

Why Does GDP Move Before G? It's all in the Measurement*

Edoardo Briganti[†]

University of California, San Diego

Victor Sellemi[‡]

University of California, San Diego

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Abstract

We find that the early impact of defense news shocks on GDP is mainly due to a rise in business inventories, as contractors ramp up production for new defense contracts. These contracts do not affect government spending (G) until payment-on-delivery, which occurs 2-3 quarters later. Novel data on defense procurement obligations reveals that contract awards Granger-cause VAR-identified shocks to G, but not defense news shocks. This implies that the early GDP response relative to G is largely driven by the delayed accounting of defense contracts, while VAR-identified shocks to G miss the impact on inventories, resulting in lower multiplier estimates.

Keywords: Macroeconomics, Government Spending, Public Procurement (JEL: E60, E62).

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[†]PhD Candidate in Economics. Email: ebbrigant@ucsd.edu.

[‡]PhD Candidate in Economics. Email: vsellemi@ucsd.edu.

1 Introduction

Studying the aggregate effects of government spending (G) requires identifying government spending shocks, which is a crucial empirical challenge. According to Ramey (2016), the two most commonly used methods for identification are the recursive method (as described in Blanchard and Perotti (2002)) and the narrative method (as described in Ramey (2011)). The recursive method places G first in a VAR model, relying on the idea that G is predetermined at time t due to decision lags. By contrast, the narrative approach uses an external instrument (e.g., defense news shocks) which reflects the anticipated shifts in defense spending brought on by exogenous military events, and places this instrument first in a VAR. Our paper provides evidence in favor of the narrative method to properly account for anticipation effects of G .

Proponents of the narrative method argue that accounting for anticipation effects is crucial to precise identification of government spending shocks. The underlying empirical result here is the immediate response of GDP and a delayed response of G (i.e., anticipation effects) following narratively-identified shocks.¹ Economic theory suggests that GDP increases upon announcement of expected future spending through a negative wealth effect, as individuals expect higher taxes and respond by increasing their labor supply. Despite this, there is still disagreement in the literature regarding the strength of this transmission mechanism.² Without a general consensus on the theoretical anticipation effect of G , the question remains: why does GDP move prior to G ?

This study introduces a new empirical inventory-based explanation for the anticipation effects of government spending. Our results show that the initial GDP response prior to G after a defense news shock is largely due to a rise in inventories of federal defense contractors. This inventory increase can primarily be traced back to an increase in newly awarded defense procurement contracts following a defense news shock. However, war-related contract awards and initial production occur several quarters before payment, which is reflected in government spending with a delay. Until payment, the related increase is reflected in aggregate inventories.

Early work by Ginsburg (1952) examines the impact of the Korean War on the US economy, and highlights the importance of inventories in understanding the

¹See Ramey and Shapiro (1998), Edelberg, Eichenbaum, and J. Fisher (1999), Burnside, Eichenbaum, and J. D. Fisher (2004), Eichenbaum and J. Fisher (2005), Ramey (2011), Barro and Redlick (2011), Ben Zeev and Pappa (2017) and Ramey and Zubairy (2018). Leeper, Walker, and S.-C. S. Yang (2013)'s also suggests to control for anticipation effects to correctly identify fiscal shocks.

²For instance, see Monacelli and Perotti (2008) and Coibion, Gorodnichenko, and Weber (2020).

effects of government spending.³ They emphasize that increased production due to government orders is reflected in private inventory investment before government expenditures. Brunet (2020) also highlights that production still in progress with unpaid federal funds will appear in inventories until it is recorded as G.

The reason GDP moves ahead of G is not necessarily a result of households anticipating government spending (the negative wealth effect). Rather, G tracks payments that are delayed compared to new orders, which appear as inventory investment in GDP. The time discrepancy between orders and payments, due to the time required to build the ordered items, leads to a mechanical anticipation effect where GDP moves before G, creating the false appearance of fiscal foresight. Our findings have important consequences for identifying government spending shocks.

We start by decomposing the increase in GDP after a defense news shock, using data from the National Income and Product Accounts (NIPA). At the aggregate level, we observe that the majority of this increase stems from a strong rise in investment, and particularly the business inventories component of investment. Secondly, we examine the panel of manufacturing industries and find that the increase in inventories after war events is driven exclusively by higher real inventories in defense industries. This result suggests that defense contractors ramping-up production underlies the positive aggregate response of inventories to a defense news shock.

As noted by Brunet (2020), the Department of Commerce’s Government Transaction Methodology Paper shows that the production of government contractors is not reflected in government spending. Rather, G only tracks payments which occur after the delivery of the ordered items, and defense production takes time. To provide direct evidence of this time delay, we construct novel quarterly time-series of defense procurement spending and defense procurement obligations. Defense procurement spending tracks payments to contractors, while obligations represent the total value of prime contract awards. Our findings show that obligations precede payments (and G) by an average of 2-3 quarters. This directly confirms the time-delay between payments and the placement of new defense orders.

This result is consistent with similar findings in the literature. In particular, Leduc and Wilson (2013) finds that a dollar of federal funds allocated to highway construction can take up to six years to be paid after being obligated at the state level, and suggest using obligations instead of spending to study the effect of

³From page 10: “It is apparent that a defense mobilization will provide a stimulus to economic expansion if government expenditures increase the aggregate demand for goods and services. However, the expansion need not await the actual growth of government expenditures. In the first place, some government expenditures for defense will lag behind the placement of orders. For a time, the increased production consequent on the orders will be reflected in private inventory investment rather than in government expenditures.”.

highway investments. Similarly, Brunet (2020) finds that the annual budget leads NIPA’s measure of G by one year and uses a newly-constructed annual variable, Budget Authority, instead of G , to estimate the effects of government spending. However, these studies do not directly document the delay in the context of quarterly defense procurement spending.

To summarize, the recorded time-delay between payments and new orders provides the accounting origin of the positive response of inventories during a military build-up: it is the unpaid production-in-progress which does not yet show up in G . By consequence, we refer to the positive effect of defense procurement obligations and defense news shocks on inventories as *time-to-build* production.

Moreover, we verify that defense procurement obligation shocks Granger-cause VAR-identified shocks of government spending. The same cannot be said for defense news shocks. In other words, it is a well-known fact that fluctuations in real government spending reflect fluctuations in defense spending that arise from military events. Since recursive shocks are based on the NIPA measure of G , the timing of these shocks will reflect the timing of payments made to contractors. This timing is delayed compared to the start of the economic impact of a military event, which is reflected in new government orders. As a result, shocks to defense procurement obligations predict VAR shocks. On the other hand, defense news shocks are recorded at the start of a military build-up, when new contracts are awarded and contractors increase production. Thus, defense news shocks are not predictable by shocks to defense procurement obligations. This time-mismatch between orders and payments, which manifests as an increase in inventories, is the primary cause of the anticipation effect captured by defense news shocks in Ramey (2011).

In conclusion, our analysis demonstrates that the fiscal multiplier computed using recursive shocks is lower than that calculated using defense news shocks. This discrepancy is entirely due to the differing responses of inventories as captured by each type of shock. Essentially, recursive shocks overlook the initial production by defense contractors that is recorded in inventories. Therefore, our findings support the use of the narrative method to accurately (i) identify government spending shocks and (ii) estimate fiscal multipliers.

The paper is organized as follows. Section 2 establishes the positive response of contractor inventories following a defense news shock. Section 3 studies the underlying economic and accounting mechanisms driving the response of inventories using novel procurement data. Section 4 shows that our findings pose a threat for the identification of government spending shocks. Section 5 concludes.

2 Response of Inventories to Fiscal Shocks

In this section, we decompose changes in the components of real output that are driven by news about future government spending rather than actual government spending. We find that the early response of GDP to defense news shocks is driven primarily by a positive and robust response in business inventories.⁴

Our starting point is Ramey (2011), who finds that aggregate output reacts immediately to news about future war-related defense spending (defense news shocks), while government spending itself has a delayed response.⁵ We replicate this result in the top panels of Figure 1. In particular, we estimate the quarterly impulse response function (IRF) of some outcome y_t of interest (e.g., GDP) using lag-augmented local projections:⁶

$$y_{t+h} = \theta_h \cdot \text{Shock}_t + \beta \cdot \mathbf{X}_t + \varepsilon_{t+h} \quad (1)$$

where y_{t+h} is the outcome, Shock_t is the updated series of narratively identified defense news shocks from Ramey and Zubairy (2018), and \mathbf{X}_t is a vector of four lags of shocks, government spending, consumption, investments, net-exports, hours worked by the private sector, and the three-month Treasury Bill rate. Following Ramey and Zubairy (2018), we divide all nominal variables by real potential output and the GDP price deflator.

To further investigate the underlying mechanism here, we decompose GDP and estimate the aggregate response of consumption, investment, government spending, and net-exports to defense news shocks. The bottom-left panel of Figure 1 shows the IRF of Investments while the bottom-right panel the one of Inventories. Notice that when we use defense news shocks (left-panel), the response of inventories is positive, significant and spikes at horizon 1, that is, even before any movement in G . Overall, it is clear that the early increase in GDP relative to G following a defense news shock initially shows up as an increase in inventories.⁷

⁴Note that we use the term “inventories” to refer to “Aggregate Changes in Business Inventories”, which is one component (along with residential and non-residential investment) of I in the decomposition $GDP = C + I + G + NX$.

⁵See also Ramey and Shapiro (1998), Edelberg, Eichenbaum, and J. Fisher (1999), Eichenbaum and J. Fisher (2005), Ben Zeev and Pappa (2017).

⁶See Jordà (2005) for local projections and Montiel Olea and Plagborg-Møller (2020) for econometric details on lag-augmented local projections.

⁷We do not observe any significant early movement in net-export. However, in samples which include the Korean War, we also observe a positive response in durable consumption at horizon 0. However, the response of durables is not robust to the exclusion of the war, and is driven by a fear of rationing which was uniquely prevalent at the onset of the Korean War (see Ginsburg (1952), Hickman (1955), Ramey (2016) and Binder and Brunet (2021)). We report in the Online Appendix A the IRFs to the other components of GDP.

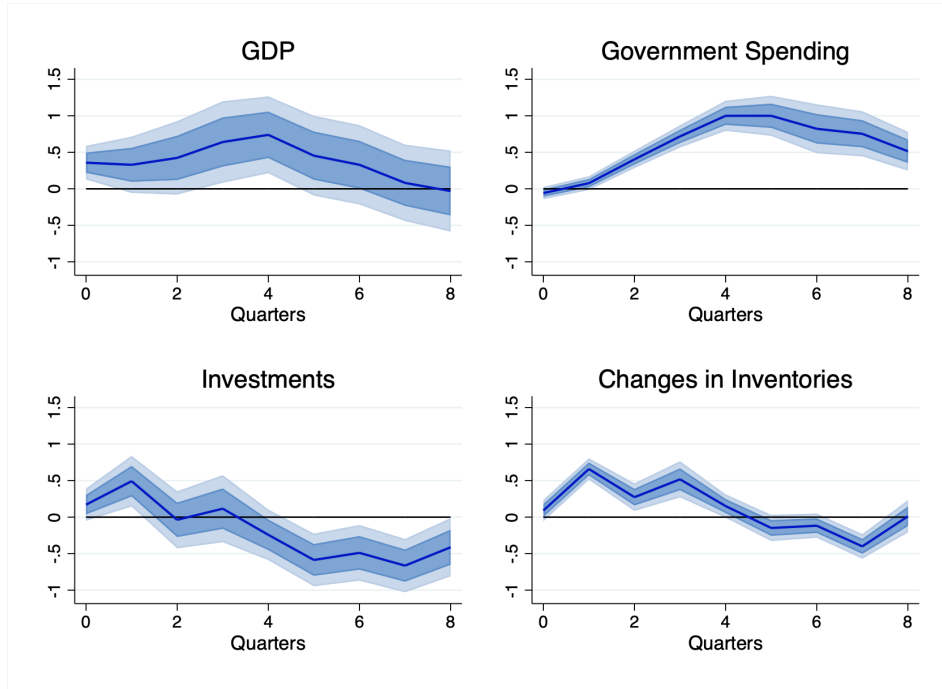


Figure 1: **Response of GDP and G to a Defense News Shock:** *IRFs of GDP, G, Investment and Changes in Inventories to a defense news shock are obtained via lag-augmented local projections. Bands represent the 68% and 90% heteroskedasticity robust standard errors. Defense news shocks are obtained from the updated series in Ramey and Zubairy (2018). Sample goes from 1947Q1 to 2015Q4. Values in the Figures are normalized by the peak response of G.*

To the best of our knowledge, we are the first to detect positive effects of inventories to defense news shocks and relate it to the anticipation effect of G.⁸

Robustness Our results are robust to the exclusion of the Korean War (the largest military build-up after World War II) from the sample, indicating that the response of inventories is not driven by periods in which defense shocks dominate.⁹

Secondly, we find that the positive response of inventories is robust to the adoption of other types of fiscal shocks. In particular, we use recursively identified shocks and shocks identified from a VAR which orders defense procurement obligations first, where defense procurement obligations capture the all universe

⁸Fatas and Mihov (2001) estimate the effect of recursively identified shocks to G on a multitude of variables and also find a positive early response of inventories. They do not discuss this result in the paper.

⁹We believe that it is important to include the largest war events in the sample as they mimic natural experiments involving government spending. However, we are aware of potential confounding factors (see Perotti (2007), J. D. Fisher and Peters (2010), Perotti (2014) and Ramey (2016)).

of defense prime contract awards (we will discuss the construction of this variable in the next sections). We report all robustness checks in the Online Appendix B.

Next, we show in the panel of manufacturing industries that the aggregate response of inventories is driven by an increase in industries which heavily contract to the federal government.

2.1 Industry Analysis: Who is Responding?

Given the positive and robust aggregate response of inventories, we study heterogeneity in this response across industries in response to war events. We find that the positive response is driven by defense industries which increase inventories during a military build-up. To do so, we use monthly data from the Bureau of Economic Analysis (BEA) to construct a panel of real inventories for 18 manufacturing industries between January 1959 and December 1997.¹⁰

The production of defense goods is concentrated in the manufacturing sector (see e.g., Ramey and Shapiro (1998), Nekarda and Ramey (2011) and Cox et al. (2021)). However, the level of government involvement varies greatly among manufacturing sub-industries. For example, the “Other Transportation Equipment” sector has 34% of its sales directly from the government. Accounting for indirect sales via input-output connections, the sector’s dependence on government purchases rises to 42% and 44% with first and second order downstream connections included (as done in Nekarda and Ramey (2011)). This heavy reliance on government purchases is unsurprising given that the sector includes sub-industries like Aircraft, Ship Building, Guided Missiles, and Space Vehicles. Conversely, the “Wood Products” sector has no sales to the government as it does not include any defense item producers.

Therefore, we construct a weight θ_i for each industry which captures the long-run average share of industry sales coming from government purchases.¹¹ Then we estimate the following equation:

$$\text{Inv}_{i,t+h} = \lambda_{ih} + \alpha_h \cdot \text{War}_t + \beta_h \cdot \text{War}_t \cdot \theta_i + \sum_{p=1}^P \varphi_{ph} \cdot \text{Inv}_{i,t-p} + \varepsilon_{i,t+h} \quad (2)$$

where $h = 0, 1, \dots, H$, Inv_{it} is total real inventories of industry i in month t , λ_{ih} is an industry fixed-effect, and War_t is war dates.¹² Consistent with Ramey and

¹⁰We thank Valerie Ramey for providing this data. Our data ends in 1997, however, most of the variation in defense spending comes from before the Nineties (Vietnam War and Soviet invasion of Afghanistan).

¹¹See Online Appendix C.2 for a detailed derivation of industry weights.

¹²We use war dates instead of defense news shocks since the former can easily be converted into monthly frequency to match our inventories data.

Shapiro (1998) and Eichenbaum and J. Fisher (2005), our war event variable is a weighted dummy with value 1 on March 1965 and 0.3 on January 1980 to indicate the start of the Vietnam War and Soviet invasion of Afghanistan, respectively.

We are interested in the estimands α_h and $\alpha_h + \beta_h$. The former is the response of inventories for those industries not connected to the government (i.e., $\theta_i = 0$). The latter is the response of industries which are highly connected to the government through government purchases (i.e., $\theta_i = 1$). If war dates have a differential positive effect on sectoral inventories which is proportional to the degree of connection to the government, we expect $\beta_h > 0$.

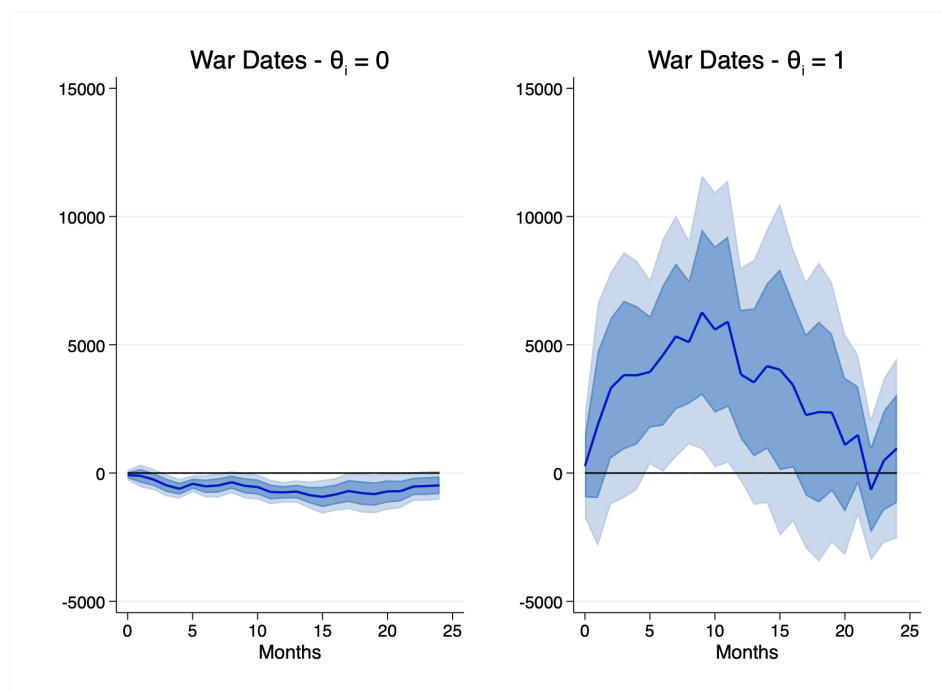


Figure 2: Response of Sectoral Inventories to War Events. *Left panel shows estimates of α_h (response when $\theta_i = 0$), right panel reports estimates of $\alpha_h + \beta_h$ (response when $\theta_i = 1$). Weights are normalized by maximum weight (i.e. the one of Other Transportation Equipment Manufacturing). Since Real Inventories are trending, data is filtered using Hamilton (2018)'s filter (we set $h = 24$ and $p = 12$, that is two years lag plus one more year of lags). The unit of real inventories is millions of 2005 chained dollars. Sample goes from 1959-Jan to 1997-Dec and uses 18 sectors breakdown of Manufacturing. Confidence bands are 68% and 90%. Standard errors are obtained via Bootstrap (standard Stata routine for `xtreg`: we use `vce(boot)` and set the seed for replicability of results; Stata uses a non-parametric type of bootstrap which resamples data with replacement).*

Figure 2 shows a significant positive and long-term differential response ($\alpha_h + \beta_h$) of defense industries' inventories to war dates. On the other hand, the change in inventories for those industries who do not supply the government (α_h) is negative and close to zero. Therefore, all of the effect of war dates on inventories is explained by the degree of connection of each sector to the government.

Robustness We verify that this differential response of defense industries' inventories is not driven by their different sensitivity to the business-cycle. In particular, we replace War_t with monetary policy shocks constructed narratively by C. D. Romer and D. H. Romer (2004) and updated by Wieland and M.-J. Yang (2020) and estimate the differential response $(\alpha_h + \beta_h)$ to be statistically indistinguishable from zero. This confirms that the reaction of federal contractors to defense news shocks is driven by war-related forces and not the associated business-cycle fluctuations.¹³

Furthermore, we make sure that the differential response of defense industries during a military build-up is not driven by spurious correlation. In particular, we re-estimate Equation (2) using randomly re-shuffled weights as commonly done in the production network literature (e.g. see Ozdagli and Weber (2020)). Again, we estimate the differential response $(\alpha_h + \beta_h)$ to be statistically indistinguishable from zero. Again, we report the results of these robustness checks in the Online Appendix C.1.

Finally, one might argue that inventories are not a direct measure of production. Therefore, we proxy defense production using average weekly hours of production and non-supervisory workers in the Aircraft industries.¹⁴ We find positive and strong effects of both defense news shocks and defense procurement obligations on this proxy of defense production. We refer to the Online Appendix C.1 for complete results and details.

3 Why Inventories and not G?

This section explains why the early stage production of defense industries during a military build-up is absorbed by inventories and not government spending (G). Briefly, part of the production process occurs between contract award and delivery, and contractors are paid after delivery. Since G is constructed primarily using payments, it measures production with delay (see also Brunet (2020)). To accurately track production as it happens, NIPA uses inventories to align the timing of production with the contract award and payment. Chapter 7 of NIPA's Handbook states:¹⁵

¹³We thank Juan Herreño for suggesting this test.

¹⁴Notice that production workers account for 82% of total private employment, on average (see Nekarda and Ramey (2020)). We choose the Aircraft industry since it specializes in defense production and we use average hours of production workers since total hours is a lagged measure of production (see Bils and Cho (1994) and Fernald (2012)). We further clarify this point in the Online Appendix C.3.

¹⁵We thank Junyuan Chen and Valerie Ramey to bring up to our attention this meaningful passage.

“A general principle underlying NIPA accounting is that production should be recorded at the time it occurs. [...] The recording of movements of goods in inventory — materials and supplies, work-in-process, and finished goods — and from inventories to final sales provides the means to allocate production to the period in which it occurred.”

The Procurement Process In the defense procurement process, obligations and spending are two distinct stages. To clarify the timing, we provide a visual representation of the process in Figure 3. The process starts with the award of a contract, which is when the government is legally bound to pay for goods/services. Although contractors are notified of contract opportunities before the award date through pre-award solicitations, these solicitations are typically posted in the same quarter as the award date and made available to contractors on a federally managed online database.¹⁶

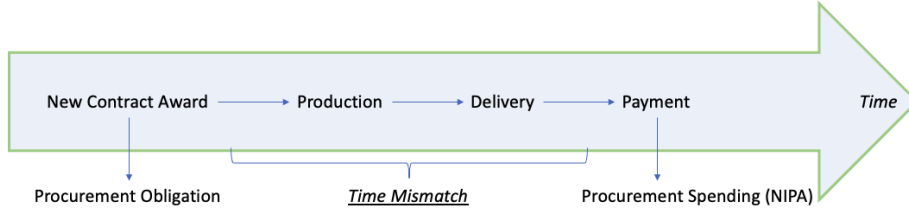


Figure 3: Timeline of Procurement Contracts. *The procurement timeline follows information from the Federal Acquisition Regulation (FAR) and the BEA’s Concepts and Methods of NIPA.*

After contracts are awarded, contractors launch a potentially long production process. In particular, contract-level data indicates that the mean and median duration of \$1 defense procurement contract are 4.2 and 5.4 years, respectively. We measure duration as the period of performance, or the number of days between award date and contract end (full delivery) date. We find that total defense procurement spending is dominated by few very large contracts with very long duration. Using the same data, Cox et al. (2021) report a very short average contract duration. However, their estimated duration is not weighted by contract size. Weighting is necessary to find the duration of \$1 of spending and not the average duration of contracts. This difference matters, since most of procurement spending comes from few very large contracts. If we do not weigh by contract size, our results are consistent.¹⁷

¹⁶Generally, solicitations are posted on beta.sam.gov and are linked to the eventual contract award using the solicitation ID. Further discussion can be found in the Online Appendix D.5

¹⁷We use defense contract data from the federal procurement data system (FPDS) from 2000 to 2020. FPDS encompasses every federal transaction at daily frequency. We report results in

Given that production takes a long time, when do associated payments actually occur? According to the Federal Acquisition Regulation (FAR), the canonical rule for payments to federal contractors from government agencies is *payments-after-delivery* (see FAR 32.904).¹⁸ Finally, NIPA constructs G using mainly outlays, that is, payments to contractors (see Brunet (2020)).

Therefore, NIPA’s accounting rules result in a delay in tracking defense production due to the time it takes to produce items. In the following sections, we create a measure of defense procurement spending and obligations to directly observe the time gap between the start of production (when the contract is awarded) and when NIPA records it (at delivery).

Construction of Defense Procurement Spending and Obligations We construct a novel database of defense procurement spending and obligations. Spending measures payments from federal agencies to contractors, while obligations measure the total value of federal funds as soon as they are contractually obligated to firms. To construct the spending series, we use the accounting identity discussed in Cox et al. (2021):

$$\begin{aligned} (\text{Procurement Spending})_t &\approx (\text{Intermediate Goods \& Services Purchased})_t + \\ &\quad + (\text{Change in Government Fixed Assets})_t + \\ &\quad - (\text{Investment R\&D})_t \\ &\approx (\text{Payment to Contractors})_t, \end{aligned}$$

where all variables are obtained from the National Income and Product Accounts (NIPA). Figure 4 plots this measure of defense procurement spending along with the annual measure of procurement spending of Dupor and Guerrero (2017), aggregated over states. The two measures are virtually identical before 1984, but afterwards the Dupor and Guerrero (2017) series omits contract actions with value less than \$25,000 and thus systematically underestimates our NIPA-based series. From 2000 onward, we also aggregate federal agency payments from the universe of procurement contracts, available in the Federal Procurement Data System (FPDS), and find that our measure is consistent.

To construct the obligations series, we aggregate the value of procurement contracts awarded by the Department of Defense (DoD) from the universe of procurement contracts recorded in the Federal Procurement Data System (FPDS). Since this data is only available from 2000 onward, we also collect historical information from the periodical *Business Conditions Digest* (henceforth BCD) which

the Online Appendix D.2.

¹⁸Certain contracts are also subject to partial-delivery-payments. However, given the multiple year average duration of \$1 of procurement spending, we still observe several quarter-long delays in partial deliveries. We further clarify this point in the Online Appendix D.3.

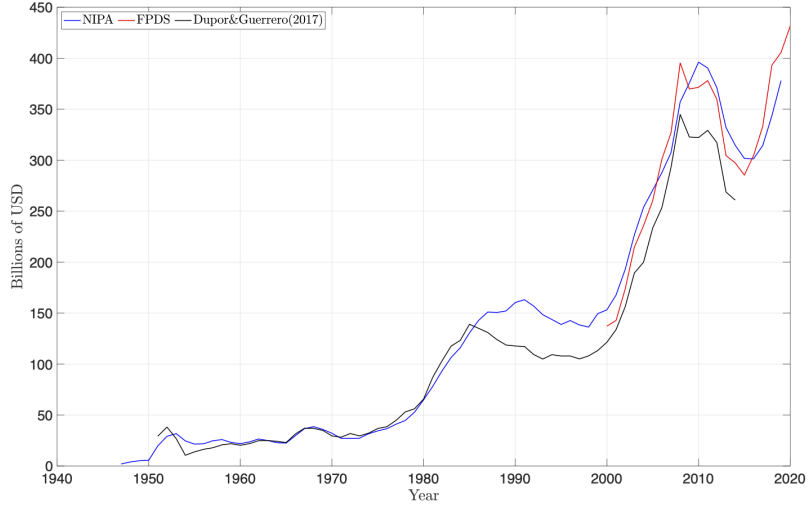


Figure 4: **Annual Defense Procurement Spending.** Data from FPDS and our newly constructed defense procurement spending variable from NIPA data are aggregated at yearly frequency to match Dupor and Guerrero (2017)'s variable.

is available from January 1951 to November 1988. We use information from the contract and spending data to impute missing quarters and construct a quarterly time series of defense procurement obligations.¹⁹

Direct Evidence of Time Mismatch in Defense Procurement The left panel of Figure 5 plots spending and obligations from Jan 1951-Nov 1988, and the right panel reports the lead-lag correlation.²⁰ From the right panel, the average lead-lag correlation significantly peaks in the North-East quadrant of the map. This suggests that changes in obligations are more highly correlated with delayed changes in spending rather than current changes in spending. The results replicate for more recent obligations data obtained from FPDS and when we look at quarterly year-to-year changes instead of simple changes. We report these robustness checks in the Online Appendix D.2. On average, we find that obligations lead spending by 2-3 quarters.

The payment (or government outlay) thus occurs several quarters after the defense contract award. This finding is consistent with the results of Leduc and

¹⁹Many thanks to Valerie Ramey for providing the BCD data. We remand to our Online Appendix D.4 for extra details on the sources of contract level data and the construction of the series.

²⁰Lead-lag correlations are useful for studying relationships in time between variables. For example, Smets, Tielens, and Van Hove (2019) use it to study the timing of propagation of inflation from upstream to downstream sectors.

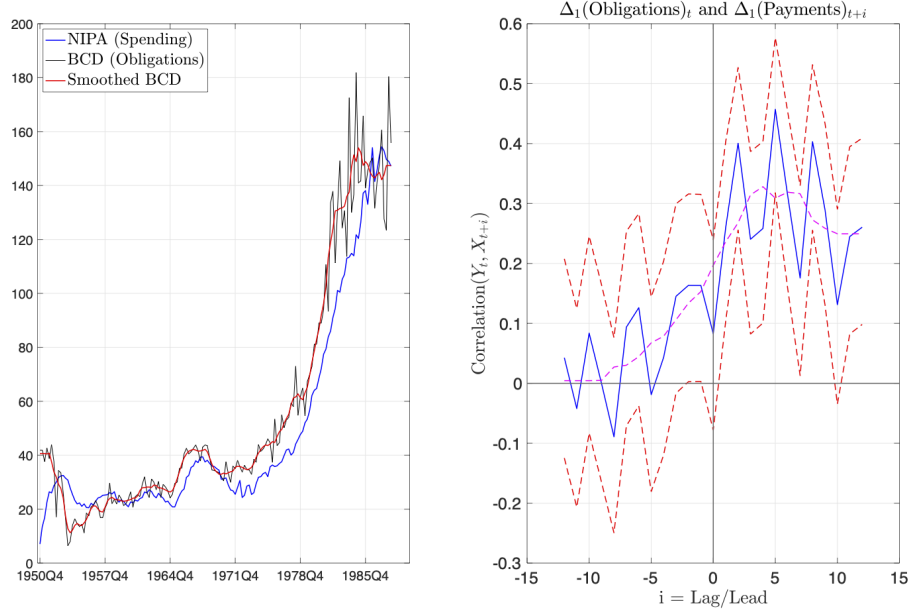


Figure 5: **Federal Defense Procurement Obligations and Spending.** *Source: BCD for Obligations and NIPA for Spending. Sample: 1951Q1 to 1988Q4. The lead-lag correlation-map plots the following: $\text{Corr}(\Delta_1(\text{Obligations})_t, \Delta_1(\text{Payments})_{t+i})$, where Δ_1 is the first difference operator and payments are proxied with our measure of defense procurement spending from the NIPA data.*

Wilson (2013) and Brunet (2020) in the context of highway spending and the aggregate annual defense budget. Moreover, this is confirmed directly by the Department of Commerce’s Government Transaction Methodology Paper:²¹

“The largest timing difference is for national defense gross investment for relatively long-term production items, such as aircraft and missiles, for which the work in progress is considered as part of business inventories until the item is completed and delivered to the Government.”

In other words, early-stage production associated with long procurement contracts is recorded at an aggregate level in inventories until the delayed payment-on-delivery. The value of completed and paid contract work is then moved from inventories to G. We can observe the delay between defense contract awards and payment directly from our data.

Finally, in the Online Appendix E, we distinguish between the response of defense contractors to actual contract awards and the anticipation of future contract awards. Firms may increase their inventories in preparation for future awards,

²¹Many thanks to Gillian Brunet for redirecting us to that document.

whether to minimize adjustment costs or reduce delivery times (i.e., production smoothing). While we identify evidence of the latter, it is of lesser importance compared to the response to actual contract awards.

4 Threats to Identification

In this section, we argue that government spending shocks identified using standard VAR methods - recursive shocks - do not capture early-stage production associated with newly awarded federal procurement contracts during a military build-up.

In most macroeconomic studies, researchers are interested in the economic effects of government spending from the moment funds are contractually obligated and contractors begin reacting. In this setting, the actual transfer of cash is not the main focus. Given our results from the previous section, we expect that recursive shocks are capturing transfers of cash rather than obligation of funds. We provide an illustrative example of this problem around the outbreak of the Korean War.

Korean War In the summer of 1950 (Q3), we observe a large defense news shock associated with the outbreak of the Korean War (bottom-left panel of Figure 6). However, the VAR-identified shock to NIPA’s measure of G does not spike until 2-3 quarters later (bottom-middle panel). Unsurprisingly, G has a slow positive response (top-left panel). On the other hand, defense procurement obligations, constructed using our obligation data, react almost immediately to the shock (top-middle panel). In other words, the DoD begins awarding defense procurement contracts at the onset of the war. We also observe quick increases in inventories starting from 1950Q4 (top-right panel) as well as in defense production, proxied by average hours of production workers in the aircraft industry (bottom-right panel).

Therefore, the recursive shocks fail to capture the initial production of defense industries in response to newly granted contracts.

Shock Predicatability We carry out Granger-Causality test on the full sample, spanning from 1947Q1 to 2015Q4, to study our ability to forecast government spending shocks. Table 1 summarizes the results.

The top panel of Table 1 shows that shocks to defense procurement obligations predict recursively identified government spending shocks. On the other hand, the second panel shows a much weaker relationship in the other direction, especially when you omit the Korean War from the sample. Our results are consistent with Ramey (2011), who shows that war dates Granger-cause recursive shocks to G but not the other way around.

The bottom panel shows that shocks to defense procurement obligations do not predict defense news shocks. This indicates that early economic effects of newly

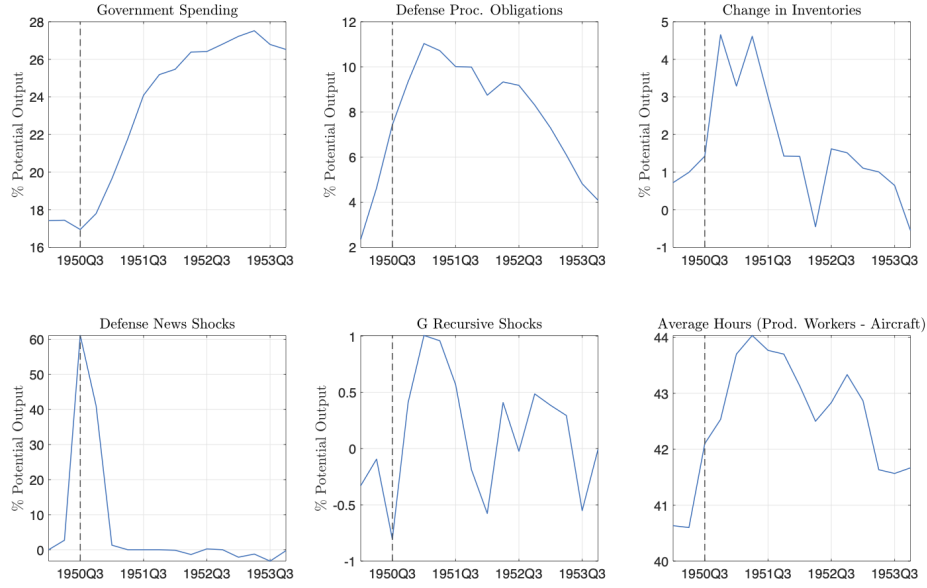


Figure 6: **Illustrative Example: Response to the Korean War**

<i>Predicted</i>	<i>Predictor</i>	<i>F</i>	<i>Pvalue</i>	<i>Korea</i>
Recursive Shocks	Obligation Shocks	15.62	0.0%	Yes
Recursive Shocks	Obligation Shocks	5.13	0.0%	No
Obligation Shocks	Recursive Shocks	2.17	3.0%	Yes
Obligation Shocks	Recursive Shocks	1.66	10.9%	No
Defense News Shocks	Obligation Shocks	0.42	91.0%	No
Defense News Shocks	Obligation Shocks	0.33	95.3%	Yes

Table 1: **Predictability of Recursive Shocks via Obligations:** *Granger Causality test is a Wald test on the 8 lags of the predictor while controlling for 4 lags of the predicted variable.*

awarded contracts, which are missed by recursive shocks to G , are captured using defense news shocks.

Consequence for Fiscal Multipliers We show that the difference in fiscal multipliers estimated using the two methods is almost entirely explained by a difference in capturing the early response of inventories.

Following Ramey (2016), we estimate cumulative fiscal multipliers using LP-IV

with both recursive shocks to G and narratively identified defense news shocks. We use the following estimation equation:²²

$$\sum_{h=0}^H y_{t+h} = \gamma_H + \mathcal{M}(H) \cdot \underbrace{\sum_{h=0}^H g_{t+h}}_{\text{instrument with Shock}_t} + \text{lags}_t + \varepsilon_{t+h}, \quad (3)$$

where $\mathcal{M}(H)$ is the cumulative government spending multiplier at horizon H , y_t is GDP at time t , g_t is government spending at time t , Shock_t is an exogenous instrument for cumulative government spending, and lags_t contains lagged values of the shock, government spending, consumption, investment, hours worked and 3 months T-Bill rate. We rescale nominal variables by potential output. The narrative method sets Shock_t equal to the defense news shock variable, while the recursive method is equivalent to setting Shock_t equal to G .

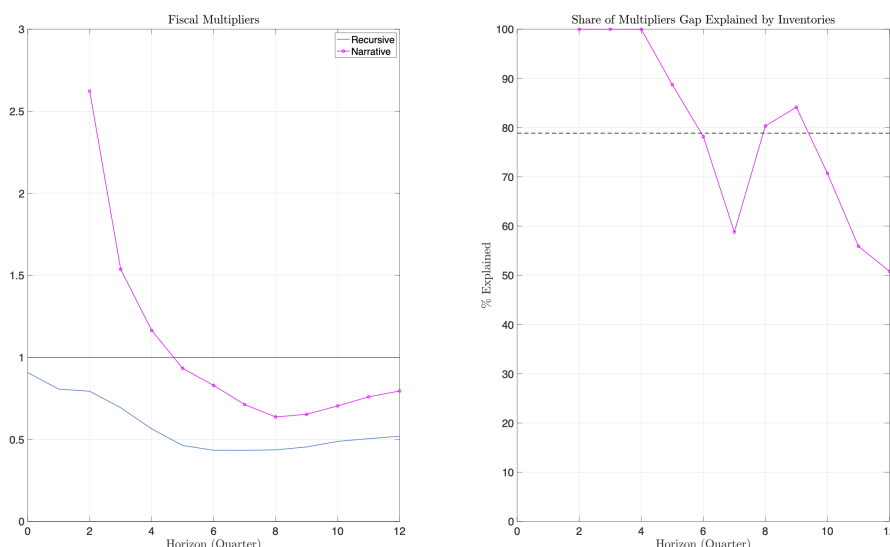


Figure 7: Cumulative Fiscal Multipliers and Multiplier-Gap. *Sample goes from 1947Q1 to 2015Q4. Left-panels: cumulative fiscal multipliers (point estimates). Right Panels: share of multipliers-gap explained by the differential response of inventories (dashed black line is the average of the response). Share is capped at 100% and is calculated only when the multiplier gap is finite and positive.*

The left panel of Figure 7 shows that the recursive method delivers uniformly lower point estimates of the multiplier relative to the narrative method. To investigate how much of the difference in multipliers (*multiplier gap*) can be explained

²²More technical details on LP-IV are available in Stock and Watson (2018).

by a differential response in inventories, we propose the following measure:

$$\frac{\hat{\mathcal{M}}(H)_{Inventory}^{Narrative} - \hat{\mathcal{M}}(H)_{Inventory}^{Recursive}}{\hat{\mathcal{M}}(H)_{GDP}^{Narrative} - \hat{\mathcal{M}}(H)_{GDP}^{Recursive}}$$

which computes the proportion of the multiplier gap (denominator) that is explained by differences in the inventory multiplier (numerator). More specifically, the inventory multiplier is estimated by replacing y_t with inventories at time t in equation (3). Figure 7 shows that on average, 80% of the multiplier gap can be explained by the differential response of inventories as captured by the shocks. In the Online Appendix F, we show that this result is robust to the exclusion of the Korean War.

To summarize, the failure of the recursive method to fully capture defense production, which is reflected in inventories, results in underestimated multipliers. This is due to G's delayed tracking of defense production during military build-ups, leading to shocks in G being inaccurately identified. The Granger-Causality test results support this. This finding raises a major challenge in identifying government spending shocks through the recursive method.

5 Conclusion

The National Income and Product Accounts (NIPA) tracks production by monitoring changes in inventories. During a military buildup, defense industries increase production in response to new procurement contracts, which results in a rise in inventories and GDP. Once the production of defense items, such as aircraft and missiles, is finished, they are delivered to the government and the contractors receive payment. This causes inventories to decrease and government spending (G) to increase as payments are recorded. The onset of a war results in GDP responding faster than G due to (1) accounting procedures and (2) the time required for production in the defense sector.

The findings of our study support the idea that the early rise in GDP relative to G after a defense news shock, as described by Ramey (2011), can be attributed to an increase in inventories. Our analysis of manufacturing sector data reveals that defense industries are responsible for the rise in inventories. By creating new quarterly time series that track defense procurement contract awards and payments, we were able to observe a 2-3 quarter gap between the two. This delay provides evidence for the existence of a time-to-build period for defense production.

Our study has three significant implications. Firstly, it provides a straightforward explanation for the early reaction of GDP compared to G in response to a defense news shock, which was previously believed to be due to households' Ricardian behavior (negative wealth effect). Secondly, the results indicate that shocks

to defense procurement obligations predict VAR shocks to government spending, which is a major issue in the identification of macroeconomic shocks (as noted by Ramey (2016)). Lastly, the delay in these shocks leads to an under-estimation of the response of inventories and, thus, of the fiscal multiplier.

Our findings highlight the significance of the anticipation effect of G , as reflected in the increase in inventories. Policymakers and economists should take into consideration the early response when evaluating the impact of government purchases on the economy.

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