The End of the Great Depression 1939-41:
Fiscal Multipliers, Capacity Constraints, and Policy Contributions

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ABSTRACT

The fiscal multiplier literature has encountered a conundrum. Recent papers agree that there is no significant information in data beyond 1955, and so the estimated multipliers depend on the inclusion of data from World War II and the Korean War. But those wartime multipliers based on 1942-45 and 1950-53 are severely biased downward due to capacity constraints and production prohibitions and thus cannot be applied to peacetime situations such as 2009-12 when capacity constraints were absent. This paper is the first to provide a solution to the conundrum by examining fiscal multipliers in the peacetime American economy of 1940-41, two years when the GDP share of government spending doubled within a few quarters yet, at least on the surface, the peacetime economy showed signs of low utilization.

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1. Introduction

The worldwide economic crisis since 2008 has revived two longstanding controversies in macroeconomics, the size of fiscal multipliers and the relative role of monetary and fiscal policy as sources of recovery from the Great Depression. This paper advances the understanding of both topics. The recent debate over the 2009-12 fiscal stimulus has created an outpouring of papers that attempt to estimate fiscal multipliers both from econometric specifications and from calibrations of theoretical models.

The recent empirical literature on fiscal multipliers has identified but not solved a basic conundrum. Hall (2009), Barro-Redlick (2011), and Ramey (2011a) find that the only time intervals that yield statistically significant fiscal multipliers are those that include the years of World War II (hereafter WWII) and the Korean War. But these wartime multipliers, which are generally estimated to be below 1.0, do not apply to peacetime situations like 2009-12 with ample excess capacity. The observed sharp increases in government spending in those two wars crowded out private spending not just through capacity constraints, but starting in 1942 through outright production prohibitions and rationing. Indeed, explicit limitations on civilian production began as early as June 1941.

This paper resolves the conundrum by estimating fiscal multipliers for 1940-41, years that qualify as peacetime but that witnessed a very sharp increase in military spending. During the six quarters 1940:Q2 to 1941:Q4 the share of total government spending in GDP doubled from 13 to 26 percent, and we build a quarterly model and obtain multiplier estimates, while previous research could not, by developing a new quarterly data set that extends from 1919 to 1947. Our central multiplier estimate refers to the period through mid-1941 and has a value of 2.5 when averaged across two independent quarterly data sets.[1] We show that the multiplier declines sharply when the last half of 1941 is included, and we provide new evidence that explains why – the U.S. economy confronted one set of binding capacity constraints after another as the year 1941 evolved. These supply restrictions that caused higher government spending to reduce private spending in the second half of 1941 are quite irrelevant to assessing the multiplier during peacetime situations exhibiting excess capacity such as 2009-12.

By choosing 1940-41 for our empirical work we complement the recent papers by Hall (2009) and Christiano, Eichenbaum, and Rebelo (2011), both of which study economies in which the short-term interest rate is fixed at its zero lower bound. Hall estimates a multiplier around 1.7 when the interest rate is held fixed, while Christiano *et al.* arrive at even higher numbers, in contrast to multipliers estimated to be below 1.0 by Barro-Redlick and Ramey.[2] The Hall and

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1. Ramey has independently developed a quarterly data set for 1939-47 but provides multiplier estimates in her paper (2011a) using her new data only for sample periods that include the war years 1942-45. Our central multiplier estimate of 2.5 is based on the average of the two data sets, ours for 1919-47 and Ramey's for 1939-47 linked to ours before 1939.

2. The Hall (2009) paper provides an econometric analysis of government spending multipliers for numerous sample periods, most of which include the years of WWII. His estimated multipliers are in the range of 0.7 to 1.0, similar to those of Ramey (2011a) and Barro-Redlick (2011). Hall's suggestion that the

Christiano *et al.* analysis is highly relevant to 1940-41, which is a notable earlier example of the zero lower bound in action; the U.S. Treasury Bill rate was in the narrow range of 0.05 and 0.13 percent during the four years 1938-41.[3]

The two years of 1940-41 meet the criterion of a sharp upward movement in government spending; this period would seem to be the ideal episode to witness the response of GDP and of private spending to an increase in government spending, because there appears at least on the surface to have been excess capacity as demonstrated by the 9.9 percent official unemployment rate for the year 1941.[4] This paper shows that the high unemployment rate of 1941 disguises numerous capacity shortages that in the last half of 1941 significantly bias down estimates of the government spending multiplier. Using the contemporary print media, we first document that the American economy went to war starting in June 1940, 18 months before Pearl Harbor, in contrast to the widespread assumption of numerous authors whom we cite that Pearl Harbor marked the beginning of the war for the U. S. economy.

Lessons from the 1939-41 period help to inform debates about fiscal multipliers in 2009-12. What is being held constant across differing estimates of fiscal multipliers? Is the crucial background variable determining the size of fiscal multipliers the level of interest rates, as implied by the current "zero lower bound" fiscal policy literature, or the extent of underutilized capacity? To what extent did the U.S. economy in 1939-41, prior to the outbreak of war, represent a valid analogy to the U.S. economy of 2009-12?

Higher government spending after 1940 in WWII and after 1950 in the Korean War boosted household incomes, but especially in WWII the households could not use their higher income to purchase the goods they wanted to buy. The personal saving rate during 1942-44 averaged an extraordinarily high 25.2 percent. Another important reason that multipliers estimated from 1942-45 or 1950-53 are irrelevant to the conditions of 2009-12 is that taxes were raised in 1940-41 and 1950-51[5] By way of contrast in 2009-12 tax rates were cut, not increased. Thus government purchases multipliers estimated from the 1940-41 period are biased downward (i.e., they are partly balanced budget multipliers) relative to pure government purchases multipliers that assume constant tax rates.

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multiplier has a higher value of 1.7 in a zero lower bound regime emerges from the analysis of his theoretical model, not from econometric estimation.

3. HSUS series Cj1232.

4. Parker (2011) provides the best available survey of the reasons why fiscal multipliers differ across varying macroeconomic environments, e.g., low-utilization recessions and high-utilization booms. However, Parker does not examine data for the WWII period and hence we do not discuss further his interesting conclusions.

5. Nominal Federal current *receipts* increased by 56 percent between 1950:Q1 and 1951:Q1 while *expenditures* actually decreased by 5 percent over the same interval. The Federal budget balance shifted for -3.0 percent of GDP in 1950:Q1 to +5.3 percent in 1951:Q1. (NIPA Tables 3.2 and 1.1.5)

The analysis of fiscal multipliers is based on a newly developed quarterly data set for the central macroeconomic variables of the interwar and wartime period, 1919-51. Measures are developed of the ratio of actual to potential GDP indicating that the GDP gap closed from -22 percent in early 1939 to +1 percent in the weeks before the Pearl Harbor attacks. A VAR model is used to estimate fiscal multipliers with substantial attention to robustness checks.

The same set of new quarterly data and tools used here to estimate the fiscal multiplier can also be used to address an earlier debate over the relative role of monetary and fiscal policy as sources of the end of the Great Depression. Candidates for this list explaining the end, each with strong supporting voices in the literature, include monetary policy, military spending, and the economy's natural mean-reverting and recuperative properties. Some of the prominent policymakers of the past half-decade made central contributions to this earlier literature, including Christina Romer, Lawrence Summers, and Ben Bernanke.

The paper is organized into eight parts including the introduction. Part 2 introduces the new data for quarterly components of real GDP and potential real GDP and describes important aspects of interwar macroeconomics with charts based on the new data. Part 3 reviews contemporary media that demonstrate the impact of the fiscal expansion on the economy of 1940-41, and it also provides substantial evidence of supply constraints, i.e., shortages, that became worse as 1941 progressed. Part 4 then reviews relevant aspects of the previous academic literature both on fiscal multipliers and on policy contributions. Part 5 contains the paper's VAR specification and Part 6 the fiscal multipliers. Part 7 presents the verdict on the relative role of monetary and fiscal policy based on the same VAR model, showing that the contribution of the two types of policy shifted from monetary to fiscal as the years 1940 and 1941 progressed. Part 8 concludes.

2. New Data for Components of GDP and for Potential Real GDP: Methods and Findings

This paper makes three new contributions to the development of the required quarterly data. First, we avoid the non-additivity problem of the chain-weighted NIPA data by measuring all real spending variables in 1937 dollars, not 2005 dollars and show that fiscal multipliers are biased downwards when the 2005-based data are used as in all previous empirical studies. Second, we create a new interpolated quarterly data set for each of the components of real GDP and the GDP deflator over the period 1919-51. Third, we develop a new series for potential real GDP, i.e., the economy's capacity to produce under normal peacetime conditions. We demonstrate that standard statistical techniques are inherently incapable of creating a potential real GDP series for the 1929-50 years of depression and war, and instead we propose a sensible alternative that produces a measure of the GDP gap consistent with an independent raw data series, the employment-to-population ratio.

2.1 The Use of 1937 Rather Than 2005 as the Base Year

A basic principle of chain-weighted quantity indexes for aggregates such as real GDP is that the components (e.g., government spending and consumption) do not add up to total real GDP, and this discrepancy becomes larger the further one goes back in time relative to the base year, currently 2005. We show in the Data Appendix in Figure A-1 that in the critical year of 1941 the ratio of real government spending to real GDP (hereafter G/Y) is overstated by 40 percent in 2005 prices compared to the alternative we use, 1937 prices. Accordingly, any study that uses 2005 prices in an empirical study of government multipliers in WWII inevitably produces estimated multipliers that are biased downward.[6] On average, the deflator used for *G* has risen faster than that used for real GDP; therefore, when the base year is changed from $1937 to $2005, *G* as a percentage of real GDP during the 1919-1947 period becomes larger.

2.2 The New Set of Quarterly Interpolated Data

The full details of the data interpolation are provided in the Data Appendix, including the source of the annual data for 1919-28 before the annual NIPA data begin, and a description of the monthly interpolators.[7] Figure A-2 in the Data Appendix compares the newly interpolated dataset to the independently created quarterly dataset of Ramey (2011a) for the overlap period 1939:Q1-1941:Q4. In particular, our series and the Ramey series both indicate that the ratio of government spending to potential real GDP (G/Y^N) more than doubled between 1940:Q2 and 1941:Q4.[8] They also show that non-government spending components of GDP relative to potential real GDP (N/Y^N) declined in the last half of 1941, a critical fact demonstrating that any understanding of the 1941 economy requires the use of quarterly data.

2.3 Potential Real GDP and the Limitations of Statistical Trends for the Interwar Period

The distinguishing features of the Great Depression are that the unemployment rate remained so high for so long (whether measured by the standard Lebergott series or the more plausible Darby (1976) series), and the corollary that actual output remained below potential output for so long. Because of flaws in the unemployment rate as a measure of cyclical utilization (see among others Coen (1973)), and because consistent monthly and quarterly employment data are not available during the interwar period, we prefer to limit our attention to utilization as measured by the ratio of actual to potential quarterly real GDP. But what is potential real GDP?

In order to separate trends from cycles, recent empirical papers in macroeconomics have adopted the band-pass filter, which eliminates certain frequencies. For instance, it has become

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6. See NIPA Table 1.1.6 for components of real GDP in $2005 and Table 1.1.6A for the same components in $1937. Further details are provided in the Data Appendix.

7. The new data on the components of real GDP are available both monthly and quarterly, but only quarterly data are used in this paper. All data used in this paper have been available for the past several years at faculty-web.at.northwestern.edu/economics/Gordon/

8. Throughout this paper government spending *(G)* includes Federal, State, and Local expenditures on goods and services.

standard in postwar empirical studies to create a band-pass filtered estimate of trend GDP by cutting out frequencies corresponding to periodicities below 32 quarters. The implausibility of the application of the band-pass (BP) filter to interwar data with this standard filtering of periodicities is exhibited in Figures 1 and 2.[9] The solid line in Figure 1 displays the level of actual real GDP (as always in $1937), which more than triples from the trough of the Great Depression to the peak of WWII production. The BP filter estimate of the real GDP trend also triples, doing little more than mimicking the main fluctuations of actual real GDP. We note in particular that the BP estimate of trend output declines between 1927 and 1932 by 25 percent, which is implausible in light of ongoing increases in the working-age population and the robust growth of output per person during the 1930s decade.

We choose instead to estimate potential real GDP as an exponential trend that extends from the late 1920s to 1950, spanning the volatility of the 1930s and 1940s, as shown in Figure 1. Our chosen years in which the exponential trend is forced to equal actual real GDP include 1913, 1924, 1928, 1950 and 1954.[10] The bottom frame of Figure 1 compares the roughly constant growth rate inherent in the exponential trend with the implausibly wild swings in the growth rate of the BP filtered trend from 1913 to 1954. Most notably, the BP trend output growth declines from a peak of 9.2 percent per year in 1924:Q3 to -7.8 percent per year in 1930:Q2.

Independent evidence supports the plausibility of the exponential trend measure of potential real GDP during the interwar period. Annual data on employment and population for this period can be compared with the alternative BP and exponential trend estimates of the GDP gap. Figure 2 displays the BP-filtered and exponential trend-based annualized output gaps.[11] The employment-population ratio can be examined directly without any need for detrending, as that ratio was stationary between 1900 and 1972. We take the raw data for the employment-population ratio, express it as an index number with 1929=100, and then calculate the percent log of that index.

Figure 2 plots 2.5 times the log index, reflecting the postwar fact that the employment-population ratio fluctuates with an elasticity to the output gap of about 0.4. As is evident in Figure 2 the exponential trend version of the log output ratio tracks the employment-population ratio very closely while the BP-filtered output ratio does not. In fact, a regression of the employment-population ratio on a constant, current and one lag of the exponential trend output gap yields an adjusted R^2 of 86 percent, while that same regression using the BP-filtered output

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9. We are grateful to Giorgio Primiceri for carrying out the BP filter estimation for our real GDP data between 1919-51. His technique follows standard practice of excluding all frequencies below 32 quarters.
10. We choose *not* to select 1941 as a benchmark year, in order not to prejudge a central issue for this paper, the extent of excess demand or supply during 1941.
11. The output gap is defined as the log percent ratio of actual to trend real GDP

gap has an adjusted R^2 of just 2 percent.[12] The decline in the employment-population ratio is a fact in the raw data, with which our output gap is highly correlated.

2.4 Behavior of the Components of real GDP and Other Explanatory Variables

The exponential trend version of potential real GDP and the percentage log output gap are used for the remainder of this paper as an organizational and conceptual device to interpret the end of the Great Depression. In this section we examine the results of the data interpolation, with components of real GDP expressed as a percentage ratio of potential real GDP (Y^N). The top frame of Figure 3 decomposes the fluctuations of the log output ratio into its two major components, government spending (G), and non-government (i.e., private) spending (N), each expressed as a ratio to potential GDP (e.g., G/Y^N). These data provide important insights about the process by which increased military expenditure crowded out private spending during WWII and even in 1941, prior to Pearl Harbor. The top frame of Figure 3 shows that the G/Y^N ratio more than doubled before Pearl Harbor (from 11.5 percent in 1940:Q2 to 25.6 percent in 1941:Q4).

To what extent was the non-government spending ratio (N/Y^N) depressed or stimulated by the government spending explosion over the same six-quarter period? The modern fiscal multiplier literature emphasizes that fiscal multipliers determined to be below 1.0 imply that private spending falls in response to a fiscal stimulus. Did N decline in 1940-41? The N/Y^N ratio was at 70.8 in 1940:Q2, rose by 5.6 points to a peak of 76.4 percent in 1941:Q3, and then dropped sharply to 74.9 percent in 1941:Q4. This decline could be evidence of crowding out via physical constraints on the production of some consumer and investment goods as a result of pressure on available industrial capacity, and of the counting of new plant and equipment investment for rearmament as government spending rather than private investment.

In addition to its new estimates of fiscal multipliers, this paper also examines the contribution of monetary policy variables to ending the Depression. The bottom frame of Figure 3 displays the value of nominal $M1$ divided by potential real GDP, showing that in relation to the right vertical scale that the money supply ratio fell from an initial value of 36.9 percent in 1928:Q1 to a trough of 20.4 percent in 1933:Q3. The same ratio was 26.6 percent in 1939:Q1, 29.3 percent in 1940:Q2, and 33.2 percent in 1941:Q4, still well below the 1928 value. This time path of the money supply, which exhibited relatively steady growth during 1939-41, points to the fiscal expansion as the reason why the economy expanded so slowly up to 1940:Q2 and so rapidly in the subsequent six quarters up to Pearl Harbor.

The bottom frame of Figure 3 also displays the money multiplier and the Fed nominal discount rate. The nominal interest rate increased from 3.5 percent in 1927:Q3 to 5.6 percent in 1929:Q3, and then it declined to a trough of 1.6 percent in 1931:Q3. The discount rate was

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12. In the regression of the employment-population ratio on the current output gap and one lag, the sum of coefficients for the exponential version is 0.40 with a t-ratio of 7.6. With the band-pass filter the sum of coefficients is 0.28 with a t-ratio of 1.3.

absolutely fixed at 1.0 percent between 1939:Q1 and 1941:Q4 (and beyond), thus creating the analogy of the fixed interest rate and avoidance of interest-rate crowding out in the zero-lower-bound environment of the fiscal expansions of both 1940-41 and 2009-12.[13]

The money multiplier was particularly endogenous in the late 1930s, the era of "pushing on a string." Banks held massive amounts of excess reserves, and gold inflows that increased the monetary base did not directly translate into increases in *M1*. From its peak in 1937:Q2 of 3.25, the money multiplier drifted steadily lower until its trough of 2.35 reached equally in 1940:Q3 and 1940:Q4, followed by a modest increase to 2.74 in 1941:Q4. The money multiplier provides evidence *against* the potency of monetary expansion, since its decline in 1938-40 offset much of the explosion of the monetary base due to the inflow of gold from Europe.

3. Contemporary Evidence on the Effects of Fiscal Expansion, 1940-41

Much of the literature on the end of the Great Depression, including Romer (1992), De Long and Summers (1988), and others, assumes that WWII began for the American economy on December 7, 1941, with the Pearl Harbor attack. As cited below in section 4.2, De Long and Summers (1998) state emphatically that "It is hard to attribute any of the pre-1942 catch-up of the economy to the war. Neither the federal government's fiscal deficit nor the surplus on trade account became an appreciable share of national product before Pearl Harbor." Likewise Romer states "Fiscal policy, in contrast, contributed almost nothing to the recovery before 1942."

These remarks are contradicted by the historical record. Section 3.1 documents the process by which the fiscal stimulus in 1940-41 occurred, with many examples of the spillover (i.e., multiplier effects) into the private sector. Then we turn in section 3.2 to evidence relevant to the emergence of capacity constraints in the American economy during 1941 that steadily reduced the government spending multiplier as that year proceeded.

3.1 The Effect of the Government Stimulus on People and Firms, 1940-41

The revival of the American economy due to the explosion of Federal defense expenditures began in 1940:Q2, the quarter in which France fell.[14] To calibrate the actual data for the economy of 1940-41, we note that nominal GDP was $101 billion in 1940, and so each nominal billion of military spending translates into one percent of nominal GDP. Ramey (2011a) documents from her *Business Week (BW)* reading the hasty upward revisions during the

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13. As noted above, the Treasury Bill rate was lower than the discount rate and hovered around 0.1 percent during 1938-41.

14. A detailed chronology "Highlights of U.S. Government Economic Involvement Before Pearl Harbor" is presented in Vatter (1985, Chart 1.2, pp. 8-10).

month of June 1940, of defense appropriations for the fiscal year starting on July 1, 1940.[15] On August 19, 1940, Congress passed another supplemental appropriations bill, boosting defense spending to 10 percent of GDP. (*New York Times*, August 20, 1940). Nominal Federal government defense expenditures actually reached $14.3 billion in 1941, up from $2.5 billion in 1940 and $1.5 billion in 1939 (NIPA Table 1.1.5).

On June 13, 1940, the *New York Times* reported that "22 new warships were signed for in an hour, topped by two new battleships." As early as June 22, 1940, *Business Week* could write:

> National Defense has become the dominant economic and social force in the United States today. It has created a new industry – armament – the ramifications of which will reach into every phase of our business life, and bring increased employment, higher payrolls, widening demands for machinery, and the construction of new factories.

Even during the winter of 1939-40 the American economy was starting to revive in response to export demand for armaments. Monthly exports in January 1940 were up 70 percent over the previous January. An author asked "Is the economy about to catch on fire?"[16] In Pittsburgh in December 1939, a woman was startled to see smoke billowing out behind her house; she never knew that there was a steel mill there which was fired up in late 1939 for the first time in ten years (Herman, p. 85).

The date of accelerated American involvement can be traced to a little-known decision by President Roosevelt in early June 1940 to strip the military arsenals of the United States in order to provide weapons that might allow the British to defend their island against the acute near-term threat of a German invasion; these supplies were assembled in early June and arrived in Britain by the end of that month. The stripping of the arsenals required immediate replenishment; orders went out to increase production of every type of military weapon that had been removed from the arsenals, including 500,000 rifles and 76,000 machine guns (Goodwin, 1994, p. 66). The first meeting of the National Defense Advisory Commission, chaired by William Knudsen (recently the CEO of General Motors) occurred on June 12. By October 1940, Knudsen had signed contracts worth 9 percent of GDP (Herman, pp. 102-107).

There was intense pressure from the top ranks of the Roosevelt Administration to supply enough military equipment to keep Britain in the war. In the first half of 1940 American aviation companies found themselves swamped with orders from Britain and France. As the British neared the end of their ability to pay for military goods, Roosevelt convinced Congress to provide the fruits of the Arsenal of Democracy as one gigantic gift under the misleading

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15. All quotes in this section from *Business Week* come from Ramey's detailed unpublished notes on her *Business Week* research. All other citations here, including those to individual books and to the *New York Times* and *Fortune,* represent original research for this paper.

16. "The Best Bargain We Can Jolly Well Make," *Fortune,* April 1940, p. 68 ff.

name Lend-Lease. After the signing of the legislation on March 11, 1941, "the steady stream of orders for British war materials was about to become a flood" (Herman, p. 137).

U.S. industry began its conversion to defense production in the summer of 1940, fully 15 minths before the Pearl Harbor date cited by DeLong, Summers, and Romer. Continental Motors, a nearly defunct automobile company with a large unused factory, signed a contract in September 1940, to redesign a 440-horsepower aircraft engine to fit into a tank, and the refitting of its vacant factory was entirely paid for by the Federal government. Chrysler became the main maker of the tank itself and began mass production in March 1941 in a new plant designed and completed in just seven months (Herman, pp. 97-100).

Another stimulus to aggregate demand was the passage in September 1940 of the Selective Service Act that instituted the military draft. Military personnel on active duty increased from 458,000 on June 30, 1940 to 1,801,000 on June 30, 1941 (Vatter, 1985, p. 8). The induction of a million draftees required the hasty construction of army training camps, and this in turn created 400,000 construction jobs, more than one percent of total 1940 employment.[17] The improvisation in the rapid building of these camps was noted in contemporary accounts, including a camp manager who solved the problem of a shortage of heating boilers by renting four railroad locomotives which were hitched up to the existing heating pipes. "All over the country, the army was crying for boilers, furnaces, heaters, and laundry machines."[18]

An advertisement for the Bell System in *Fortune* magazine (July 1941, p. 152) conveys the reality of demands for manufactured products created by the construction of all these Army training camps. "Every big military training camp is a city in itself. Like any city, it needs telephones. . . ." These sales of telephone equipment by the Bell System for military training camps was treated in the national income accounts as government spending, not private investment, and this factor alone would reduce government spending multipliers for 1941 compared to any peacetime 2009-12 analogy.

Simultaneous with the building of the army training camps was an explosion of demand for both naval vessels and merchant ships. ". . . between the fall of France and the fall of Greece, the U.S. maritime *paper* program had swelled suddenly, like a gargantuan blowfish. . . . First there was the matter of new naval construction . . . for 483 new ocean-going ships." By late September 1940, a Labor Department spokesman reported to Congress that spending just for naval vessels and aircraft would create 1.5 million man-years of work in the fiscal year beginning on July 1, 1940, equivalent to 4 percent of 1940 employment.[19]

A legendary aspect of WWII production was the building of the Liberty ships in the Kaiser shipyards in Richmond, California. Generations of economists have marveled at the

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17. Total employment in 1940, including the government sector, was 37.9 million (NIPA Table 6.5A).
18. "Camps for 1,418,000," *Fortune,* May 1941, p. 57ff.
19. "1,456,285 Man-Years Set in Ship and Plane Work," *New York Times,* September 24, 1940.

feats of increased efficiency achieved in these shipyards through "learning by doing."[20] Yet few of these observers know that the Kaiser Richmond shipyards were constructed and fully operational well before the Pearl Harbor attacks. Construction of the yards began on December 28, 1940, when a bulldozer sank into the impenetrable mud flats. The first keel was laid on April 14, 1941, less than four months later. Ultimately that shipyard built 747 Liberty ships.[21] While the initial April 1941 keel took eight months to complete and launch, "learning by doing" proceeded rapidly and a Liberty ship was actually built and launched in November 1942 in merely five days (Herman pp. 131,137, 188-91).

The literature reviewed in Part 4 by Summers, De Long, Romer, and others dates the military-fueled economic expansion as starting with the Pearl Harbor attack of December 7, 1941. This contrasts starkly with the profound sense of national emergency evident in contemporary media. *Fortune* magazine, normally a beacon of capitalism and economic freedom, published a startling editorial in July 1941 ("Prelude to Total War", p. 35):

> Our first act must be to give up the very basis of our civilization. Our prices must be controlled, our economic incentives must be taxed, our materials must be subjected to priorities, our property and our scientific inventions must be put at the disposal of the state. We surrender these liberties temporarily, but surrender them we must.

3.2 Was the American Economy Close to Operating at Full Capacity in 1941?

A critical aspect of twentieth century U.S. economic history depends on the rate of utilization of a single year, 1941. This utilization rate matters not just for the topics of this paper, but also for any assessment of productivity growth and technical progress in the decade of the 1930s in contrast to the 1940s. Using our exponential trend version of potential real GDP together with the average of our newly interpolated data set and that of Ramey for 1939-41, the percent log output gap was minus -3.1 percent in 1941:Q3 and +0.3 percent in 1941:Q4, meaning that the economy recovered its full potential level of output roughly midway through that quarter, or a few weeks *before* the Pearl Harbor attacks.

But what if the exponential trend is wrong? It is quite plausible that potential GDP grew more slowly than the 1928-50 average during the 1930s, due to a very low level of private investment during that decade. If the trend of potential GDP growth was slower in 1928-41 than the average growth rate for 1928-50, this implies that the trend was faster in 1941-50. This in turn implies that the log percent output ratio was higher throughout 1941, resulting in a

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20. The basic Liberty ship data were compiled and presented in Searle (1945). Lucas (1991) reproduced some of Searle's charts. The theory of "learning by doing" was developed by Arrow (1962), but he did not cite the Liberty ship example in his seminal paper.

21. Liberty ships were also built in other shipyards, and a total of 2,446 such ships were built during the war.

greater extent of capacity constraints in 1941 than in our data set. What evidence is available about the utilization rate of the U.S. economy in 1941?

The official BLS unemployment rate declined from 14.6 percent in 1940 to 9.9 percent in 1941. That point of departure makes 1941 look like a year of relatively low utilization. However, Darby (1976) has criticized the official estimate, because it omits those employed by government relief programs. Darby's 1941 unemployment estimate, treating the government workers as employed, is 6.0 percent rather than 9.9 percent (Darby 1976, Table 3, p. 8). Whether these workers are counted as unemployed or not, they were clearly available as part of the potential labor force and eagerly took higher-paying private-sector jobs as the expansion accelerated during 1940-41.

There is less uncertainty that much of the manufacturing sector was operating at or above capacity during 1941. While it is hard to match up estimates of production and capacity for most products, it is possible to do so for steel, clearly a critical material in the manufacture of armaments. The capacity utilization ratio of steel and steel ingots reached as low as 20 percent in 1932, recovered to 72 percent in 1937, hit another low of 39.6 percent in 1938, and then soared to 82.1 percent in 1940 and 97.3 percent in 1941. Steel supply was as tight in 1941 as in any subsequent year of WWII.[22] "By the second quarter of 1941, expansion of the defense program and of the level of civilian demand to new high levels brought ingot capacity utilization to overfull capacity rates" (Novick *et al.* 1949). "Official Washington and a growing number of private economic commentators reversed gears and began to sound the alarm about inadequate steel capacity in early 1941" (Vatter, 1985, p. 27).

The soaring demand for aircraft led to supply constraints in the aluminum industry, and the inadequacy of supply to civilian industry was discussed with specifics:

> Warplanes are almost entirely aluminum. So long as all these are being built, civilian fabricators must be content with the aluminum that is left. Trains, kettles, auto pistons, zippers, cables, dragline booms, and outboard motors stand on the aluminum bread line, grateful for favors received.[23]

Unfortunately it is not possible to match capacity with production estimates for any important industry besides steel in the 1940-41 period, so we turn now to anecdotal evidence.

It was already evident in May 1941 that automobile production would soon be subject to production limitations due to raw material constraints, and a 20 percent cutback in auto production was announced in that month. "Don't be taken aback if production of 1942-model passenger cars is cut 50 percent, or even more, instead of the announced 20 percent . . . . new

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22. *Historical Statistics of the United States Millennial Edition Online,* steel production series Dd399 divided by steel production capacity series Dd656. Utilization rates in the four years 1941-44 were respectively 97.3, 96.8, 98.1, and 95.5.

23. "Aluminum and the Emergency," *Fortune,* May 1941, pp. 66ff.

cars are selling faster than the auto companies can make them" (Ramey from *BW*, May 31, 1941, p. 13). Despite the high demand for automobiles, spending on consumer durables actually fell in the third and fourth quarters of 1941 due to mandated production cutbacks (Vatter, 1985, p. 12; see also Ramey 2011a, data supplement). [24]

The reasons for the decline in the consumption and investment components of GDP in the second half of 1941 are well documented, albeit not recognized by the existing economic literature on the end of the Great Depression. In the fall of 1941 the rearmament administrators ordered that auto production be cut by half. In October nonessential construction was ordered halted in order to make materials available for defense construction.[25]

As early as April 1940 a capacity ceiling had been reached in the machine tool industry: Tearing along close to capacity, the toolmakers are said to be so wrought up under the strain of trying to fill foreign and domestic commitments that new customers are almost afraid to appear with new orders, lest they be thrown out of the office.[26]

By January 1941, the machine tool factories were so swamped by demand that they ramped up operations to 24 hours per day, 7 days per week (Broehl, pp. 170-71). By May 1941 the machine tool shortage had become acute. A *Fortune* writer traveled to tiny Springfield, Vermont, population 5,000, where the Jones & Lanson company accounted for fully five percent of the total national machine tool output. The two hotels in town were "crammed" with "representatives of American and foreign firms nervous about their machine-tool priorities." Company representatives traced the boom in demand to a year earlier when "the collapse of France let loose a new batch of orders from the English and from U.S. firms, and . . . J&L found itself quoting lengthening delivery dates, from six months, to eight months, then a year in advance." By May 1941, the owner of the company was faced with an impossible task. "The fact is, he says, the demand is now infinite."[27]

Readers of *Fortune* magazine in 1940-41 could hardly turn a page without encountering indications of an ongoing boom of investment for plant construction. Yet much of this was not counted as private investment in the national accounts. The decision by the Jones & Lanson machine-tool company to double plant capacity was entirely financed by the U.S. government.

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24. Vatter (1985, p. 12) summarizes the argument of this section of the current paper: "The competition between civilian and military demand was very easy on the former during the first half of the year [1941], but the military gradually began to crowd out the civilian during the latter half. This is indicated by the dropping off of durable consumer goods outlays in the third quarter and of private domestic investment in the fourth quarter."

25. For details on the successive shut-downs of civilian industry in the fall of 1941, see Herman (2012, pp. 153-55).

26. "The Best Bargain We Can Jolly Well Make," *Fortune*, April 1940, p. 70.

27. Facts and quotes in this paragraph come from "Jones & Lanson," *Fortune*, May 1941, pp. 74ff.

This is an early example of "government-owned privately-operated" (GOPO) investment that was discovered by Gordon (1969) and further quantified by Wasson, Musgrave, and Harkins (1970). This internalizing of investment expenditures within the government had the effect of biasing downwards fiscal multipliers estimated from the 1940-41 period as contrasted with postwar intervals of fiscal stimulus.

The emergence of inflation provides further evidence of capacity constraints in 1941. "Call it inflation or merely a big bulge in the cost of living, President Roosevelt is faced with the alternative of cracking down quickly or watching prices and wages go skyrocketing" (Ramey from *BW*, July 12, 1941). The annual rate of change of the price level, as measured by the GDP deflator between 1940:Q4 and 1941:Q4, was 9.3 percent. This supports the view that the U.S. economy was straining at the limit of capacity constraints, at least in the durable goods sector, in 1941. Nevertheless there was still plenty of labor. Also consistent with the view that product markets were tighter than labor markets was the decline in labor's share of net domestic factor income from 65.7 percent in 1939 to 62.0 percent in 1941.[28]

Thus we emerge with the verdict that the economy of 1941 was split between excess supply in the labor market and excess demand in a growing fraction of the manufacturing sector as the year progressed. Perhaps the most convincing contemporary account of capacity constraints in mid-1941 came from the Director of the Office of Price Administration:

> Civilian supplies of all kinds are being requisitioned for military needs so as to force the cutting down of production for civilian use . . . When [aluminum supply] is cut off suddenly, as has happened recently, businessmen face bankruptcy and whole communities lose the payroll lifeblood of their existence . . . Auto production is being limited and faces almost complete extinction. Can anyone estimate, at this time, the far-reaching dislocations of stoppage?"[29]

4. The Literature on Fiscal Multipliers and the End of the Great Depression

The recent literature on fiscal multipliers ignores the effects of wartime capacity and production constraints on the response of private sector GDP to a stimulus created by higher government defense spending. Section 4.1 reviews several of recent fiscal multiplier papers from this perspective, and the concluding section criticizes the earlier literature debating whether the end of the Great Depression was primarily due to monetary policy, fiscal policy, or other factors.

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28. The source is NIPA Table 1.10. Labor's share is employee compensation divided by net domestic factor income, which in turn is gross domestic income minus production taxes less subsidies minus capital consumption allowances.
29. Leon Henderson, "We Only Have Months," *Fortune,* July 1941, p. 68.

4.1 The Fiscal Multiplier Literature, Capacity Constraints, Patriotism, and Labor Supply

The set of papers by Barro and Redlick (2011), , Hall (2009) and Ramey (2011a), estimates a widely varying set of fiscal multipliers, some of which cast doubt on whether the 2009-12 Obama fiscal stimulus program could have revived real GDP by any significant amount.[30] The Hall and Barro-Redlick papers identify the conundrum summarized above in our introductory section -- the only changes in government expenditures that were large enough to contain useful information are those associated with WWII and the Korean War. Hall states explicitly that "there is little hope of learning much about the multipliers from any data after the mid-1950s" (2009, p. 192). Similarly, Barro-Redlick conclude that "in the post-1954 sample, there is insufficient variation in defense outlays to get an accurate reading on defense spending multipliers" (2011, p. 79). Ramey agrees (2011a, p. 7) that "the F-statistic is very low for samples that exclude both periods [WWII and Korea]."[31]

Although these three papers all estimate multipliers from time-series equations extending over the full intervals when these two wars were being fought (1942-45 and 1950-53), they do not confront the reality of capacity constraints, production prohibitions, and rationing. Government mandates caused auto production to cease in February 1942, and production stopped on many other types of civilian goods, including residential housing. Female hosiery was unavailable during the war, and even shoes were rationed. Despite these impediments to private spending, the three papers suggest that the estimated multipliers spanning WWII and the Korean War are relevant to the very different conditions of the peacetime economy in 2009-12 when unemployment was high and capacity utilization was low.

How do the authors confront the downward bias inherent in their inclusion of wartime data? Ramey (2011a) does not address the issue; her subsequent comments in a separate paper (2011b) are discussed below. In contrast, Hall (2009, p. 190) recognizes the problem that "direct controls on consumption through rationing arguably held back consumption growth that would have occurred under free-market conditions" and admits that as a result his multiplier estimates including 1942-45 are "downward biased." But then he claims that there is an offsetting upward bias including "the draft and the wartime surge in patriotism," concluding that on balance the "net bias is downward." Barro-Redlick (2011, p. 84) repeat Hall's arguments, dismissing the relevance of the production prohibitions and rationing because of "mandated increases of production and labor" and "patriotism [which] likely shifts labor supply outward".

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30. We do not discuss further the Christiano-Eichenbaum-Rebelo (2011) paper, because it is entirely theoretical and bases its quantitative analysis only on calibration exercises without use of any data involving WWII. We also do not consider the recent papers by Parker (2011) and Taylor (2011) which are primarily based on data for the past decade and do not use any data for the WWII era.

31. Ramey (2011c) provides a comprehensive survey of papers on fiscal multipliers. It is beyond the scope of this paper to provide comments on the many papers which she surveys. However, she provides several paragraphs of a critique of an earlier version of this paper, and our response is incorporated into this section.

Both the Hall and Barro-Redlick limit their comments to subjective assessments without analyzing the available data on labor-market outcomes before and during the war.

In order to assess the responsiveness of labor supply Table 1 provides annual data for the years 1940 and 1944, which show that the total labor force rose between these years by 10 million.[32] As a result of this influx into the labor force, Ramey (2011b, p. 9) reaches the conclusion that "samples that include World War II should produce estimates of the GDP multiplier that are much higher than [normal peacetime conditions]."   Since high multiplier estimates would imply that private spending was raised rather than lowered by government spending, Ramey presumably means that the influx of new workers into the labor force was available to produce private output, i.e., personal consumption expenditures and private domestic investment.

However, she neglects the most basic fact about the labor market of World War II, that the newly entering workers were needed to offset the exodus of young men into the armed forces. As shown in lines 1 through 3 of Table 1, the increase in the total labor force of 10.0 million between 1940 and 1944 was *more than offset* by the increase in the total number in the armed forces of 11.0 million, as the civilian labor force *declined* by 1.0 million. This is hardly an "elastic" labor force response from the viewpoint of the civilian economy.

Where did the additional civilian workers come from, given that the civilian labor force declined by 1.0 million? As shown in lines 4 and 5 of Table 1, the decline in unemployment contributed 7.5 million additional workers, of whom roughly two-thirds were actually unemployed in 1940 and the remaining one-third were Darby's (1976) government relief workers. Civilian employment increased by 6.4 million, the difference between the decline in the labor force and the decline in unemployment.

Were these 6.4 million net additional private employees available to produce private consumption and investment, as Ramey assumes? No, they were part of the private economy producing goods and services for the government, and all of this was counted as government spending, not private spending. These employees were working for private organizations, from Henry Kaiser's shipyards to Henry Ford's "Great Room" building B-24's, to every other type of ship, tank, gun, small arm, munition, and uniform manufacturer that helped the U.S. and its Allies to win WWII. Indeed, the 6.4 million additional civilian employees could not possibly have achieved this production miracle by themselves, and they were of necessity joined by millions more who were compelled to shift from the production of prohibited civilian goods to the production of military hardware.

The production prohibitions and rationing prevented consumers from purchasing what they normally would have bought with the income received from higher GDP during 1942-45.

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32. Ramey (2011b) provides similar evidence by comparing monthly labor market data for September 1940 and March 1945.

The percentage saving rate out of disposable income soared from 5.7 percent in 1940 to an average of 25.2 percent in 1942-44, far above any other year in the history of the national income accounts. In real 1937 dollars, government spending increased from $14.4 billion in 1940:Q3 to $105.2 billion in 1945:Q1, an increase of $90.8 billion. In fact real government spending in 1945:Q3 was larger than *all* of total real GDP in 1940:Q3.[33] How much of this represented government procurement of goods produced by private-sector employees, and how much represented salaries for the military?

The evidence suggests that enlisted men in the WWII military earned roughly $1,000 per year per man, implying that the 11.5 million additional military employees would have added $11.5 billion to government spending. Double that to $23 billion to include direct provision of uniforms and food to the military, and for higher pay to officers, and we are left with a 1940-45 increase of $67.3 billion (90.3 minus 23) in government procurement from the private sector. Could this amount have been produced by the 6.4 million extra civilian employees shown in line 4 of Table 1? This marginal product of $10,515 per added private-sector worker compares to an average product of $2,470 as private-sector real GDP per private-sector employee in 1940.[34] The $10,515 figure is greatly exaggerated, because much of the extra government procurement was produced not by the formerly unemployed but rather by workers in the private sector who had been compulsorily switched from civilian to military production. Not only did the Detroit Big Three shut down auto production to make tanks and aircraft, but smaller firms converted from making metal toys and tea kettles to guns or shells, and from making female underwear to making military parachutes.

The decline of private fixed investment during 1942-45 reflected not just production constraints, but also the fact that the government financed all of the new plant capacity and most of the new equipment built to produce all those tanks and aircraft.[35] Fully one-half of the nation's capacity to produce aluminum in 1945 was government-owned (Vatter, 1985, p. 26). The number of machine tools in the U.S. doubled between 1940 and 1945, and of newly built machine tools more than 70 percent were government-owned.[36]

Additional evidence of the downward bias of government spending multipliers estimated from the years 1942-45 emerges from the negative correlation of government and

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33. All real expenditure data in this section are based on the *average* of our interpolated data and the independently developed Ramey quarterly data. By coincidence non-government real GDP *(N)* was $87.2 billion in 1940:Q3 and a nearly identical $86.8 billion in 1945:Q3.

34. *Sources:* private-sector GDP from NIPA table 1.9.5 and private-sector employment from NIPA table 6.5A.

35. Real private domestic investment rose from $13.2 billion in 1940:Q2 to a peak of $18.4 billion in 1941:Q3, and then declined to $6.9 billion in 1945:Q1.

36. There were 1.3 million machine tools in the U.S. in January 1940, and an additional 800,000 were built by July 1943. Of these 100,000 were exported, leaving an increase of 700,000 (or 54%) in the domestic economy. Of these, "more than 500,000" were owned by the government. All data in this footnote come from Broehl (1959, pp. 192-94).

non-government spending at the end of the war. The four-quarter log percent change of government spending between 1945:Q2 and 1946:Q2 was -116 percent while the increase in non-government GDP (N) was +33 percent. For real consumption, private investment, and net exports to increase by 33 percent in a single year reveals the tightness of the wartime production prohibitions and the extent of labor and capital input that had temporarily been shifted into military production.

A separate issue arises about the increase of Federal income tax revenues in 1940-41. As Barro-Redlick show (2011, p. 61) the average marginal income tax rate almost doubled between 1940 and 1941 from 6.9 to 12.6 percent and then increased further to a peak of 26.8 percent in 1945. The ratio of total government tax revenue to GDP increased from 16.4 percent in 1940 to 18.7 percent in 1941 to 23.0 percent in 1945. The increase of tax rates between 1940 and 1941 is relevant to the debate about the application of government expenditure multipliers estimated from 1940-41 to the peacetime situation of 2009-12 when tax rates were lowered, not increased.

Since the stimulus to GDP provided by higher government spending in 1940-41 was partially offset by restraint due to higher taxes, multipliers estimated without an explicit tax rate variable are biased downward. This includes our estimates presented below in Part 6 and also Hall's (2009) estimates. Barro-Redlick (2011) and Ramey (2011a) included a tax rate variable in their regressions, but their results are hard to interpret because they only included the Barro marginal income tax variable, ignoring the fact that income taxes were a relatively small part of government revenue in 1940-41. The final section of the Data Appendix provides examples suggesting that increases in tax rates in 1940-41 may have reduced government spending multipliers as we present in Table 2 below by about 0.6 points, i.e., from 3.1 to our central estimate of 2.5.[37]

4.2 Monetary, Fiscal, and Mean Reversion Effects

The fiscal multiplier controversy is echoed in an earlier literature that debated whether fiscal policy mattered at all in ending the Great Depression. Romer (1992) finds that fiscal policy had little to do with the recovery, and she suggests that expansionary monetary policy after 1934 was the sole source. In contrast, Sims (1998, p. 20) concludes that "during the Great Depression, the role of interest rate policy in generating and propagating cycles was modest." Vernon (1994) also disagrees with Romer's monetary explanation, finding that the fiscal expansion related to WWII was the major factor in the recovery. Alternative ideas exist as well, including De Long and Summers (1988) and Bernanke and Parkinson (1989), who promote the idea that the recovery was largely due to the self-correcting or mean-reverting forces inherent in the structure of the economy. Of these competing theories, we will focus primarily on the debate about the relative roles of monetary and fiscal policy in ending the Great Depression, since this debate is highly relevant to the discussion of fiscal multipliers in 1940-41.

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37. The Data Appendix also discusses the treatment of taxes in the Barro-Redlick (2011) and Ramey (2011) papers.

The quarterly data of this paper date the end of the Great Depression to the period between 1939:Q1 and 1941:Q4.[38]   In the context of our estimates of the output gap, a statement made in De Long and Summers (1988) stands out:

> By the time World War II began and the government began to exert command over the economy, more than five-sixths of the Depression's decline in output relative to trend had been made up. It is hard to attribute any of the pre-1942 catch-up of the economy to the war. Neither the federal government's fiscal deficit nor the surplus on trade account became an appreciable share of national product before Pearl Harbor. (p. 467)

This quotation from De Long and Summers is worth including for four reasons. First, it suffers from a logical flaw in citing the fiscal deficit and the trade deficit. Both tax revenues and imports are endogenous and thus deficits or surpluses cannot be used as measures of shocks to output. If tax revenues and imports rise rapidly enough, then an autonomous increase in government spending or exports can be masked by offsetting increases in tax revenues or imports. Second, their statement ignores the concept of the structural fiscal surplus or deficit, which was introduced by Brown (1956) to argue that the New Deal was unsuccessful because it failed to increase the structural deficit. Indeed the ratio of government spending to trend real GDP (G/Y^N) hardly changed during the years 1929-39 and only began to take off in mid-1940.[39] Third, these authors ignore the role of explicit tax rate increases in preventing the emergence of a large fiscal deficit in the wake of large 1940-41 increases in government spending. Fourth, and most important, the quotation treats U.S. expenditures on WWII as starting with Pearl Harbor, whereas this paper's new dataset and contemporary accounts show that WWII for the American economy began in June 1940, not on December 7, 1941.

De Long and Summers' argument against fiscal policy is furthered by Romer (1992, p. 25), who states that "monetary developments were a crucial source of the recovery of the U.S. economy from the Great Depression. Fiscal policy, in contrast, contributed almost nothing to the recovery before 1942". In terms of the impact of WWII, Romer says the following:

> The U.S. money supply rose dramatically after war was declared in Europe because capital flight from countries involved in the conflict swelled the U.S. gold inflow. In this way, the war may have aided the recovery after 1938 by causing the U.S. money supply to grow rapidly. Thus, World War II may indeed have helped to end the Great Depression in the United States, but its

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38. Real GDP in $1937 was 92.9 billion in 1937:Q2, then fell to a low of 86.4 billion in 1938:Q2, followed by a recovery to 91.7 billion in 1939:Q1 and 94.5 billion in 1939:Q2. We take 1939:Q1 as the quarter that begins the end of the Great Depression, because its value is closer to 1937:Q2 than is the value of 1939:Q2.

39. Over the interval between 1929:Q4 and 1940:Q2 the G/Y^N ratio in our data cycled up and down between a minimum of 9.0 percent in 1933:Q3 and a maximum of 13.0 percent in 1938:Q4; the value was 11.4 percent in 1940:Q2 at the beginning of the rearmament buildup.

expansionary benefits worked initially through monetary developments rather than through fiscal policy (1992, p. 26).

Our new quarterly data showing an explosion of government spending between mid-1940 and late 1941 are enough to refute Romer's position, but Romer's other results can also be questioned. The money supply is equal to nominal GDP divided by velocity, and thus a rise in the money supply must either increase nominal GDP or reduce velocity. Romer implicitly assumes that changes in the money supply directly influenced nominal GDP with an elasticity of 1.0. But velocity fell from 1937-1940 when the money supply was increasing without the support of expansionary fiscal policy, and then rose in 1940-1941 when the stimulative effect of fiscal policy kicked in.[40]

5. VAR Methodology

A single VAR model is developed in this paper which is equally capable of estimating fiscal multipliers or of disentangling the relative contributions of monetary and fiscal policy in the end of the Great Depression. This model is estimated on data from 1919:Q1 to 1941:Q3 and thus is immune to the criticism that the fiscal multiplier estimates of Hall, Barro-Redlick, and Ramey are all dependent on data for the wartime years 1942-45 and 1950-53. The novelty in this paper is to stop the estimation in 1941:Q3 in order to eliminate the influence of capacity constraints and production prohibitions in creating an artificial war-related negative correlation between government defense spending and private spending.

New and old papers alike support the assumption that government defense purchases represent the ideal exogenous variable in a macroeconometric model. Wartime spending is driven by geopolitical events and exhibits little if any feedback from the economy. This paper accepts the standard assumption that changes in government defense spending are exogenous.[41]

5.1 The Choice of Interwar VAR Time Period, 1920:Q2-1941:Q3

The benchmark interwar VAR described in this paper is estimated for the time span 1920:Q2-1941:Q3. The starting point of 1920:Q2 is dictated by the 1919:Q1 start date of our new quarterly data set and the need to allow for lags in the VAR estimation. The end point of the estimation is 1941:Q3 rather than 1941:Q4: the "capacity crowding-out effect" evident in 1941:Q4 is not relevant to the search for estimates of fiscal multipliers that might be applicable to peacetime situations of insufficient demand.

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40. The velocity of M1 fell from 3.08 in 1937:Q2 to 2.72 in 1940:Q2 and then increased to 3.20 in 1941:Q4.
41. For instance Hall (2009, p. 189) writes that "Military spending does not respond to forces determining GDP or consumption . . . I have long believed that this aspect of the identifying assumption is one of the more plausible in macroeconomics."

5.2 VAR Methodology

The structuring of this paper's VAR models, statistical testing and overall methodology follow the examples set by Bernanke, *et al.* (1997), Gordon and Veitch (1986), Sims (1998) and Stock and Watson (2001). Our baseline VAR includes the variables real Government Expenditures (*G*), real GDP minus *G* (hereafter abbreviated *N*),[42] the nominal M1 Money Supply (*M1*), the M1 Money Multiplier (*MM*), and the Federal Reserve Bank of New York (nominal) Discount Rate (*R*).[43] M1, MM, and R are the variables used to determine the contribution of monetary policy, while G acts as the sole fiscal policy variable. The economy's response of real GDP and of non-government GDP to G provides a measure of fiscal multipliers that hold constant the values of the monetary variables, while the inclusion of the monetary variables allows a contest to measure the relative importance of the fiscal and monetary expansions in ending the Great Depression.

Following Bernanke *et al.* (1997), variables are normalized by expressing them as a ratio to potential real GDP. Our VAR uses 5 quarterly lags to correct any over-adjustment of seasonal effects present within the seasonally adjusted data.[44] The VAR historical decomposition presented in Part 6 requires assumptions to be made about the moving average representation of the vector time series, in particular regarding the innovations[45] in the variables. By using orthogonalized innovations, innovations in each variable can be examined individually, an important advantage of conducting our testing within the VAR framework. This paper uses the Cholesky factorization method, which suffers from the potential problem that, if the residuals are correlated, ordering the variables in alternative ways can produce results different enough to alter the conclusions of the test. Subsequently we show in robustness tests that alternative VAR ordering schemes do not substantially change our estimated fiscal multipliers nor our conclusions on the relative importance of monetary and fiscal policy.

5.3 VAR Variable Ordering

Given the geopolitical determinants of *G* in this period, we take it to be an exogenous variable, ordered first in our baseline VAR model. Subsequently we subject this ordering to robustness tests. As for the other variables, we group the three monetary variables in the order *M1, MM,* and *R.* We place *N* (non-government GDP) alternatively before and after the monetary variables, presuming that *N* should be influenced by all the fiscal and monetary variables but also recognizing evidence that *N* experienced substantial autonomous movements in 1939-41 due to capacity constraints and a shift of plant construction and equipment purchases investment from privately financed *I* to government-financed *G.*

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42. *N* is equal to the sum of real Consumer Expenditures, real Private Investment and real Net Exports.
43. See the Data Appendix for the precise definition and calculation of these variables.
44. The use of 5 quarterly lags is recommended in Chapter 10 of Estima (2007).
45. Innovations in the variables can be thought of as the changes in the variables' values not predicted by the VAR coefficients. "Innovations" are also known as "shocks" in some other papers. The terms are interchangeable, but this paper uses "innovations" throughout for consistency.

While Hall and Barro-Redlick do not estimate VAR models, Ramey's (2011a) paper does create a new VAR model in which the exogenous variable is her "defense news" variable, which is the present discounted value of expenditure appropriations by Congress as reported by *Business Week,* from 1939 to 2008. Following this in her VAR are *G, N* (split into two variables, nondurable consumption and private fixed investment), and three variables that we do not consider, aggregate hours worked, the Barro-Redlick average marginal tax rate and a measure of the real wage. Since we are interested in the effects of monetary policy, we include our three monetary variables but economize on degrees of freedom by consolidating consumption and investment into our *N* variable (which also includes consumer durables and net exports), and by omitting hours, the tax rate, and the real wage. Ramey expresses her expenditure variables in per-capita terms while we express ours as ratios to potential output.

We cannot test the Ramey specification because her news variable does not work for our time period. There are no data on news about national defense between the end of WWI in 1919:Q1 and the first significant positive defense appropriations in 1940:Q2. [46] This means that in our 1920-41 time period, the news variable consists of 84 consecutive quarters of zeros.

6. VAR Results and Fiscal Multipliers

Part 6 describes the VAR results, the innovations in government spending, and the implied fiscal multipliers. Then Part 7 applies the VAR model to the decomposition of the relative contributions of monetary and fiscal policy to the end of the Great Depression during 1939-41.

6.1 VAR Historical Decompositions

The main tools we use to analyze the output of the VAR are historical decompositions. As displayed in Figure 4, these determine the contribution of the orthogonalized innovations in each variable to the performance of *G* and *N* over the period 1939:Q1-1941:Q4. The results for *G* and *N* are then combined to produce the historical decomposition of *Y*. The three frames of Figure 4 each display three lines: the solid black lines of each figure show the actual path of the variable examined (either *G, N* or *Y*) as a percentage of Y^N, the dashed lines show the basic VAR dynamic forecast described below, and the grey lines show how innovations in *G* influence the variable examined over the 1939:Q1 to 1941:Q4 time period.

As expected, the innovation-free VAR predictions fail to capture the actual evolution of the variables, since innovations occurred in all of the variables over the 1939:Q1-1941:Q4 period. The combined effect of these innovations is equal to the difference between the actual level of

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46. We attempted to introduce her variable into our analysis by augmenting her series with a "negative news" value about the end of WWI in 1919:Q1, based on the Barro-Redlick (2011, p. 53-54) measure of defense spending. The augmented series was not statistically significant.

each variable and the value given by the basic VAR dynamic forecast. The purpose of the historical decomposition is to quantify the relative contribution of innovations in each variable to explaining this gap. This is done using the same dynamic forecast technique described above, except now innovations in each variable are allowed to enter into the forecast, one variable at a time. When the dynamic forecast ends in 1941:Q4, the cumulative effect of the innovations in each variable on the movements of the variable examined can be calculated. The results can be seen for all three variables examined (G, N and Y) in the grey lines in the three frames of Figure 4.

The historical decomposition of G shown in the top frame supports our view that the sharp rise in G during 1940-41 was exogenous. The basic VAR dynamic forecast does a poor job predicting what actually happened in G/Y^N between 1939:Q1 and 1941:Q4 period, illustrating that if all innovations had been suppressed, G/Y^N would have risen by much less than it did in reality. By following the basic VAR dynamic forecast, G would have increased by only 3.4 percent of Y^N from 1939:Q1 to 1941:Q4 instead of the 12.7 percent of Y^N that actually occurred.

The middle frame of Figure 4 displays the historical decomposition of N, which allows us to assess the impact of fiscal and monetary policy on the non-government components of GDP during the recovery period. The basic VAR dynamic forecast predicts a 12.5 percentage point *fall* in N/Y^N over the period, whereas N actually *rose* by 9.5 percent. This substantial rise in N appears to be caused entirely by government spending. A striking conclusion is that innovations in N itself had a negative impact on the value of N. If all other variables had followed the paths predicted by the VAR coefficients and only N had been allowed to deviate as it did in reality, N would have ended up a full 22 percent of Y^N lower in 1941:Q4 than the actual outcome.

How should the negative innovations in non-government spending be interpreted? As the threat of war grew in the United States during 1941, real consumer expenditures and private investment fell as American resources were being diverted toward the war effort.[47] Further, much of the structures and equipment investment that did take place in the last half of 1941 was financed by the government and was classified as part of G rather than part of N. This shift shows up as negative innovations in N, but it also shows up as positive innovations in G as the resources were now being used for government-financed war production. Therefore, if the negative innovations in N are factored into the forecast, but the positive innovations in G are suppressed, the net effect is the much lower forecast of N.

The grey line in the middle frame shows that almost all of the difference between the actual increase in N and the decrease predicted by the VAR forecast is accounted for by innovations in G. If innovations in G only are allowed to enter into the 1939:Q1-1941:Q4 VAR

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47. In addition, the third component of N, NX, fell sharply starting in 1940:Q4, reflecting the closures of foreign markets that were previously customers of U.S. exports (Germany, France, all of Western Europe, Japan after the oil embargo of mid-1941, and also a reduction in the ability of the UK to finance civilian imports). This drop enters as a negative innovation in N, since net exports are a component in N.

dynamic forecast of N, the result is 18.7 percent of Y^N higher in 1941:Q4 than that of the basic VAR dynamic forecast.

The bottom frame of Figure 4 combines the two top frames by displaying the same values for total output $(Y = G + N)$. As before, in each case the contribution of government spending (G) must be compared not to a baseline of zero change, but rather to the no-innovation basic VAR dynamic forecast. There was a 22.2 percent increase, as the actual Y/Y^N ratio recovered from 78.1 percent in 1939:Q1 to 100.3 percent in 1941:Q4, but the basic VAR dynamic forecast of Y, again represented by the dashed line in the bottom frame of Figure 4, predicts a decline in the Y/Y^N ratio by 9.2 percentage points. Thus the total gap between the actual 22.2 percent increase and the 9.2 percent VAR forecast decline is 31.4 percent, which by definition, must have been contributed by innovations in the five variables of the VAR model. Of this 31.4 percentage point gap, 24.9 percentage points is explained by innovations in government spending, or 79 percent of the total gap.

6.2 Fiscal Multipliers

In Part 4 above we reviewed the major recent papers in the fiscal multiplier literature and concluded that they share several common features that cause them to understate the government spending multiplier. To avoid these problems we limit our calculation of fiscal multipliers to a sample period alternately ending in 1941:Q2 and 1941:Q4 as a recognition that capacity constraints were in effect not only in 1942-45 but also in the last half of 1941. Our VAR model provides the framework needed to discuss fiscal multipliers, that is, exogenous changes in the G/Y^N ratio in 1940-41. We do not measure the actual change in GDP divided by the actual change in government spending, as do Hall (2009) and Barro-Redlick (2011), but rather our multiplier is the VAR measure of the marginal effect of G innovations on GDP relative to the marginal effect of G innovations on G itself. This method of calculating the multipliers explicitly calculates the marginal changes in Y relative to the marginal changes in G by subtracting out from both the change predicted by the VAR model when no innovations in any variable are allowed to occur. Subsequently we examine the robustness of the results to this approach.[48]

Table 2 provides a summary of the estimated fiscal multipliers. The left column is the most important, because it makes its calculation stopping in 1941:Q2, before most of the capacity constraints took effect. The right column going through 1941:Q4 yields uniformly lower multiplier estimates, reflecting the impact of the capacity constraints of the last half of 1941. The simulations begin in 1940:Q2, the final quarter before the explosive increase in G that is treated by the VAR model as an exogenous innovation. The resulting multiplier for the simulation ending in 1941:Q2 is 1.8 with our data and 3.2 with the Ramey data. The main difference between our data and Ramey's is that our data has a slight decline in G/Y^N from

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48. The Hall-Barro-Redlick multiplier would divide the increase in real GDP between 1940:Q2 and 1941:Q3 by the increase in government spending over that same interval. That calculation would yield a multiplier of 1.92 (+22.7 billion of real GDP stimulated by +11.8 billion of government spending).

1941:Q1 to 1941:Q2, implying an inverse relationship to GDP growth during that quarter, whereas Ramey's does not.[49] This has the effect of reducing our fiscal multiplier estimate compared with that using Ramey's data.

When the simulations are extended to 1941:Q4 and encounter the period of capacity constraints in the last half of 1941, the multipliers are much smaller, with both data sets yielding multipliers of 0.9. Because both methods of developing the quarterly data for 1939-41 have advantages and disadvantages, a natural solution is to base the results on the average of the multiplier values from the two data sets, as is displayed in the third line of Table 2. Our central estimate for the multiplier when the data are averaged is 2.5. This is much higher than the estimates, often below 1.0, obtained in the recent literature and for a good reason – the war years themselves are excluded due to production prohibitions, rationing, and capacity constraints.

The 2.5 estimate of the fiscal multiplier needs to be qualified for the effect of rising tax rates in 1940 and 1941. The numerical exercise conducted in Section 6 of the Data Appendix suggests that the estimated multiplier for the 1940-41 period when tax rates were rising understates the true multiplier relevant to a situation of constant tax rates, and the latter is higher by between 0.6 and 0.8. Thus the constant-tax equivalent of our central multiplier estimate is not 2.5 but between 3.1 and 3.3. The equivalent multiplier for 2009-11 would be lower than 3.1 to 3.3 because spending leakages into taxes and imports are now higher than in 1940-41.

6.3 Robustness Checks for Fiscal Multiplier Estimates

To simplify the number of alternative results that are presented here, we limit our robustness checks to those that use the average of the two data sources, our new interpolated data series and that of Ramey. In Table 2 the basic result using the average of the two data sources as shown on the third line is 2.5 for the period through 1941:Q2 and a much lower 0.9 for the period through 1941:Q4, which for comparison with the subsequent results will be abbreviated 2.5/0.9.

The first robustness check converts the VAR model from five to six variables, adding the GDP deflator. This slightly raises the multiplier from the baseline result of 2.5/0.9 to 2.9/1.1. Four other robustness checks are carried out by varying the order in which the variables enter the VAR model. The four alternatives are (1) to shift *N* from fourth to second place, (2) to switch *G* and *N* from first and second place to the reverse order, (3) move the *M1* and *MB* monetary variables to first and second in order, moving *G* and *N* to third and fourth place, and (4) to retain the primacy of the monetary variables and switch the position of *N* and *G.* The results of these robustness tests are all to yield the same or slightly higher multipliers for both periods, that ending in 1941:Q2 and 1941:Q4.

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49. The reason that our data has this decline in G/YN from 1941:Q1 to 1941:Q2 is discussed in Part 2.

Another way to vary the methodology is to adopt an alternative method of calculating fiscal multipliers. Instead of taking the estimated innovations in Y and G relative to the no-shock prediction of the VAR model, we can consider the possibility that the prediction of the VAR model is subject to error, in particular by its forecast of a substantial decline in N after 1939 in the absence of any shocks. Thus an interesting variant is provided in the bottom line of Table 2, which recalculates the multiplier as the contribution of the G innovation to the change in Y divided by the contribution of the G innovation to the change in G, with no reference to the forecasts of the unshocked VAR model. The resulting fiscal multipliers are slightly smaller for the 1941:Q2 end date (2.3 compared to the baseline 2.5) but slightly larger for the 1941:Q4 end date (1.2 compared to 0.9).

Overall the results provide a variety of estimates that bound the multiplier through 1941:Q2, using the average of the two data sets, at between 2.3 and 3.0. As indicated before, because taxes increased during this period, the results are a mixture of pure government spending multipliers and balanced budget multipliers; pure government expenditure multipliers would be higher. These estimated multipliers for the period ending in 1941:Q2 also need to be adjusted down before they can be applied to the post-2009 time frame, due to the greater size of tax and import leakages in the contemporary economy post-2009 as compared to 1940-41.[50]

7. Policy Contributions to the End of the Great Depression

The same model can be used to address the question, "what were the relative contributions of fiscal and monetary policy to the end of the Great Depression?" Given the absence of fiscal stimulus up until 1940:Q2, it is not surprising to learn that the relative contributions of monetary and fiscal policy are highly time-dependent. Monetary policy was more important in early 1940 and fiscal policy took over as the main driver toward economic recovery in 1941. But, given that the 18-point increase in the ratio of actual to potential real GDP occurred in the six quarters after 1940:Q2, it would be difficult to dispute the role of the fiscal expansion as a major contributor to the recovery.

7.1 Using the VAR Model to Estimate the Fiscal and Monetary Policy Contributions

The basic VAR dynamic forecast, already used as a baseline to calculate the fiscal multipliers in Table 2, assumes that there are no innovations in any of the variables. The combined effect of these innovations is equal to the difference between the predicted level of each variable resulting from the estimated innovations and the value given by the basic VAR

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[50] Barro-Redlick (2011, Table II, p. 75) include tax change variables in their regressions, but those most relevant for this paper are insignificant for the starting period 1939 (annual) through their common termination date of 2008. Ramey (2011, Figure XI, p. 35) also includes tax changes in her VAR and finds that the multiplier for tax increases is only 0.1 for 1939-2008, compared to her peak estimate of about 0.9 for government spending.

dynamic forecast. The purpose of the historical decomposition is to quantify the relative contribution of innovations in each variable to explaining this gap.

As we have seen, real consumer expenditures and private investment fell were crowded out by capacity constraints in the last half of 1941.[51] This shift shows up as negative innovations in N and positive innovations in G. Government spending crowded out private investment through supply restrictions[52] rather than the traditional channel of higher interest rates. When we see a negative innovation of N in the results discussed below, we can interpret it as follows: the VAR model predicts that investment is positively related to income growth but is surprised that investment shrinks rather than grows after early 1941 despite the rapid growth of real GDP. The VAR model has no way of knowing, of course, that newly built plants in mid-to-late 1941 were being paid for by the government and are treated in the national accounts as G, not N.

Our decompositions of the contributions of fiscal and monetary policy are based on the same VAR model discussed above in section 6.1. The model's forecasts for G, N, and Y are calculated for 1939:Q1 to 1941:Q4 first as a baseline forecast for the VAR with no shocks after 1939:Q1 included. Then the model's forecasts are calculated sequentially when shocks in each of the five variables are included, one by one. The contribution of a variable is defined as the increase between 1939:Q1 and 1941:Q4 in the forecast of the Y/Y^N ratio based on that variable's innovation as compared to the basic VAR forecast that assumes no innovations.

Figure 5 displays the contributions of the five variables in the VAR model. Each frame shares a black line, showing the actual value of Y/Y^N that rises from 78.1 percent in 1939:Q4 to 101.3 percent in 1941:Q4. The black dashed line shows the basic VAR forecast assuming no shocks in any of the five variables; this rises slightly and then declines to a 1941:Q4 value of 75.1 percent. In each of the five frames there is a grey line displaying the contribution of shocks in that particular variable. For instance, the government spending *(G)* shock alone causes the VAR model to predict an increase in the Y/Y^N ratio from 78.5 percent to 95.8 percent, an increase of 17.3 percent, and 20.6 percentage points greater than the basic VAR forecast. The remaining frames of Figure 5 show the small positive contributions of the monetary policy variables (*M1*, *MM*, and *R)* and the negative contribution of private spending *(N)*.

The results in Table 3 are best understood by going through the calculations that derive the numbers in the first row, based on our data and our basic VAR model which has the variables in the same order as in the baseline fiscal multiplier estimates of Table 2. The no-shock VAR forecast is that the Y/Y^N ratio would have declined from a forecast value of 78.5 in 1939:Q1 to 75.1 in 1941:Q4, a decline of 3.4 percent of Y^N. The same forecast with the G innovation included shows an increase in the forecast value of Y/Y^N from 78.5 to 95.8 percent, an

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51. In addition, the third component of N, *NX*, fell sharply starting in 1940:Q4, reflecting the closures of foreign markets that were previously customers of U.S. exports (Germany, France, all of Western Europe, Japan after the oil embargo of mid-1941, and also a reduction in the ability of the UK to finance civilian imports). This drop enters as a negative innovation in N, as well.
52. These included both current and anticipated supply restrictions, see Part 3.

increase of 17.3 percentage points. The difference between the increase generated by the G innovations and the decline implied by the no-shock VAR forecast is defined as the contribution of fiscal policy, or 20.6 percent (= 17.3+3.4, adjusted for rounding). This 20.6 percent contribution from fiscal policy is equal to 89.1 percent of the actual 23.2 percent increase in the Y/Y^N ratio between 1939:Q1 and 1941:Q4. These are the numbers that yield the fiscal policy contribution of "89" recorded in the first column and first row of Table 3.

Similarly, the sum of the contribution of the three separate monetary variables ($M1$, MM, and R) is 34 percent. The contribution of the VAR model's forecast error together with the contribution of N is -23 percent. This is divided into contributions of -14 percent for the VAR model error and -9 percent for the forecast of private spending (N). Fiscal policy innovations related to WWII were the key to the recovery from the Great Depression, with monetary policy innovations playing a supporting role.

As shown in Table 2 above, the fiscal multipliers are higher when the Ramey quarterly data are used instead of our interpolated data. Similarly, the fiscal policy contribution is greater with the Ramey data than with our data, as is shown by comparing the first two rows in Table 3. As compared with the 89 percent fiscal contribution with our data, the same calculation with the Ramey data yields a fiscal contribution of 135 percent. As in Table 2 for fiscal multipliers, our baseline results take an average of the results with the two data sets, yielding a fiscal policy contribution of 111 percent.

7.2 Robustness Checks

The same robustness tests can be applied here as in Table 2 above. Other papers on similar subjects such as Sims (1998) have included a variable in the VAR to isolate the effects of inflation. This paper measures inflation using the newly interpolated quarterly GDP deflator, and it is possible that leaving this variable out of the VAR might have introduced omitted variable bias. Table 3 presents a version of the VAR model that includes the GDP deflator as a sixth variable. This addition has little effect other than slightly reducing the positive contributions of fiscal and monetary policy and thus reducing also the negative contributions of the model residual and the negative N innovations.

VAR results using orthogonalized innovations are subject to change when the VAR ordering is modified, and thus alternatives to our baseline VAR ordering of $(G, M1, MM, N, R)$ should be tested. The final four rows of Table 3 display the results of four other plausible VAR orderings, as in Table 2. One interesting result that emerges is that advancing a variable in the VAR ordering does not necessarily increase the percentage of the recovery it explains, implying that the added influence of moving a variable up in the ordering can work both ways.

For example, monetary policy innovations explain 21 points more of the recovery in the baseline ordering where $M1$ and MM are placed after G than when they are moved ahead of G. On the other hand, there is no change in the contribution of the "other" category when N is

placed in front of *M1* and *MM*. While the outcomes of the different orderings are interesting to examine individually, the most important conclusion is that these alternative results have virtually no impact on our central result that innovations in G were the major factor in the recovery from the Great Depression.

7.3 Summary of the Main Results

Figure 6 displays how this baseline result using the average of the two data sets changed over the course of the recovery. During the first quarter of the recovery, from 1939:Q1 to 1939:Q2, both fiscal and monetary policy innovations had negative effects on Y/Y^N. Moving rightward, the chart shows that monetary policy innovations accounted for the entire 1939:Q1-1940:Q2 increase in Y/Y^N, with the positive fiscal policy contribution offset by the residual category. This result is consistent with Romer (1992) and Vernon (1994), both of whom attribute this early portion of the recovery to monetary factors. However, the recovery was only 21 percent[53] complete in 1940:Q2, and after this point our results become increasingly contradictory to Romer (1992)[54] as the percentage of the recovery attributable to fiscal policy innovations rises dramatically. Already by 1940:Q4 the fiscal policy contribution was 76 percent, somewhat greater than the monetary policy contribution of 66 percent. Taking the contributions all the way out to the full recovery date of 1941:Q4 leads to our baseline result, using the average of the two data sets, with 111 percent of the recovery from the Great Depression attributable to innovations in fiscal policy, 34 percent to monetary policy innovations, and -45 percent to other factors.

8. Conclusion

This paper is about two perennial topics in macroeconomics, about which interest has been revived by the worldwide economic crisis of 2008-12. These are the size of fiscal multipliers and the sources of recovery from the Great Depression. This paper has provided a set of new results that shed light on both topics. First, we cannot estimate fiscal multipliers relevant for a depressed peacetime economy like 1933 or 2009-11, in which there is low utilization of capital and labor, from the war years 1942-45 when production of many consumer and investment goods was prohibited, nor from the Korean War years 1951-53 when the utilization of capital and labor reached the highest rates of the postwar era. The novel contribution of this paper is to highlight the dramatic fiscal expansion of the 18 months between mid-1940 and the end of 1941, but to caution that these six quarters cannot be interpreted without taking account of the significant capacity constraints that emerged in the U.S. economy

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53. 21 percent = (1940:Q2 value of Y/YN minus 1939:Q1 value of Y/YN) / (100 minus 1939:Q1 value of Y/YN) = (82.7 – 78.1) / (100 – 78.1).

54. Our results remain fairly consistent with those of Vernon (1994) throughout, even though we use a completely different dataset and methodology.

in the last half of 1941, disqualifying that half-year as well for inclusion in the data used to estimate fiscal multipliers.

Second, an attempt to quantify capacity constraints in 1941 requires that we revisit the statistical estimation of potential real GDP in the interwar period. Third, we must weigh evidence on capacity constraints by reading the contemporary descriptions of economic conditions in the business press published in 1940 and 1941. Fourth, fiscal multipliers should be measured not as raw GDP changes divided by raw changes in government spending, but both numerator and denominator should be stated *relative* to the forecast of some model of an alternative scenario in which the fiscal shock is absent. Fifth, fiscal multipliers estimated from an era like 1940-41 in which tax rates were rising are biased downward for application to periods like 2009-12 when tax rates were constant or falling. Sixth, the relative role of monetary and fiscal policy in ending the Great Depression during 1939-41 must be guided by an explicit econometric model.

Hall (2009) and Barro-Redlick (2011) are aware that their estimation of spending multipliers from data that include the war years 1942-45 cannot be applied to normal low-utilization peacetime situations, and they attempt to provide some justification for their results by appealing to "patriotism" and an increased labor supply as countering the prohibitions and constraints on the production of civilian goods. This paper shows that the increased labor supply was more than offset by the exit from the civilian labor force of men drafted into the military, leading to a decline in the civilian labor force. Millions of workers made the transition from unemployment to civilian employment, but they were too few to explain how government procurement from the private sector grew from 1940 to 1944 by 65 percent of 1940 real GDP. Many more millions of workers shifted from building peacetime goods like cars and brassieres to wartime goods like tanks and parachutes.

This paper contributes numerous innovations in the ability of economists to study the 1940-41 period during which government defense spending ended the Great Depression. We have developed a new quarterly data set back to 1919, converted the data to a base year of 1937 instead of 2005 in order to avoid base-year bias, estimated a new VAR model for 1920-41 using those data, decomposed the absolute and relative contributions of monetary and fiscal policy as explanations of the end of the Great Depression, and suggested a new framework for estimating fiscal multipliers for 1940-41. In addition, we provide new quarterly estimates of potential real GDP and of the output gap for the interwar period.

All testing in this paper is done within a 5 variable, 5 lag VAR framework that accounts for the correlations among the variables and presents a model for the recovery period that is designed to capture the separate contributions of monetary and fiscal policy. In 1941:Q4, real GDP stood at 101 percent of potential real GDP compared with 78 percent in 1939:Q1, the date that we use as the start of the recovery from the Great Depression. Therefore, this paper attempts to explain the 23 percent increase in real GDP that occurred over this time period, when expressed as a share of potential output (Y^N).

The paper uses its VAR model to calculate fiscal multipliers. This multiplier is 2.5 when the alternative multipliers generated by our data and Ramey's alternative data are averaged. The paper supports the results of Hall (2009) and Christiano-Eichenbaum-Rebelo (2011) that fiscal multipliers are higher when there is a zero lower bound (ZLB) that eliminates the usual crowding-out effect of fiscal expansions due to higher interest rates. This paper shows that the U.S. economy in 1938-41 was stuck at the ZLB, with a Treasury bill rate of between 0.05 and 0.13 percent. Thus the relatively high multipliers estimated in this paper in the ZLB regime of 1940-41 are relevant for the ZLB U.S. economy of 2009-2012.

The results of this paper contradict the views of Romer (1992) and De Long and Summers (1988), who believe that fiscal policy did not meaningfully contribute to the recovery effort until 1942. This paper's new dataset, as well as contemporary evidence from 1940-41 editions of *Business Week*, *Fortune* and the *New York Times,* show that government spending as a percentage of potential output started to rise dramatically in 1940:Q3, five quarters before the recovery was complete and fully 18 months *before* Pearl Harbor. Romer recently defended her 1992 paper, stating that "My argument paralleled E. Cary Brown's famous conclusion that in the Great Depression fiscal policy failed to generate recovery, not because it does not work but because it was not tried" (Romer 2009, p.7). In contrast, the new dataset shows that during the prime recovery period between 1939:Q1 and 1941:Q4, the government spending percentage of potential output doubled, rising by 13 percent to nearly 26 percent of Y^N. Therefore, it is unclear how Romer can claim that fiscal policy "was not tried."

Beyond its statistical estimates of fiscal multipliers and policy contributions, this paper makes a unique contribution by reviewing the contemporary media for 1940-41. We document that the American economy went to war starting in June 1940 and that the fiscal stimulus in 1940-41 was partly crowded-out not by higher interest rates, but rather by capacity constraints in critical areas of manufacturing that became increasingly acute in the second half of 1941. Previous studies of 1940-41 have been misled by the high 1941 unemployment rate into thinking that multipliers calculated from 1940-41 can be applied to 2008-11. We show to the contrary that the 1941 economy was bifurcated, with excess capacity in its labor market but capacity constraints in many of the key manufacturing industries.

By July 1941, the American economy was in a state of perceived national emergency. We document a plea from the business-oriented *Fortune* magazine that the free enterprise system must now succumb to pervasive government controls, including price controls. We show in quarterly data not just that private consumption and investment actually declined in late 1941, but also we explain why. Macroeconomists have a lot to learn from the unprecedented events of 1940 and 1941, and this paper points to a new level of understanding.

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Data Appendix by Source (*FOR ONLINE PUBLICATION)*

Section 1: Monetary Policy Variables

- *Source:* NBER Macrohistory Database, Last modified April 10, 2008
http://www.nber.org/databases/macrohistory/contents/

Interest Rate (Jan. 1919-Dec. 1951): Discount Rates, Federal Reserve Bank of New York, NBER Series 13009, X11 s.a.
Data Adjustments: Data are in monthly format. Quarterly data = average of monthly data by quarter.
Variable: R

M1 Money Supply (Jan. 1919-Jan. 1959):
Data for Jan. 1919-Dec. 1946. Ratio-linked to FRED data in Jan. 1959, see below:
U.S. Money Stock, Commerical Banks Plus Currency Held By Public, NBER Series 14144a, Seasonally adjusted (s.a.)
Data for Jan. 1947 to Jan. 1959. Ratio-linked to FRED data in Jan. 1959, see below:
U.S. Demand Deposits, Adjusted Time Deposits, All Commercial Banks, Plus Currency Held By the Public, NBER Series 14144c, s.a.
Variable: M1

- *Source:* Federal Reserve Bank of St. Louis – FRED. http://research.stlouisfed.org/fred2/

M1 Money Supply (Jan. 1959-Dec. 2008): M1 Money Stock, FRED Series M1SL. Last updated: 2/13/2009, s.a.
Data Adjustments: Series ratio-linked in January 1959 to M1 series from NBER Macrohistory Database cited above. The 1919-1959 series is ratio linked to the FRED data because we originally wanted a continuous series for M1 from 1919-2009, and multiplying the original data by a fixed ratio should not affect the results. Data are in monthly format. Quarterly data = average of monthly data by quarter.
Variable: M1

Monetary Base (Jan. 1918-Jan. 2009): St. Louis Adjusted Monetary Base, FRED Series AMBSL. Last updated: 2/20/2009, s.a.
Data Adjustments: Data are in monthly format. Quarterly data = average of monthly data by quarter.
Variable: MB

M1 Money Multiplier: Equals M1 Money Supply divided by the Monetary Base.
Variable: MM

Section 2: Real GDP, GDP Deflator and Real GDP Components

2a. The Use of 1937 Rather than 2005 as the Base Year for Real GDP and its Components

Annual NIPA data for real GDP and its components are available in 2005 prices (hereafter $2005) back to 1929. However, there are significant disparities between total real GDP and the sum of the underlying components of real GDP for years that are more than a decade away from the base year chosen for deflation. Figure A1 shows the comparison between the $1937 and $2005 real GDP residuals as a percentage of real GDP, as well as the large difference created by the alternative base years in measures of *G* as a percentage of real GDP. On average, the deflator used fo *G* has risen faster than that used for real GDP; therefore, when the base year is changed from $1937 to $2005, *G* as a percentage of real GDP during the 1929-53 period becomes bigger.

There is an old saying that "every time they move the base year later, WWII gets bigger." An easy solution to this problem created by chain-weighted measurement is to use the readily available $1937 measures of real GDP components. Figure A-1 shows that in the critical year 1941, the sum of components of real GDP in $2005 is overstated by 7 percent, and the ratio of government spending to real GDP *(G/Y)* in $2005 is overstated by more than 40 percent (that is, the ratio is 30 percent in $2005 vs. 21 percent in $1937). Because the overstatement of GDP in $2005 is much less than the overstatement of government spending, any study that uses $2005 will yield fiscal policy multipliers that are biased downward, and this bias applies to all of the recent empirical fiscal multiplier literature.

2b. Chow-Lin Interpolation of GDP Components Using Interpolators from the NBER Database

In order to increase the frequency of our database and thus the degrees of freedom in our regressions, this paper converts annual GDP component data into quarterly data using an interpolation procedure described in Chow and Lin (1971). Annual GDP component data are taken from the NIPA,[55] but as the NIPA dataset only begins in 1929, annual data for 1919-1928 are obtained by ratio-linking the 1929 NIPA data[56] to annual data[57] from Gordon and Veitch (1986).[58] The continuous annual time series from 1919-1941 are then transformed into monthly data from 1919:1-1941:12 using the Chow-Lin interpolation procedure.[59] The Chow-Lin process converts each annual series into a monthly series while maintaining the annual sum by regressing on related monthly series. The related monthly series are obtained from the NBER's Historical Statistics Database and are chosen based on their perceived relevance to the variable

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[55] Individual annual GDP component sources are described in Section 2b below.

[56] The value for 19xx = G-V's 19xx value multiplied by (NIPA 1929 value / G-V 1929 value).

[57] G-V's dataset consists of annualized quarterly data. Annual data equals the sum of the quarterly data divided by 4.

[58] G-V's data for 1919-1928 is sourced primarily from Swanson and Williamson (1971) along with other sources described in the G-V Data Appendix.

[59] This process was done in the statistical software program RATS using the procedure Chowlin; specific code is available upon request.

in question.[60] The goal is to select monthly series that have annual values highly correlated with the movements of the annual series over the 1919-1941 time period. For example, the related monthly series for the GDP Deflator are the monthly Consumer Price Index and the monthly Index of Wholesale Prices. The Chow-Lin interpolation process regresses the annual dependent variable (Y_{it}) on annualized forms of the monthly independent variables (the matrix X_{it}) and an *annual* error term (U_t):

$$Y_{it} = X_{it}\beta + U_t \quad (1)^{61}$$

The *monthly* errors (u_t) in each interpolation are assumed to follow an AR(1) process, which makes the first autocorrelation (ρ_A) of U_t related to the monthly autocorrelation coefficient (ρ_M). By solving the system of equations and performing an iterative GLS procedure to obtain estimates of β and ρ_M, monthly estimates for the dependent variable can be calculated using the formula:

$$\hat{y}_{it} = x_{it}\hat{\beta} + \hat{\rho}_M \hat{u}_{t-1} \quad (2)$$

This interpolation process is repeated for each of the nine real GDP components, and the related monthly series used to interpolate each annual series are identified in the table on the next page. Following the advice of Gordon and Veitch (1986), different sets of monthly interpolators are used for each component of GDP, "in order to avoid a spurious correlation between the dependent and explanatory variables" when performing the statistical tests (287). For testing purposes, the monthly data are aggregated into quarterly data to smooth out any monthly anomalies and thus create a more reliable dataset.

GDP components for 1942:1-1951:12 (not directly used in the paper) are obtained by repeating the above procedure over the entire 1919-1951 span. The 1919:1-1941:12 data are run separately in order to avoid having the Chow-Lin procedure's smoothing parameter affect the data for the second half of 1941, a crucial period for our study.[62] For example, as real investment is severely depressed in early-1942, when the Chow-Lin procedure is run over the entire 1919-1951 period the data for late-1941 is also depressed because of the smoothing mechanism. This is not what the monthly interpolators indicate actually happened to real investment in late-1941 and thus we cut off the Chow-Lin procedure in 1941:12 to avoid this issue.

Gordon and Veitch (1986) also use the Chow-Lin procedure to interpolate quarterly GDP components for the interwar period. However, our new dataset goes beyond theirs in several ways. Two of the new dataset's major improvements are extending the time series out to 1951 for comparison purposes[63] and utilizing more monthly interpolating variables. Our

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[60] Related monthly series were also chosen so that they could be made into a continuous strand from 1919:1-1951:12.

[61] For a more complete and technical description of the complex formulas and statistics that go into the Chow-Lin process, see Chow and Lin (1971).

[62] The only series where 1919:1-1941:12 data comes from the Chow-Lin process run over the entire 1919-1951 period is the GDP Deflator.

[63] Note the data used in the paper comes from the 1919:1-1941:12 interpolation, not the 1919:1- 1951:12 interpolation described here.

1951:Q4 end-date, as opposed to 1941:Q4 in Gordon-Veitch, allows for a comparison with the official BEA quarterly data during the five-year overlap period that starts in 1947:Q1. The new quarterly estimates can be 'tested' against those of the BEA for the period 1947:Q1-1951:Q4 and indeed the interpolated variables match up very well, with an average correlation coefficient for the 12 comparable series equal to 93.1%.[64] The new data also compare favorably over the crucial period 1939:Q1-1941:Q4 to an independently developed quarterly dataset for GDP components created by Ramey (2011a) (see Figure A2). The main differences between the new dataset and that of Gordon and Veitch are described below and on the following page.

Gordon and Krenn (2011) vs. Gordon and Veitch (1986)		
	G&K (2011)	G&V (1986)
Interpolation End-Date	1951:Q4	1941:Q4
Number of Interpolators Used	29	14
Separation of Cons. Nondurables and Services?	Yes	No
Comparison to BEA Quarterly Data?	Yes	No

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[64] Comparisons to BEA quarterly data 1947:Q1-1951:Q4 are done with interpolations based on $2000 annual variables to be more similar to the $2000 BEA quarterly data. Comparison testing was not done for $1937 because no official $1937 quarterly data exist, but interpolations based on $1937 annual variables follow the same interpolated trends as the $2000 annual variables.

Table A-1. Variables Used in Chow-Lin Interpolation		
Variable Interpolated	**Time Period Interpolated**	**Independent Series in Interpolation**
1. Real GDP		Sum of Components
1A. GDP Deflator	1/17-12/41	*C T CPI WPI*
2. Real Consumer Durables	1/19-12/41	*C T IPDM ORDDUR*
3. Real Consumer Nondurables	1/19-12/41	*C T COAL DPTSLS FOOD GROC PAP POW*
4. Real Consumer Services	1/19-12/41	*C T BUS DPTSLS GROC IIPT*
5. Investment, Real Producers' Durable Equipment	1/19-12/41	*C T EMPD IIPT IPDM*
6. Investment, Real Residential	1/19-12/41	*C T RCONSTR RCONT RFLOOR RNUM RVAL*
7. Investment, Real Nonresidential Structures	1/19-12/41	*C T NRCONSTR NRCON NRFLOOR NRVAL*
8. Real Change in Business Inventories		Smoothed into monthly data using sliding weights
9. Real Government Expenditures	1/19-12/41	*C T GOV*
10. Real Exports	1/19-12/41	*C T EXP*
11. Real Imports	1/19-12/41	*C T IMP*
** See Below for description of abbreviations.		

- *Source:* NBER Macrohistory Database, Last modified May 17, 2001
  http://www.nber.org/databases/macrohistory/contents/

Monthly Interpolators:

BUS = Index of the Physical Volume of Business Activity, Babson, NBER Series 01001,
    X11 seasonally adjusted (s.a.)

C = Constant term used the regression

COAL = Bituminous Coal Production, NBER Series 01118, X11 s.a.
Data Adjustment: In original series, April 1946 is set to 46.1 from 6.1 to correct for a probable typo.

CPI = Consumer Price Index, All Items Less Food, NBER Series 04052, X11 s.a.

DPTSLS = Index of Department Store Sales, NBER Series 06002b, X11 s.a.

EMPD = Index of Factory Employment, Total Durable Goods, NBER Series 08146a and 08146c, X11 s.a.
Data Adjustment: Series ratio linked in Jan. 1939

EXP = Total Exports, NBER Series 07023, X11 s.a.
Data Adjustment: Changed to real terms by dividing by X-Deflator/100

FOOD = Index of Production of Manufactured Food Products, NBER Series 01260b, s.a.

FREIGHT = Freight Car Shipments, Domestic, NBER Series 01149, X11 s.a.

GOV = Federal Budget Expenditures, Total, NBER Series 15005b through 15005f, X11 s.a.
Data Adjustment: Changed to real terms by dividing by G-Deflator/100. Series ratio linked in Jan. 1932, July 1937, July 1939, and July 1945.

A problem arises in this series because it includes not just G but also transfer payments, which are excluded when calculating GDP. The monthly interpolator series is distorted by particularly large transfer payments in scattered quarters. To find these quarters, we calculated the monthly log change in the interpolator, after changing the data to real terms and X11 s.a. Whenever a monthly change of +40 percent or more was followed by a monthly change of approximately the same amount with a negative sign, we replaced that "bulge" observation by the average of the preceding and succeeding months. These bulges occurred and were corrected for in 4 months: 1931:12, 1934:01, 1936:06, and 1937:06. Because the interpolation procedure forces the sum of the monthly values to equal the annual value, this approximation has no effect on the annual values of the monthly or quarterly series of G.

GROC = Sales by Grocery Chain Stores, NBER Series 06008a and 06008b, X11 s.a.
Data Adjustment: Series ratio linked in Jan. 1935

IIPT = Index of Industrial Production and Trade, NBER Series 12004c, s.a.

IMP = Total Imports, NBER Series 07028, X11 s.a.

Data Adjustment: Changed to real terms by dividing by IM-Deflator/100

IPDM = Index of Production of Durable Manufactures, NBER Series 01234b, s.a.

IPM = Index of Production of Manufacturers, Total, NBER Series 01175, X11 s.a.

NRCONT = Total Building Contracts, Engineering News-Record, Original Data, NBER Series 02003, X11 s.a.
Data Adjustments: Changed to real terms by dividing by I-Nonresidential Structures Deflator/100.

NRCONSTR = Total Construction, Value, Engineering News-Record, Original Data, NBER Series 02003, X11 s.a.
Data Adjustments: Changed to real terms by dividing by I-Nonresidential Structures Deflator/100.

NRFLOOR = Total Nonresidential Building Contracts, Floor Space, F.W. Dodge Corp., NBER Series 02178a and 02178c, X11 s.a.
Data Adjustment: Series ratio linked in Jan. 1925

NRVAL = Total Nonresidential Building Contracts, Value, F.W. Dodge Corp., NBER Series 02177a and 02177c, X11 s.a.
Data Adjustments: In original series, May 1951 is set to 631 from 1631 to correct for a probable typo. Changed to real terms by dividing by I-Nonresidential Structures Deflator/100. Series ratio linked in Jan. 1925.

ORDDUR = U.S. Manufacturers' New Orders of Durable Goods, NBER Series 06084a, 06084b, 06084c, and 06091, X11 s.a.
Data Adjustments: In original series 06084b, Aug. 1945 set equal to average of July and Sept. 1945 to correct for a probable typo. In original series 06091, values for 1919 (all months) set equal to value of Jan. 1920 to complete series. Series 06084b and 06084c changed to real terms by dividing by C-Durable Goods Deflator/100. Series ratio linked in Jan. 1929, Jan. 1939, and Jan. 1947.

PAP = Index of Paper and Pulp Production, NBER Series 01259, X11 s.a.

POW = Electric Power Production, NBER Series 01128 and 01128a, X11 s.a.
Data Adjustment: Series ratio linked in Jan. 1936

PWEM = Production Worker Employment, Manufacturing, Total, NBER Series 08010, X11 s.a.

RCONT = Total Building Contracts, Engineering News-Record, Original Data, NBER Series 02003, X11 s.a.
Data Adjustments: Changed to real terms by dividing by I-Residential Deflator /100.

RCONSTR = Total Construction, Value, Engineering News-Record, Original Data, NBER
    Series 02003, X11 s.a.
    Data Adjustments: Changed to real terms by dividing by I-Residential Deflator/100.

RFLOOR = Total Residential Building Contracts, Floor Space, F.W. Dodge Corp., NBER Series
    02012a and 02012c, X11 s.a.
    Data Adjustment: Series ratio linked in Jan. 1925

RNUM = Total Residential Building Contracts, Number of Buildings, F.W. Dodge Corp., NBER
    Series 02013a and 02013c, X11 s.a.
    Data Adjustment: Series ratio linked in Jan. 1925

RVAL = Total Residential Building Contracts, Value, F.W. Dodge Corp., NBER Series 02011a
    and 02011c, X11 s.a.
    Data Adjustments: Changed to real terms by dividing by I-Residential Deflator/100.
    Series ratio linked in Jan. 1925

T = Trend term appearing in the regression

WPI = Index of Wholesale Prices, NBER Series 04048c, X11 s.a.

NBER Macrohistory Database Notes:
- All monthly interpolator series are set to 1/1919 = 100 except CPI and WPI, which were set to
    1/1917 = 100 (these two extra years for YDEF allow for inflation calculations if need be).
- All monthly interpolator series cover the timespan 1919:01-1951:12 except CPI and WPI,
    which cover 1917:01-1951:12.
- s.a. = already seasonally adjusted in NBER Macrohistory Database.
- X11 s.a. = seasonally adjusted via the X11 seasonal adjustment program in RATS.

2b. Annual Variables from BEA and Earlier Data Sources: 1919-1951

Note: We debated between using $1937, $1952, and $2005 for the annual 1919-1951 data. We
settled on $1937 (except Figure 1 which uses $2005 for comparison's sake) because we wanted to
be able to set 'GDP = sum of components' with the smallest residual possible. See table below:

Average Abs. Value of Residual / GDP			
Time Period	**$1937**	**$1952**	**$2005**
1919-1929	1.5%	7.5%	3.4%
1929-1939	1.3%	4.2%	4.9%
1939-1945	1.0%	2.4%	15.3%
1945-1951	4.6%	0.1%	4.2%
1919-1941	1.3%	5.7%	4.4%
1919-1951	2.0%	4.1%	6.1%

$1937 has the lowest absolute value of the residual as a percentage of GDP for 3 of the 4 time periods. Most importantly, it has the smallest residual for the time periods this paper is concentrated on: 1939-1945 and 1919-1941. Thus all values in this paper are expressed in billions of $1937.

- *Source:* Bureau of Economic Analysis (BEA): http://bea.gov/index.htm

Real GDP: Billions of chained $1937. Sum of interpolated GDP components: CD + CND + CS + IPDE + IRES + INRES + BUSINV + G + X – IM.
Data Adjustments: Data from 1913:Q1-1918:Q4 is from Gordon-Veitch variable RGNP72, ratio linked in 1919:Q1 to sum of interpolated GDP components as described above. Data from 1952:Q1 to 1954:Q4 is from the NIPA Table 1.1.6B, Line 1: GDP minus Line 25: Residual, last revised 3/19/04. This series has been reverse ratio linked in 1951:Q4 to sum of interpolated GDP components as described above.
Variable: Y

GDP Deflator: NIPA Table 1.1.9, last revised 12/23/08. Index numbers, 1937=100.
Data Adjustments: Ratio linked to Gordon-Veitch (1986) variable GNPDEF in 1929. Changed from 2000=100 to 1937=100 by multiplying by 100 divided by the 2000=100 1937 value. Annual data multiplied by 12 to keep Chow-Lin interpolated monthly data as 1937=100.
Chow-Lin Interpolated Variable: YDEF

Personal Consumption Expenditures (C)-Durable Goods: NIPA Table 1.1.6A, last revised 3/19/04. Billions of chained $1937.
Data Adjustments: Reverse ratio linked to NIPA Table 1.1.6B (last updated 3/19/04) in 1947 to extend the series (in chained $1937) out to 1951. Ratio linked to Gordon-Veitch (1986) variable CDUR72 in 1929.
Chow-Lin Interpolated Variable: CD

C-Nondurable Goods: NIPA Table 1.1.6A, last revised 3/19/04. Billions of chained $1937.
Data Adjustments: Reverse ratio linked to NIPA Table 1.1.6B (last updated 3/19/04) in 1947 to extend the series (in chained $1937) out to 1951. Ratio linked to Gordon-Veitch (1986) variable CNDUR72 in 1929 multiplied by the 1929 ratio of C-Nondurable Goods to C-Nondurable Goods and Services.
Chow-Lin Interpolated Variable: CND

C-Services: NIPA Table 1.1.6A, last revised 3/19/04. Billions of chained $1937.
Data Adjustments: Reverse ratio linked to NIPA Table 1.1.6B (last updated 3/19/04) in 1947 to extend the series (in chained $1937) out to 1951. Ratio linked to Gordon-Veitch (1986) variable CNDUR72 in 1929 multiplied by the 1929 ratio of C-Services to C-Nondurable Goods and Services.
Chow-Lin Interpolated Variable: CS

C-Durable Goods Deflator: NIPA Table 1.1.9, last revised 12/23/08. Index numbers, 2000=100.
Data Adjustments: Ratio linked to Gordon-Veitch (1986) variable CDURDEF in 1929.
Monthly deflator obtained by setting annual values = July values. Other months
obtained by yearly log-linear interpolation.

Gross Private Domestic Investment (I)-Nonresidential Equipment and Software: NIPA
Table 1.1.6A, last revised 3/19/04. Billions of chained $1937.
Data Adjustments: Reverse ratio linked to NIPA Table 1.1.6B (last updated 3/19/04) in
1947 to extend the series (in chained $1937) out to 1951. Ratio linked to Gordon-Veitch
(1986) variable PRODUR72 in 1929.
Chow-Lin Interpolated Variable: IPDE

I-Residential: NIPA Table 1.1.6A, last revised 3/19/04. Billions of chained $1937.
Data Adjustments: Reverse ratio linked to NIPA Table 1.1.6B (last updated 3/19/04) in
1947 to extend the series (in chained $1937) out to 1951. Ratio linked to Gordon-Veitch
(1986) variable IRES72 in 1929.
Chow-Lin Interpolated Variable: IRES

I-Nonresidential Structures: NIPA Table 1.1.6A, last revised 3/19/04. Billions of chained $1937.
Data Adjustments: Reverse ratio linked to NIPA Table 1.1.6B (last updated 3/19/04) in
1947 to extend the series (in chained $1937) out to 1951. Ratio linked to Gordon-Veitch
(1986) variable NONRES72 in 1929.
Chow-Lin Interpolated Variable: INRES

I-Residential Deflator: NIPA Table 1.1.9, last revised 12/23/08. Index numbers, 2000=100.
Data Adjustments: Ratio linked to Gordon-Veitch (1986) variable IRESDEF in 1929.
Monthly deflator obtained by setting annual values = July values. Other months
obtained by yearly log-linear interpolation.

I-Nonresidential Structures Deflator: NIPA Table 1.1.9, last revised 12/23/08. Index numbers,
2000=100.
Data Adjustments: Ratio linked to Gordon-Veitch (1986) variable NONRESDF in 1929.
Monthly deflator obtained by setting annual values = July values. Other months
obtained by yearly log-linear interpolation.

I-Change in Private Inventories: NIPA Tables 1.1.6A and 1.1.6B, last revised 3/19/04.
Billions of chained $1937.
Data Adjustments: Reverse ratio linked to NIPA Table 1.1.6B (last updated 3/19/04) in
1947 to extend the series (in chained $1937) out to 1951. Data for 1919-1928 is from
Gordon-Veitch (1986) variable DBUSI72. This was changed to real $1937 terms by
multiplying the value by the average 1929 value of Gordon-Veitch variable GNPDEF

divided by the 1929 value of YDEF. Annual data smoothed to monthly data using sliding weights and dividing by 12 (note: 1918 value assumed to be 0):

Weights on Annual Data by Month

	t-1	t	t+1
Jan	11/24	13/24	0
Feb	3/8	5/8	0
Mar	7/24	17/24	0
Apr	5/24	19/24	0
May	1/8	7/8	0
June	1/24	23/24	0
July	0	23/24	1/24
Aug	0	7/8	1/8
Sept	0	19/24	5/24
Oct	0	17/24	7/24
Nov	0	5/8	3/8
Dec	0	13/24	11/24

Variable: BUSINV

Government Consumption Expenditures and Gross Investment (G): NIPA Table 1.1.6A, last revised 3/19/04. Billions of chained $1937.
Data Adjustment: Reverse ratio linked to NIPA Table 1.1.6B (last updated 3/19/04) in 1947 to extend the series (in chained $1937) out to 1951. Ratio linked to Gordon-Veitch (1986) variable GOVPUR72 in 1929.
Chow-Lin Interpolated Variable: G

G-Deflator: NIPA Table 1.1.9, last revised 12/23/08. Index numbers, 2000=100.
Data Adjustments: Ratio linked to Gordon-Veitch (1986) variable GOVPURDF in 1929. Monthly deflator obtained by setting annual values = July values. Other months obtained by yearly log-linear interpolation.

Imports (IM): NIPA Table 1.1.6A, last revised 3/19/04. Billions of chained $1937.
Data Adjustment: Reverse ratio linked to NIPA Table 1.1.6B (last updated 3/19/04) in 1947 to extend the series (in chained $1937) out to 1951. Ratio linked to Gordon-Veitch (1986) variable MPT72 in 1929.
Chow-Lin Interpolated Variable: IM

Exports (X): NIPA Table 1.1.6A, last revised 3/19/04. Billions of chained $1937.
Data Adjustment: Reverse ratio linked to NIPA Table 1.1.6B (last updated 3/19/04) in 1947 to extend the series (in chained $1937) out to 1951. Ratio linked to Gordon-Veitch (1986) variable XPT72 in 1929.
Chow-Lin Interpolated Variable: X

IM-Deflator: NIPA Table 1.1.9, last revised 12/23/08. Index numbers, 2000=100.
Data Adjustments: Ratio linked to Gordon-Veitch (1986) variable MPTDEF in

1929. Monthly deflator obtained by setting annual values = July values. Other months obtained by yearly log-linear interpolation.

X-Deflator: NIPA Table 1.1.9, last revised 12/23/08. Index numbers, 2000=100.
Data Adjustments: Ratio linked to Gordon-Veitch (1986) variable XPTDEF in 1929. Monthly deflator obtained by setting annual values = July values. Other months obtained by yearly log-linear interpolation.

BEA Notes:
-   See Table 1 for specific Chow-Lin interpolators used for each variable.
-   All annual series are 1919-1951 except YDEF, which is 1917-1951 to allow for the possible inflation calculations.
-   It doesn't matter that all deflators (except the GDP Deflator) are 2000=100 because they are only used to change some of the interpolators into real terms, and the interpolators are all set to 1919=100.

- *Source:* Gordon, Robert J. and John M. Veitch (1986). "Fixed Investment in the American Business Cycle, 1919-83," in Robert J. Gordon, ed., The American Business Cycle: Continuity and Change (University of Chicago Press for NBER, 1986), pp. 267-335. Data below from the quarterly data.
http://www.nber.org/data/abc/.

Note: These data are used to extend our annual series back to 1919 (1917 for YDEF), see above for specific series details.

CDUR72 = Consumption Durable Goods, $1972
CDURDEF = Consumption Durable Goods, Deflator
CNDUR72 = Nondurable Goods and Services, $1972
DBUSI72 = Change in Business Inventories, $1972
GNP = Nominal GNP
GNPDEF = GNP Deflator ($1972=100)
GOVPUR72 = Government Purchases, $1972
GOVPURDF = Government Purchases, Deflator
IRES72 = Investment Residential Structures, $1972
IRESDEF = Investment Residential Structures, Deflator
MPT72 = Imports, $1972
MPTDEF = Imports, Deflator
NONRES72 = Non-Residential Structures, $1972
NONRESDF = Non-Residential Structures, Deflator
PRODUR72 = Producers Durable Equipment, $1972
RGNP72 = Real GNP, $1972
XPT72 = Exports, $1972
XPTDEF = Exports, Deflator

Gordon-Veitch Note: Data changed to annual terms needed for interpolation by summing quarterly data and dividing by four.

Section 3. Calculation of Sum of Components Potential Real GDP (Y^N): 1913:Q3-1954:Q4

Following the rational of Gordon (2009) pp. 7-8, the years 1913, 1928, 1950 and 1954 were chosen as "benchmark" years, as in these years it is assumed that sum of components real GDP is roughly equal to sum of components potential real GDP. These years were chosen such that the economy was "neither in a recession nor in an unsustainable peacetime or wartime boom" (8). This paper adds 1924 as an additional benchmark year after examining a study of capacity utilization found in Lazonick (2002). Between these years, it is assumed that sum of components potential real GDP grows at a constant exponential rate, in order to avoid the distortion caused by the two world wars and the Great Depression. The exponential quarterly growth rates g_i are calculated with the formula:

$$g_i = \ln(x_t / x_{t-n}) / n$$

where i = (1 for 1913-24, 2 for 1924-28, 3 for 1928-50, and 4 for 1950-54), x_t = the annual sum of components real GDP for the benchmark year, and n = the number of quarters between the benchmark years. For example, n = 44 for 1913-1924.

The sum of components potential real GDP series starts in 1913:Q3. 1913:Q3 = (x_{1913} / 4)* exp(g_1 / 2). Subsequent quarters' values until 1924:Q3 are equal to the previous quarters' values multiplied by exp(g_1).

1924:Q3's value = (1924:Q2's value)*exp((g_1 + g_2) / 2). Subsequent quarters' values until 1928:Q3 are equal to the previous quarters' values multiplied by exp(g_2).

1928:Q3's value = (1928:Q2's value)*exp((g_2 + g_3) / 2). Subsequent quarters' values until 1950:Q3 are equal to the previous quarters' values multiplied by exp(g_3).

1950:Q3's value = (1950:Q2's value)*exp((g_3 + g_4) / 2). All subsequent quarters' values are equal to the previous quarters' values multiplied by exp(g_4).

Section 4. Real Compensation per Hour and Total Economy Productivity: 1933-1941

- *Source:* Bureau of Economic Analysis (BEA): http://bea.gov/index.htm

Nominal Compensation of Employees, Paid (NCOMP): NIPA Table 1.10, last revised 4/29/09.

GDP Deflator (YDEF): NIPA Table 1.1.9, last revised 4/29/09.

Real GDP (RY): Billions of $1937. NIPA Table 1.1.6A, last revised 3/19/04.

- *Source:* Kendrick, John W. (1961). *Productivity trends in the United States.* General Series 71, National Bureau of Economic Research. Princeton, N.J.: Princeton University Press.

Total Man-hours Including Government (H): Table A-X p. 313

- *Calculations:*

Real Compensation of Employees, Paid (RCOMP): Equals 100*(NCOMP / YDEF)

Real Compensation per Hour: Equals RCOMP / H.

Total Economy Productivity: Equals RY / H.

Section 5. Figure A-1 Source ($2005 data)

1919-1929 annual data from Balke and Gordon (1989), ratio-linked in 1929 to annual data from BEA NIPA Table 1.1.6 for $2000, ratio-linked in 1929 to annual data from BEA NIPA Table 1.1.6A (which is reverse ratio-linked in 1947 to NIPA Table 1.1.6B) for $1937

Section 6. Figures 1 and 2 Source Information

1913-1954 band-pass filtered output cycles and trends isolating frequencies corresponding to periodicities between 6 and 32 quarters estimated from our new set of quarterly data 1913-54 were provided to us by Giorgio Primiceri.

Civilian employment and the population aged 14+ come from the *Millennial Edition of the Historical Statistics*, series Ba471 and Aa140, respectively.

Section 5. Comments on Differences between Our Data and Ramey Data

Ramey (2011a) used a completely different method to arrive at her quarterly data for GDP and GDP components. Instead of using monthly interpolators, Ramey utilizes the 1954 National Income supplement of the predecessor agency of the BEA, which published quarterly nominal GDP and components measures back to 1939:Q1. Ramey converted this into real terms by creatively deflating the nominal data by various mixes of CPI components. The fact that these two uniquely created datasets line up so well over the 1939:Q1 to 1941:Q4 period, as shown in Figure A-2 lends credibility to both approaches.

One notable difference between the newly interpolated dataset and Ramey (2011a) data is that our data show a slight decline in G/Y^N from 1941:Q1 to 1941:Q2 while Ramey's data show a steady increase. This quarterly zig-zag in the data has an impact on our subsequent impact of fiscal multipliers, and we choose to base our central results on estimates from an average of our data and the Ramey data.

The nominal raw data for the NBER's monthly series for federal government expenditures, which is used to interpolate our quarterly series for G, shows an 11% rise between 1941:Q1-1941:Q2. However, after converting nominal dollars to real \$1937 and seasonally adjusting the data,[65] 1941:Q2 government expenditures were actually 6% lower than 1941:Q1.[66] As shown in Sections 6 and 7, this inverse relationship between the growth of G and growth of Y during this crucial time period biases down both our estimate of how much of the recovery can be explained by innovations in G and our fiscal multiplier estimates relative to using Ramey's data series. To eliminate data uncertainty as a source of error, our basic estimates in Tables 2 and 3 are based on the average of our interpolated data and the Ramey data for the period starting in 1939:Q1. Ramey data are not available prior to 1939:Q1 and hence are ratio-linked to our data in 1939:Q1.

Section 6. How Much are Government Spending Multipliers Biased Down in 1940-41 Due to Tax Increases?

Care must be taken to interpret the rise in government tax revenues during 1940-41 as a combination of higher tax rates and higher tax revenue generated by rising GDP and incomes at the initial 1940 tax rates. To decompose tax revenues between higher GDP and higher tax rates, as before we use the identity $Y \equiv G + N$, where N is non-government expenditures on GDP (consumption, investment, and net exports). We then divide the determinants of non-government spending N into an autonomous and induced part, $N = N_a + nY(1-t)$, where N_a is the autonomous component of N, n is the marginal propensity of private spending, and t is the tax rate. Our task is to determine the impact of the higher tax rate in 1941 compared to 1940 on the multiplier. Since we know the values in 1940 and 1941 of Y, G, N, and t, we have one equation in the two unknowns N_a and n, and we can express the unknown N_a as a function of various plausible values of n.[67]

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65. All non-seasonally adjusted monthly interpolating series are seasonally adjusted prior to the Chow-Lin interpolation procedure. See the Data Appendix for more details.

66. The vast majority of the difference is due to the seasonal adjustment procedure. On average, Q1 government expenditures are 3.8% below the average quarterly amount for a given year (and thus gets bumped up by the seasonal adjustment) while Q2 is 10.3% above average (and thus gets bumped down significantly by the seasonal adjustment). Q3 is 7.4% below average and Q4 is 0.9% above average.

67. $N_a = Y(1-n(1-t)) – G$. For instance in 1940 the average N/Y ratio was 0.861. The 1940 solution for N_a is *18.6* when n is assumed to be 0.76 and 11.7 when n is assumed to be 0.86. The 1941 solutions are respectively 17.5 and 9.7 for the same assumed values of n.

For various combinations of N_a and n that are consistent with 1941 Y and G, we can compare actual GDP for 1941:Q2 with the hypothetical value if tax rates has been left unchanged at the 1940 levels. Since in 1940 the average ratio N/Y was 0.86, we start with a central N/Y ratio of 0.86 and explore a range of marginal propensities (n) between 0.76 and 0.84. For a marginal propensity of 0.76, the government spending multiplier is 1.73 when rising tax rates are ignored but is 2.34 for a constant 1940 level of tax rates. This discrepancy becomes larger at higher assumed values of n. For instance, an assumed marginal propensity of 0.84 yields a multiplier of 2.55 for a constant level of tax rates, fully 0.82 above the estimated multiplier that ignores tax changes. Based on this paragraph, we shall suggest that estimated government purchases multipliers for 1940-41 understate the pure purchases multiplier by between 0.6 and 0.8.[68]

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68. Barro-Redlick (2011) include the change in the tax rate in their estimated equations for the change in GDP but use the average marginal personal income tax rate, which ignores the fact that the personal income tax only accounted for 15 percent of total government tax revenue in 1942.

Figure 1. Real GDP in $1937 and Annual Rates of Change of Band-Pass Filtered and Exponential-through-Benchmarks Estimates of Potential Real GDP, 1913-54
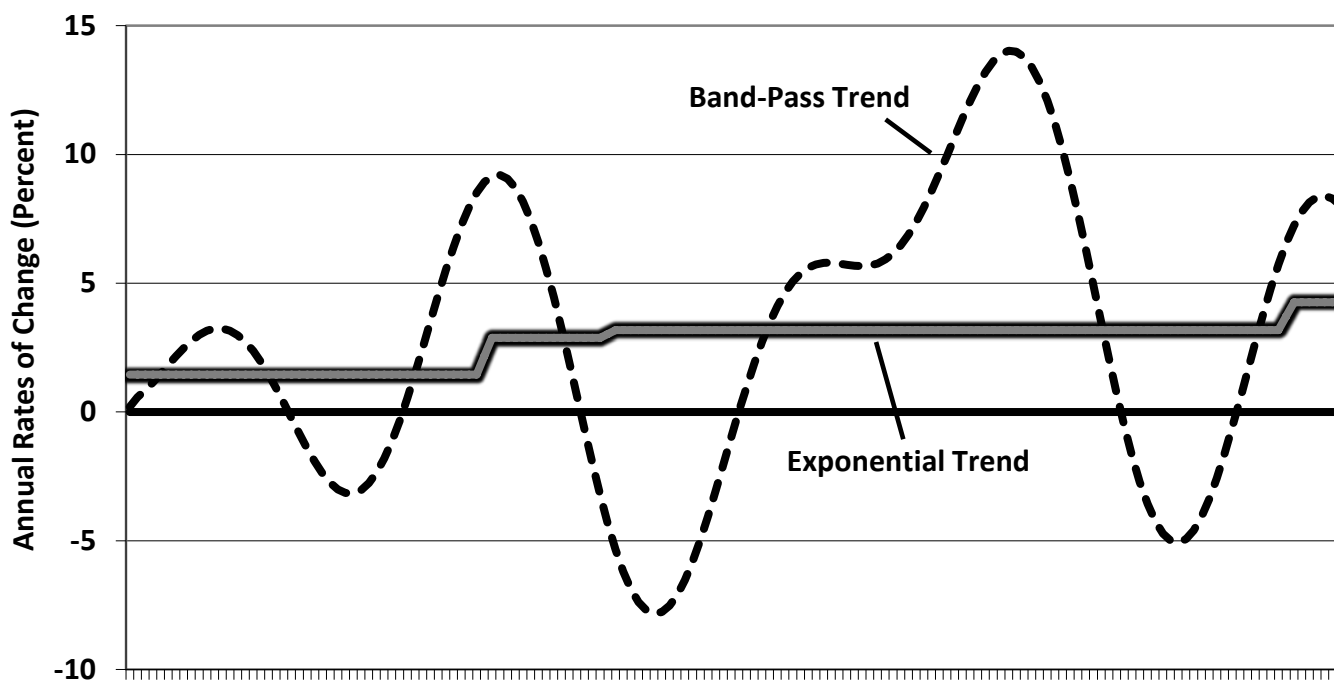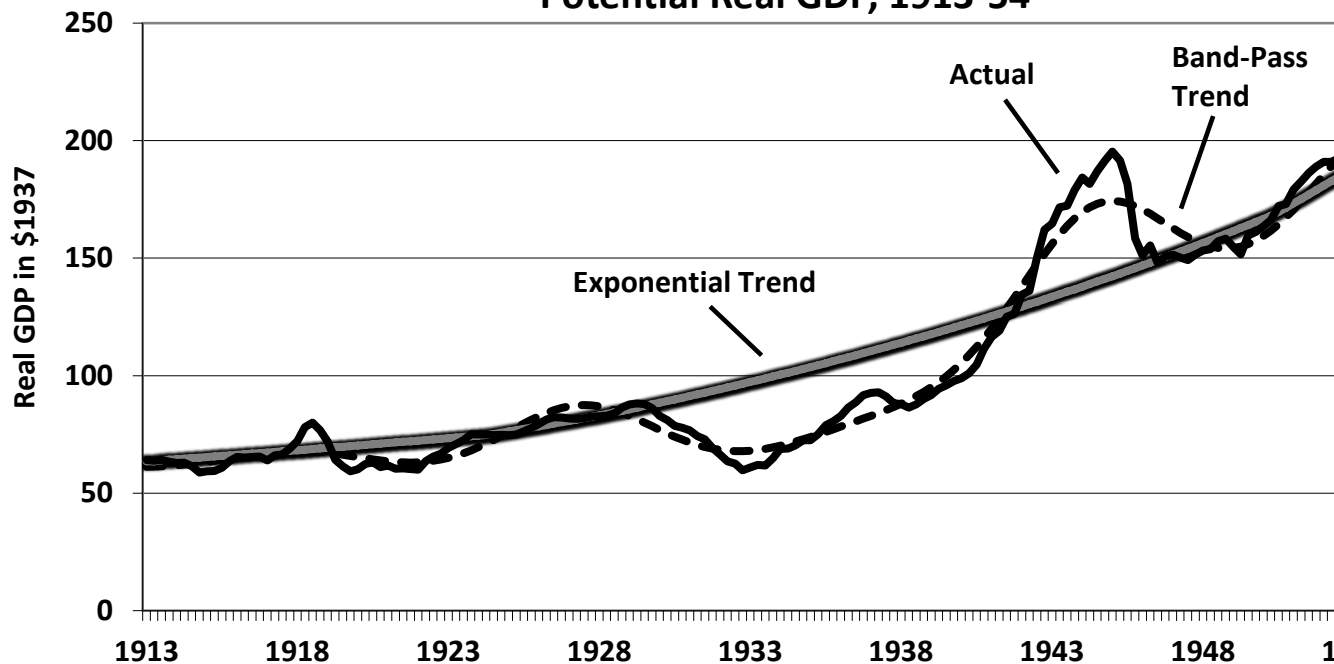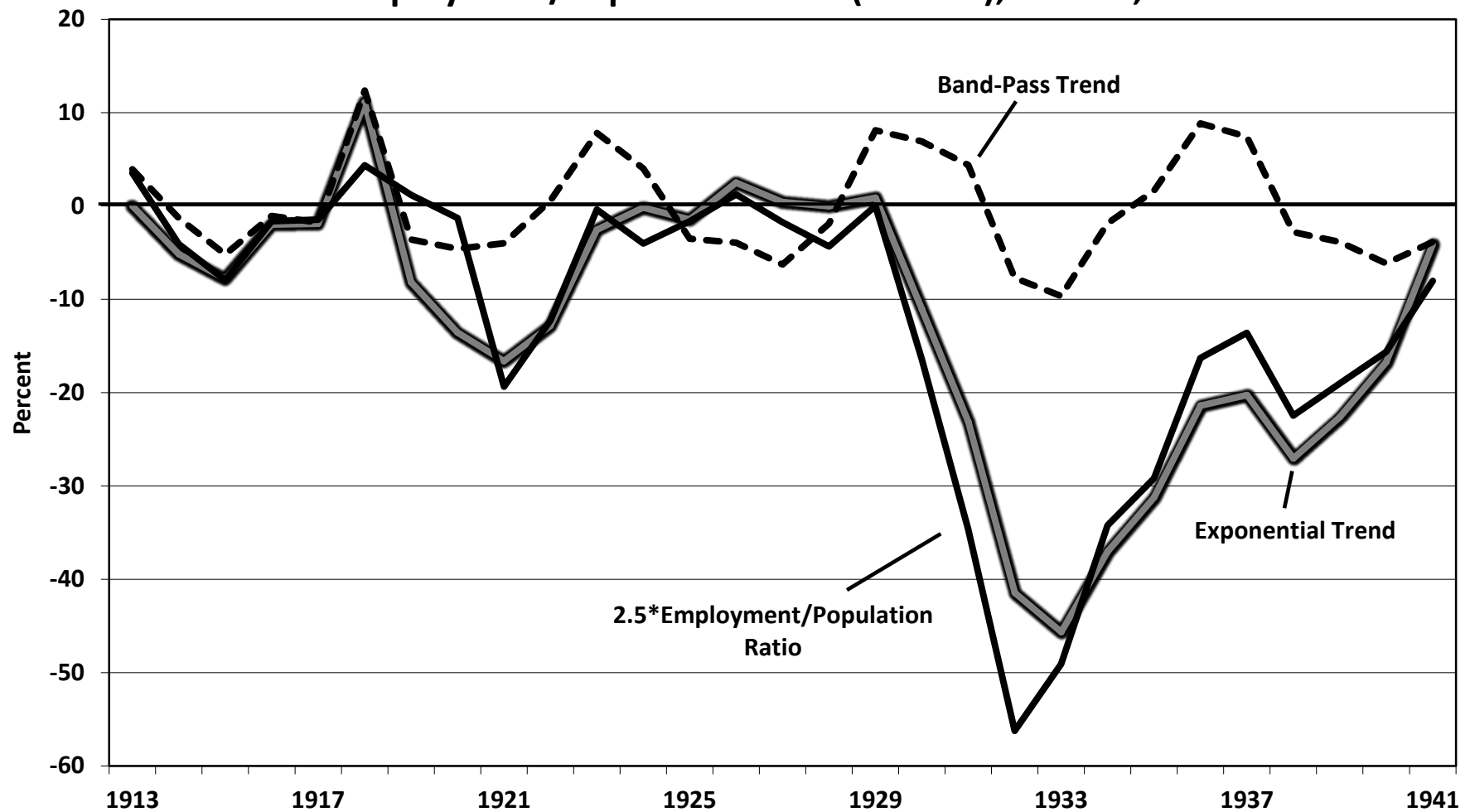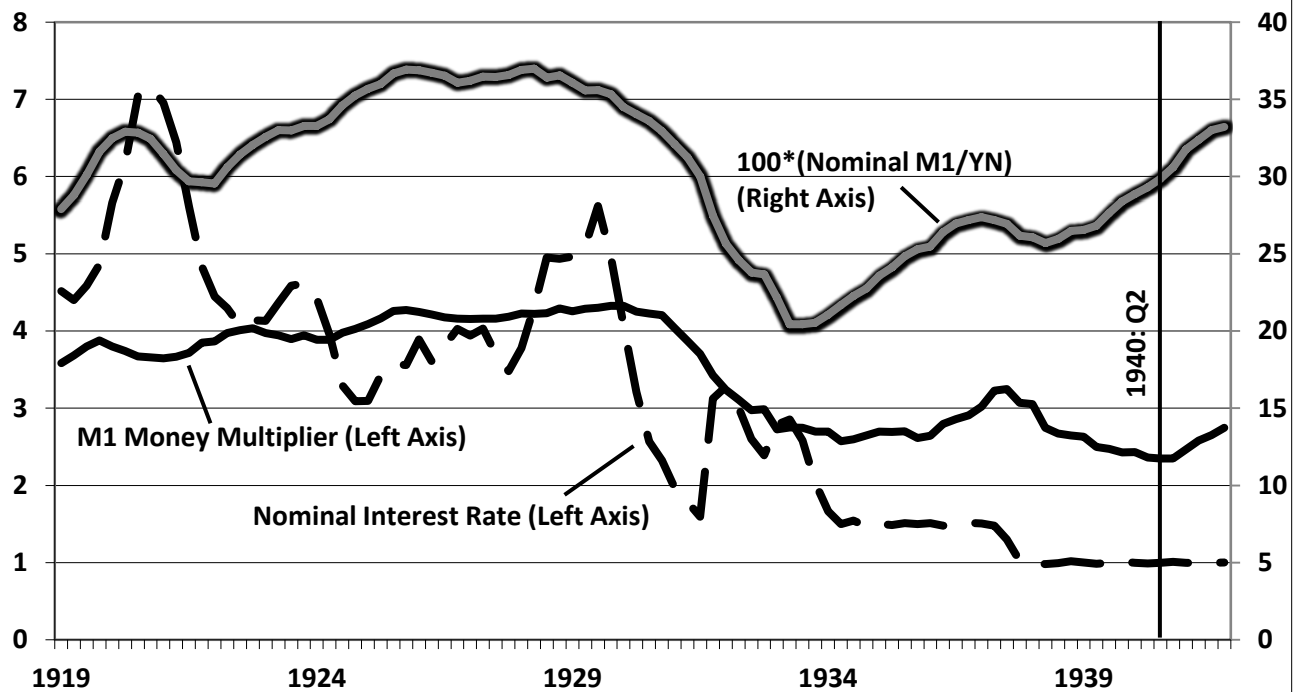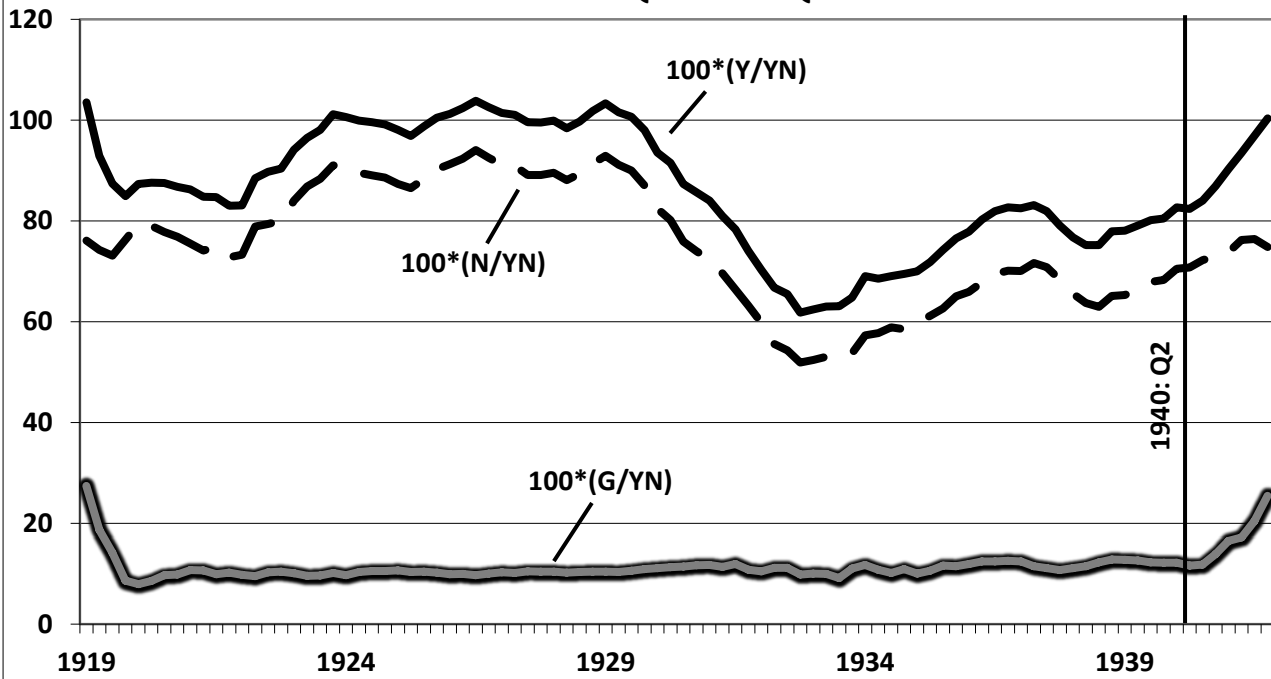
Figure 2. Percent Log Ratio of Actual to Trend Real GDP, Band-Pass Filtered and Exponential-through-Benchmarks and 2.5x the Percent Log of the Employment/Population Ratio (1929=0), Annual, 1913-41
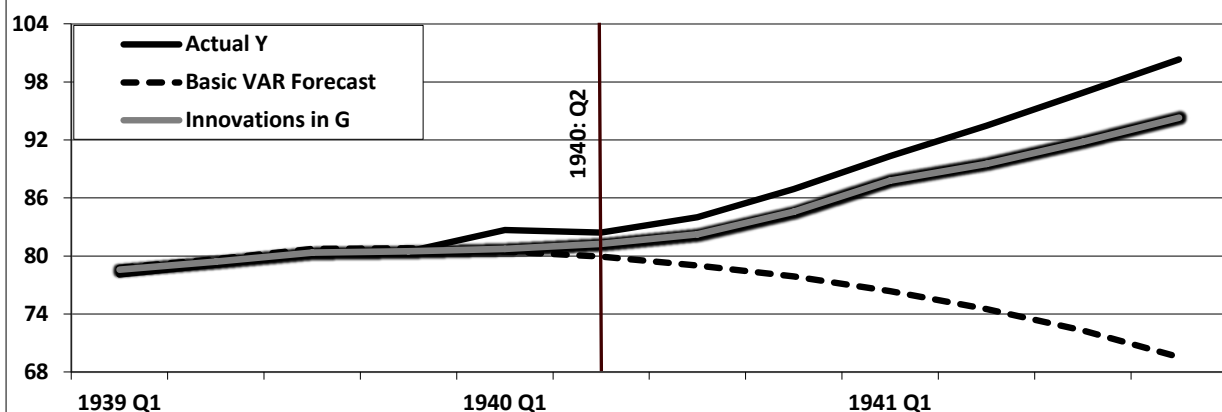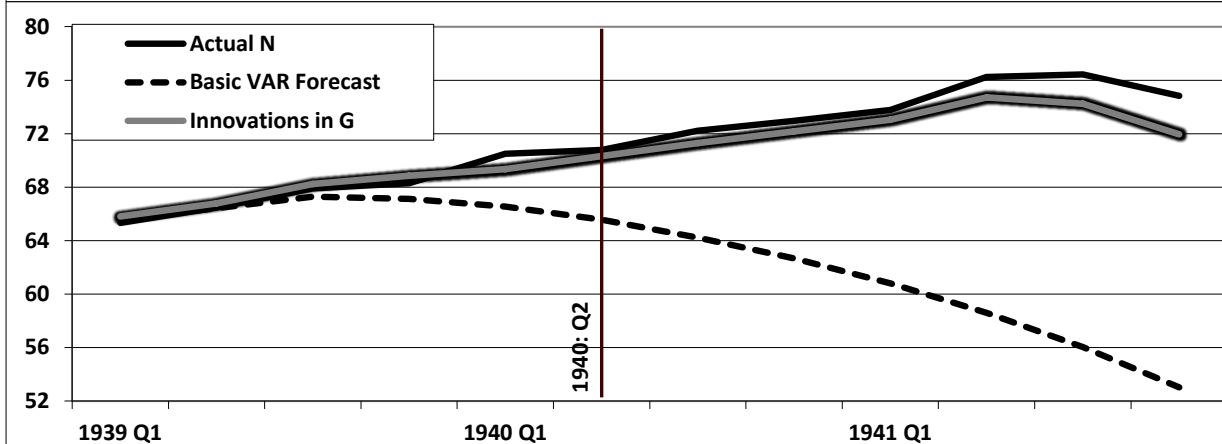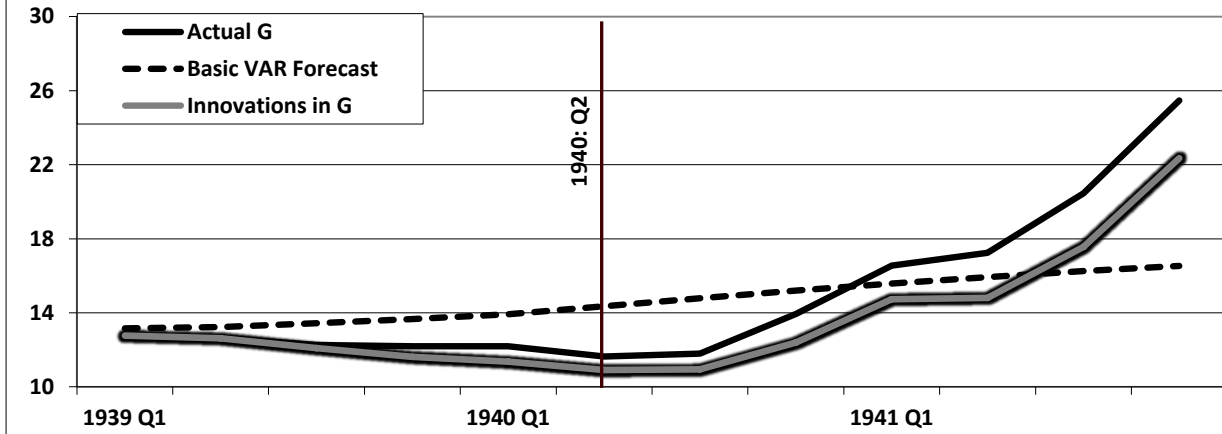
Source: See Data Appendix

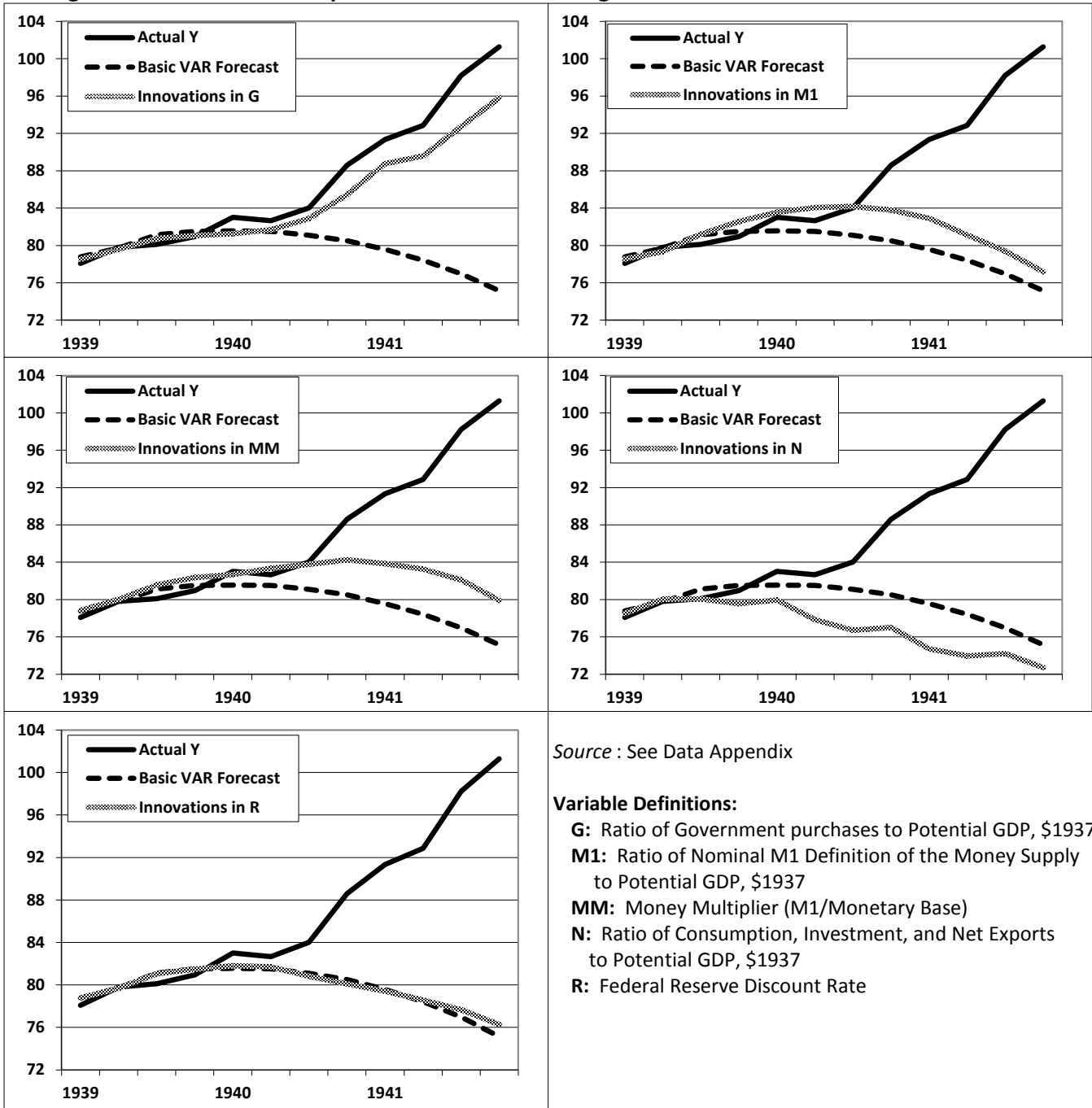# Figure 3. Output Gap and Variables Used in the VAR, 1919:Q1-1941:Q4

Source: See Data Appendix

Figure 4. Historical Decompositions: 1939:Q1 to 1941:Q4

Source: See Data Appendix

Figure 5. Historical Decomposition of Real GDP Using Gordon-Krenn Data: 1939:Q1 to 1941:Q4


Legends for charts:
- Actual Y
- Basic VAR Forecast
- Innovations in G
- Innovations in M1
- Innovations in MM
- Innovations in N
- Innovations in R

Source : See Data Appendix

Variable Definitions:
  G: Ratio of Government purchases to Potential GDP, $1937
  M1: Ratio of Nominal M1 Definition of the Money Supply
      to Potential GDP, $1937
  MM: Money Multiplier (M1/Monetary Base)
  N: Ratio of Consumption, Investment, and Net Exports
      to Potential GDP, $1937
  R: Federal Reserve Discount Rate

Figure 6. Percentage of the Recovery Explained by Fiscal Policy Innovations, Monetary Policy Innovations and Other Factors, Using Average of Gordon-Krenn and Ramey Data: 1939:Q2 to 1941:Q4
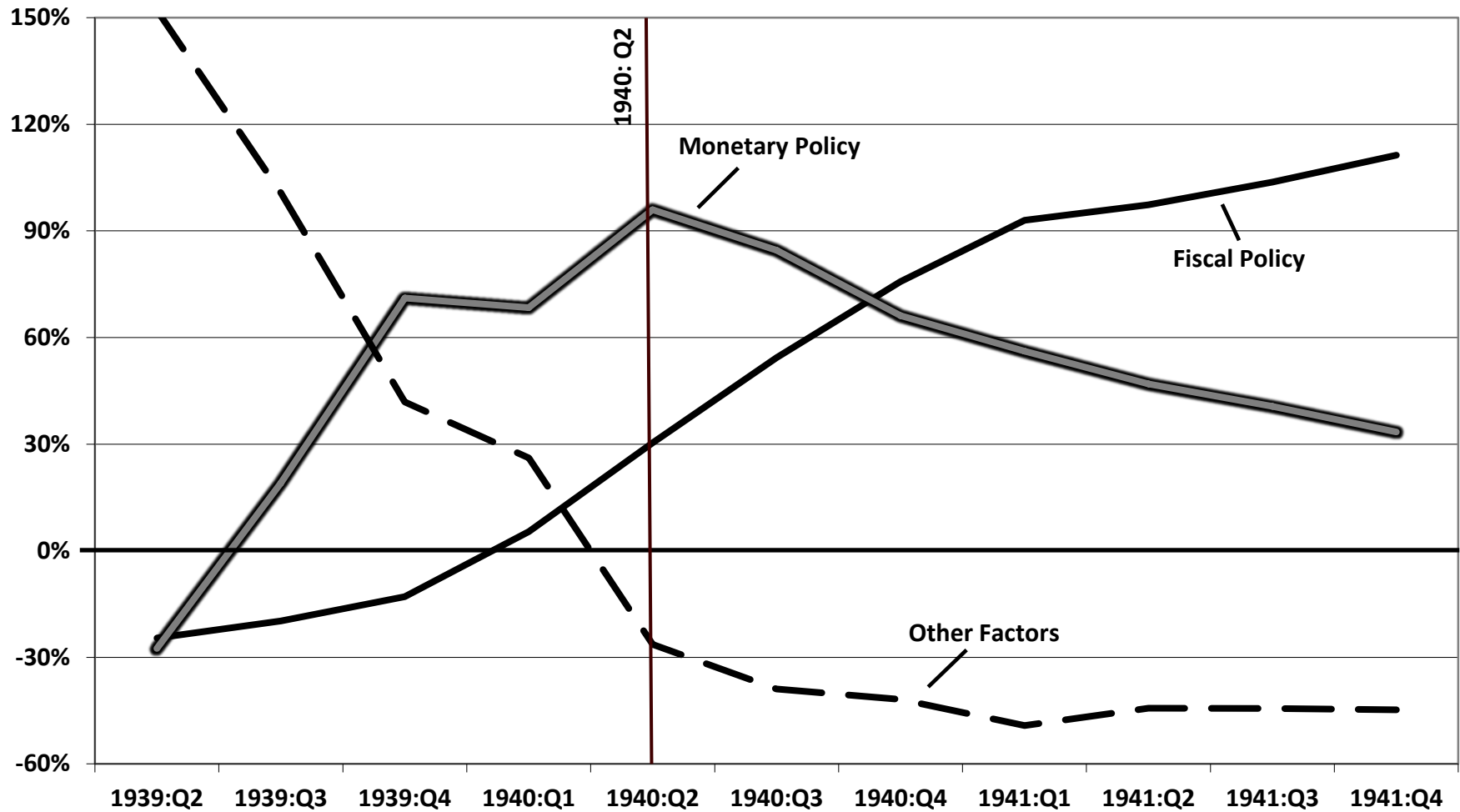
Source: See Data Appendix

Table 1

Labor Force, Armed Forces, Employment, and Unemployment, 1940 and 1944 (in thousands)

Magnitude	1940	1944	Change, 1940 to 1944
1. Total Labor Force	56,098	66,082	9,984
2. Armed Forces	458	11,452	10,994
3. Civilian Labor Force	55,640	54,630	-1,010
4. Civilian Employment	47,520	53,960	6,440
5. Unemployment	8,120	670	-7,450
Addendum:			
6. Female Total Labor Force	14,140	19,370	5,230
7. Male Labor Force	42,020	46,670	4,650

Sources : Lines 3, 4, 5: *HSUS Millenial Edition: Series* Ba479, Ba481, Ba484. Line 2: Series Ed26.
  Line 1: Sum of Lines 2 and 3. Lines 6 and 7: *HSUS Colonial Times to 1958:* Series D14, D20.

Table 2

Fiscal Multiplier Estimates Using Basic VAR Dynamic Forecast Starting in 1940:Q2, Alternative Dates and VAR Robustness Tests

VAR Time Period	Data Source	VAR Ordering	Multiplier Time Period	
			1940:Q2-1941:Q2	1940:Q2-1941:Q4
Baseline Result				
1920:Q2-1941:Q3	Gordon & Krenn	G, M1, MM, N, R	1.8	0.9
1920:Q2-1941:Q3	Ramey (2011a) *	G, M1, MM, N, R	3.2	0.9
1920:Q2-1941:Q3	**Average**	**G, M1, MM, N, R**	**2.5**	**0.9**
Adding GDP Deflator to the VAR Model				
1920:Q2-1941:Q3	Average	G, M1, MM, N, R, YDEF	2.9	1.1
Alternative VAR Orderings				
1920:Q2-1941:Q3	Average	G, N, M1, MM, R	2.5	0.9
1920:Q2-1941:Q3	Average	N, G, M1, MM, R	2.8	1.5
1920:Q2-1941:Q3	Average	M1, MM, G, N, R	2.5	0.9
1920:Q2-1941:Q3	Average	M1, MM, N, G, R	3.0	1.6
Alternative Methodology: Do Not Subtract VAR Forecasts				
1920:Q2-1941:Q3	Average	G, M1, MM, N, R	2.3	1.2

* Ramey (2011a) data is reverse ratio linked to Gordon and Krenn (2011) data in 1939:Q1 for *G* and *N*

Source : See Data Appendix

Table 3

## Summary of VAR Robustness Checks, Using Dynamic Forecast from 1939:Q1 to 1941:Q4

VAR Time Period	Data Source	VAR Ordering	Percentage of Recovery Explained		
			Innovations in G	Innovations in MP *	Other **
Baseline Result					
1920:Q2-1941:Q3	Gordon & Krenn	G, M1, MM, N, R	89	34	-23
1920:Q2-1941:Q3	Ramey (2011a) ***	G, M1, MM, N, R	135	32	-67
1920:Q2-1941:Q3	**Average**	**G, M1, MM, N, R**	**111**	**34**	**-45**
Adding GDP Deflator to the VAR Model					
1920:Q2-1941:Q3	Average	G, M1, MM, N, R, YDEF	103	28	-31
Alternative VAR Orderings					
1920:Q2-1941:Q3	Average	G, N, M1, MM, R	111	33	-44
1920:Q2-1941:Q3	Average	N, G, M1, MM, R	116	33	-48
1920:Q2-1941:Q3	Average	M1, MM, G, N, R	132	12	-45
1920:Q2-1941:Q3	Average	M1, MM, N, G, R	139	12	-52

6

* MP = Monetary Policy (Combined Effect of Innovations in M1, MM and R)

** Other = Combined Effect of Basic VAR Dynamic Forecast and Innovations in N

*** Ramey (2011a) data is reverse ratio linked to Gordon and Krenn (2011) data in 1939:Q1 for G and N

Source : See Data Appendix

Figure A-1. $1937 vs. $2005 Comparison for GDP Residual / GDP and G / GDP: 1919-1951
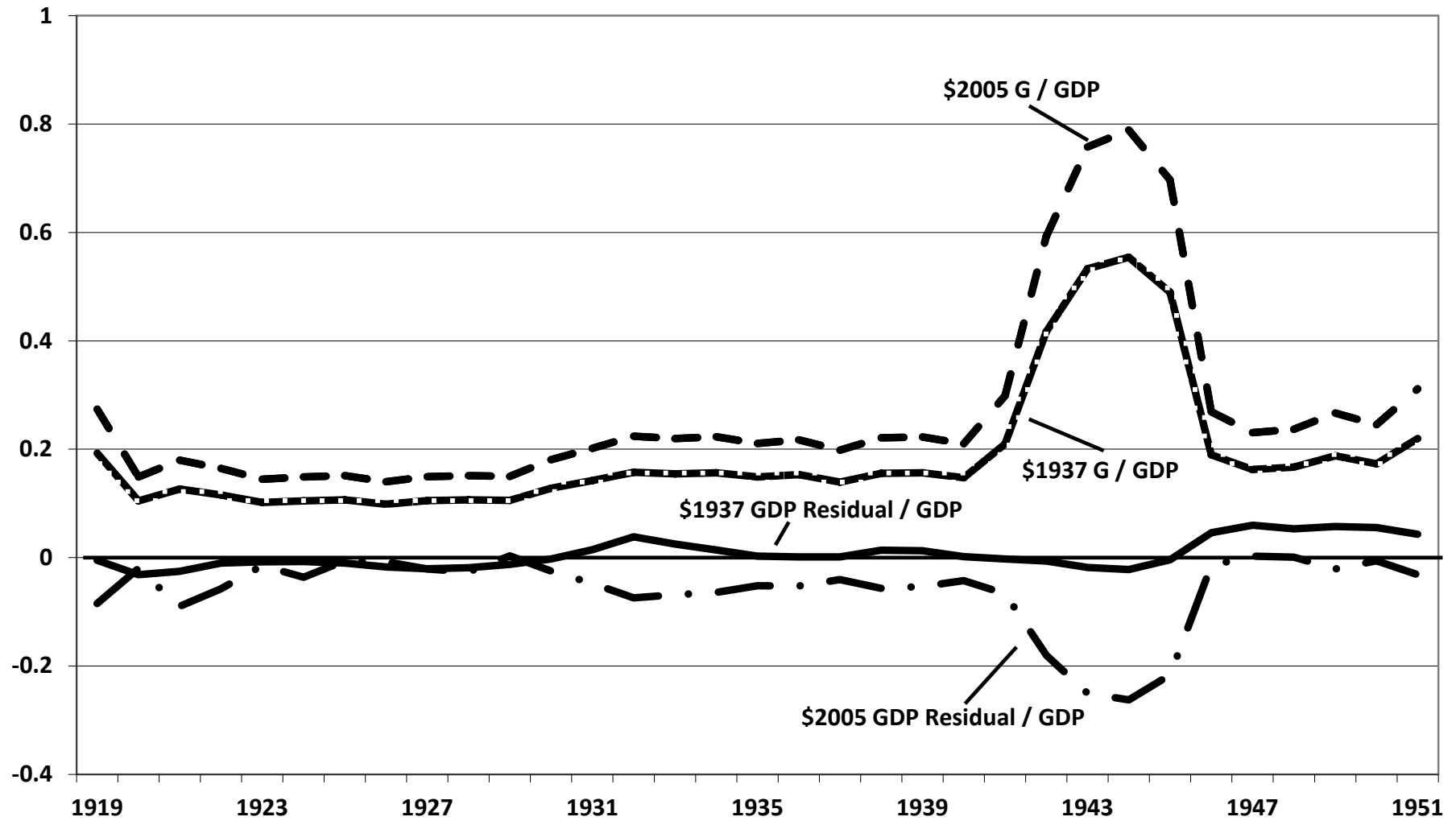
Source: See Data Appendix

Figure A-2. Comparison of Newly Interpolated Dataset to Data from Ramey (2011a), 1939:Q1-1941:Q4*
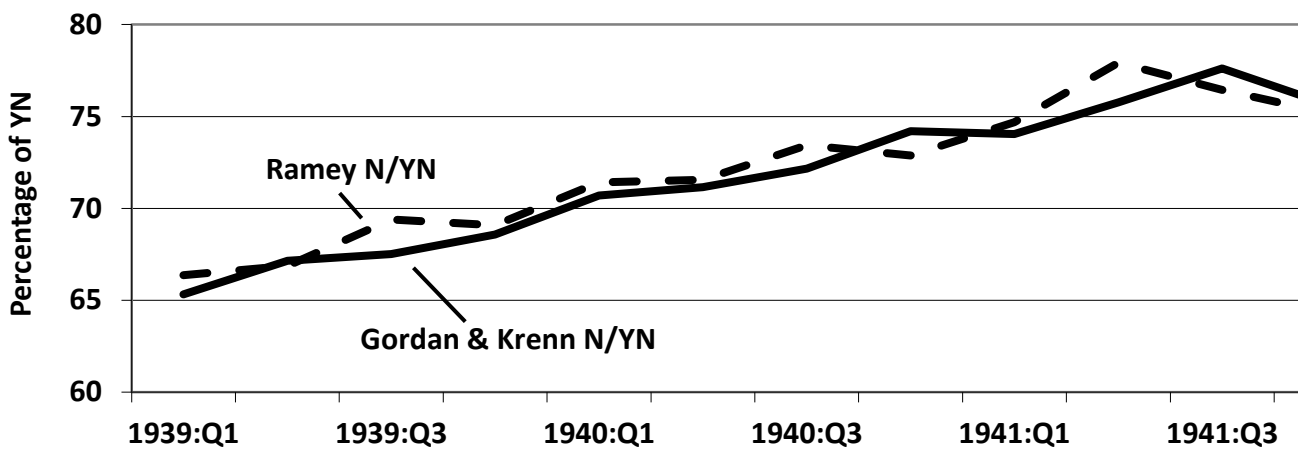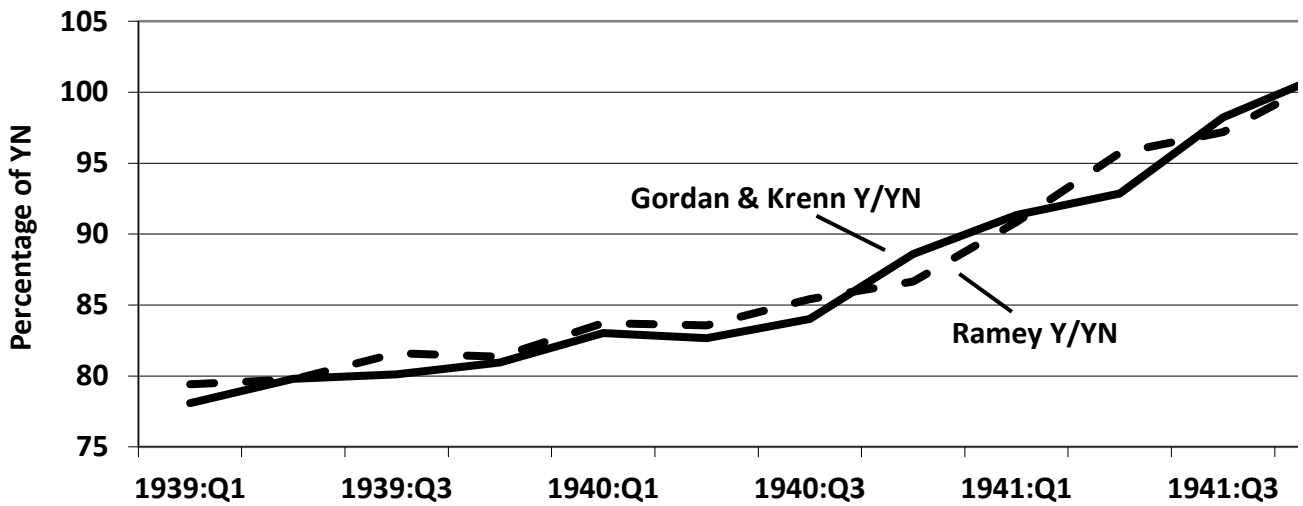
* N = Real GDP (Y) minus Real Government Spending (G)