Separable Preferences		
Volcker-Greenspan Monetary Policy	0.22	0.85
Constant Real Rate	1.00	0.85
Constant Nominal Rate	-0.39	0.85
Constant Nominal Rate (ρ_g=0.85)	1.70	0.90
Flexible Prices	0.39	0.43
Panel B: GHH Preferences		
Volcker-Greenspan Monetary Policy	0.15	1.48
Constant Real Rate	7.00	1.48
Constant Nominal Rate	-0.64	1.48
Constant Nominal Rate (ρ_g=0.50)	8.73	2.09
Flexible Prices	0.00	0.30

The table reports the government spending multiplier for output deflated by the regional CPI for different specifications of the business cycle model presented in the text. Panel A presents results for the model with separable preferences, while panel B presents results for the model with GHH preferences. The first three rows in each panel differ only in the monetary policy being assumed. The fourth row in each panel varies the persistence of the government spending shock relative to the baseline parameter values. The fifth row presents results for a version of the model with flexible prices.

TABLE VII

Open Economy Relative Multipliers for Output, Employment and Inflation

	Output	Employment	CPI Inflation
No Capital	1.48	2.10	0.15
w/ Capital, Baseline	1.10	0.79	0.10
w/ Capital, High Labor Supply Elast.	1.47	1.44	0.02
w/ Capital, Flexible Prices	0.45	0.23	0.30

The table reports the open economy relative government spending multiplier for output, employment and CPI inflation for the model with GHH preferences both excluding and including capital. Output is deflated by the regional CPI. The first row presents results for the baseline specificaiton of the GHH model (same as in in table 5). The second row presents results for the baseline calibration of the model with capital. The third row presents results for the model with capital and with a labor supply elasticiy of 25. The last row presents results for the model with capital and flexible prices.

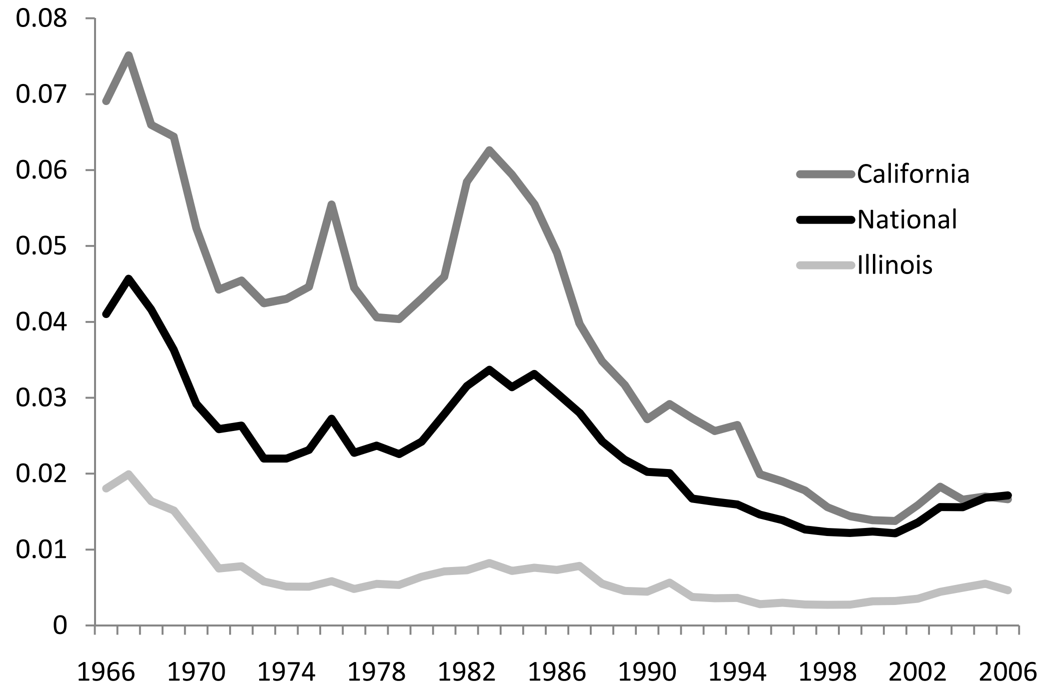

Figure I
Prime Military Contract Spending as a Fraction of State GDP

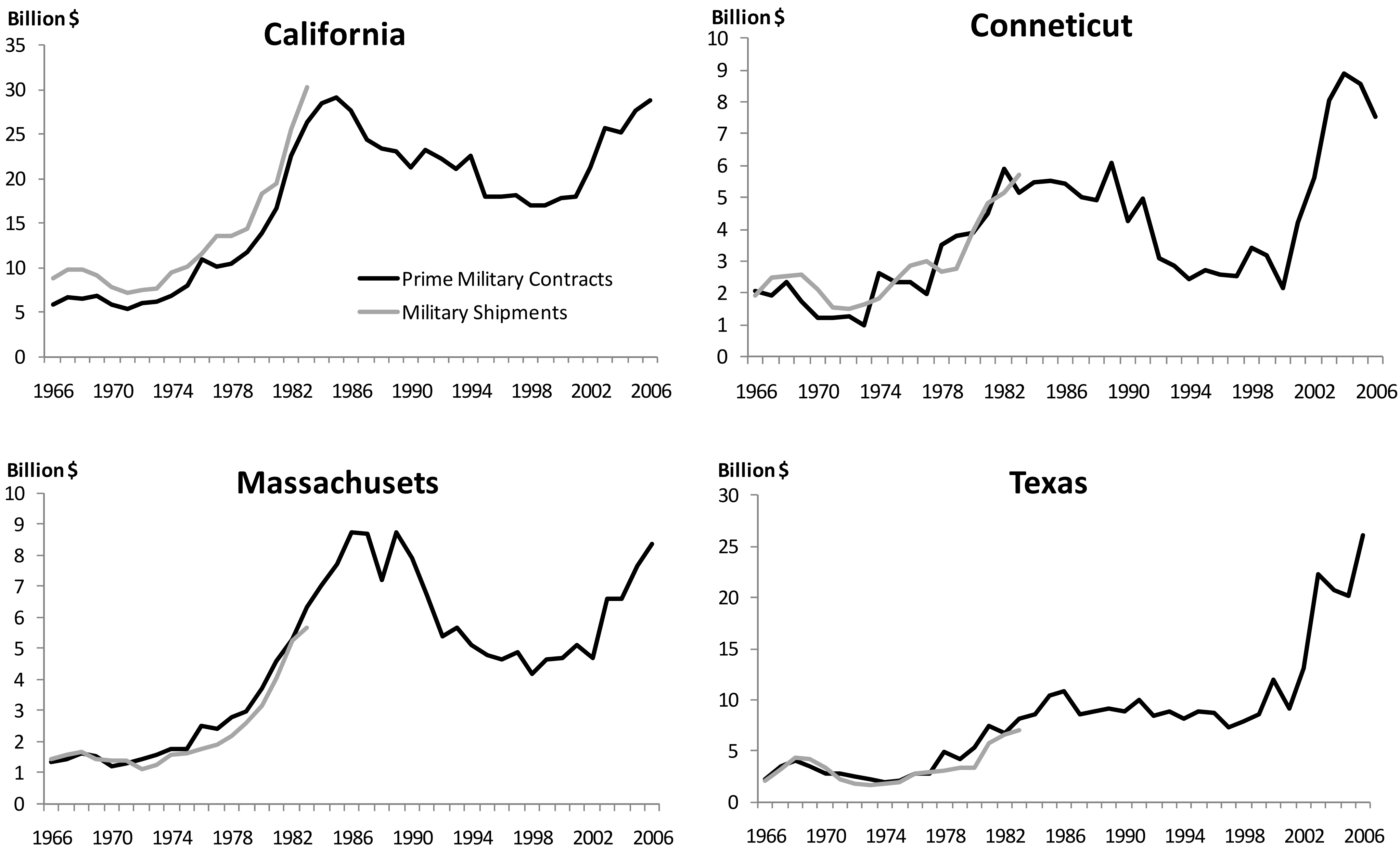

Figure II
Prime Military Contracts and Military Shipments

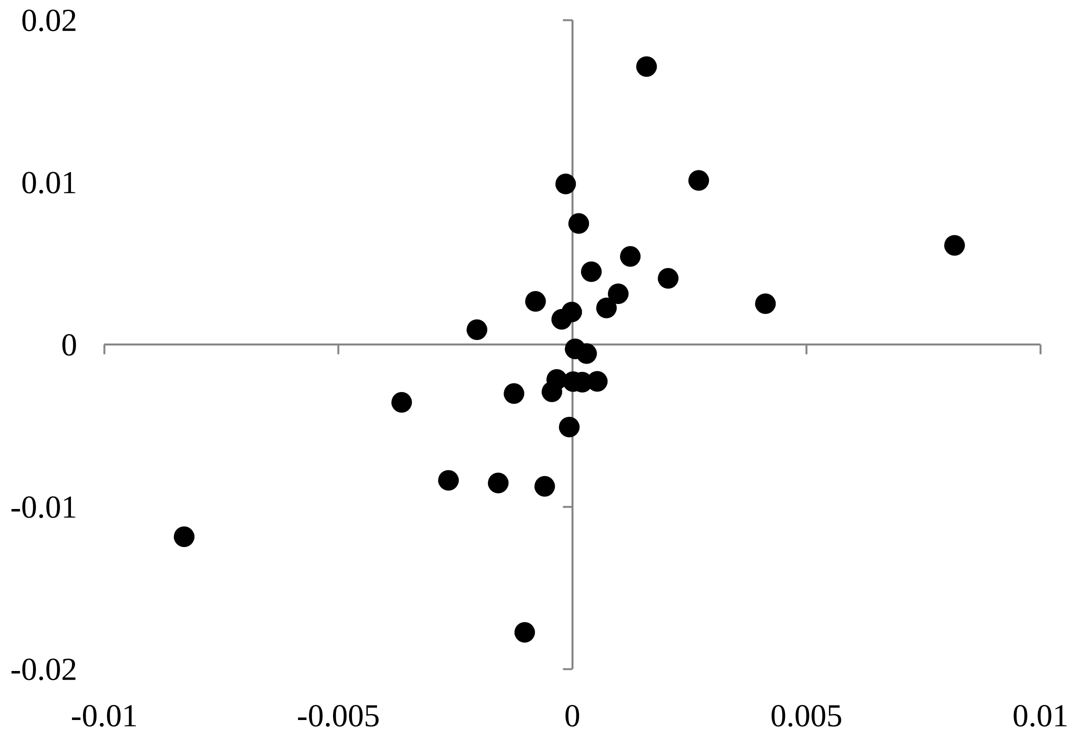

FIGURE III

Quantiles of Change in Output Versus Predicted Change in Military Spending

The figure shows averages of changes in output and predicted military spending (based on our first-stage regression), grouped by 30 quantiles of the predicted military spending variable. Both variables are demeaned by year and state fixed effects.

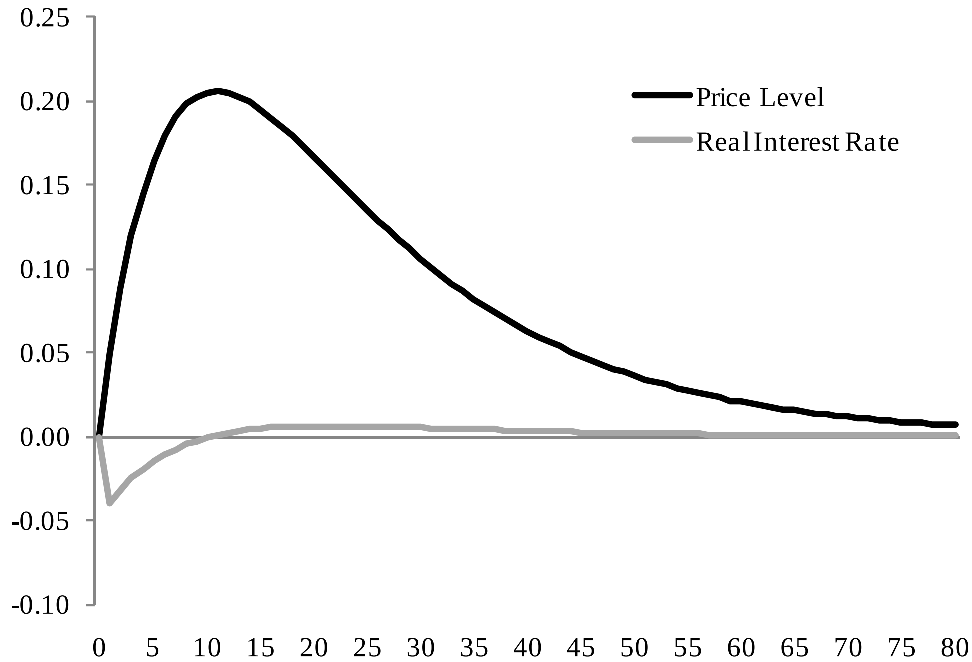

Figure IV
Prices and Real Interest Rates after a Government Spending Shock

The figure plots the relative price level and the relative real interest rate in the two regions for the model with separable preferences after a positive government spending shock to the home region.

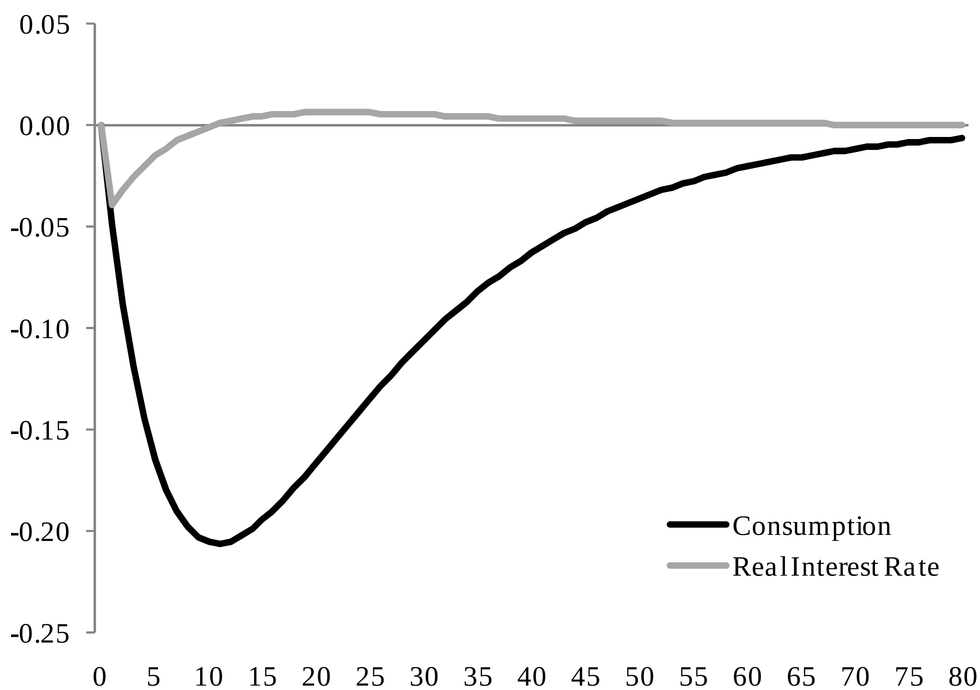

Figure V
Consumption and Real Interest Rate after a Government Spending Shock

The figure plots the relative consumption and the relative real interest rate in the two regions for the model with separable preferences after a positive government spending shock to the home region.

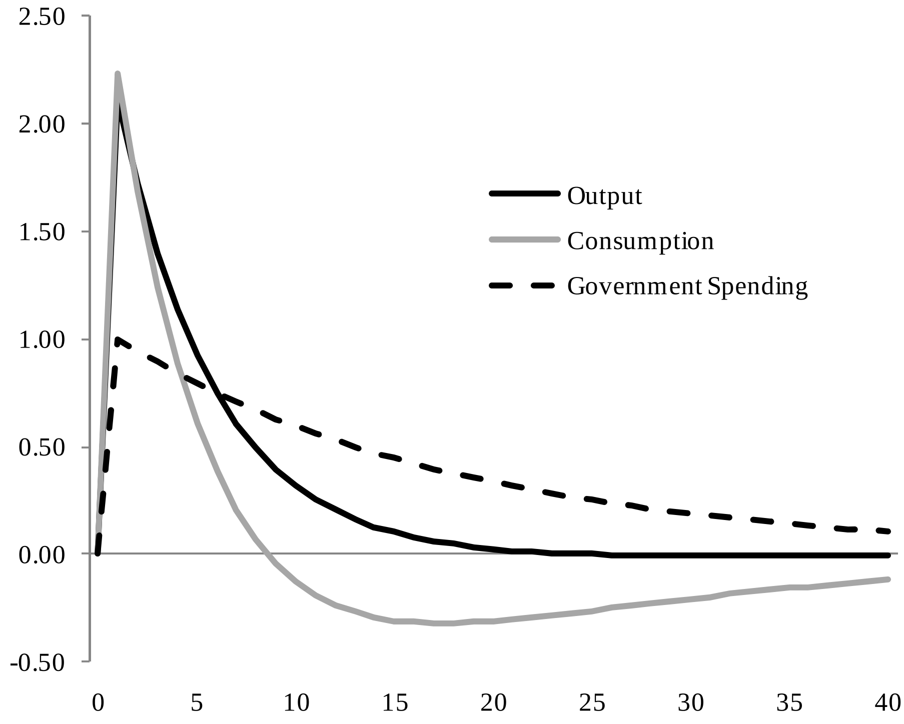

Figure VI
Output and Consumption after a Government Spending Shock in GHH Model

The figure plots the relative output and consumption in the two regions for the model with GHH preferences after a positive government spending shock to the home region.