The Consumption Multiplier of Government Purchases: Evidence from U.S. States*

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Abstract

We analyze evidence from US states to compute the open economy relative multiplier along the lines of Nakamura and Steinsson (2014). Identification of exogenous government spending shocks is achieved by exploiting the secular tendency of some states to receive a disproportionate share of military spending relative to others. Our contribution is twofold. First, we gather additional procurement data to extend the previous series until 2013, thus including the Great Recession and its aftermath. Second, to our knowledge, this is the first attempt at analyzing the effects of military spending shocks on an aggregate consumption measure at state level. Estimated short run multipliers on output range between 1.3 and 1.6. There is some weak evidence that points to a positive effect on private consumption in the short run. Nonlinearities in the estimated multipliers seem to play a much more important role: both output and consumption respond sharply when unemployment is relatively high, or since the onset of the Great Recession. We use these estimates as a diagnostic tool to evaluate the performance of competing models of the economy. The strong evidence pointing to state-dependent multipliers, even after controlling for monetary policy, seems to be consistent with the predictions of a New-Keynesian model with credit-constrained consumers.

Keywords: Fiscal Policy, Government Spending Multiplier, Aggregate Consumption, Regional Heterogeneity.

JEL Classification: E21, E24, E62.

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1 Introduction

Since the onset of the Great Recession, one of the most heated debates in macroeconomics has revolved around the role of fiscal policy at times in which monetary policy alone is not effective. The Keynesian tradition points out that countercyclical government purchases are likely to be effective in spurring economic activity when the nominal interest rate is at its lower bound or when there are credit constrained consumers who are unable to transfer wealth intertemporally. A standard result in Neoclassical macroeconomics, instead, is that fiscal policy shocks cause a negative wealth effect on the household sector. If Ricardian equivalence holds, then households will take into account the necessary increase in taxes that will to occur sooner or later if the government is to be solvent and cut consumption while increasing their labor supply.

Empirical analyses of the effects of fiscal policy shocks have recently been puzzling. In particular, results from vector autoregressions usually point to a positive response of output, employment and consumption to fiscal shocks, while the results obtained using either aggregate military spending or the narrative method reveal a negative short term impact on consumption and a much lower multiplier on output.

A relatively new strand of literature has tried to analyze the effects of fiscal policy by exploiting regional variation in macroeconomic aggregates. These attempts include the work by Nakamura and Steinsson (2014) and Giavazzi and McMahon (2012), among others. As thoroughly discussed in the latter, there are advantages and disadvantages to such an approach. On the positive side, looking at cross-sectional variation allows one to control for a host of confounders, the most important being monetary policy. Fiscal-monetary policy interactions are paramount in the theoretical literature on fiscal policy, because the multiplier is a function of the response of monetary policy. Hence, by including time effects, one is able to control for the response of the central bank, which is obviously constant across states. Moreover, identification of plausibly exogenous fiscal policy shocks is generally more credible in this setting, because it is achieved either exploiting natural experiments, or weakening significantly the usual assumptions of exogeneity of military spending shocks.

The main downside of using regional data is that, precisely because the time effect is capturing all factors that are constant across states, estimates of the fiscal multipliers do not take into account the wealth effect associated to either a contemporaneous or a future increase in taxes. This implies that the estimated multipliers are at best a biased version of the more conventional closed economy counterparts on which much of the recent literature has focused. Indeed, what is actually estimated is a different object, which Nakamura and Steinsson call open economy relative multiplier. The correct thought experiment that must be done to understand this concept consists in first envisioning a situation in which the Federal Government administers a spending shock to one particular state, and then tracking the response of the variables of interest in that state relative to all the others.

In light of the above discussion, it is clear that one cannot use standard models of the economy to run counterfactual experiments while at the same time keeping consistency with the empirical ex-
exercise that is conducted. One of the most important aspects of Nakamura and Steinsson’s work is precisely the development of such a model in which both the closed and the open economy multipliers can be computed and compared following a spending shock to one state. Our work builds upon these recent studies, in particular Nakamura and Steinsson, and Giavazzi and MacMahon. The original contribution consists in the collection of new evidence on both military purchases and personal consumption expenditures at state level, which is then framed and analyzed in light of the theoretical framework of Nakamura and Steinsson.

The paper is organized as follows. Section 2 briefly outlines the empirical literature on both the aggregate and the cross sectional multiplier. Sections 3, 4 and 5 present the data, the empirical model and the regression results. Sections 6 and 7 present the theoretical framework of Nakamura and Steinsson and comment on the empirical validity of the predictions of several versions of the model. Finally, we draw the main conclusions in Section 8. In the Appendix, we present the robustness checks for our empirical model.

2 The Empirics of Fiscal Policy

2.1 Fiscal Multipliers

In much of the fiscal policy literature, the object of interest is the fiscal multiplier. This is conventionally defined as the ratio of the level change of a certain variable of interest over the spending shock, which may be either temporary or persistent. In particular, the multipliers analyzed in much of the literature, as well as in our work, are variations on the following formula:

$$\beta = \frac{\sum_{k=0}^{K} \Delta y_{t+k}}{\sum_{k=0}^{K} \Delta g_{t+k}}$$

Expression (2) also differs from (1) because, instead of tracking the flow evolution of the variable of interest, one computes the deviation of the variable from its steady state value, which is denoted by

$$\beta_{p.v.} = \frac{\sum_{k=0}^{K} \left( \prod_{j=0}^{k} r_{t+j} \right) (y_{t+k} - y_{t+k}^n)}{\sum_{k=0}^{K} \left( \prod_{j=0}^{k} r_{t+j} \right) (g_{t+k} - g_{t+k}^n)}$$

In (1), $\Delta$ refers to the level change in the variable of interest. Moreover, it is often assumed that the path for the spending shock is short lived, in the sense that $\Delta g_{t+k} = 0 \forall k \geq 1$.

Recent works by Leeper and his co-authors (2009a; 2010; 2011), as well as Mountford and Uhlig (2008), have criticized this formula, especially when one is interested in computing the multiplier implied by different models. In particular, they claim that one should keep in mind that the response of output that matters for individuals must be discounted by the expected real interest rate to transform “future” dollars in current real expected values. Hence, a correct present value multiplier would be:

$$\beta_{p.v.} = \frac{\sum_{k=0}^{K} \left( \prod_{j=0}^{k} r_{t+j} \right) (y_{t+k} - y_{t+k}^n)}{\sum_{k=0}^{K} \left( \prod_{j=0}^{k} r_{t+j} \right) (g_{t+k} - g_{t+k}^n)}$$

Expression (2) also differs from (1) because, instead of tracking the flow evolution of the variable of interest, one computes the deviation of the variable from its steady state value, which is denoted by
the subscript $n$. Assuming that the economy was at its steady state in $t - 1$, both in terms of $y$ and of $g$, then (2) would be equivalent to (1) for $K = 0$. But, this is no longer true if one sets $K \geq 1$, not only because of the inclusion of the interest rate component, but also because tracking the deviation of output from its steady state is conceptually and mathematically different from tracking its percentage change.

Because of the difficulty of computing a “steady state” value of the dependent value in applied empirical work, in what follows we will maintain the conventional definition of the multiplier reported in (1). Moreover, we maintain the following naming convention as far as the multipliers implied by different horizons are concerned:

- Impact multiplier if $K = 0$;
- Short run multiplier for $K = 1$ (for annual data);
- Long run multiplier for either $K = 2, 3$ (for annual data).

### 2.2 Aggregate Time Series Evidence

There are three main approaches that have been used to characterize empirically the impact on key aggregate macroeconomic of a fiscal policy shock using aggregate data. The first consists in exploiting exogenous events such as wars and military buildups. Under the assumption that the events that led to a war were unrelated to the state of the economy, then the effects of these large swings in spending on output can be computed, for instance with the war dates dummy introduced in Ramey and Shapiro (1998), or by controlling for the average marginal tax rate as in Barro and Redlick (2009). Studies using aggregate military spending shocks usually find a small multiplier on output, and a negative impact on consumption.

The second approach has been pioneered by Blanchard and Perotti (2002), who identified a vector autoregression in which institutional decision and implementation lags were used to justify the Choleski decomposition, and in which the tax elasticity to output was calibrated with long run data. These studies usually find that a government spending shock raises output, consumption, employment and the real wage, a strikingly Keynesian result. Numerous papers followed this path, but this methodology has recently been criticized by Leeper et al. (2009b), in which the authors point out that Vector Autoregressions have a non-invertible moving average representation in the presence of fiscal foresight. This occurs because the information sets of agents inside the model and the econometrician's are misaligned. Moreover, Ramey (2011b) shows that her military news variable has explanatory power for the residuals implied by standard Vector Autoregressions, thus suggesting that anticipation effects might be relevant.

The third approach is that followed by Romer and Romer (2010; 2014), as well as Alesina et al. (2012) and Guajardo et al. (2014), who use the narrative method to identify exogenous fiscal policy
shocks.\textsuperscript{1} Their methodology requires to manually read primary sources on all legislated tax or spending changes and to classify them either as endogenous or exogenous depending on the most likely motivation behind the policy decision. Under the assumption that their classification is correct, then one can use such series in a very simple empirical model because they are exogenous. These studies usually find large multipliers on tax shocks, implying for instance that a tax hike will lead to a contraction of output.

\subsection*{2.3 Cross-Sectional Evidence}

Recently, there has been an upsurge in the number of papers that have tried to identify government spending shocks using regional data, at different levels of disaggregation. Even abstracting from the problem of identification of exogenous fiscal policy shocks, the main advantage of this literature consists in the fact that it explores cross-sectional variation in a monetary and fiscal union. In this setting, the econometrician is able to control for the response of all those factors that are common either across states or across time, thus allowing an easier interpretation of the estimates, which are sheltered from monetary-fiscal policy interactions.

Beyond this general point, then, it is also more likely that truly exogenous fiscal policy shocks will be identified through quasi-experiments that are likely to provide a plausibly exogenous source of variation. This approach has been followed by Suarez-Serrato and Windenger (2010; 2011), Shoag (2013), Acconcia et al. (2014), Clemens and Miran (2012), Chodorow-Reich et al. (2012), among others.

Nakamura and Steinsson (2014) use a different identification strategy that relies on the exogeneity of Federal level military spending build-ups and draw-downs with respect to the state-level economic conditions, an assumption which is considerably milder than the corresponding one of exogeneity of military spending with respect to aggregate economic developments. Since this is the focus of our empirical analysis, we leave the detailed description of this identification strategy to the following sections.

\section*{3 Data}

\subsection*{3.1 Personal Consumption Expenditures}

The main contribution of this paper consists in using new measures of private consumption expenditures at state level, that have not been available to the public up to August 2014. The Bureau of Economic Analysis has been working for several years on this particular project, directed towards the computation of estimates of an analogue of the widely used National PCE measure for each state.\textsuperscript{2} As

\textsuperscript{1}The latter two focus on the effects of fiscal consolidations rather than on the separate multipliers for taxes and spending.

\textsuperscript{2}See Awuku-Budu et al. (2014) for a more thorough discussion of the methodology followed by the BEA.
of today, the panel of time series span the period 1997-2012, thus including 16 years. Considering that there are 50 States and the District of Columbia, this provides 816 data points that can be used in various statistical analyses. As far as the series themselves are concerned, the BEA provides a 16-category disaggregation of personal consumption expenditures. Of our interest are particularly services and goods, both durable and non-durable. Notice that durable goods consumption reported here should actually be thought of as durable investment, while no measure of a stock of durable goods is available to our knowledge.

The prototype estimates of the BEA are important on two grounds. First, they provide us with new time series that are estimated using a methodology that closely follows the one that the BEA uses to estimate the National aggregates, thus alleviating concerns related to endogeneity or to data quality. Second, they improve on the kind of analyses that can be performed at the Federal level by allowing greater variation in the time series for consumption and opening up the possibility of extending earlier works that only dealt with GDP or employment measures.

### 3.2 Military Spending

In the US, there are three public entities that have the legal authority to levy taxes and allocate spending. These include the Federal Government, State Governments, and Local Governments, which can either be at the municipal level, or at the county level. The analysis conducted in our work focuses on spending decisions taken at the Federal level. Hence, the reader should keep in mind that when we mention state-level spending shocks, we are referring to appropriations that have been allocated to a particular state by the Federal Government.

Military spending is just one of the components of total Federal Government spending. We focus on this component for the reasons outlined above in the introduction, and, in particular, the fact that the decisions concerning military spending are to a large extent driven by geopolitical considerations that go beyond the short term performance of the economy.

The first measure is taken from Nakamura and Steinsson and it is available for the period 1967-2006. As thoroughly discussed by the authors, the Department of Defense compiles a database of all purchases above 25,000$ by collecting the DD-350 forms that prime contractors must fill in when they are awarded a certain contract.

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3There have been several attempts in the recent literature to construct state-level measures of consumption. These usually employ econometric techniques that use other variables, such as employment or wages, as determinants of private consumption consumption. Alternatively, retail sales estimates have been used, which can be considered under some assumptions as a good approximation of consumption. In her doctoral dissertation, Zhou (2010) carefully discusses the data available as of 2010 that could be used to construct estimates of consumption growth at state level. A whole different line of work is the one pursued by Giavazzi and MacMahon, who use the Panel Study of Income Dynamics to track individuals over time and impute the value of consumption for individual households from the Consumer Expenditure Survey, along the lines of Blundell et al. (2004).

4A potential issue is that when a company is awarded a certain contract, it might decide to assign the task to a so-called sub-awardee or sub-contractor. Sub-contractors need not reside in the same location as the prime awardee whose position is reported in the compiled dataset. At the same time, though, the correct assignment of the location of spending
The second measure runs from 1983 until 2010 and it is constructed from the Consolidated Federal Funds Report (CFFR) of the U.S. Census Bureau. Raw data from this database are presented in files that contain several million records, each one representing the allocation of funds for a specific geographic location, federal program, and further classified according to the type of spending (direct payments, grants, procurement contracts, salaries and wages and so on). The structure of the database allows to easily compute state-level totals by summing over codes that belong to the same geographic unit.

Finally, and in order to extend the time-span of available data beyond 2010, I gathered additional data from USAspending.gov for the period 2000-2013. Since the signing into law of the Federal Funding Accountability and Transparency Act of 2006, this website has received the mandate to publish all details about Federal spending, thus replacing the CFFR of the U.S. Census Bureau.

Figure 3.1a compares aggregate dollar spending derived from the three panel datasets discussed above. One can see how remarkably close the three series are, if one takes into account the fact that small procurement contracts are excluded from the measure derived from the DD-350 forms but not from the one published in the CFFR and on usaspending.gov. More importantly, the dynamics of aggregate spending is consistent for all three series. Further, consider the three measures for some representative states, reported in Figure 3.1b. As it is natural given that the nation-wide aggregates are not exactly the same, the three series show some minor discrepancies in levels. Nevertheless, their evolution over time seems fairly consistent. Given that we are not interested in the level of dollar spending in military procurement but on its rate of change, this picture is rather comforting for us.

Given all the above, we decided to compute a new measure of military procurement spending that joins the information of the three series, by simply taking the mean of the series that are available for each given year. We are confident that the very high consistency between the series keeps some “jumps” from forming in those years in which a superseded series is no longer available. The main advantage of the new measure is the longer timespan of 48 years from 1966 to 2013.

#### 3.3 Output, Employment and Additional Data

The BEA is an invaluable source of information when it comes to regional data for the United States. Their datasets cover a wide variety of topics, ranging from estimates of the Gross State Product to personal income, personal current transfer receipts, and employment. In addition, some of these series are available at lower geographical levels, notably metropolitan areas and counties.

One major drawback of the GSP measure released by the BEA is that it is expressed in nominal terms, while only from the end of the 80ies the Federal agency has tried to construct measures that incorporate an implicit state-level price deflator that allows to track economic activity in real terms.

should be that of the sub-awardee. Nevertheless, the authors provide convincing evidence that subcontracting is not an issue when it comes to the allocation of spending at state level, because actual military shipments from a certain geographic location seem to track fairly closely the series of military spending allocated to that region.
Figure 3.1: Comparison of military procurement data from various sources

(a) National Aggregates

(b) State Level Aggregates - Selected States
Hence, in much of the analysis that follows, we will use the longer nominal series deflated by the national CPI measure. From a purely economic standpoint, this is not entirely correct, because there is no reason to assume that states as far apart as New York and Montana, both geographically and in terms of their economies, show a similar dynamics of prices.

As far as unemployment is concerned, we use data from the Bureau of Labor Statistics, and in particular the Local Area Unemployment Statistics (LAUS) that provide county level estimates of total employees, unemployed and labor force. Data are available from 1976 to 2013, inclusive. The CPI measure is taken from the Federal Reserve Bank of Saint Louis’s Economic Database. It is the price index of all urban consumers and the base year is 2005. Population and employment data has been collected from the BEA.\(^5\)

\section{The Econometric Specification}

As far as the identification of fiscal policy shocks is concerned, our work closely follows Nakamura and Steinsson (2014) and Giavazzi and McMahon (2012). In particular, the key is to recognize that some states receive a disproportionate per capita level of military spending while the share of others is almost zero. This implies that when a nationwide increase in military spending is decided, certain states will receive a disproportionate spending shock compared to others. In the words of Nakamura and Steinsson, as long as the Federal Government does not embark on a military buildup because these states are faring badly relative to others, one can treat the change in aggregate military spending as exogenous to state-level economic developments. All in all, this is a weaker assumption than the one usually made about aggregate military spending and aggregate economic activity.

A potential pitfall regards the allocation of spending across states. Suppose, for instance, that in a certain year the Federal government decides to increase aggregate military spending because of concerns related to foreign affairs. Even if this decision is not taken because any of the states that usually receive procurement spending is faring better or worse than others, it might still be that the allocation of spending between states is affected by congressmen trying to obtain funds for their electoral districts. As long as it is easier for congressmen to argue in favor of more spending at times of hardship, using the change in state military spending would be incorrect. This argument is clearly formalized in Giavazzi and McMahon (2012). The two following paragraphs will present the slight adaptation of

\(^5\)An important remark is that the employment data from LAUS is on a residency basis, while data from the BEA is derived from the Current Employment Statistics (CES) of the Bureau of Labor Statistics. The CES estimates the number of employees that work in a certain state. This difference is crucial when one is interested in the response of employment following a spending shock (where CES data is appropriate) or in characterizing the tightness of the labor market in a certain state (where LAUS is instead recommendable).
their strategy to our context.

4.1 Notation and Variables of Interest

In what follows, the reader should keep in mind that upper case variables are State level or National aggregates expressed in real terms using the nation-wide CPI measure as deflator, while lower case variables express the same quantity in per capita terms. Let:

\[ y_{i,t} = \frac{Y_{i,t}}{N_{i,t}}, \quad c_{i,t} = \frac{C_{i,t}}{N_{i,t}}, \quad g_{i,t} = \frac{G_{i,t}}{N_{i,t}} \]

Respectively, these are real per capita GSP, consumption and military procurement spending in state \( i \) in year \( t \). \( N_{i,t} \) is state population in year \( t \). Quite naturally, national aggregates are defined by taking the sum across states of state-wide aggregates. In particular:

\[ Y_t = \sum_{i=1}^{51} Y_{i,t}, \quad C_t = \sum_{i=1}^{51} C_{i,t}, \quad G_t = \sum_{i=1}^{51} G_{i,t}, \quad N_t = \sum_{i=1}^{51} N_{i,t} \]

This procedure is justified by the fact that real State-wide aggregates are obtained by deflating the nominal value by the same price index. Next, national per capita measures are obtained by taking the ratio of the relevant aggregate to national population.

Some relative measures will be used later and are defined here. First, let State \( i \)'s share of real gross military spending in year \( t \) be:

\[ \theta_{i,t} = \frac{G_{i,t}}{G_t} \]

Second, let the population share be defined as:

\[ \eta_{i,t} = \frac{N_{i,t}}{N_t} \]

Finally, level and percentage changes are denoted with \( \Delta \) and \( %\Delta \), respectively. For instance, consider real per capita gross state product:

\[ \Delta y_{i,t} = y_{i,t} - y_{i,t-1}, \quad %\Delta y_{i,t} = \frac{y_{i,t} - y_{i,t-1}}{y_{i,t-1}} \]

As far as employment is concerned, we denote with \( E_{i,t} \) employment in a certain state \( i \) in year \( t \). Naturally, we can define the employment population ratio as:

\[ e_{i,t} = \frac{E_{i,t}}{N_{i,t}} \]
4.2 Derivation of Exogenous Shocks

Following Giavazzi and MacMahon, we find a decomposition of the variable of interest in a component that is plausibly exogenous and in another one that, instead, might be endogenous. First, consider the following identity:

\[ G_{i,t} = \theta_{i,t} G_t \]

Then, the spending change between two consecutive years can be expressed as:

\[ G_{i,t} - G_{i,t-1} = \theta_{i,t} G_t - \theta_{i,t-1} G_{t-1} \]

This identity can be rewritten as:

\[
G_{i,t} - G_{i,t-1} = \underbrace{\theta_{i,t} G_t - \theta_{i,t-1} G_{t-1}}_{=0} + \theta_{i,t} G_{t-1} - \theta_{i,t-1} G_{t-1}
\]

\[ = \theta_{i,t} (G_t - G_{t-1}) + G_{t-1} (\theta_{i,t} - \theta_{i,t-1}) \]

\[ = (\theta_{i,t} - \theta_{i,t-1}) (G_t - G_{t-1}) + G_{t-1} (\theta_{i,t} - \theta_{i,t-1}) \]

\[ = (G_t - G_{t-1}) \theta_{i,t} - (\theta_{i,t} - \theta_{i,t-1}) G_{t-1} + (G_t - G_{t-1}) (\theta_{i,t} - \theta_{i,t-1}) \]

The first term is the direct effect on state level spending that comes from the change in Federal spending. The second term isolates the effect of the change in the share of that particular state. The third term is a residual that captures the combined effect of both decisions, and it is zero if either Federal spending doesn't change, or if the share of a certain state is constant. Consider now what happens when variables are expressed in per capita terms:

\[
g_{i,t} - g_{i,t-1} = \frac{G_{i,t}}{N_{i,t}} - \frac{G_{i,t-1}}{N_{i,t-1}}
\]

\[ = G_t \theta_{i,t} - G_{t-1} \theta_{i,t-1} \]

\[ = \frac{\theta_{i,t} N_t}{N_{i,t}} - \frac{\theta_{i,t-1} N_{t-1}}{N_{i,t-1}} \]

\[ = g_t \frac{\theta_{i,t}}{\eta_{i,t}} - g_{t-1} \frac{\theta_{i,t-1}}{\eta_{i,t-1}} \]

A similar argument as the one above shows that:

\[
g_{i,t} - g_{i,t-1} = (g_t - g_{t-1}) \frac{\theta_{i,t}}{\eta_{i,t}} + \left( \frac{\theta_{i,t}}{\eta_{i,t}} - \frac{\theta_{i,t-1}}{\eta_{i,t-1}} \right) g_{t-1}
\]

(3)

Next, consider the following:

\[
\frac{\theta_{i,t}}{\eta_{i,t}} = \frac{G_{i,t}}{G_t} \frac{N_t}{N_{i,t}} = \frac{g_{i,t}}{g_t}
\]

So, the first term on the right hand side of (3) captures the fact that the change in nationwide per capita spending must be scaled for a certain state \( i \) by a factor that depends on the ratio between the...
per capita spending in state $i$ and the nationwide figure. Hence, we can rewrite (3) as:

$$g_{i,t} - g_{i,t-1} = (g_t - g_{t-1}) \frac{g_{i,t}}{g_t} + \left( \frac{g_{i,t}}{g_t} - \frac{g_{i,t-1}}{g_{t-1}} \right) g_{t-1}$$

$$= (g_t - g_{t-1}) \left( \frac{g_{i,t}}{g_t} + \frac{g_{i,t-1}}{g_{t-1}} - \frac{g_{i,t-1}}{g_{t-1}} \right) + \left( \frac{g_{i,t}}{g_t} - \frac{g_{i,t-1}}{g_{t-1}} \right) g_{t-1}$$

$$= (g_t - g_{t-1}) \frac{g_{i,t-1}}{g_{t-1}} + \left( \frac{g_{i,t}}{g_t} - \frac{g_{i,t-1}}{g_{t-1}} \right) g_{t-1} + \left( \frac{g_{i,t}}{g_t} - \frac{g_{i,t-1}}{g_{t-1}} \right) (g_t - g_{t-1})$$

This expression highlights the three components that make up the level change in per capita spending in state $i$ and year $t$. Next, we can normalize the variables by per capita gross domestic product in the previous period to obtain a scaled version of the spending shock.

$$\frac{g_{i,t} - g_{i,t-1}}{y_{i,t-1}} = \left( \frac{g_t - g_{t-1}}{y_{i,t-1}} \right) \frac{g_{i,t-1}}{y_{i,t-1}} + \left( \frac{g_{i,t}}{g_t} - \frac{g_{i,t-1}}{g_{t-1}} \right) \frac{g_{t-1}}{y_{i,t-1}} + \left( \frac{g_{i,t}}{g_t} - \frac{g_{i,t-1}}{g_{t-1}} \right) \frac{(g_t - g_{t-1})}{y_{i,t-1}}$$

(4)

Under the assumption that the growth rate of output does not depend on its base level, only the first term of this summation can be thought of as exogenous with respect to state level business cycle conditions. Hence, we define the first shock to be:

$$\Omega^A_{i,t} = \left( \frac{g_t - g_{t-1}}{y_{i,t-1}} \right) \frac{g_{i,t-1}}{y_{i,t-1}}$$

Where the subscript $A$ refers to the fact that this is the first kind of shock that we consider. One concern with using such a shock is that $\frac{g_{i,t-1}}{y_{i,t-1}}$ might still be correlated to $\Delta y_{i,t}$ or $\Delta c_{i,t}$. In particular, consider the following identity:

$$\Omega^A_{i,t} = \left( \frac{g_t - g_{t-1}}{g_{t-1}} \right) \frac{g_{i,t-2}}{y_{i,t-2}} + \left( \frac{g_t - g_{t-1}}{g_{t-1}} \right) \left( \frac{g_{i,t-1}}{y_{i,t-1}} - \frac{g_{i,t-2}}{y_{i,t-2}} \right)$$

The second component might be suspect if one believes that there is some persistence in the dependent variable of interest. To rule out these concerns, we also define an alternative instrument, which we dub shock $B$, by taking the long run average of the military spending share for each state. Hence:

$$\Omega^B_{i,t} = \left( \frac{g_t - g_{t-1}}{g_{t-1}} \right) \bar{\mu}$$

Where:

$$\bar{\mu} = \frac{1}{T} \sum_{t=1}^{T} \frac{g_{i,t}}{y_{i,t}}$$

This is consistent with the objection in Giavazzi and MacMahon that the first component of the right hand side might still be endogenous. However, our shock $A$ can still be used in the general setting, because the spending over output ratio is pre-determined with respect to the shock at time $t$. 

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4.3 Regression Analysis

4.3.1 Our Model

This section will present the econometric specifications that will be estimated. Following what is usually done in the literature, we define the impact open economy fiscal multiplier as:

\[
\beta = \frac{\Delta y_{i,t}}{\Delta g_{i,t}} = \frac{y_{i,t} - y_{i,t-1}}{y_{i,t-1}} \cdot \frac{g_{i,t} - g_{i,t-1}}{g_{i,t-1}} \cdot \frac{g_{i,t-1}}{y_{i,t-1}} = \frac{\%\Delta y_{i,t}}{\%\Delta g_{i,t}} \frac{y_{i,t-1}}{y_{i,t-1}}
\]

That is, \( \beta \) is the ratio of the percentage change of output over the change in the fiscal variable expressed in percent of output. The above expression makes it clear that one should consider the percentage change in public spending adjusted by the share of public spending over GSP. In turn, we can rewrite this expression as:

\[
\frac{y_{i,t} - y_{i,t-1}}{y_{i,t-1}} = \beta \frac{g_{i,t} - g_{i,t-1}}{y_{i,t-1}}
\]

If both the growth rate of output and public spending had zero mean, were serially uncorrelated, and the spending change were exogenous with respect to output, one would be able to estimate \( \beta \) with a simple OLS of the former on the latter for each state \( i \), suppressing the constant term. First, \( \%\Delta y_{i,t} \) does not have a zero mean, because real output per capita has been growing during the last 50 years. Therefore, we can add a state-specific constant term, say \( \alpha_i \), that captures this long term growth for each state:

\[
\frac{y_{i,t} - y_{i,t-1}}{y_{i,t-1}} = \alpha_i + \beta \frac{g_{i,t} - g_{i,t-1}}{y_{i,t-1}}
\]

At this point, the cross sectional dimension allows enough degrees of freedom to accommodate another set of variables, namely time effects. Hence, we can write the model as:

\[
\frac{y_{i,t} - y_{i,t-1}}{y_{i,t-1}} = \alpha_i + \delta_t + \beta \frac{g_{i,t} - g_{i,t-1}}{y_{i,t-1}} + \varepsilon_{i,t}
\]

Fixed effects account for time-invariant characteristics of any state that impact the dependent variable of interest. Similarly, time effects allow to control for economic factors that are shared by all states in any given year. This makes it clear how a panel data approach improves upon a simple analysis of the time series of the same variables at the national level. Since monetary policy is decided and implemented by the Federal Reserve at the Federal level with a single interest rate in any given year \( t \), the time dummy will capture its effect and alleviate the usual problem of distinguishing between the fiscal multiplier when monetary policy is accommodative or “leaning against the wind”.

Finally, consider a more complete version of the multiplier above, which allows one to track the response of output to the fiscal policy shock after \( K \) years, or to see what happens when more involved
paths of shocks are considered:

\[
\beta = \sum_{k=0}^{K} \frac{y_{i,t+k} - y_{i,t+k-1}}{y_{i,t+k-1}}
\]

The empirical specification that allows for the estimation of the dynamic multiplier \( \beta \) is

\[
\frac{y_{i,t} - y_{i,t-1}}{y_{i,t-1}} = \alpha_i + \delta_t + \sum_{k=0}^{K} \beta_k \frac{g_{i,t-k} - g_{i,t-k-1}}{y_{i,t-k-1}} + \varepsilon_{i,t}
\]

(5)

where \( \beta = \sum_{k=0}^{K} \beta_k \). Given the possible endogeneity of our regressor, we run a first stage regression on the shocks \( \Omega^A_{i,t} \) and \( \Omega^B_{i,t} \):

\[
g_{i,t} - g_{i,t-1} = \alpha_i + \delta_t + \gamma \Omega^j_{i,t} + \nu_{i,t}
\]

Notice that, almost by construction, our instrument satisfies the exclusion restriction. Indeed, if \( \Omega^j_{i,t} \) is to have any impact on the dependent variable of interest, then this will reasonably occur through its effect on the scaled growth of military spending. Exogeneity of the instrument has been discussed above and it rests on the assumption that \( \Delta g_t \) is uncorrelated with any idiosyncratic shocks that might impact a certain state. Finally, the relevance condition can be assessed by looking at the marginal F-statistic of the first stage regressions. Judging by the very large values of the F-Statistic, it seems that all three basic properties of a good instrument are present for both \( \Omega^A_{i,t} \) and \( \Omega^B_{i,t} \).

<table>
<thead>
<tr>
<th>Shock</th>
<th>First Stage F-Statistic(^6)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>With Shock</td>
</tr>
<tr>
<td>( \Omega^A_{i,t} )</td>
<td>684</td>
</tr>
<tr>
<td>( \Omega^B_{i,t} )</td>
<td>1103</td>
</tr>
</tbody>
</table>

In order to gauge the extent to which our exogenous instruments are able to predict the growth rate of military spending, Figure 4.1 presents the fitted values of the first stage regression for our shocks \( \Omega^A_{i,t} \) and \( \Omega^B_{i,t} \) for four states that are particularly sensitive to changes in military procurement spending. This picture highlights an important factor that should be taken into account. Both our instruments reduce by a significant amount the total variability of spending growth, suggesting that the second and third components of (4) are not, in general, small or irrelevant. Hence, this validates our claim that the allocation of spending across states is subject to relevant variation over time.

\(^6\)We report the F-statistic of the first stage regressions when the shock is included or not. The difference on the value of the F-statistic is intended to give the marginal contribution of its inclusion. Note that both time and state fixed effects must be included in the first stage regression because it may be the case that state specific characteristics, or certain events that occurred in some year impacted on the endogenous part of the scaled growth of military spending.
Figure 4.1: Comparison of the Predicted Values from First Stage Regression and the Exogenous Shock

(a) Shock A

(b) Shock B
4.3.2 The Model in Nakamura and Steinsson

The empirical model implemented by Nakamura and Steinsson is:

\[
y_{i,t} - y_{i,t-2} = \alpha_i + \delta_{i,t} + \beta \frac{g_{i,t} - g_{i,t-2}}{y_{i,t-2}} + \epsilon_{i,t}
\] (6)

The fiscal multiplier is again the \( \beta \) coefficient of the regression, the estimates of which are the object of interest. The interpretation of this coefficient is straightforward: a fiscal policy shock worth 1% of GDP over two years will have a \( \beta \)% effect on the dependent variable over the same two years, keeping all other variables fixed. The authors justify their use of biannual growth rates on the grounds that it is able to capture the dynamics of the response of output in a parsimonious way, by avoiding estimation of several lags of the fiscal shock.

Moreover, as already mentioned above and clearly shown with the decomposition, the scaled spending shock might be endogenous. Nakamura and Steinsson use two instruments to solve this problem. The first consists in running a first stage regression whereby the spending shock is regressed on an interaction variable that consists of state dummies multiplied by the nationwide scaled military spending shock. The first stage regression in their empirical model reads:

\[
g_{i,t} - g_{i,t-2} = \alpha_{i,t} \frac{g_{i,t} - g_{i,t-2}}{y_{i,t-2}} + \delta_t + \nu_{i,t}
\]

The second approach is to construct a simpler “Bartik” instrument by computing the mean of the share of military spending per capita allocated to each state in the first 5 years of the sample, and then using this as the share that multiplies government spending growth at the Federal level in the first stage regression (see Bartik, 1991).

Hence, they choose to let the IV estimator take care of extracting the exogenous component out of the scaled spending shock for each data point. One potential pitfall of this strategy is that it requires the estimation of a first stage regression with many variables. In particular, we find that the F-statistic of their first stage regression is about 7, suggesting that their instruments might be weak.

4.3.3 Exogeneity of the Fiscal Shock

From an econometric point of view, we need to provide evidence in support of the two following assumptions, to ensure that the coefficients of interest are consistently estimated in both models:

- Exogeneity of the military spending shocks: this requires the scaled spending shock to be uncorrelated with the idiosyncratic state-specific shock \( \epsilon_{i,t} \);
- Absence of any omitted variable that is correlated with the military spending shocks at the state level.
As far as the first assumption is concerned, both Giavazzi and MacMahon, and Nakamura and Steinson point out the possibility that the allocation of military spending across states, albeit historically stable around state-specific means that display significant variation across states, might still be correlated to the state of the economy at the local level. That is, it is not at all clear that, even if aggregate military spending is exogenous to the state of the business cycle across states, the same will be true of its allocation. Both our instruments and those used in previous studies are based on the idea that national military procurement spending decisions are taken independently of the cyclical conditions in single states that usually receive a disproportionate share of funds. This implies that they are arguably exogenous with respect to the error term $\varepsilon_{i,t}$.

The second assumption is also very relevant. Indeed, if there are omitted variables that are correlated with the spending shock and such that they have an impact on the dependent variable, then the estimators of the coefficients of all regressors will be inconsistent. In our context, this assumption is generally weaker than the corresponding one in a closed economy setting. To understand why, one can think of the empirical model in Romer and Romer (2010), where the growth rate of output is regressed on the exogenous tax shock and its lags. In this setting, aggregate government spending is an obvious suspect for omitted variable bias, since it is likely to be correlated with the regressors. Hence, the authors have to check that the inclusion of government spending in their model does not alter the results. In our setting, the fixed effects take care of absorbing all the variability that is constant either across states (time effects) or that is specific to certain states (state effects). Therefore, the omitted variable must be one that is not only correlated with our exogenous shock, but also not constant either across observations or across time. To illustrate, even if any positive spending shock is met by a corresponding increase in taxes, this will not bias our estimates of the multipliers unless the states that receive a disproportionate amount of spending are also subject to a specific tax shock. Hence, we need not worry if these states either bear a considerably higher tax burden on average, or if the Federal Government raises taxes across all states in response to a spending shock.

Instead, one worrisome possibility is that State Governments might react in response to a shock to military purchases by varying their taxes or spending. If this were the case, then the fixed effects would not shelter us from concerns of omitted variable bias. In all US state’s constitutions but Vermont’s there is some sort of legislative provision requiring the state to keep a balanced budget, also called Balanced Budget Amendment. Specifically, this constitutional provision requires each state to keep prospective expenditures and tax revenues equal over time. For more details, see the reports published by the National Association of State Budget Officers (NASBO, 2014) and especially by the National Conference of States Legislatures (NCSL, 2010). Therefore, we claim that the stance of fiscal policy at the state level should be roughly neutral at all times, thus alleviating concerns of omitted variable bias.
5 Empirical Results

5.1 Short and Long Run Multipliers

The baseline estimates of the short run fiscal multipliers are reported in Table 5.1. Here we include both the empirical model à la Nakamura and Steinsson, with biannual growth rates of the dependent variable and of the spending shock, and the more general model in (5) with $K = 3$. In order to keep consistency between the estimates of the multipliers from the model in (6) and those from our model, we report the sum of the coefficients $\beta_0$ and $\beta_1$. In this way, we hope to capture an effect similar to that estimated by Nakamura and Steinsson, even if one has to keep in mind that the regressor of interest in Nakamura and Steinsson’s model is a biannual shock. Our approach is validated by the fact that our sources list all military contracts that have been assigned to a certain state during the relevant year. Hence, the response to a shock is best thought of as occurring not necessarily on impact, but also with some delay.

Short run estimates of the multiplier on output range between 1.27 and 1.47, depending on the exogenous instrument used in each case and on the model. These estimates are broadly consistent with those found by other studies which exploit regional variation, for instance Acconcia et al. (2014). The estimated coefficient on the broad measure of PCE is positive, and ranges between 0.32 and 0.76. Nevertheless, it is not very precisely estimated, with significance at 10% achieved only with our model. As far as standard errors are concerned, one must keep in mind the rather short timespan over which we are able to track the response of consumption, namely 1998-2012. This implies that, in general, our estimates will be subject to comparatively larger standard errors than those of output. As far as the breakdown of PCE is concerned, larger multipliers can be found on nondurables, with durables consumption being almost unresponsive to military procurement shocks. The response of services seems to be driving the result, while nondurable goods consumption does not react.

The comparison between the results obtained using the models in (5) and (6) reveals that while the multiplier on output is not significantly different if one uses one specification or the other, the same is not true of consumption, for which the timespan over which one considers the fiscal shock seems to matter more for the results. Moreover, it is interesting to note how the difference between the results using shock A and B as defined above in section 4.2 is rather small.

The response of employment, as expected, is sharp and precisely estimated. When government purchases increase, also employment does, with multipliers ranging between 0.67 and 1.57 depending on the model used. The stark difference between the point estimates in Nakamura and Steinsson’s model and ours is probably due to a certain persistence in the response of employment, which implies that the two-year shocks considered by Nakamura and Steinsson will lead to a more marked impact on employment in the short term.

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7Although this may seem disproportionate compared the usual multipliers found in the literature, one has to keep in mind that we are using annual data, and that we are taking the sum of the first two coefficients $\beta_0$ and $\beta_1$, which implies that we track the response over a time period that potentially spans 2 years.
Table 5.1: The short run effects of military spending

<table>
<thead>
<tr>
<th>Model</th>
<th>Output</th>
<th>Consumption</th>
<th>Employment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All</td>
<td>All</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td>Nondurables</td>
<td>Durables</td>
<td>Serv Goods</td>
</tr>
<tr>
<td></td>
<td>Level</td>
<td>Ratio</td>
<td></td>
</tr>
<tr>
<td>NS</td>
<td>1.47***</td>
<td>0.32</td>
<td>0.19</td>
</tr>
<tr>
<td></td>
<td>(0.36)</td>
<td>(0.30)</td>
<td>(0.23)</td>
</tr>
<tr>
<td>New - ΩA&lt;sub&gt;i,t&lt;/sub&gt;</td>
<td>1.43***</td>
<td>0.76*</td>
<td>0.73*</td>
</tr>
<tr>
<td></td>
<td>(0.33)</td>
<td>(0.39)</td>
<td>(0.37)</td>
</tr>
<tr>
<td>New - ΩB&lt;sub&gt;i,t&lt;/sub&gt;</td>
<td>1.27***</td>
<td>0.65*</td>
<td>0.62*</td>
</tr>
<tr>
<td></td>
<td>(0.40)</td>
<td>(0.34)</td>
<td>(0.32)</td>
</tr>
</tbody>
</table>

Each cell in the table reports the estimate of the open economy fiscal multiplier. Row 1 replicates the estimates of the coefficient $\beta$ for various specifications of the model in Nakamura and Steinsson, also running the specification on consumption. Rows 2 and 3 show the sum of the coefficients $\beta_0$ and $\beta_1$ in our baseline model. Standard errors are clustered at state level. All regressions include state fixed effects and year dummies. Employment “level” refers to the growth rate of employment, while “ratio” is the growth rate of the employment-population ratio. Levels of significance are given by Wald tests on the linear restriction; in row 1, this reduces to a t-test on the single coefficient, while in rows 2-3 the relevant restriction is tested looking at the value of the F-statistic. Significance levels are conventional: *** implies significance at 1%, ** at 5%, * at 10%.

In addition to the short term effects of military spending on output, consumption and employment, it is also interesting to measure the total effect on these variables over a longer horizon. This is useful because it might informative as to the timing and persistence of the response of the variable.

The results are reported both in Table 5.2 and in Figure 5.1, which portrays the results for the 8 variables of interest by means of impulse response functions for the more robust shock B. That is, we consider a unitary shock to the fiscal variable at a certain point, and we track the dynamic response of each dependent variable, shutting down future shocks. All graphs report 90% confidence intervals around the point estimate, as well as standard deviation bands, which roughly correspond to a 68% confidence interval. This allows one to compare the cumulative multiplier over 2 and 3 years with the period-by-period response.

As far as the results are concerned, we can see how the cumulative multipliers on output increase significantly and are consistently above 2, both for shock A and B. This implies that a 1% relative spending shock in a certain state increases relative output by more than 2%. As far as the impulse response function for output is concerned, we see that the estimates are not very precise. Nonetheless, judging by the robust standard error estimates, we can reject the hypothesis that the cumulative multiplier is below 1 at conventional levels of significance.

Turning to the response of consumption, we can see how the long run multipliers are now either unchanged with respect to the short run case or slightly smaller, and generally not significantly different from zero. There is a difference between the estimates obtained using shock A and those obtained using shock B, suggesting that when the strictly exogenous version of the shock is considered, the effect becomes smaller. The conclusion is that, even if the multiplier on consumption is positive, it is so mainly in the short run, with the effect turning negative from the second year after the shock.

As far as the shape of the impulse response function is concerned, we see how the peak response is reached one year after the shock, with PCE rising by about 0.6. Once again, the breakdown of PCE
Figure 5.1: Impulse Response Function of the Baseline Specifications - Shock B
Table 5.2: The effects of military spending at longer horizons

<table>
<thead>
<tr>
<th>Shock Lags</th>
<th>Output</th>
<th>Consumption Nondurables</th>
<th>Durables</th>
<th>Employment Level</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ω_{i,t}</td>
<td></td>
<td>All</td>
<td>All</td>
<td>All Serv Goods</td>
<td>All</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>0.91**</td>
<td>0.86**</td>
<td>0.68*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>0.70**</td>
<td>0.66**</td>
<td>0.59*</td>
</tr>
<tr>
<td>Ω_{i,t}</td>
<td></td>
<td>2</td>
<td>0.50</td>
<td>0.52</td>
<td>0.40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>0.13</td>
<td>0.18</td>
<td>0.28</td>
</tr>
</tbody>
</table>

Each cell in the table reports the open economy multiplier for our model, either summing β₀ through β₂ or β₀ through β₃. Standard errors are clustered at state level. All regressions include state fixed effects and year dummies. Employment enters as dependent variable either alone as percentage change or controlling for population. Levels of significance are given by Wald tests on the linear restriction. Significance levels are conventional: *** implies significance at 1%, ** at 5%, * at 10%.

in its main components reveals that the response of nondurables, and in particular services, is driving the result, while the multipliers on both nondurable and durable goods purchases are essentially nil.

Finally, the response of employment is, as expected, particularly strong and persistent. This is clearly seen by comparing the results for the long run multiplier at 2 years and those at 3 years. In each instance, the estimated coefficient increases, implying that there is a positive effect even 3 years after the shock. These results are mirrored in the impulse response function, which shows a nice hump-shaped response of employment which is significantly positive for three years after the shock.

5.2 Multipliers at High versus Low Unemployment Rates

This section and the next will explore fiscal multipliers with a more general model:

\[
\frac{y_{i,t} - y_{i,t-1}}{y_{i,t-1}} = \alpha_i + \delta + \sum_{k=0}^{K} \beta_k^{\text{NORM}} \frac{g_{i,t-k} - g_{i,t-k-1}}{y_{i,t-k-1}} + \sum_{k=0}^{K} \left( \beta_k^{\text{COND}} - \beta_k^{\text{NORM}} \right) \frac{g_{i,t-k} - g_{i,t-k-1}}{y_{i,t-k-1}} + \varepsilon_{i,t} \tag{7}
\]

The coefficient on the interaction term refers to the difference between the multipliers when a condition is met, \(\beta_k^{\text{COND}}\), and those in normal times, \(\beta_k^{\text{NORM}}\).

The Keynesian tradition points out that multipliers largely above 1 on public spending are more likely to be present during periods of slack, that is, when resources are not fully employed. Hence, recent empirical efforts have been directed towards assessing the validity of this prediction (see Owyang).

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8One can recover a point estimate of \(\beta_k^{\text{COND}}\) by simply taking the sum of the two estimated coefficients for each \(k\). As far as the standard errors are concerned, one can use the usual formula for the variance of the sum of two random variables. This is the procedure used to draw the implied IRFs with their confidence bands when the dummy takes value 1. Similarly, short run multipliers are computed by taking the sum of the coefficients on both the shock and the interaction for \(k = 0, 1\).
### Panel A: National Slack Dummy

<table>
<thead>
<tr>
<th>Shock</th>
<th>Slack</th>
<th>Output</th>
<th>Consumption</th>
<th>Durables</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>All</td>
<td>All</td>
<td>Nondurables</td>
</tr>
<tr>
<td>Ω_{i,t}^A</td>
<td>Low</td>
<td>1.47*</td>
<td>0.68</td>
<td>0.79</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.83)</td>
<td>(0.60)</td>
<td>(0.56)</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>2.68***</td>
<td>1.40***</td>
<td>1.23***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.48)</td>
<td>(0.42)</td>
<td>(0.35)</td>
</tr>
<tr>
<td>Ω_{i,t}^B</td>
<td>Low</td>
<td>0.60</td>
<td>0.62</td>
<td>0.61</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.06)</td>
<td>(0.48)</td>
<td>(0.43)</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>2.54***</td>
<td>1.32***</td>
<td>1.24***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.51)</td>
<td>(0.39)</td>
<td>(0.34)</td>
</tr>
</tbody>
</table>

### Panel B: State Slack Dummy

<table>
<thead>
<tr>
<th>Shock</th>
<th>Slack</th>
<th>Output</th>
<th>Consumption</th>
<th>Durables</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>All</td>
<td>All</td>
<td>Nondurables</td>
</tr>
<tr>
<td>Ω_{i,t}^A</td>
<td>Low</td>
<td>1.06</td>
<td>0.71</td>
<td>0.82</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.99)</td>
<td>(0.52)</td>
<td>(0.49)</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>2.69***</td>
<td>1.28***</td>
<td>1.11***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.40)</td>
<td>(0.48)</td>
<td>(0.39)</td>
</tr>
<tr>
<td>Ω_{i,t}^B</td>
<td>Low</td>
<td>0.67</td>
<td>0.58</td>
<td>0.61*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.09)</td>
<td>(0.38)</td>
<td>(0.36)</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>2.03***</td>
<td>1.32***</td>
<td>1.19***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.62)</td>
<td>(0.43)</td>
<td>(0.38)</td>
</tr>
</tbody>
</table>

Each cell reports the estimate of the open economy fiscal multiplier in the model with the dummy variable. “High” means that we are summing both the coefficients on the interaction and those on the fiscal shock, while “Low” means we are taking the sum of the fiscal shock but not of the interaction. Standard errors are clustered at state level. All regressions include state fixed effects and year dummies. Employment enters as dependent variable either alone as percentage change or controlling for population. Levels of significance are given by Wald tests on the linear restriction. Significance levels are conventional: \(*\) * implies significance at 1%, \(*\) ** at 5%, \(*\) *** at 10%.

et al., 2013 and Auerbach and Gorodnichenko, 2013). The exercise we conduct in this section is conceptually the same one Nakamura and Steinsson implement in their study. In particular, we define the dummy variable as taking a value of 1 during periods of slack and 0 otherwise. In addition, we distinguish between periods in which the Nation as a whole is experiencing above average unemployment, and periods during which only the single states are in such condition. Because of the need to estimate more parameters, we preferred to be parsimonious in the specification, by setting \(K = 2\), and by computing only short term multipliers as the sum of the \(\beta_k^j\) coefficients for \(k = 0, 1\).

Notice that one might wonder whether it makes sense to distinguish between state and national slack. We have computed the summary statistics for both variables and then computed time correla-

---

9Economic slack is assessed by taking the Hodrick-Prescott filter of the relevant unemployment series and then letting the dummy take value 1 when the cyclical component is positive, and 0 otherwise.
tions for each state. The mean across states of the time correlation is 0.73 with a standard deviation of 0.08, while we find that this is highest for California, Ohio and Virginia, standing in the range 0.85–0.9, while it is significantly lower for Hawaii and Georgia, for which it is about 0.55.

The results from the estimation of model (7) are presented in Table 5.3, as well as in Figures 5.2 and 5.3 for four of the eight variables of interest.\textsuperscript{10}

Consider first the response of output. The short run multiplier in normal times is much smaller both when shock A or B is used as an instrument. Moreover, it even becomes smaller than 1 for shock B. In sum, we can say that, consistently with Nakamura and Steinsson, we find that when unemployment is low, the fiscal multiplier on output seems not very responsive. Instead, the picture is rather different if the dummy takes value 1. Indeed, in this case the multiplier is very large, exceeding 2 in all specifications also when state slack is considered. Moreover, it is much more precisely estimated, allowing us to be more confident that the true value is above the critical threshold of 1.

As far as the results on consumption are concerned, we see that the value of the multiplier is much higher in periods of slack, while the point estimates are basically unchanged with respect to average short run multipliers. Moreover, statistical significance is achieved only when economic slack is present. Hence, we can say that we are quite confident that the true response of consumption following a spending shock in some state relative to others is positive. Once again, the picture is rather consistent if one looks at the breakdown of PCE in its components: services consumption is driving the result, while nondurable and durable goods do not seem to be responsive.

The impulse response functions are also interesting and somewhat puzzling. Indeed, in normal times the impact response of output is almost nil, while consumption reacts positively. Then, the effect is rapidly reversed and PCE begin falling in period 1. In periods of slack, instead, the response of both output and consumption is large but occurs in the year after the shock has taken place, thus with some delay. Nevertheless, one should keep in mind that our measure of military procurement lists all contracts that have been assigned throughout a given year. Hence, one cannot be sure so as to the precise timing of the shock vis-à-vis its effect on macroeconomic aggregates. In particular, it might be more plausible to focus on the reaction of the variables in the year after the shock has occurred.

\textsuperscript{10}We do not report the estimates of this model when employment is the dependent variable, in order to avoid the likely presence of simultaneity bias arising from fact that unemployment and employment, especially at the state level, might be jointly determined. Therefore, no causal statements can be made in this case. Nevertheless, running these regressions under the assumption that the dummy is determined independently of state or national unemployment, or simply recasting the estimates as suggestive correlations, we find that the response of employment is particularly strong during periods of slack.
Figure 5.2: Impulse Response Function of the specification with National Slack dummy

![Graphs showing impulse response functions for different categories with point estimates, standard deviation bands, and 90% confidence intervals.](image-url)
Figure 5.3: Impulse Response Function of the specification with State Slack dummy

- **GSP – Normal**
- **GSP – State Slack**
- **PCE – Normal**
- **PCE – State Slack**
- **NONDURABLES – Normal**
- **NONDURABLES – State Slack**
- **DURABLES – Normal**
- **DURABLES – State Slack**

Legend:
- **Point Estimate**
- **St.Dev Bands**
- **90% Confidence Interval**
5.3 The Great Recession and its Aftermath

5.3.1 Estimates

Recent events have shown that the US economy has experienced a significant setback since the onset of the Great Recession of 2007-2009. This was the starkest recession since the Great Depression of the thirties, and the macroeconomic discourse has been focused again on such issues as the effects of the zero-lower-bound on interest rates, the effectiveness of monetary policy and that of fiscal policy (see also the introduction of Ramey, 2011a).

From the standpoint of our empirical analysis, we are in a rather favorable position to gauge whether something significant has changed in the response of the economy to fiscal policy shocks since the onset of the Great Recession. Indeed, we do not need to worry about the joint effect of the zero-lower-bound or of binding credit constraints due to the deleverage process that has occurred during and after the recession: time fixed effects will take care of absorbing the joint effect implied by the stance of monetary policy, while only the remaining component will be captured by our open economy relative multiplier.

Using once again model (7), we define the dummy variable as follows as taking value 1 for all years after and including 2008.\footnote{We choose 2008 because the official NBER Recession quarters range between 2007: 4 and 2009: 2 and we are constrained by annual data.} The estimates are presented in Table 5.4 and in Figure 5.4.

As far as the results are concerned, once again we find a very strong effect of fiscal policy on output when the dummy takes value 1. In particular, the multiplier becomes 2.37 both with shock A and B. The standard error is quite large though, and this prevents us from concluding that the true value is greater at the usual significance levels. Nevertheless, this is likely to be due to the short time horizon for which the dummy takes value 1.

The picture is strikingly different in the case of PCE, and especially when shock B is considered. Indeed, now the multiplier on consumption is very large and significant only after 2008, while it is nil before. This implies that consumption has only been responsive to public expenditures after 2008 in our sample. But, the important thing is to notice that this conclusion is reached \textit{irrespective of the zero-lower bound environment}, which is captured inside the fixed effect. Hence, there must be some other factor in the economy that explains this sharp discontinuity in the response of consumption. Moreover, given that our sample is not very long, this raises some questions as to the interpretation of the results from the previous section, in which it has been shown that the response of consumption seems to be sharper when unemployment is high. Indeed, unemployment has been above trend for almost all the periods for which the dummy takes value 1.

Consistently with the results highlighted before, the response of the components of consumption is divided between the sharp one of services and the sluggish one of nondurable and durable goods. This fact can also be appreciated by looking at the impulse response functions which show how all the variables of interest react over time after a positive shock. In particular, it seems that PCE rise
Table 5.4: The short run effects of military procurement after the Great Recession

<table>
<thead>
<tr>
<th>Shock</th>
<th>Output</th>
<th>Consumption</th>
<th>Employment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All</td>
<td>All</td>
<td>Nondurables</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>All</td>
</tr>
<tr>
<td>Ω ≃ \text{Normal}</td>
<td>1.45***</td>
<td>0.53</td>
<td>0.48</td>
</tr>
<tr>
<td></td>
<td>(0.34)</td>
<td>(0.47)</td>
<td>(0.43)</td>
</tr>
<tr>
<td></td>
<td>2.37***</td>
<td>1.17*</td>
<td>1.20**</td>
</tr>
<tr>
<td></td>
<td>(0.63)</td>
<td>(0.59)</td>
<td>(0.53)</td>
</tr>
<tr>
<td>Ω ≃ \text{Recession}</td>
<td>1.08**</td>
<td>0.08</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>(0.43)</td>
<td>(0.47)</td>
<td>(0.40)</td>
</tr>
<tr>
<td></td>
<td>2.37***</td>
<td>1.58***</td>
<td>1.54***</td>
</tr>
<tr>
<td></td>
<td>(0.92)</td>
<td>(0.55)</td>
<td>(0.46)</td>
</tr>
</tbody>
</table>

Each cell reports the estimate of the open economy fiscal multiplier in the model with the dummy variable. “High” means that we are summing both the coefficients on the interaction and those on the fiscal shock, while “Low” means we are taking the sum of the fiscal shock but not of the interaction. Standard errors are clustered at state level. All regressions include state fixed effects and year dummies. Employment enters as dependent variable either alone as percentage change or controlling for population. Levels of significance are given by Wald tests on the linear restriction. Significance levels are conventional: *** implies significance at 1%, ** at 5%, * at 10%.

both on impact and in the year following the shock and begin falling only after 2 years. Finally, the results seem to be reversed when employment is considered. Indeed, we see now that after the Great Recession employment has not been responsive to spending shocks, while it usually is the case in normal times.

5.3.2 Discussion

From an econometric point of view, we treat the Great Recession dummy as strictly exogenous, under the “prior belief” that something has changed in the economy which might have brought about a nonlinearity in the size of the fiscal multiplier. That is, we treat the dummy as a deterministic object and not as a random variable as it was in the case of model (7) with national and state slack.

Nevertheless, one may argue that our identification strategy breaks down after the Great Recession, because the ARRA was signed into law in 2009 providing a spending stimulus of about 700B$ across the board, inclusive of military spending. This concern is alleviated when one considers two factors. First, our identification strategy requires the nationwide decisions about military spending to be uncorrelated with the performance of those states that are prone to be assigned funds for military procurement relative to that of other states. The ARRA was signed into law following the seemingly ineffective actions of the Fed, which, after reaching the zero-lower-bound, was unable to provide additional stimulus in a conventional way. Moreover, it was motivated by concerns related to the overall economy of the US, and not to the state specific business cycles.

Second, according to Cogan and Taylor (2012), the ARRA was largely ineffective in generating a positive stimulus for the economy, because many states which received grants used these funds to reduce their deficits and levels of debt, while at the same time managing to keep a balanced budget. In sum, these two remarks should somehow alleviate concerns related to a possible failure of our
Figure 5.4: Impulse Response Function of the specification with the Great Recession dummy
6 The Open Economy Multiplier as a Diagnostic Tool

One of the key contributions of Nakamura and Steinsson’s paper is the development of a theoretical framework in which it is possible to analyze the results obtained from their empirical analysis. That is to say, one should not be tempted to conclude that if the estimates of $\beta$ are, say, 1.5, then the multiplier for the whole US economy will be the same. Indeed, what is estimated from the empirical model is a different theoretical entity that can be related to the usual closed economy multiplier but that it is by no means the same.

While the closed economy multiplier on Government spending is in general a function of the response of monetary policy and of taxes, in our empirical setting these two factors are kept constant and relegated to the time and state fixed effects. It follows that a positive spending shock to a certain state $i$ generates an effect that is best thought of as relative to other states in the sample. Hence, this explains the need for a new theoretical framework in which to analyze the effects of fiscal policy shocks.

With the above in mind, the authors develop a medium scale New-Keynesian Open Economy Dynamic Stochastic General Equilibrium model that features two regions in a monetary and fiscal union. The model can be conveniently used to perform counterfactual experiments in both the closed economy setting and in the open economy setting, in a way that closely tracks the empirical specification. The most important characteristics of their model, beyond the open economy setting, are the presence of staggered prices à la Calvo (see Calvo, 1983), monopolistic competition in the goods markets and common monetary and fiscal policies.

Consistently with the international economics literature, the two regions in their model are called Home and Foreign. The Home region should be considered as the US state in which the spending shock occurs, while the rest of the country is summarized in the Foreign region. In particular, each region is endowed with an exogenous AR(1) process for government spending. That is to say, at the steady state the Federal Government purchases the differentiated varieties produced by both regions and the exogenous shocks of the two processes are made to be almost perfectly correlated. To simulate a Federal decision that impacts only the Home region, then, the experiment is run by setting a unitary shock to the exogenous process for the Home region and then tracking the dynamic response of the system over time.

To be more specific, the authors simulate the model for a very long time horizon and then run the same regressions as in the empirical model (6). This allows them to compute an open economy relative multiplier that can be related directly to the one estimated in the previous chapter. We adapted their code to our empirical framework, asking the software to estimate the coefficients of our empirical specification (5), for both the open economy setting and for the economy as a whole. Moreover,
we also computed the coefficients of the regressions for consumption and employment, which are not reported in the published version of their paper.

6.1 The Relevance of the Response of Consumption

The gist of the argument in Nakamura and Steinsson’s paper is that the open economy relative multiplier is a powerful diagnostic tool to discriminate among competing models of the economy.

For instance, it is usually very cumbersome to compare the performance of the Neoclassical model and of the New-Keynesian models by the implied response to a fiscal policy shock, because it can be shown that both can generate roughly the same response of output for a suitably specified monetary policy rule. Nevertheless, the two models yield very different predictions about the response of other variables.

6.1.1 The New-Keynesian and Neoclassical Models

Consider first the New-Keynesian model. This model is implied by the calibration of the Calvo parameter at \( \alpha > 0 \): this means that firms are randomly prevented from adjusting prices with a positive probability in each period. This creates a role for the monetary authority because prices do not respond immediately to shocks. Hence, Nakamura and Steinsson endow the Federal Government with three different specifications of a monetary policy rule. The first is a standard augmented Taylor rule in which the Central Bank sets the nominal interest rate by responding aggressively to inflation and mildly to the output gap \( (\phi_\pi = 1.5 \text{ and } \phi_y = 0.5) \), while taking into account the previous quarter value of the nominal rate with an autoregressive parameter \( \rho_i = 0.8 \). In particular, the rule reads:

\[
\hat{r}_t^n = \rho_i \hat{r}_{t-1}^n + (1 - \rho_i) \left( \phi_\pi \hat{\pi}^ag_t + \phi_y \hat{y}^ag_t + \phi_g \hat{g}^ag_t \right) \tag{8}
\]

In equation (8), hatted variables are log deviations from steady state, and \( \hat{\pi}^ag_t, \hat{y}^ag_t \) and \( \hat{g}^ag_t \) are constructed as weighted averages of the corresponding objects in the two regions, where the weight is given by the parameter that determines the relative size of Home and Foreign.

The second rule is a constant real rate rule whereby the monetary authority responds to shocks to government spending by keeping the real interest rate constant. Finally, the third rule consists in keeping the nominal interest rate fixed. In the words of the authors, these three rules are meant to characterize progressively more accommodative responses to fiscal policy shocks. Moreover, they argue that the last rule is akin to a setting in which the economy is at the Zero Lower Bound that is believed to last indefinitely.

In the Neoclassical version of their model, the Calvo parameter is set at \( \alpha \approx 0 \).\(^{12}\) This implies that

\(^{12}\)To be specific, the authors set \( \alpha = 10^{-6} \) to allow the simulation of the model without rewriting the expectational system of linear difference equations to accommodate the new parametrization. Hence, they are able to use the same code to simulate both models.
prices are flexible and monetary policy is no longer a factor in determining the size of the multiplier. Nevertheless, the response of fiscal policy in terms of taxes becomes an important determinant of the multiplier on public spending, to the extent that distortionary taxes on labor income are raised to keep the balance in the Federal government budget following a spending shock.

6.1.2 The Specification of Household Preferences

The second dimension in which the authors explore the effects of a positive Government spending shock relates to the specification of Household preferences. In particular, households in the Home region are endowed with either of the following utility functions:

\[
u(C_t, L_t(x)) = C_t^1 - \sigma^{-1} - \frac{L_t(x)^{1+\nu^{-1}}}{1 + \nu^{-1}}\] (9)

\[
u(C_t, L_t(x)) = \left[ C_t - \frac{L_t(x)^{1+\nu^{-1}}}{1 + \nu^{-1}} \right]^{1-\sigma^{-1}} \frac{1-\sigma^{-1}}{1 + \nu^{-1}} \] (10)

In both specifications, \(C_t\) is an aggregate consumption bundle made up of differentiated varieties produced either in the Home region or in the Foreign region, while \(L_t(x)\) is the differentiated labor of type \(x\) supplied to firms. As far as the parameters are concerned, \(\sigma\) is the intertemporal elasticity of substitution of consumption when the specification is (9), while \(\nu\) is the Frisch elasticity of labor supply and \(\chi\) is a parameter that governs the disutility of labor. The instantaneous utility functions (9) and (10) differ because the first one is standard while the second is an adaptation of the preferences described in Greenwood, Hercowitz, and Huffman (1988). The fundamental difference between the two specifications is that the cross derivative of utility with respect to consumption and labor is not 0. That is to say, the marginal utility derived from consumption depends on the amount of labor supplied. As discussed in Monacelli and Perotti (2008), Hall (2009) and Bilbiie (2011), allowing for complementarities between consumption and labor has substantial effects on the government spending multiplier. The idea is that the standard positive response of employment to a negative wealth effect brings about an increase in the marginal utility of consumption, which therefore increases because of said complementarities. This implies that labor has to increase even more for the additional production to take place, thus reinforcing the initial positive effect on consumption.

6.2 Discriminating Between Competing Models

The simulated multipliers are presented in Table 6.1. Panel A reports the figures from the New-Keynesian model, while Panel B those from the Neoclassical model in which prices are fully flexible.

---

13 The specifications are the same for households in Foreign, but the aggregate consumption bundles differ because of home-bias. Moreover, \(x\) is used to capture the fact that households supply a differentiated kind of labor to the monopsonistically competitive firms.
In the latter case, since the model does not have any features beyond price stickiness that generate a persistence in the response of the key variables of interest, we only report the impact multiplier, that is, the coefficient $\beta_0$. This table is very informative about the relationship that exists both between the closed and open economy multipliers, and between the separable and GHH preferences.

We can clearly see how the closed economy multiplier is extremely sensitive to the specification of monetary policy, and how, in this respect, the response of consumption is particularly dependent on the kind of monetary policy. The multiplier ranges between $-1$ and 0.88. A positive response of consumption is possible in the New-Keynesian model if the monetary policy seeks to maintain nominal interest rates constant, thus implying a reduction in the real interest rate generated by the increase in expected inflation. The response of output is consequential to that of private consumption, and it ranges accordingly from lows of 0.19 to 1.70 in the fixed nominal rate case. Another interesting aspect that Nakamura and Steinsson do not focus on is the fact that the dynamic response of the closed economy multiplier implied by the model is almost mute, meaning that the effect vanishes almost immediately and there is not significant persistence or reversal in the response to the shock.

In the Neoclassical model, the response of consumption is of course negative, with a rather small multiplier on output and a mildly positive response of employment. As expected, matters get worse when distortionary taxes on labor income are raised to keep a balanced budget at the Federal Level with the response of consumption becoming even more negative and that of employment less strong.

At this point, one would let the data speak and decide, on the basis of the estimates of the multiplier, which model is more promising. But, the fundamental problem is that empirical exercises carried out at the aggregate level cannot control for the stance of the monetary policy in a straightforward way. Similarly, one cannot easily recast the estimates of the open economy multiplier in terms of the closed economy counterpart, because this conceptual exercise overlooks the importance of the wealth effect.

Instead, what can be done is a comparison of the values of the open economy multiplier simulated in the various specifications of the model with the estimates presented in section 5. Indeed, one can see from the table how this object is insensitive to the specification of monetary policy. The argument in Nakamura and Steinsson is that, since both the New-Keynesian and the Neoclassical model fail to deliver a relative multiplier on output which is consistent with their empirical evidence, then another specification should be considered. Moreover, it is clear from the simulations that one cannot easily discriminate between the New-Keynesian and the Neoclassical models with separable preferences just by looking at the implied multiplier on output, because both are below the critical threshold of 1 and it would be empirically challenging to reject one while accepting the other.\textsuperscript{14}

\textsuperscript{14}We also tried to run some simulations to assess the sensitivity of the values to the chosen parametrization. Clearly, if one is to have any effect on the open economy multiplier, then one should change some of the coefficients that differentiate the two regions. These are the degree of home bias, the relative size of the home region, and the persistence of the spending shock. Only the latter parameter has an appreciable effect, inversely related to the size of the multiplier. When $\rho_g = 0$, the separable preferences model delivers an open economy multiplier of 0.95 on output and practically nil on consumption.
Table 6.1: Government Spending Multiplier in Nakamura and Steinsson’s Model

**Panel A: New-Keynesian Model (α = 0.75)**

<table>
<thead>
<tr>
<th>Policy</th>
<th>Variable</th>
<th>Lags</th>
<th>Aggregate Multiplier</th>
<th>Relative Multiplier</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Separable</td>
<td>GHH</td>
</tr>
<tr>
<td><strong>Taylor Rate</strong></td>
<td>Output</td>
<td>1</td>
<td>0.19</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>0.19</td>
<td>0.06</td>
<td>0.64</td>
</tr>
<tr>
<td></td>
<td>Consumption</td>
<td>1</td>
<td>-1.02</td>
<td>-1.19</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>-1.02</td>
<td>-1.17</td>
<td>-0.10</td>
</tr>
<tr>
<td></td>
<td>Employment</td>
<td>1</td>
<td>0.28</td>
<td>0.07</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>0.28</td>
<td>0.09</td>
<td>0.90</td>
</tr>
<tr>
<td><strong>Real Rate</strong></td>
<td>Output</td>
<td>1</td>
<td>1.00</td>
<td>7.00</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1.00</td>
<td>7.00</td>
<td>0.64</td>
</tr>
<tr>
<td></td>
<td>Consumption</td>
<td>1</td>
<td>0.00</td>
<td>7.50</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>0.00</td>
<td>7.50</td>
<td>-0.10</td>
</tr>
<tr>
<td></td>
<td>Employment</td>
<td>1</td>
<td>1.49</td>
<td>10.45</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1.49</td>
<td>10.45</td>
<td>0.90</td>
</tr>
<tr>
<td><strong>Nominal Rate (%)</strong></td>
<td>Output</td>
<td>1</td>
<td>1.70</td>
<td>8.73</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1.70</td>
<td>8.73</td>
<td>0.74</td>
</tr>
<tr>
<td></td>
<td>Consumption</td>
<td>1</td>
<td>0.88</td>
<td>9.66</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>0.88</td>
<td>9.66</td>
<td>-0.07</td>
</tr>
<tr>
<td></td>
<td>Employment</td>
<td>1</td>
<td>2.54</td>
<td>13.02</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>2.54</td>
<td>13.02</td>
<td>1.06</td>
</tr>
</tbody>
</table>

**Panel B: Neoclassical Model (α ≈ 0)**

<table>
<thead>
<tr>
<th>Policy</th>
<th>Variable</th>
<th>Lags</th>
<th>Aggregate Multiplier</th>
<th>Relative Multiplier</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Separable</td>
<td>GHH</td>
</tr>
<tr>
<td><strong>No Tax</strong></td>
<td>Output</td>
<td>0</td>
<td>0.39</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>Consumption</td>
<td>0</td>
<td>-0.77</td>
<td>-1.25</td>
</tr>
<tr>
<td></td>
<td>Employment</td>
<td>0</td>
<td>0.58</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>Tax</strong></td>
<td>Output</td>
<td>0</td>
<td>0.32</td>
<td>-0.18</td>
</tr>
<tr>
<td></td>
<td>Consumption</td>
<td>0</td>
<td>-0.85</td>
<td>-1.48</td>
</tr>
<tr>
<td></td>
<td>Employment</td>
<td>0</td>
<td>0.48</td>
<td>-0.27</td>
</tr>
</tbody>
</table>

The table reports the coefficients of the regressions run on the simulated data from the model. Policy refers to the monetary policy rule in the New-Keynesian model and to the fiscal policy rule in the Neoclassical model. Lags refers to the coefficients shown: 1 means that the sum of the first two coefficients is shown, 3 means that the sum of all coefficients is shown, while 0 is shown in Panel B because flexible prices imply that the adjustment is instantaneous. In Panel A, when the policy is “Nominal Rate”, the persistence of public spending is adjusted so as to guarantee the presence of a finite multiplier on output in the closed economy setting. In particular, \( \rho_g = 0.85 \) in the separable preferences case and \( \rho_g = 0.5 \) in the GHH case. Hence, the results for the open economy setting in the separable vs. GHH case are not directly comparable. In Panel B, “No Tax” refers to the policy that keeps constant the income tax rates, while “Tax” corresponds to the Balanced Budget policy whereby \( \tau_t \) is adjusted so as to keep aggregate tax revenues equal to aggregate spending in every period.

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At this point, the authors show how GHH preferences, in combination with sticky prices, are able to deliver a model with a higher multiplier on output, which is consistent with the figure they find in the empirical exercise. Once again, the Neoclassical model’s predictions are inconsistent with the evidence, because the multiplier on output is exceedingly small. Nevertheless, it is possible to show that looking at output alone may not be enough to gauge the appropriateness of the GHH case. Indeed, by slightly altering the parameter that describes the persistence of public spending from $\rho_g = 0.933$ to $\rho_g' = 0.95$, the implied long run multiplier on output in the separable and GHH cases become very similar at around 0.6 (these coefficients are not shown in the table). Nevertheless, if one provides evidence of a positive short run response of consumption, then this will undoubtedly go in favor of the GHH specification, since the separable preferences case cannot deliver a positive response of consumption. The economic rationale behind the reduction in the open economy multiplier on output in the face of this reparameterization lies in the additional negative wealth effect that comes from higher prospective public expenditures, which will crowd out private spending also in the GHH case after the initial positive response of consumption. Nevertheless, the coefficient $\beta_0$ of the impact response of consumption remains positive and quite large, thus suggesting that the complementarities brought about by the nonseparable preferences may be a relevant factor.

To sum up, the open economy relative multiplier can be conveniently thought of as a diagnostic tool that allows macroeconomists to assess the performance of competing models. Since it is insensitive to the specification of monetary policy, it has the advantage of being a particularly sharp diagnostic tool when it comes to comparing either the Neoclassical model against the New-Keynesian model, or the separable preferences case to the GHH case. In particular, it is crucial to look at the response of consumption, because the multiplier on output alone is somewhat sensitive to the parameter describing the persistence of the government spending shock, while the positive response of consumption is distinctive of the GHH case. Given that in Section 5 we found some evidence weakly suggestive of a positive short term multiplier on consumption, this somehow provides additional evidence in favor of the New-Keynesian model with GHH preferences.

7 Reconciling the Empirical Evidence

The previous section has overlooked one of the main findings of our empirical exercise. In particular, we showed that the multiplier on both output and consumption is particularly large when there are underutilized resources in either the whole country or in the single state. Moreover, it seems that after the great Recession there has been a very large sensitivity of consumption to fiscal policy shocks. Finally, the response of employment does not seem to be particularly sharp during periods of slack.

15 Clearly, this value of this multiplier is substantially lower than the estimated one. Given that the separable preferences case cannot deliver an output multiplier above 1, the argument by Nakamura and Steinsson stands if one is able to show that the estimated multiplier is above 1 with considerable confidence. But, this is not always the case for output multipliers estimated in section 5, while the positive response of consumption is somewhat clearer.
In their model, Nakamura and Steinsson do not focus on the effects of said nonlinearities, both in a technical sense when they apply the linear solution method proposed by Sims (2002), and in an interpretative sense when they do not explicitly allow for labor market imperfections that can generate equilibrium unemployment, or credit market imperfections in the form of borrowing constraints. Nevertheless, in the empirical section, they provide supportive evidence of such nonlinearities, by showing that the multipliers on output are particularly large in periods of economic slack.

The key point is that the finding of a positive open economy consumption multiplier is not dependent on any specific monetary policy rule. Hence, the power of our empirical result is that, irrespective of the zero lower bound on interest rates, consumption has been more sensitive to fiscal policy shocks after 2009. Therefore, there must have been some other factor that has driven this result.

One possibility is the presence of credit market imperfections, and particularly, of a borrowing constraint on the household sector. If this is the case, then at times of economic hardship the constraint becomes binding, thus rendering consumers inside the model effectively unable to transfer resources intertemporally as they would like to do. As discussed by Galí et al. (2007), the inclusion of credit constrained consumers might prove effective in generating a positive response of consumption, even if the open economy framework is less straightforward to analyze because one has to take into account the differential effects in both regions. This is also highlighted by recent research by Leeper et al. (2011), who point out the the largest multipliers are delivered by a standard New-Keynesian model with credit constrained consumers.

Another interesting empirical fact is that there is a clear tendency for impact multipliers to be very small, while it is usually the first lag of government spending that has the largest and most precisely estimated coefficient. This highlights the fact that the model in Nakamura and Steinsson might not capture this hump-shaped response of the main variables of interest, which could be obtained when one introduces more realistic features in the model. One such possibility is consumption habit formation which is usually exploited to generate a greater persistence in the response of consumption to shocks.

Finally, our results also suggest that when consumption responds positively to a shock, then it is especially the nondurable component, and in particular services consumption, which responds positively, while there is a clear tendency for durable investment to remain insensitive to fiscal shocks. Recent work by Berger and Vavra (2014a; 2014b) has highlighted both theoretically and empirically the fact that durables consumption might be less responsive in recessions than in expansions. The economic intuition is that since durable purchases are subject to fixed costs of adjustment, then fewer households will choose to adjust durables in recessions, thus leading to a decreased sensitivity of this particular component of spending in recessions. Moreover, the authors have recently shown that, by estimating a Smooth Transition VAR similar to the one employed by Auerbach and Gorodnichenko (2013), one can see how the response of durables consumption is much more sensitive in expansions than in recessions. In addition, the bulk of the variability is determined by the response of residential
investment, with consumer durables being not particularly reactive.

In this respect, it is important to recognize that Berger and Vavra define durables investment as the sum of durable goods purchases and residential investment. While it would be interesting to compare our results to theirs, one has to keep in mind that our prototype PCE measures do not include residential investment, but only durable goods purchases. Given that the bulk of the positive response in normal times estimated by Berger and Vavra comes from the former, we can only say that our rather flat estimates for durable goods purchases are consistent with their findings.

8 Conclusions

Standard closed economy fiscal multipliers are a function of the response of monetary policy in a New-Keynesian model, and of the response of taxes in the Neoclassical model. Hence, on top of the empirical challenge of distinguishing between a monetary authority that is accommodative or that “leans against the wind”, one is confronted with the additional difficulty of choosing between two models that are conceptually rather different but that can generate multipliers in a relatively wide range for realistic calibrations (see also Leeper et al., 2011).

The estimated open economy relative multipliers improve on the closed economy counterparts because they are insensitive to the stance of monetary policy. Nonetheless, they have to be interpreted in a suitable framework of reference. The natural setting is the open economy DSGE model developed by Nakamura and Steinsson. When their model is simulated, it delivers theoretical counterparts to our short and long run relative multipliers.

Our empirical results provide overall weak suggestive evidence in favor of the New-Keynesian model with GHH preferences, especially because of the positive response of consumption. Nevertheles, this model cannot match both the strong empirical finding of a larger short term multiplier when unemployment is above trend or after the Great Recession, and the hump-shaped response of consumption and output. Finally, the differential response of durables and non-durables is, at first sight, consistent with the results from vector autoregressions found by Berger and Vavra, although we are unable to track the response of residential investment to a fiscal policy shock.

Our results are especially powerful because we are able to discriminate empirically between the effect of the stance of monetary policy (including the zero lower bound on interest rates), and all other factors that might impact the multiplier on consumption. All in all, we find strong evidence that the multiplier is state-dependent, and this is particularly suggestive of the presence of credit constrained consumers. In light of these findings, a fruitful avenue for future research would be to extend the theoretical framework in order for it to deliver a nonlinear fiscal multiplier, for instance through the inclusion of credit constrained consumers, while at the same time introducing some features of the model specification that are able to generate the observed persistence in the estimated multipliers.
References


Alberto Alesina, Carlo Ambrogio Favero, and Francesco Giavazzi. The output effect of fiscal consolidations. Working Papers 450, IGIER (Innocenzo Gasparini Institute for Economic Research), Bocconi University, 2012. 2.2


Richard Blundell, Luigi Pistaferri, and Ian Preston. Imputing consumption in the PSID using food demand estimates from the CEX. Ifs working papers, Institute for Fiscal Studies, October 2004. 3


National Association of State Budget Officers, editor. *Capital Budgeting in the States*, 2014. 4.3.3


Appendix A  Robustness Checks

This appendix presents and discusses the results from the estimation of different specifications that are intended to alleviate possible concerns related to the econometric validity of our empirical exercise. The results from all checks are reported in Table A.1 and Figures A.2 and A.3. The first section discusses the importance of anticipation effects and whether these have any impact on the results that we obtain, while the second concerns a technical feature of our specification, which omits the lagged value of the dependent variable.

A.1 Anticipation Effects

Some of the most recent literature has highlighted the importance of taking into account expectations about future policy, to the extent that the information sets of agents and of the econometricians might be misaligned (see for instance the discussion in Leeper, 2010; Ramey, 2011b). Clearly, it is rather hard to obtain a precise measure of expectations about military spending, and even more so about state-level military spending. In what follows, we describe the two approaches that we have followed to provide a robustness check for our results.

The first strategy is rather conventional and it consists in estimating a model that not only includes the lags of the independent variable, but also its leads. The assumption is that, on average, the coefficients on the leads should be zero if the spending change is unanticipated, while it might be significant if it is anticipated by agents who respond immediately to shocks. To be parsimonious with the specification, we set $K = 1$ and include two leads of the military procurement variable instrumented with our shock B. The results are reported in Table A.1, and specifically in rows 1 and 2. One can see that the implied short term multiplier on output is still significant and very precisely estimated, but the point estimate does not allows us to reject the hypothesis that below 1 at standard levels of significance. The sum of the coefficients on the two leads is positive, at 0.6, but it is not precisely estimated. This suggests that some anticipation effects might be present which induce output to respond before the shock occurs, but this statement cannot be made in a statistically meaningful way.

As far as consumption is concerned, the multipliers become slightly smaller but significance is still achieved in the case of services consumption and overall nondurables. The sum of the coefficients of the two leads is slightly negative but not significantly smaller than zero. The same is not true of the response of employment: there is some evidence of an anticipation effect for the employment-population ratio, which responds before a shock occurs roughly the same way it responds after it has happened.

The second strategy consists in drawing on earlier work by Valerie Ramey, who has compiled a very useful quarterly series from a narrative record that summarizes the information available to the public about the present discounted value of future nation-wide policy changes, which are all that matters for the identification of exogenous variation in state-level military spending growth.
Table A.1: Robustness Checks

<table>
<thead>
<tr>
<th>Test</th>
<th>Multiplier</th>
<th>Output</th>
<th>Consumption</th>
<th>Employment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All</td>
<td>All</td>
<td>Nondurables</td>
<td>Durables</td>
</tr>
<tr>
<td></td>
<td>All</td>
<td>Serv</td>
<td>All</td>
<td>Level</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Goods</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short</td>
<td>Lead</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.22***</td>
<td>0.53</td>
<td>0.56*</td>
<td>-0.07</td>
</tr>
<tr>
<td></td>
<td>(0.44)</td>
<td>(0.35)</td>
<td>(0.30)</td>
<td>(0.33)</td>
</tr>
<tr>
<td></td>
<td>Lead</td>
<td>-0.21</td>
<td>-0.23</td>
<td>0.14</td>
</tr>
<tr>
<td></td>
<td>(0.98)</td>
<td>(0.53)</td>
<td>(0.43)</td>
<td>(0.34)</td>
</tr>
<tr>
<td>News</td>
<td>Short</td>
<td>1.61***</td>
<td>1.04***</td>
<td>0.96**</td>
</tr>
<tr>
<td></td>
<td>(0.44)</td>
<td>(0.48)</td>
<td>(0.43)</td>
<td>(0.40)</td>
</tr>
<tr>
<td></td>
<td>Short</td>
<td>1.16***</td>
<td>1.14***</td>
<td>1.05***</td>
</tr>
<tr>
<td></td>
<td>(0.37)</td>
<td>(0.31)</td>
<td>(0.29)</td>
<td>(0.26)</td>
</tr>
<tr>
<td></td>
<td>Long</td>
<td>1.69***</td>
<td>0.61*</td>
<td>0.58*</td>
</tr>
<tr>
<td></td>
<td>(0.44)</td>
<td>(0.35)</td>
<td>(0.31)</td>
<td>(0.30)</td>
</tr>
</tbody>
</table>

Rows 1 and 2 (Lead) test the presence of anticipation effects by including 2 leads of the independent variable (instrumented with $\Omega_i^B$). Row 3 (News) shows the coefficient estimates when the instrument is computed with the unexpected component of $\Delta g$. Rows 4 and 5 (AB) list the estimates of the short and long run multipliers when we estimate the model with 1 lag of the dependent variable with the Arellano and Bond GMM estimator. Tests of autocorrelation of the differenced shocks soundly reject AR(2), suggesting that the specification is correct. Standard errors are clustered at state level and are robust in AB. All regressions include state fixed effects (except AB) and year dummies. Levels of significance are given by Wald tests on the linear restriction; significance levels are conventional: *** implies significance at 1%, ** at 5%, * at 10%.

Thus, we are able to use this wealth of information to differentiate between anticipated and unanticipated shocks. The idea is that the level change in real per capita spending at the National level can be written as:

$$\Delta g_t = \Delta g_t^a + \Delta g_t^u$$

where $\Delta g_t^a$ is the component of the actual change in military spending that is anticipated by the public on the basis of the information at their disposal as of year $t$, while $\Delta g_t^u$ is the surprise, or unanticipated shock. Only the latter is what we are interested in, since anticipated shocks are cumbersome to analyze in our econometric framework. The component $\Delta g_t^a$ is the fitted value of a regression of the overall change $\Delta g_t$ in Federal military procurement spending on an annual sum of the Ramey military spending news variable, expressed in real per capita terms.\(^{16}\) To be more specific, we run the following regression:

$$\Delta g_t = \alpha + \gamma g_{t}^{\text{NEWS}} + \nu_t$$  \hspace{1cm} (11)

Figure A.1 shows how the national military spending change might have been predicted solely on the basis of the available information, assuming that Ramey’s measure is able to capture precisely such information. The three major spending changes that occurred at longer frequencies are the Reagan buildup of the 80ies, the draw-down during the 90ies and the surge in procurement spending that followed 9-11 and the wars in Afghanistan and Iraq. All these spending changes were somehow

\(^{16}\)This variable is intended as representing the present discounted value of military spending news, which, in the words of Valerie Ramey, is all that matters from the standpoint of optimizing agents.
Figure A.1: National Change in Real Per Capita Military Procurement and Anticipated Component

The implied discrepancy between the change in spending expected on the basis of the available news and actual spending is the unanticipated, or surprise fiscal shock. Letting $\hat{\varepsilon}_t$ denote the residuals from regression (11), we are now ready to construct two new versions of the exogenous shocks $A$ and $B$ derived above in section 4.2. In particular, fiscal shock $A$ can be written as:

$$
\Omega_{i,t}^A = \Omega_{i,t}^{A,u} + \Omega_{i,t}^{A,a} = \hat{\varepsilon}_t \frac{\theta_{i,t-1}}{\eta_{i,t-1}} + \Delta g_t \frac{\theta_{i,t-1}}{\eta_{i,t-1}}
$$

We added a superscript $u$ or $a$ to denote the unanticipated and anticipated components of the nationwide change in military spending. Then, we simply discard the second part of the expression, defining the new shocks $A$ and $B$ as:

$$
\Omega_{i,t}^{A,u} = \hat{\varepsilon}_t \frac{\theta_{i,t-1}}{\eta_{i,t-1}} \quad \Omega_{i,t}^{B,u} = \hat{\varepsilon}_t \frac{\bar{\mu}}{g_t}
$$

Informally, we maintain the following assumptions:

- The news variable is a good measure of military spending news, and it captures information available to the public up to a classical measurement error which is uncorrelated with the residual in the main regression.

- Agents in the economy believe that the share of future gross real spending that will be allocated
to their state will be equal to either the contemporaneous share of real gross spending, or its
time average (when shock B is used).

Notice that the second assumption is quite restrictive. A possibly fruitful for future research would be
to gather information about military spending news at the state level, for instance analyzing newspa-
pers and other sources to look for news about the prospective allocation of spending at the state
level. Nevertheless, consider the following point: our identification strategy works by effectively mut-
ing the component of the change in military spending at the state level that is due to a change in the
state’s share of spending. By focusing only on news about the nation-wide spending, we can get a
clear picture as to how the supposedly exogenous component is believed to be affected in the future.

The results are reported in Table A.1. We can appreciate how, if anything, controlling for military
spending news increases our estimated multipliers while at the same time raising confidence levels.
Indeed, now the multiplier on consumption is about 1 and it is rather precisely estimated. The rest of
the results are in line.

A.2 Controlling for Persistence in Growth Rates

Another interesting factor that is not taken into account by either Nakamura and Steinsson (2014),
Giavazzi and McMahon (2012) and Acconcia et al. (2014), is the fact that the growth rate of output
might display a certain persistence, meaning that the current value is in part determined by the value
of the previous quarter. If this is the case, our empirical model (5) is misspecified, because it is a
restricted version of this more general model:

\[
\frac{y_{i,t} - y_{i,t-1}}{y_{i,t-1}} = \alpha_i + \rho \frac{y_{i,t-1} - y_{i,t-2}}{y_{i,t-2}} + \delta_t + \sum_{k=0}^{K} \beta_k \frac{g_{i,t-k} - g_{i,t-k-1}}{y_{i,t-k-1}} + \epsilon_{i,t},
\]

(12)

If \( \rho \neq 0 \), then consistent estimation of the parameters of model (5) would only be achieved if the
correlation between the fiscal shock and its lags, and lagged output growth were zero (something that
would be rather disconcerting for our empirical analysis). Moreover, simply including the lagged
value of output growth inside the model is not a valid strategy in panel data analysis, in contrast to a
time series model of the kind used in Romer and Romer (2010), where lagged output growth is thought
of as predetermined with respect to the exogenous shock. This difficulty can be illustrated in a rather
simple way by taking first differences. For notational simplicity, set \( K = 0 \) and forget about the time
fixed effect. Then, the model reads:

\[
\Delta \frac{y_{i,t} - y_{i,t-1}}{y_{i,t-1}} = \rho \Delta \frac{y_{i,t-1} - y_{i,t-2}}{y_{i,t-2}} + \beta_0 \left( \Delta \frac{g_{i,t} - g_{i,t-1}}{y_{i,t-1}} \right) + \left( \epsilon_{i,t} - \epsilon_{i,t-1} \right)
\]

(13)

Evidently, since the composite error term contains \( \epsilon_{i,t-1} \) and the first difference of the lagged growth
rate of output the contemporaneous value of the growth rate at time \( t - 1 \), one cannot in general
consistently estimate \( \beta_0 \) with neither a Random Effects estimator, nor a Fixed Effects estimator. The
solution is to use either the IV method described in Anderson and Hsiao (1981), or the GMM approach of Arellano and Bond (1991), which proves to be more efficient. These estimators work by constructing instruments from past values of the dependent variable, so that the lagged value of, say, output growth, can be projected on a set of variables that are predetermined with respect to the composite error term in (13).

Hence, we apply the Arellano and Bond GMM estimator to specification (12), with three lags of the independent variable instrumented with our shock B. The results are reported in table A.1. If anything, our results become sharper, in terms of the estimated standard errors, while the point estimates of both the short and long run multipliers on output become significantly smaller. In particular, we have that the short run multiplier on output is just above 1 while the long run multiplier is about 1.69, showing signs of significant persistence of the effect of government spending shocks, even when the persistence in output is partialled out. Finally, and more importantly, it seems that the estimates of the multipliers on consumption become slightly larger and more precisely estimated.
Figure A.2: Impulse Response Function of the specification with Ramey's News measure

The figure shows impulse response functions for different variables:

- **GSP**
- **PCE**
- **PCE – Non Durables**
- **PCE – Services**
- **PCE – Non Durable Goods**
- **PCE – Durable Goods**
- **Employment**
- **Employment Ratio**

Each graph includes a point estimate, standard deviation bands, and a 90% confidence interval.
Figure A.3: Impulse Response Function of the specification with lag of the dependent variable (Arellano and Bond)
Appendix B  Geography and Data

Our empirical exercise required the gathering of data from very disparate sources for very different geographical entities. This appendix briefly summarizes the work done in this respect, both by presenting the main geographic units that were encountered in the compilation of our datasets and providing additional information as to the way in which data were gathered and handled.

Every operation performed on our data was done exclusively using Stata 13, so as to minimize the possibility of any accidental loss of information that might happen when one uses different softwares. Several scripts have been written that take as input the original files as they are provided by the primary sources and convert them to the format used by Stata to keep panel data.

B.1 Counties and States

Both military spending data from the CFFR of the US Census and labor market data from the LAUS of the Bureau of Labor Statistics have been provided by the primary sources in text files that report the relevant information at the level of the County. Hence, we had to aggregate these data at State Level and merge them inside the state level dataset constructed from all other sources.

In the US, there are 50 states and the District of Columbia. Hawaii was the last one to be declared a state, changing its status of “Territory” in 1959. Nowadays, there are 4 organized territories of the US, namely Puerto Rico, The Virgin Islands, Northern Marianna Islands and Guam. Very often, federal agencies include data for these territories, that have to be excluded. Be it as it may, the states offer the highest possible temporal consistency in terms of boundaries.

As far as counties are concerned, there are a few notable remarks. First of all, the boundaries have been overall very stable throughout the sample years and have been provided with a rather consistent coding standard that is used by all primary sources (FIPS 5-digit county code). Nevertheless, not all of the 50 states and DC share the same conventions. In particular, Louisiana has parishes instead of counties, while Alaska features boroughs as well as large parts of its territory which are largely uninhabited. Therefore, the Federal statistical agencies have provided a county or county equivalent classification inside a consistent framework of reference. This notwithstanding, Alaska went through major boundary changes throughout the sample years, with many boroughs or census areas being created and dissolved. Since the level of analysis is the state, there are not problems related to county definitions as long as there are no overlapping and as long as all counties are listed in our datasets.

In order to aggregate a variable which is expressed in dollars or that is an absolute number (such as population) it suffices to consider the sum. The same is not true of ratios or per capita values, which cannot be aggregated.

---

The Federal Information Processing Standard or FIPS code is a 5-digit number that identifies each and every of the about 3000 counties and county equivalents in the US. The convention is that the first two digits identify the US state or territory, while the last three digits the county.
B.2 The Dataset

B.2.1 Data Sources

The following is a list of the sources

- **Census Bureau's Consolidated Federal Funds Report.** The CFFR series provides a breakdown of Federal Government obligations and expenditures by place, county, state and for each year between 1983 and 2010. Now discontinued, it provides invaluable information about federal outlays in the fiscal years prior to 2001, that are those available through the new website [usaspending.gov](http://usaspending.gov). CFFR gathers data from a number of sources to compile a dataset that classifies each outlay by object, federal program, and federal agency (after 1993). The actual data are provided through the FTP network of the U.S. Census Bureau. These are yearly data files from 1983 through 2010. I merged all these datasets that provide a standard location code. Where the outlay cannot be traced down to the state or county, the Bureau provides this information as “State Undistributed” giving it a county 3-digit FIPS code of 999 and “U.S. Undistributed” giving it a county 5-digit FIPS code of 99999.

- **BEA’s Income, Employment, Compensation, Transfers, Taxes, Prototype PCE and Population data.** I merged all datasets from BEA at state level. The original data descriptors were kept and used as variable labels in intermediate datasets.

- **Data from USASpending.gov.** The data were extracted using the API on their website. Then, they were imported as they are inside Stata and assigned conventional state FIPS codes for merging procedures.

- **Data from Nakamura and Steinsson (2014).** Selected data was gathered from Nakamura and Steinsson’s dataset, in particular about military spending.

B.2.2 Variables Naming Conventions and Procedures

The datasets assembled all come with a unified variable naming standard. In particular:

- The geographic reference variables are as follows:

  18 The object category includes: DR (Direct Payments to individuals for retirement and disability), DO (Direct Payments to individuals for other reasons), DX (Direct Payments to other than individuals), GG (Grants, all kinds), PC (Procurement Contracts), SW (Salaries and Wages), DL (Direct Loans), GL (Guaranteed or Insured Loans), II (Insurance). Note that only objects DR, DO, DX, GG, PC, SW represent Federal Government’s expenditures, as the other categories are contingent liabilities.

  19 Identified by the Catalog of Federal Domestic Assistance standardized code, or, where missing, a similar code that keeps the agency in the first two digits.

  20 According to the FIPS-95 standard classification code.
- **fips**: county 5-digit FIPS code.\(^{21}\)
- **fipsstate**: state 2-digit FIPS code, derived as the first two digits of **fips**.
- **fipscounty**: county 3-digit FIPS code, derived as the last three digits of **fips**.
- **fipsplace**: place 5-digit FIPS code, also known as ZIP code (it will be never the object of active usage).
- **fipsagency**: 4-digit FIPS-95 code of the Federal Agency. Used only for CFFR data.
- **idprogram**: it specifies the Census's ID code of the Federal Program. The format is **xx.xxx** where the first two characters specify the Federal Agency / Type of program. Used only for CFFR data.
- **cfdaagency**: it specifies the Federal Agency / Type of program. It consists of the first two characters of **idprogram**. Used only for CFFR data.
- **state / county**: specifies the name of the geographic entity.
- **statecode**: specifies the conventional postal code of the state (e.g., NJ is New Jersey, TX is Texas and so on).

- Each variable is assigned a label explaining the content, and the name of the variable is suggestive of the content and chosen in such a way that abbreviations can be fruitfully exploited (e.g., **rcap**\(*\)milproc selects all military procurement series, including those in Nakamura and Steinsson, those from CFFR, those from USASpending.gov and the national measures).
- Original files are never modified, while scripts are written that load the data in whatever format is found and adjust it to Stata standards for panel data. Both original files and DTAs are kept and are available upon request.

### B.2.3 Prototype PCE by State and the NIPA

The Prototype PCE measures come with a 16-category disaggregation that mirrors intermediate components of the more complete disaggregation at the National level. Moreover, data are only at an annual frequency. The following table reports the components included inside each of the Nondurable goods, Services, and Durable Goods categories analyzed in chapter 5.

For a more thorough discussion about the methodology and the primary data sources, we refer the interest reader to the official release of the Bureau of Economic Analysis and to the accompanying paper by Awuku-Budu et al. (2014).

\(^{21}\) Notice that slight modifications, such as **fips census**, are possible when the reference between different systems must be used. For instance, when mapping the data at county level, one needs to keep in mind the difference between the Census codes and the BEA/Customized ones.

\(^{22}\) This acronym stands for Non-Profit Institutions Serving Households. Moreover, it consists of the net consumption expenditures of such institutions, that remain after the receipts from sales are excluded from total output.
Table B.1: Disaggregation of State-Level Prototype Personal Consumption Expenditures measure by components (from BEA)

<table>
<thead>
<tr>
<th>Major</th>
<th>Intermediate</th>
<th>Fine Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Durable</td>
<td></td>
<td>Motor Vehicles and Parts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Furnishings and durable household equipment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Recreational goods and vehicles</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other durable goods</td>
</tr>
<tr>
<td>Nondurable</td>
<td></td>
<td>Food and beverages purchased for off-premises consumption</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clothing and footwear</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gasoline and other energy goods</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other nondurable goods</td>
</tr>
<tr>
<td>Services</td>
<td>Households</td>
<td>Housing and utilities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Health care</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Transportation services</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Recreation services</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Food services and accommodations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Financial services and insurance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other services</td>
</tr>
<tr>
<td></td>
<td>NPISH</td>
<td>Gross Output - Receipts from sales</td>
</tr>
</tbody>
</table>

B.2.4 **CFFR and USASpending.gov**

The datasets of the CFFR can be freely accessed on the website of the US Census Bureau. All text files come with a data descriptor that allows a prompt and easy manipulation of the several million records that make up each year’s dataset. The data contained therein are obligations of funds for a specific contract or transfer and refer to almost all governmental agencies. Only the Tennessee Valley Authority refused to submit data for publication in the CFFR, thus it is excluded. We refer the interested reader to any one of the many yearly reports that have been published during the period of activity of the CFFR.

The key simplification that comes when one is interested in extracting data about military spending from the CFFR is that the US Census Bureau made no attempt at discriminating the allocated funds by Federal Program. Hence, it is very easy to compute a sum by relying on the classification of the spending category, namely procurement contracts, or PC. Once only these records are kept, it is very easy to collapse the dataset at State level. More information on the exact procedures can be obtained by looking at the script files that we wrote and that are available upon request.

Data from USASpending.gov is extremely extensive and very cumbersome to analyze for the period 2000-2013 for which data are available. Luckily, the API of the website allows to compute an annual sum of all procurement spending allocated to each state, for each fiscal year from 2000 to 2013 inclusive.