The Impact of World War II on U.S. Productivity Growth

by

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ABSTRACT

This paper considers the productivity impact on the U.S. economy of the period of war

mobilization and demobilization that lasted from 1941 to 1948. War productivity

optimists have pointed to the role of learning by doing in military production and spinoffs

from military R and D as the basis for asserting a substantial positive effect of military

conflict on potential output. The conventional macroeconomic productivity numbers are

not, however, consistent with this view, since they show slower TFP growth between

1941 and 1948 than either before or after. I suggest, moreover, that this slower growth

rate is actually overstated. The paper explores the dimensions of the double shock to the

economy of rapid mobilization and demobilization, and argues for adopting a less rosy

perspective on the supply side effects of the war.

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Introduction

The historiography of the Great Depression has been overwhelmingly concerned with the sources of the deficiencies in aggregate demand responsible for more than a decade of double digit unemployment over the twelve year period 1929-1941. The narrative has been infused with leitmotivs of failure and loss: of output, of employment, and of expenditure. In contrast, the macroeconomic history of the golden age (1948-73), the quarter century following the end of demobilization, has, on balance, radiated the bright glow of success. The emphasis has been on an American economic colossus standing astride the world in a position of dominance not realized before, or, in quite the same way, since (Ferguson, 2004, p. 18).

Awkwardly situated between Depression era "failure" and postwar "success" has been the Second World War, a disruption to the "normal" path of economic development every bit as significant, although in different ways, as was the Depression. As a consequence of its temporal location, the conflict has acquired almost mythological significance in bridging these two story lines, although it has in fact received relatively little detailed examination from macroeconomists and economic historians. Conventional wisdom credits the war both with "bringing us out of the Depression" and with "laying the foundations for postwar prosperity."

There is some reason to believe that by the end of the 1930s the private economy was on the road to recovery, and might have continued in that direction, even in the absence of the stimulus from the government sector that followed. Of all components of autonomous spending, residential construction took the longest to reapproach levels experienced during the 1920s (Field, 1992). Nevertheless, after reaching a nadir in 1933,

it climbed back steadily, and by 1941, before the war curtailed private house construction, it was approaching 1929 levels (see Figure 6).[1] Some of the recovery after 1939, one might argue, was in response to the stimulus provided by anticipatory rearmament spending. But, as I show below, a very small fraction of cumulative war spending had actually taken place at the time Pearl Harbor was attached.

That said, there can be little doubt that the war administered a huge demand shock to the economy, especially from 1942 onwards, the result of a massive increase in deficit spending and an expansionary monetary policy committed to pegging both short and long term rates at low levels. The standard interpretation, however, couples the demand story, at least implicitly, with emphasis on a powerful supply shock, one resulting from learning by doing in military production (Alchian, 1963) and spinoffs from military research and development. That posited supply shock has to be a main underpinning of the claim that the war "laid the foundations for postwar prosperity."

My concern in this paper is principally with the second part of the conventional wisdom, that which credits much of the achieved level of potential output in 1948 to war induced positive supply shocks. To what degree was the war responsible for establishing the technological, organizational, and infrastructural preconditions for what Rostow (1961) called the "age of high mass consumption"? This paper follows upon a reconsideration of twentieth century U.S. economic growth that finds productivity advance between 1929 and 1941 far stronger than has been traditionally appreciated (Field 2003). A corollary is a greater skepticism about the rosy supply side picture typically painted of the impact of the war years.

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[1] The peak in housing construction during the 1920s was in 1926.

The conventional productivity data for the private nonfarm economy show that TFP, which had been growing very rapidly between 1929 and 1941, continued to increase from 1941 to 1948, but at a markedly slower rate. As a war productivity pessimist, one does need to acknowledge, up front, that productivity levels appear to have been higher in 1948 than they had been in 1941. The question I wish to pose, however, is whether they were as high as they would have been in the absence of the war, or stated alternately, whether these productivity levels might have been reached earlier in the absence of the conflict.

There is a strong case to be made, and this paper will attempt to make it, that whatever positive shocks may have been associated with progress in the mass production of airframes, ships, penicillin, or munitions/fertilizer were largely counterbalanced by the negative shocks associated with the disruptions to the economy resulting from rapid mobilization and demobilization. Previous work has established that the years 1929 through 1941 were marked by an exceptionally high rate of total factor productivity growth, with the consequence that a significant fraction of the productivity foundations of the postwar epoch were already in place by 1941, before full scale war mobilization (Kendrick, 1961, Field, 2003). Thus the rate of increase of TFP between 1941 and 1948 is lower than many people realize.[2]

Why? Mobilization/demobilization delivered a one-two punch, whipsawing the economy, as it first force fed very rapid expansion in a limited number of war related sectors, such as other transport equipment, and then equally rapid contraction. The

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[2] I will argue, moreover, towards the end of the paper, that the standard numbers probably overstate productivity growth between 1941 and 1948.

conflict diverted the cream of American scientific and engineering talent, who had <u>not</u> been experiencing high unemployment rates during the Depression (see Margo, 1991), into military work such as the Manhattan project. Mobilization required that managers and workers pay attention not only to the wrenching tasks of reorienting production within and between sectors, but also to a panoply of regulations associated with government contracting and resource allocation in what, at least within the military sector, approached a command economy (U.S. Civilian Production Administration, 1947).[3] There was certainly some learning by doing in high profile sectors such as airframes and shipbuilding, and some war related R and D spinoffs, such as radar and microwaves. But the overall effect of World War II was probably to slow the growth of TFP and potential output. The best way to describe the supply side effects of the war is that they represented, in the aggregate, a retardative supply shock, slowing down the breakneck pace of advance that had been achieved during the Depression years.

The Timing of Economic Mobilization

The supply shocks associated with mobilization and demobilization were short, they were sharp, and whether they were positive or negative, they were experienced almost entirely after the U.S. entered the war. The military build up, which had only barely begun when Pearl Harbor was attacked in December of 1941, led to a massive ramp up in military and naval construction in 1942, a surge in equipment and ordnance production

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[3]Although the U.S. did not resort to an industrial draft, as did Britain, where workers could be commanded (rather than enticed) to work in a war industry, the U.S. did effectively socialize investment flows and direct them in ways dictated by the imperatives of war. As Figures 4, 5 and 6 show, private domestic investment, as well as non-war related public investment, such as the construction of streets and highways, was crowded out during the conflict, and vast amounts of taxed or borrowed money was used by the government, through the instrument of the Defense Plant Corporation, to purchase new machine tools and construct plant in strategic sectors. Civilian automobiles and appliance production was shut down, and critical raw material flows were allocated essentially by fiat, with some dual use inputs (gasoline and tires, for example) subject to rationing.

that peaked in 1943, and an expansion of employment in the Federal government, both civilian and military, that peaked in 1944. By 1948, with demobilization largely complete, nonmilitary production revived, and unemployment at 3.4 percent, these changes had been almost entirely unwound.

Either of these shocks alone would have imposed substantial transition costs on the economy. Together they represented something of a double whammy. The war put the economy through a wringer, not once, but twice. From this perspective, it is hardly surprising that total factor productivity grew much more slowly between 1941 and 1948 than it had between 1929 and 1941.

Although belief that the war had associated with it large positive productivity effects was common during the conflict and immediately thereafter, a more nuanced and pessimistic evaluation was shared by economists familiar with the effects of mobilization and demobilization. Solomon Fabricant was an exemplar of this group; his general pessimism is echoed by Jules Backman and Martin Gainsbrugh (see Backman and Gainsbrugh, 1949). Here's what Fabricant wrote in 1952:

> Despite beliefs frequently held to the contrary, little contribution to the defense effort may be expected from productivity….The composition and even the volume of output undergo radical transformation. Speed rather than cost is the criterion. And fundamental changes occur in the organization of the economy. In a word, attention is diverted from the mainsprings of progress.
> In such a situation, the energy of businessmen is devoted not to new improvements and additions to knowledge, but to adapting standard mass production methods to the munitions industries. And they are under the necessity of learning new rules. Price, production, and other controls have to be studied and the very rapid and radical changes in them require attention. Little time or energy is left for improving efficiency.
> …The new workers are inexperienced; and some are handicapped. Some of the new equipment brought into production is standby equipment, not worth operating in normal times, and the flow of new and up to date equipment is slowed to a trickle. The mines reopened are low grade or high cost mines…. Inventories are

inadequate, and delays in receiving materials hold up production lines. Ersatz materials frequently require more labor for processing. Long hours cut the strength of labor and management.

As a result, national output per man hour fails to rise at the peacetime rate.

Fabricant went on to note that railroads were an exception to this rule, because of their unusual cost structure, and that productivity declines in trade and services were sometimes disguised because they took the form of deterioration in quality. But "in most peacetime and manufacturing industries…, actual and palpable declines occur. For skilled labor is pulled away, transport is choked, and materials come hesitatingly and in meager quantity."

He concluded his analysis by acknowledging that some munitions manufacturing did experience rapid production gains. He referred to the famous case of shipbuilding, noting a doubling of output per hour in the three years following Pearl Harbor. But he also observed that these increases were from very low levels immediately following conversion, so that "even the wartime peak in productivity may be below the level of the industry's peacetime productivity" (Fabricant, 1952, pp. 30-31).

Some of Fabricant's arguments address why one cannot expect, overall, a big contribution to wartime output growth from productivity advance. Many of the retardative forces, such as disruptions to production from erratic inventory control, would in principle disappear with the cessation of hostilities, with no permanent ill effects. But other factors identified help explain why war imposed a persisting cost in terms of the trajectory of long term productivity advance. Technical, scientific, and managerial energies were diverted from commercial pursuits towards the war effort. There was invention and learning by doing as a result, but not all of it was relevant when peace

returned. And there was an opportunity cost. When scientists and engineers devote their time to building atomic bombs and businessmen are preoccupied with learning new administrative rules, and when success is measured by one's ability to produce large quantities of ordnance quickly in an environment of cost plus contracts, it is scarcely surprising that the overall rate of commercially relevant innovative activity slows down.

Table 1
Compound Annual Growth of Total Factor and Labor Productivity, United States, 1919-2000

	TFP	Output/Hour
1919-29	2.02	2.27
1929-41	2.31	2.35
1941-48	1.29	1.71
1948-73	1.90	2.88
1973-89	.34	1.34
1989-2000	.78	1.92

Sources: 1919-48: Kendrick (1961), Table A-XXIII. 1948-2000, Bureau of Labor Statistics www.bls.gov. See also Field (2003). Data are for the private nonfarm economy.
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Table 1 reports the rates of total factor and labor productivity growth before, during and after the period of war mobilization and demobilization, calculated from the conventional data. The choice of 1941 as a breakpoint is critical, and some discussion is warranted, since John Kendrick (1961) and others who followed his example used 1937. 1937 was a local peak (unemployment was still 14.3 percent), whereas in 1941 unemployment averaged less than 10 percent for the first time in a decade, and it is the closest we can get to a fully employed peacetime economy before significant effects of war mobilization are experienced. But while 1941 is far preferable to 1937, it is still not ideal, because unemployment was higher (9.9 percent) than it was in 1929 (3.2 percent)

or 1948 (3.4 percent). In any particular historical circumstance, productivity levels for an economy operating below capacity might be higher or lower were the economy operating at full employment. Theory can provide a rationale for cyclical adjustment in either direction. I leave to the penultimate section of this paper discussion of what kind of an adjustment one might make for the remaining cyclical effect, and how large it should be.

For the moment, the contrast between 2.31 percent per year (1929-41) and 1.29 percent year (1941-1948) is quite enough to motivate the paper. We begin with the striking observation that high TFP growth during the Depression years meant, according to these numbers, that achieved productivity levels in 1941 were more than 30 percent higher than was true in 1929. Because of the absence of capital deepening over this period, this was true for both labor productivity and TFP. Readers may have the impression that with Lend Lease and other expenditures in anticipation of war the U.S. was already on something like a full scale war footing by the time of Pearl Harbor. If this were true, and if one were an "optimist" about the effects of war on productivity, one might argue that some of the productivity levels in 1941 were attributable to the defense build up that had already been underway for two years.

It is important to appreciate how small a share of total war spending had actually taken place at the time Pearl Harbor was attacked. The U.S. spent $1.8 billion on military manpower, structures, equipment, and other ordnance in 1940, and $6.3 billion in 1941 (these figures exclude veterans' benefits). If one wanted to emphasize the extent of the build up in 1941 one could say that spending had more than tripled compared to the previous year. But this is clearly dwarfed by what followed. Combined military spending in 1940 and 1941 represented just 3.2 percent of the 1940-46 cumulative total.

Adjusting for price changes makes virtually no difference in these calculations. Column

2 of Table 2 reports the price index for national defense expenditures, rescaled so that

1940 = 100. This index rises 6.7 percent in 1941, but then trends slightly downward,

presumably reflecting some learning by doing and productivity improvement in the

production of ordnance. The combined share of 1940 and 1941 spending in real terms is

still just 3.2 percent of the cumulative 1940-46 total.

Table 2
U.S. Military Spending, Nominal and Real, 1940-46 (billion dollars)

|	Nominal	Price Index National Defense	Real
1940	1.8	100.0	1.8
1941	6.3	106.7	5.9
1942	22.9	104.4	21.9
1943	63.4	105.5	60.1
1944	76.0	103.8	73.2
1945	80.5	104.5	77.0
TOTAL	250.9		240.0

Sources: column 1 shows the sum of outlays on the Army and the Navy: Historical Statistics of the United States (1975), Series Y 458, 459, p. 1114.
Column 2: wea.bea.gov, National Income and Product Accounts, Table 1.5.4; accessed 4/3/2005.

Like total military spending, and not coincidentally, the average number of U.S.

military personnel also more than tripled, comparing the calendar year 1941 with 1940.

But one needs to appreciate both how completely demilitarized the U.S. economy had

been during the Depression, and how much mobilization was still to come. Figure 1,

drawn from the 1951 Statistical Abstract of the United States, make this point vividly.

The uptick in military personnel in 1941 looks large in comparison with 1940, but is

dwarfed by what followed. And the 1.8 million average military personnel in 1941 seems

trivially small in comparison with the armed forces of Germany, Japan, and Italy, each of

Figure1

FIG. X.—MILITARY PERSONNEL AND PAY: 1936 TO 1950

[1950 data for Jan.–June only. See table 248]
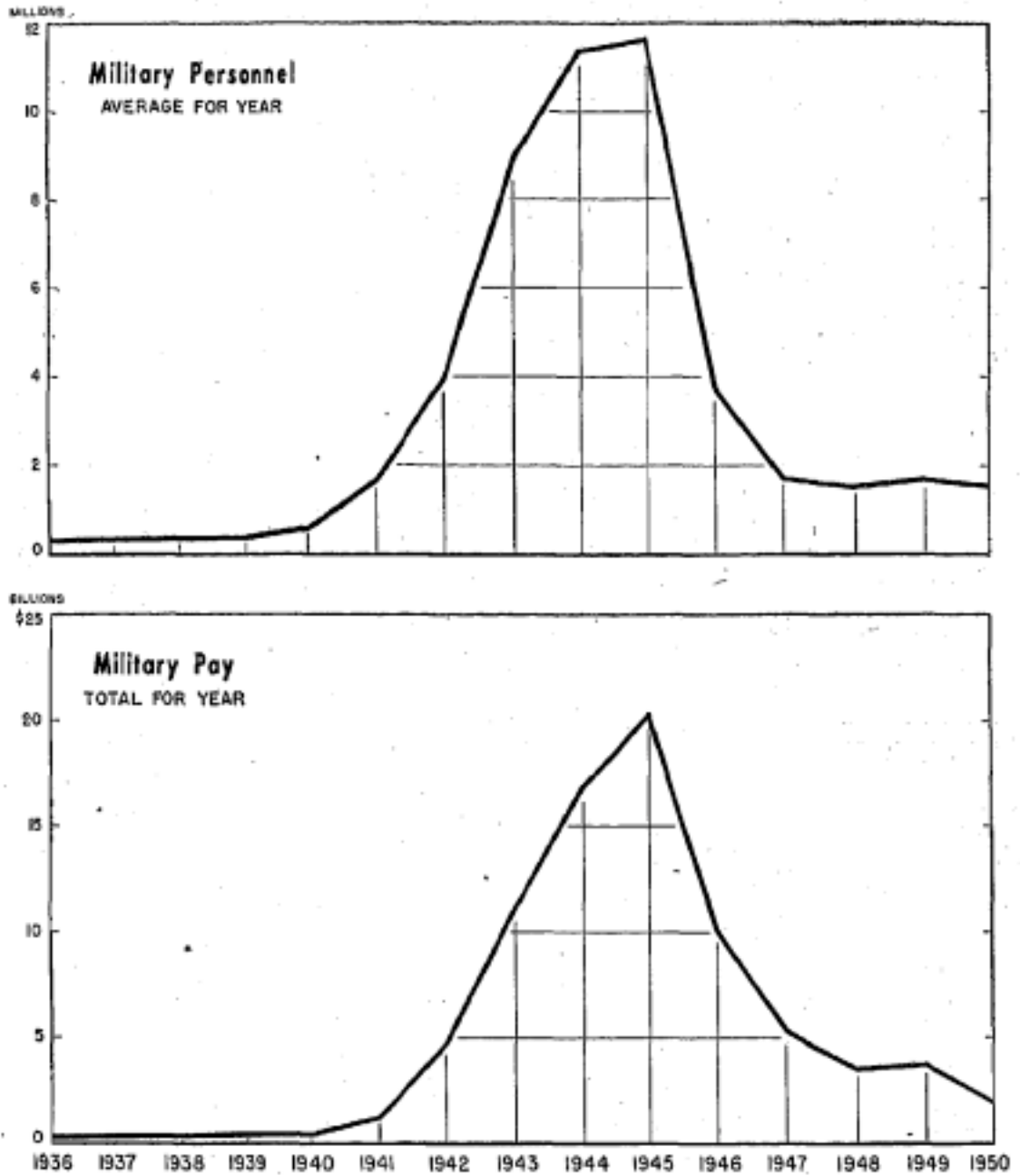
Source: Department of Labor, Bureau of Labor Statistics.

U.S. Bureau of the Census, <u>Statistical Abstract of the United States, 1951</u>, p. 210.

which already had more than 7 million men in uniform, including reserves, at the beginning of 1940 (Nelson, 1946, p. 30).

The pattern observed in military manpower is also evident in the time series for US military aircraft production. Output of 19,455 planes in 1941 was more than three times the 6,028 produced in 1940, but barely a fifth of peak (1944) production of 95,272.

Figure 2
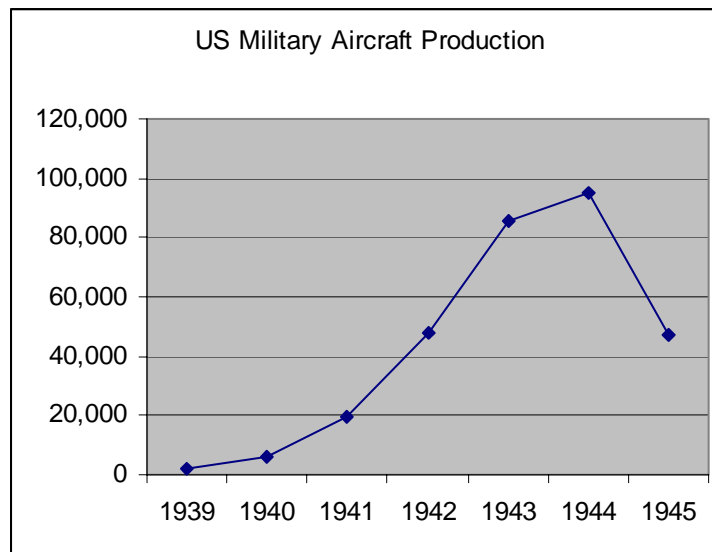
Source: Historical Statistics of the United States 1975, Series Q566, p. 768.

This pattern is even more pronounced for ship production (Table 2), in part because of the country's urgent need after 1941 to make good on the losses suffered at Pearl Harbor. Starting from low levels, production of combatant ships peaked in 1943, at more than 17 times 1941 levels. The surge in production of landing craft in 1944, however, pushes the peak in total ships produced to that year.

Finally, let's look at the division of industrial production between war and nonwar activity (Figure 3). This chart, which is based on indexes compiled by the Federal Reserve Board, shows that in 1941 military production accounted for less than a fifth of

the total, and civilian industrial production was still increasing. In 1942, 1943, and 1944,

on the other hand, civilian production declined, and military production accounted for

more than half of the total.

Table 2
US Military Ship Production, 1941-1946

	1941	1942	1943	1944	1945	1946
Combatants (Total)	33	141	568	420	152	73
Battleships	2	4	2	2		
Aircraft Carriers	1	1	15	8	5	7
Aircraft Carriers (large)					2	
Aircraft Carriers (escort)	2	13	50	37	13	4
Battle Cruisers				2		
Heavy Cruisers			4	2	8	4
Light Cruisers	1	8	7	11	7	6
Destroyers	16	81	128	84	74	38
Destroyer Escorts			306	197	6	
Submarines	11	34	56	77	37	14
Patrol and mine craft	167	743	1106	640	238	6
Auxilliaries	83	184	303	630	402	43
Landing Craft	1035	9488	21525	37724	17958	21
District Craft	261	786	677	577	661	48
TOTAL	1579	11342	24179	39991	19411	191

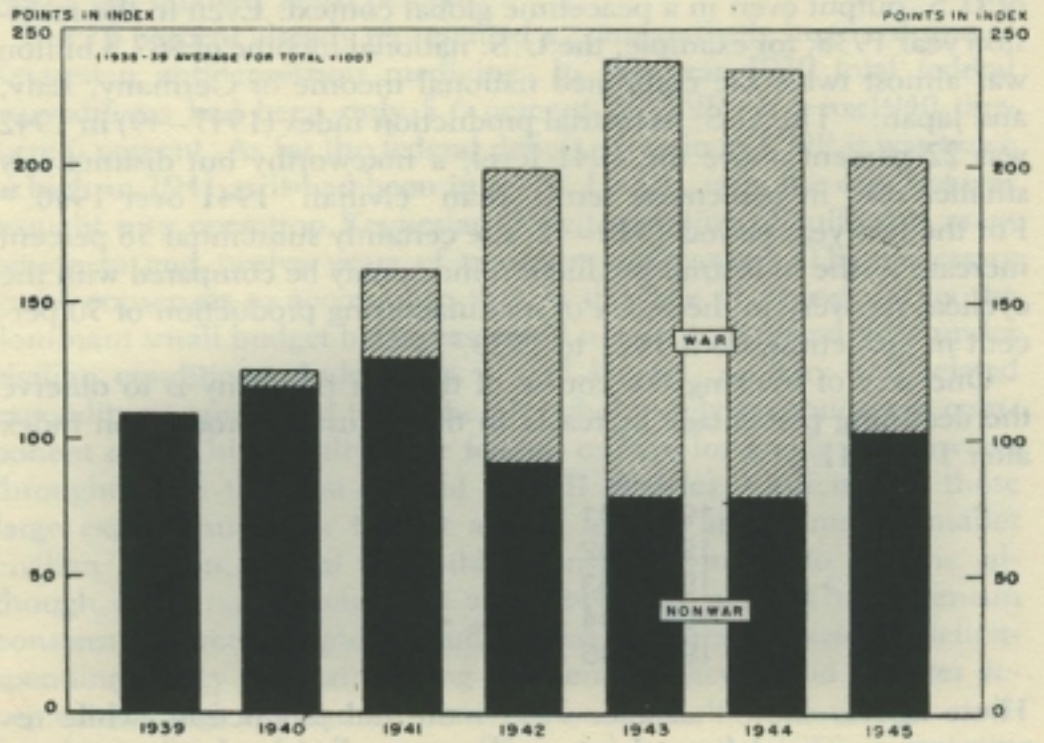Source: Statistical Abstract of the United States, 1947, p. 222
Note: data for 1945 include a total of 457 converted ships: 5 patrol and mine craft, 240
auxiliaries, 127 landing craft, and 85 district craft.

Figure 4 provides another view of mobilization and demobilization, showing that

the wartime expansion of industrial production was almost exclusively a durable goods

phenomenon. It also shows industrial production peaking in October of 1943, when

manufacturing accounted for a larger share of U.S. value added than it ever had before or

ever would again, and falling precipitously after February of 1945.

Chart 1.3

Industrial Production

Source: Board of Governors of the Federal Reserve System.

FIG. XXIX.—INDUSTRIAL PRODUCTION INDEXES: 1935 TO 1951

[1935–39 average for total=100. Based on physical volume, adjusted for seasonal variation. See table 916]

POINTS IN TOTAL, INDEX

250

200

150

100

50

0

1936   1938   1940   1942   1944   1946   1948   1950

TOTAL

MONTHLY

DURABLE MANUFACTURES

NONDURABLE MANUFACTURES

MINERALS

Individually, and in the aggregate, these data show that although the U.S. may have been "gearing up for war" prior to 1942, it was doing so from a very low base, and what had been accomplished through the end of 1941 was small compared to what would come subsequently. Achieved levels of production, total factor productivity and output per hour in 1941 cannot have had much to do with learning by doing from military production or spillovers from military R and D.

Sectoral Redistributions of Labor

The next section of the paper takes a broader look at the effects of mobilization and demobilization on the economy, in particular on its manpower requirements. Tables 3 and 4 are based on data on full time equivalent workers from the 1986 National Income and Product Accounts. What I have done is divide the major sectors of the economy into those acquiring and those releasing workers between 1941 and 1943 (Table 3) and between 1943 and 1948 (Table 4). Although total military spending and military manpower continued to rise in 1944, 1943 represented the peak of industrial production and economic mobilization per se (see Figure 4). For the sake of consistency I have used it as the breakpoint for the analysis of both governmental and nongovernmental employment.

For the nongovernmental sector we find the following major sectors releasing workers between 1941 and 1943: the motor vehicle industry, construction, wholesale and retail trade, and agriculture. Together, these five sectors account for 1.026 million of the total 1.580 million FTEs contributed by releasing sectors over this two year period.

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We then identify six major sectors acquiring workers. The largest by far was other transport equipment (not motor vehicles). This sector, which was producing the ships and planes already discussed, as well as tanks and a variety of other vehicles, acquired over a two year period a mind-boggling 2.6 million FTEs, a 384 percent increase over its 1941 employment of 675,000 FTEs. The second biggest acquirer of labor was iron and steel and their products, including ordnance, followed by nonelectric machinery, electric machinery, chemicals, and railroad transportation. Together these six sectors accounted for 88 percent of the total increase of 5.302 million FTEs in the acquiring sectors.

It is striking how narrowly concentrated were the sectors acquiring labor. Other transport equipment (tanks, ships, planes) accounted for 49 percent of the increase in FTEs in acquiring sectors. Adding in iron and steel products including ordnance, one gets to 64 percent. In contrast, the two largest releasing sectors (motor vehicles and construction) accounted for barely 34 percent of the total FTEs contributed by releasing sectors. FTE acquisitions were therefore much more highly concentrated than FTE releasers. Economic mobilization for war was very far from a balanced, across the board expansion of the economy.

This methodology does not capture flows within sectors. For example, automobile production effectively ceased in February of 1942, and workers remaining in the motor vehicles industry were producing military vehicles such as jeeps and trucks.

We now turn to the government sector, where between 1941 and 1943 we find 1.317 million released from work relief and 132 thousand released from state and local government employment. Between 1941 and 1943 the U.S. military acquired 7.349

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million FTEs and Federal civilian employment another 1.553 million. Finally, government enterprises acquired 74,000.

Overall, summing the non-government sector consolidated acquisition of 3.722 million and the government sector consolidated acquisition of 7.527 million, we have a net inflow from the ranks of the unemployed or not in the labor force of 11.249 million.

Taken together, mobilization led to a rapid expansion of the economy, but one which represented a very sharp distortion of the "normal" channels of such an expansion.

Although nongovernment FTEs peaked in 1943, total FTEs peaked in 1944 at 54.982 million (1.3 million above the 1943 total), largely because of an additional increment of 2.3 million military FTEs which counterbalanced the declines beginning elsewhere. Military equipment had to be produced before it could be used. By the time of D-Day, the military goods production machine had already begun to wind down.

In the short span of two years, between 1941 and 1943, the US automobile industry shut down and reconverted to defense production. Nondefense construction largely ground to a halt, as military and naval construction soared. People streamed out of farms and wholesale and retail trade into defense factories and the military, and they were joined by hundreds of thousands, indeed millions more from the ranks of the unemployed and not in the labor force. Billions of dollars were spent by the Defense Plant Corporation to build government owned privately operated plants and equip them with machine tools to jump start the airframe and shipbuilding industries, produce aviation fuel and synthetic rubber, and aluminum. Then, before the economy could catch its breath, most of the ordnance was expended, the war was won, and full scale demobilization was underway. By the time this paper is delivered at Barcelona in June of

2005, the "war on terror", declared after 9/11, will have lasted longer than U.S.

involvement in the Second World War.

Table 3
United States, 1941-1943
Labor Acquirers and Labor Releasers

Non Government	(Full Time Equivalents, thousands)	
Labor Releasers:	FTE's Released	1941 FTEs
Motor vehicles and equipment.................	(330)	655
Contract Construction	(208)	1774
Wholesale trade.................................	(200)	1952
Farms	(179)	2201
Retail trade.....................................	(109)	5075
Sum, above 5 sectors	(1,026)	
Total Labor Releasers	(1,580)	
	FTE's Acquired	
Labor Acquirers		
Other transportation equipment...............	2,596	675
Iron and steel and their products, incl. ordnance.	819	1641
Machinery, except electrical.................	370	1087
Electric and electronic equipment............	353	607
Chemicals and allied products................	269	580
Railroad transportation......................	249	1285
Sum, above 6 sectors	4,656	
Total Labor Acquirers	5,302	
Government		
Labor Releasers		
Work Relief	(1,317)	1364
State and local..................................	(132)	2922
Labor Acquirers		
Military	7,349	1680
Federal civilian, except work relief	1,553	944
Government enterprises	74	431
Totals: Inflows from Unemployed, NILF		
Non-government sector	3,722	
Government sector	7,527	
TOTAL	11,249	

Source: <u>National Income and Product Accounts of the United States, 1929-1982</u>.
Washington: Government Printing Office, 1986, Table 6.7a, p. 275.

Table 4 uses the same methodology to study demobilization from 1943 to 1948. What we see here is a rough reversal of the trends associated with mobilization. The two biggest acquirers of labor during mobilization, other transport equipment and iron and steel and their products, including ordnance, were the two biggest releasers during demobilization, and the FTEs released by these two sectors (3.388 million) were almost exactly equivalent to those acquired during mobilization (3.415 million). Symmetrically, the biggest acquirers of labor during demobilization were largely the sectors that had released the most during mobilization, in particular motor vehicles, retail and wholesale trade, and construction. Another big acquirer was finance, insurance, and real estate. Home building and nonresidential private construction, as well as other forms of physical capital accumulation revived in the postwar period, finally surpassing 1929 rates after two decades in which investment had been depressed (the Depression years) or largely government controlled (the war years). Employment in intermediation and brokering correspondingly increased. Agriculture, on the other hand, continued to lose FTEs, reflecting a long term secular trend.

The analysis understates the impact of demobilization in the government sector, since government FTEs peaked in 1944. The military added an additional 2.336 million FTEs between 1943 and 1944, although other components of government FTEs were largely unchanged. Federal civilian FTEs went up 23,000, government enterprises went down 26,000, state and local lost another 79,000, and the remaining 47,000 on work relief went away. The huge increase in the military would make the outflows from government larger for an analysis based on a 1944-1948 transition.

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Table 4
Labor Acquirers and Labor Releasers, United States, 1943-1948 (x 1,000)

Non Government
Labor Acquirers

	FTEs acquired	1943 FTEs
Retail trade....................................	1,511	4,966
Services.......................................	756	5,226
Contract Construction	712	1,566
Wholesale trade.................................	676	1,752
Motor vehicles and equipment................	441	325
Finance, insurance, and real estate.............	281	1,389
Telephone and telegraph......................	202	490
TOTAL Acquired	6,099	

Labor Releasers

	FTEs released	
Other transportation equipment...............	(2,800)	3,271
Iron and steel and their products, incl. ordnance.	(588)	2,460
Chemicals and allied products................	(126)	849
Electric and electronic equipment............	(73)	960
Agriculture, Forestry, Fisheries	(56)	2,121
Nonferrous metals and their products	(32)	508
Railroad transportation......................	(31)	1,534
TOTAL Releasing		
	(3,709)	

Government
Labor Acquirers

State and Local	1,062	2,790

Labor Releasers

Federal civilian (not work relief)	(1,119)	2,497
Government Enterprises	(294)	505
Work relief	(47)	47
Military	(7,485)	9,029

TOTALS

Government net release	(7,883)
Non government net acquires	2,390
TOTAL Outflows to unemployed, NILF	5,493

CHANGING SHARES IN NATIONAL OUTPUT

The record of the past decade shows the growth and changing pattern of the economy under the impact of World War II, the conversion to peacetime, and the postwar resumption of expansion. Real consumption has expanded steadily to new all-time highs, while total output in 1950 was only moderately below the wartime peak.

BILLIONS OF DOLLARS

1950 PRICES

TOTAL GROSS NATIONAL PRODUCT

PERSONAL CONSUMPTION EXPENDITURES

GOVERNMENT PURCHASES OF GOODS AND SERVICES

GROSS PRIVATE DOMESTIC INVESTMENT

NET FOREIGN INVESTMENT

PERCENT OF TOTAL

INVESTMENT 1/

PERSONAL CONSUMPTION EXPENDITURES

GOVERNMENT PURCHASES OF GOODS AND SERVICES
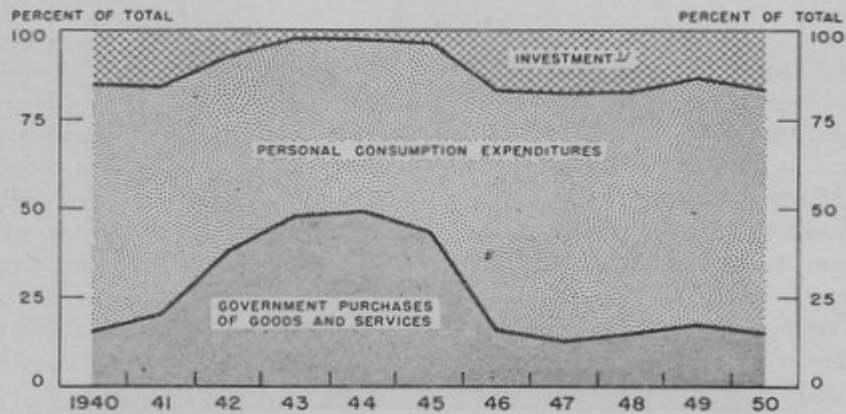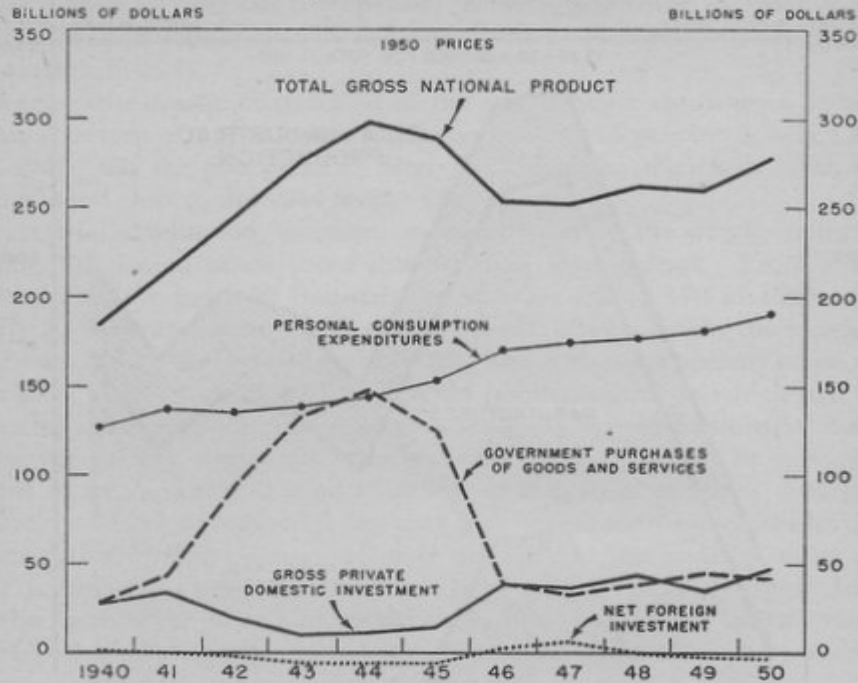
1/ GROSS PRIVATE DOMESTIC INVESTMENT AND NET FOREIGN INVESTMENT. SEE UPPER PART OF CHART FOR DOLLAR VOLUME OF EACH ITEM.

SOURCE: COUNCIL OF ECONOMIC ADVISERS.

Source: Economic Report of the President, 1951, p. 56.

Figure 5 shows, on a share basis, how rising proportions of Government spending crowded out domestic private investment, net exports, and consumption during the war (the current account went into deficit largely because of unilateral transfers). These numbers do show the absolute value of consumption rising in real terms throughout the war, except in 1942, although Higgs (1992, 1999) has argued that this is misleading because the price deflators used do not correctly measure the increasing real costs of goods in the context of rationing or simple unavailability. In other words, he would have the series for real personal consumption spending dip substantially during the war years before reviving.

Although the question of how much real consumption rose or dropped during the war remains at issue (see also Rockoff, 1998), there is little dispute that government spending increased and that private investment in the country declined, not just as shares of GDP, but in absolute terms. There were also significant changes in the composition of public investment. Figures 6 and 7 show trends in public and private construction expenditures. The nominal data are taken from Table A-18, p. 188 of the Economic Report of the President, 1951. The deflators are taken from the Bureau of Economic Analysis website, accessed April 2, 2005. Private residential construction spending is deflated by the residential structures index. All of the other series, both private and public, are deflated by the index for private nonresidential structures. The indexes are rescaled so that 1929 = 100.0, and consequently for that date, real equals nominal.

Several conclusions are apparent from these charts. First, residential construction, the sick child of the U.S. economy throughout the Depression, had by 1941 laboriously climbed back to within striking distance of its 1929 level (see Field, 1992). The war took

the steam out of this forward movement, and by 1944 private housing construction was at an even lower level than it had been at the depths of the Depression in 1933. It was not until 1948 that residential construction surpassed its 1929 rate. Nonresidential private construction was also depressed during the war, driven almost to the vanishing point in 1943. Other private construction, largely public utilities, was less dramatically affected by the war, principally because energy, especially electric power, was critical to the war effort.

If we look at public construction, we are first struck by the big peak for 1942 in military and naval construction and other public nonresidential building. Mobilization for war can be thought of as consisting of three waves, each cresting respectively in the years 1942, 1943 and 1944. 1942 saw massive military construction, 1943 the peak in military industrial production, and 1944 the peak in military FTEs. Build the production facilities, produce the ordnance, and then let the military use it.

A second point to note, which I have stressed in earlier work, is the high rate of street and highway construction during the Depression years. This spending remained close to or above 1929 levels through 1941, creating a modern surface road infrastructure that was essentially complete by the outbreak of the war. War spending crowded out highway construction during the war, and this spending came back more slowly than housing production immediately after the war. The public infrastructure spending of the 1930s had already begun to generate spillovers in transportation, distribution, and housing before the war (see Field, 2005b). It continued to do so afterwards. Thus one can make a strong case that it was a combination of product and process innovation

during the Depression, and Depression era infrastructure building, far more than the war, that was responsible for 1948 productivity levels.

We can also see in this chart the impact of bridge, dam, tunnel, and other non-highway public infrastructure spending during the Depression. This too was crowded out during the war years, although the magnitude of the drop was lower, partly because recovery had been less dramatic.
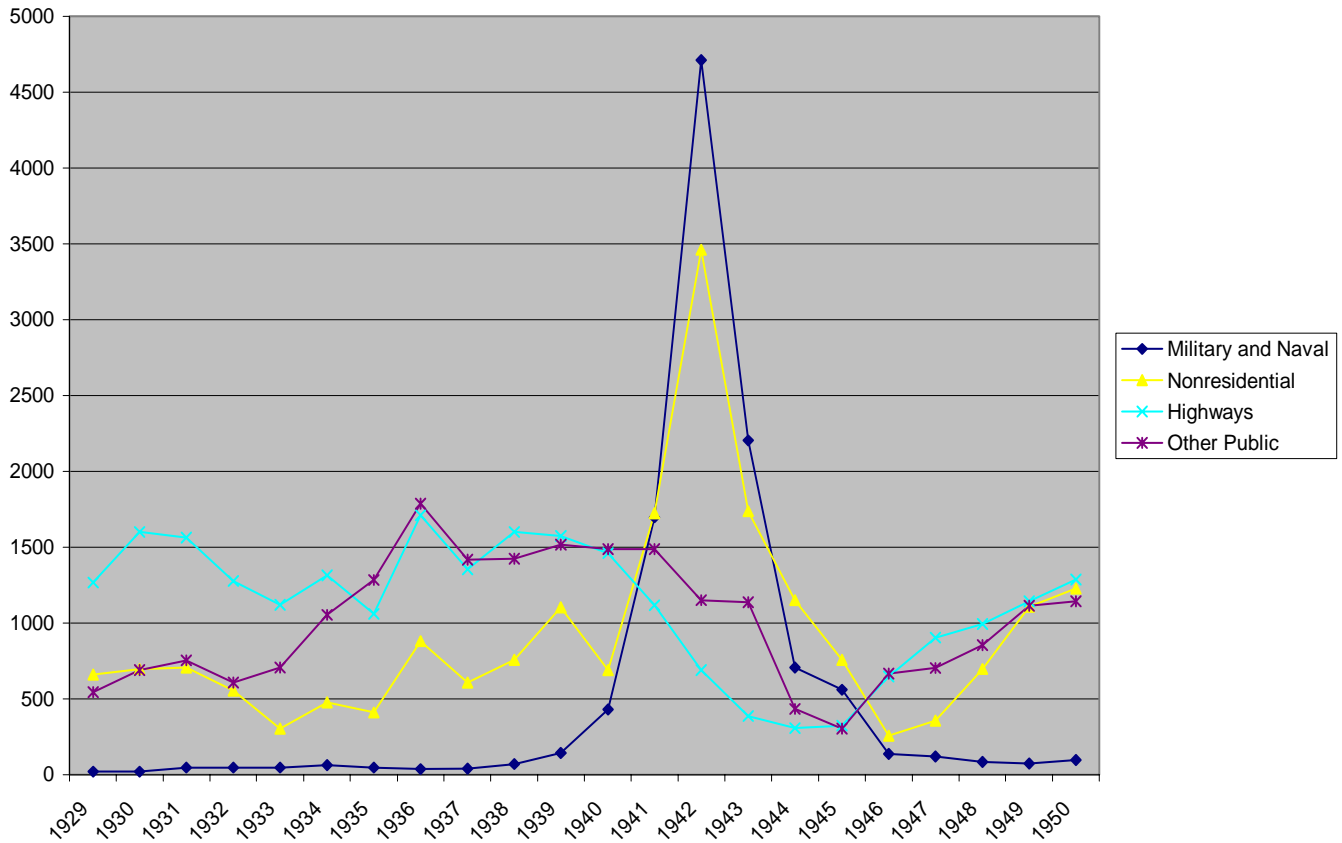
Figure 6

Real Private Construction Spending, 1929-50
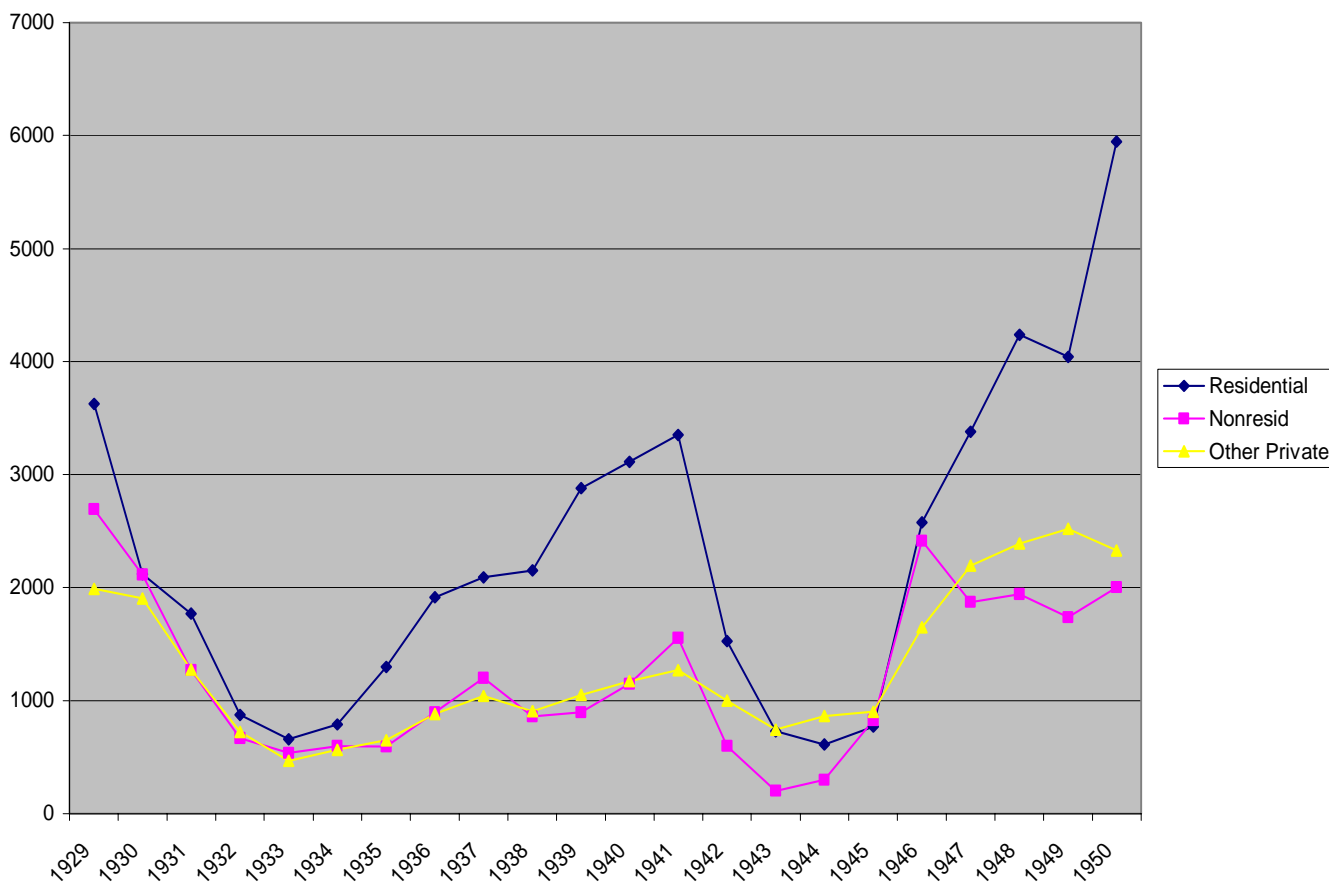
Sources: See text.   Nominal Data: Economic Report of the President, 1951, Table A-18, p. 188.
Deflators: www.bea.gov, accessed April 2, 2005.

Figure 7

Real Public Construction Expenditures, 1929-1950

Sources: See text. Nominal Data: Economic Report of the President, 1951, Table A-18, p. 188.
Deflators: www.bea.gov, accessed April 2, 2005.

Sensitivity Analysis: Adjustments to 1941 and 1948 Productivity Levels

The purpose of this penultimate section is to consider a cyclical adjustment for 1941

productivity, and an adjustment to 1948 productivity based on inadequate accounting for

government owned privately operated capital sold to the private sector after the war, and

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how such adjustments might affect the relative magnitude of productivity growth during the period of mobilization and demobilization.

The standard of the business in measuring productivity change over time is, if possible, to calculate from peak to peak, so as to control for cyclical confounds. 1941, with its 9.9 percent unemployment, is not ideal in this respect. The question is whether productivity levels in 1941 would have been higher or lower had the economy been at full employment, and if so by how much. Traditional economic models with constant returns to scale suggest that productivity should move countercyclically. The argument is that labor experiences diminishing returns as increasing doses are applied to a capital stock largely fixed in the short run. Correspondingly, when unemployment rates rise, so would capital labor ratios and along with them, productivity levels.

The data, on balance, has not been kind to this hypothesis, in the sense that during a number of epochs productivity has moved with, rather than against the cycle. This history, in turn, has led theorists to search for explanations for procyclicality. The most widely cited factor is labor hoarding, but it seems unlikely that this could have played an important role over a twelve year period experiencing first a severe drop in employment and then a recovery of similar magnitude (hours for the private nonfarm economy were essentially the same in 1941 as they had been in 1929). Other mechanisms, however, could account for procyclicality. These include network externalities and, in general, any factors that might conduce to increasing returns to scale. Such conditions would be particularly prevalent where innovation and investment in infrastructure was an important contributor to higher TFP.

The Depression years, in fact, were one of those periods evidencing strongly procyclical productivity. Table 5 provides the underlying data. The first column shows Kendrick's index of total factor productivity for the private nonfarm economy. Column 2 shows the continuously compounded rate of change in that index from one year to the next. Column 3 is the national civilian unemployment rate from Lebergott, and column 4 the change in percentage points in that rate.

Table 5
Cyclical Effects on Total Factor
Productivity, United States, 1929-41

	PNE TFP (Kendrick)	Change from prior year $(\ln(t)-\ln(t-1))$	unemployment Rate (Lebergott)	Change % points
1929	100.0		3.2	
1930	96.5	-0.0356	8.7	5.5
1931	95.3	-0.0125	15.9	7.2
1932	90.5	-0.0517	23.6	7.7
1933	88.7	-0.0201	24.9	1.3
1934	101.2	0.1318	21.7	-3.2
1935	105.9	0.0454	20.1	-1.6
1936	112.6	0.0613	16.9	-3.2
1937	114.4	0.0159	14.3	-2.6
1938	115.0	0.0052	19.1	4.8
1939	119.4	0.0375	17.2	-1.9
1940	122.4	0.0248	14.6	-2.6
1941	132.0	0.0755	9.9	-4.7
1948	144.5	0.0905	3.4	-6.5

If we regress the change in TFP (ΔTFP) on the change in the unemployment rate (ΔUR), we get the following results:

$$\Delta\text{TFP} = \quad .0283 \quad - \quad .0092 * \Delta\text{UR}$$
$$R^2 = .647 \quad (3.02) \quad (-4.28)$$

(t statistics in parentheses; data are for 1929-41; n = 12)

The intercept term can be interpreted as showing that TFP had a trend growth rate of approximately 2.83 percent per year over this twelve year period. The coefficient on ΔUR suggests that every percentage point decrease in the unemployment rate raised TFP growth by about .92 percent. We can use this equation for two closely related exercises, first to make a cyclical adjustment to the 1941 productivity level and second to imagine what one more year of peacetime growth and declining unemployment would have meant for productivity in the U.S.

If one is a war productivity optimist, one thinks of 1948 as the first year in which a demobilized peacetime economy benefited from all the new production knowledge generated during the war, and this influences one's interpretation of its achieved productivity level. A better way to think of 1948, in my view, is: 1941 with full employment. The major new consumer product, television, had had all of its development work done before the war, been rolled out to the public at the New York World's Fair in 1939, but had its commercial exploitation delayed until after the war. One can tell a similar story about nylon. The 1948 surface transport infrastructure, which underlay productivity levels in distribution, transportation, and housing, had been almost entirely completed before 1942. All of this suggests that if we imagine a world without the disruptions of the war, with the economy continuing a rapid progression towards full employment in 1942, productivity levels in 1942 could well have approached those achieved in 1948. In a closely related exercise, we can ask what productivity levels would have been in 1941 had unemployment been at 1948 levels (3.4 percent).

Unemployment in 1948 was 6.5 percentage points lower than it had been in 1941. Using the estimated coefficient from the above regression, we can predict that had unemployment in 1941 been as low as it was in 1948, TFP would have been 5.98 percent higher than it was (-.0092 * -6.5 = .0598). TFP in 1948, measuring using natural logs, was 9 percent higher than 1941. So approximately two-thirds of the productivity gap between 1941 and 1948 would be eliminated if we make a cyclical adjustment to the 1941 data.

Table 6
Compound Annual Growth of Total Factor and Labor Productivity, United States, 1919-2000, with Cyclical Adjustment for 1941

	TFP	Output/Hour
1919-29	2.02	2.27
1929-41	**2.81**	**2.86**
1941-48	**.44**	**.86**
1948-73	1.90	2.88
1973-89	.34	1.34
1989-2000	.78	1.92

Sources: See Table 1, text.

Any positive cyclical adjustment to measured 1941 productivity to account for the fact that the economy had not yet reached capacity would raise the estimated TFP growth rate between 1929 and 1941, and lower it between 1941 and 1948. Kendrick's TFP index for the private nonfarm economy stands at 132.0 for 1941. If we make the 5.98 percent adjustment implied by the above analysis, we are at a cyclically adjusted 1941 level of 140.1. The level for 1948 is 144.5, implying less than a half a percent growth (.44 percent per year) between 1941 and 1948, as compared with 2.81 percent per year between 1929

and 1941.[4]   Table 6 revises the numbers reported in Table 1 to include rates of growth

based on a cyclically adjusted productivity level for 1941.The revised numbers, including

growth rates for output per hour, are bolded.

The 1941-48 growth rate would be further reduced were one to make an adjustment

to 1948 TFP for the value of formerly GOPO (government owned, privately operated)

capital, much of which was already in the hands of the private sector by 1948 (the major

exception was synthetic rubber, which was not completely deaccessioned until 1955).

Gordon has argued that this capital was often sold off in sweetheart deals, and that its

value has not been adequately included in the standard capital stock measures (see

Gordon 1969, Rockoff, 1998, p. 106). If the capital stock input should be higher for

1948, the level of TFP in that year would have to be lower, and so, by definition, would

its rate of growth between 1941 and 1948. It would not take a large nod in Gordon's

direction on this account to reach a cyclically adjusted rate of growth of TFP of close to 0

for the private nonfarm economy between 1941 and 1948.

We can also ask, counterfactually, what might have happened had the Japanese

attack been delayed twelve months. Due to the disruptions associated with conversion

and war mobilization TFP in actuality grew hardly at all between 1941 and 1942 (132.5

vs. 132). But suppose the economy had experienced one more year of peacetime growth

in which the economy benefited from the trend growth rate in TFP and the

unemployment rate fell to 1948 levels. The regression results suggest that in this case,

1948 productivity levels would have been approached in 1942. This conjecture is based

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[4] The 2.81 percent compound annual growth resulting from this exercise is very close to the 2.83 percent
implied by the intercept term on the regression using 1929-41 data.

on adding the 2.83 intercept term from the equation to the 5.98 percent predicted increase in TFP from a drop in the unemployment rate of 6.5 percentage points. Summing these two terms leads to a predicted level of TFP in 1942 8.7 percent higher than 1941, just shy of the measured 1948 level.

On average, there were 5.560 million unemployed in 1941. Had the unemployment rate been at its 1948 level of 3.4 percent, with higher employment in construction, motor vehicles, other manufacturing sectors, wholesale and retail trade, and finance, insurance and real estate, 3.547 million of them would have been at work. Unemployment was falling rapidly during 1941. In the fourth quarter it was down to an average of 3.4 million, with a civilian labor force of 53.9 million, yielding an unemployment rate of 6.3 percent (Statistical Abstract of the United States, 1946, p. 173).

Had trends persisted in the absence of war, employment, TFP, and labor productivity would all likely have been higher in 1942. As Figure 6 shows, housing construction was robust and growing in 1939, 1940 and 1941, and when the postwar housing boom emerged with full force in 1948, it took off from where it had been arrested in 1941. Since the failure of residential construction to revive fully was one of the major contributors to the persistence of low private investment spending during the Depression, its signs of revival in the years immediately preceding the war suggest that had peace continued, investment, output and employment growth would have continued as the economy reapproached capacity.

Both of the adjustments discussed strengthen the importance of productivity advance between 1929 and 1941, and weaken its likely magnitude between 1941 and 1948. One concludes from this analysis that the 1.29 percent per year cumulative growth

in TFP per year between 1941 and 1948 calculated from the standard data, a rate of growth already much lower than that recorded between 1929 and 1941, overstates productivity advance across the period of mobilization and demobilization.

Conclusion

By 1948 the US economy had demobilized, the civilian economy was booming, and unemployment stood at the remarkably low peacetime rate of 3.4 percent. Housing and private nonresidential building had finally risen above their 1929 levels, as had automobile production. Between 1941 and 1948, TFP in the private nonfarm economy, according to the standard measures, grew at a compound annual rate of 1.29 percent of year, respectable in comparison with 1973-89, but far below the rapid advance before (1929-41) or after (1948-73). As the previous section suggests, the rate of advance between 1941 and 1948 reflected in these numbers is probably overstated.

We come back to the question posed at the start of this essay. How much of the achieved productivity level of the 1948 civilian economy should reasonably be attributed to the war? The two main components of the "war stimulates productivity growth" thesis involve learning by doing in military production and spinoffs from military research and development. Much attention has been paid to the success stories in producing ships and airframes. There are several reasons, however, why one should be skeptical that this had much to do with how the economy performed in 1948. First, as Fabricant noted, the initial productivity levels immediately following conversion were low. Second, much of the success here involved the application to these military goods of mass production methods that had been pioneered in the 1920s and the 1930s in the civilian economy. In other words, organizational and technical advances prior to 1942 contributed to the

success of economic mobilization more than the latter did to postwar productivity. Even on the technical (as opposed to production side), it is notable that there was not a single combat aircraft produced during the Second World War that was not already on the drawing boards before it began.

Finally, and most importantly, whatever commodity specific learning by doing took place between 1942 and VJ day in 1945 was largely irrelevant by 1948 because most of it applied to the other transport equipment sector, and that sector, having practically quadrupled in size between 1941 and 1943 (based on FTEs), was smaller in 1948 than it had been in 1941.

The second component of the thesis emphasizes spillovers from military research and development. Items often referenced include radar, microwaves, atomic power, and techniques for mass producing penicillin. Unlike learning by doing producing C-47s, the penicillin experience clearly had more peacetime applicability, as did improved techniques learned on the battlefield for treating trauma. Radar might not have been developed as soon as it was in the absence of the war. But with microwaves and atomic power, and many of the other putative spillover candidates, one has to ask how much the war accelerated a scientific and technological trajectory that was proceeding very well prior to it.

The scientific and engineering community, in cooperation with government officials, managers and workers had, by all accounts, and based on our experience with war mobilization, done a superb job in helping to expand the potential output of the economy between 1929 and 1941. This community was then asked to drop much of what it was doing and focus on challenges central to the war effort. In the process, some

discoveries and learning useful for civilian production took place. But these were accidental and incidental, and it is unlikely that the stock of economically relevant knowledge (both technical knowledge and production knowledge) was on balance higher compared to what it would have been in the absence of war.

Employment of scientists and engineers in US manufacturing increased 74 percent between 1927 and 1933, and then almost tripled between 1933 and 1940. Growing at a compound rate of 13.3 percent per year the number of scientists and engineers in U.S. manufacturing increased from 10,918 to 27,777 over that seven year period. The rate of increase between 1940 and 1946 slowed to 8.4 percent per year (Mowery and Rosenberg, 2000, p. 814), and both Schmookler (1966) and Mensch (1978), in their enumerations of basic innovations, record sharp declines following the peak in the five year period 1935-39.

There continues to be a popular perception that war is beneficial to an economy, particularly if it does not lead to much physical damage to the country prosecuting it. The effect of research into the effects of armed conflict, however, has usually been to produce a more nuanced view. For example, an earlier tradition (Hacker, 1947) saw the Civil War as a tremendous stimulus to the Northern economy, whereas more systematic quantitative inquiry has led to an emphasis on its retardative effects on growth (Goldin and Lewis, 1975). In that spirit, this research represents a revisionist approach to the analysis of the Second World War, although one which is not entirely unanticipated. As we become more comfortable thinking of the latter half of the twentieth century as an appropriate venue for economic history research, it will be appropriate to delve more

deeply as well into the Cold War's impact on the growth of potential output in the United States.

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