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The Impact of the Second World War on U.S. Productivity Growth[1]

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 lasting from 1941 to 1948. Optimists have pointed to 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. Productivity data for the private nonfarm economy are not consistent with this view, since they show slower TFP growth between 1941 and 1948 than before or after. The paper argues for adopting a less rosy perspective on the supply side effects of the war.

I.

The historiography of the Great Depression in the United States 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, *Colossus*, 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.'[2]

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.[3] 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 (Searle, 'Productivity'; Alchian, 'Reliability'; Gemery and Hogendorn, 'Learning Curves') and spinoffs from military research and development (Ruttan, *Is War Necessary*). 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 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, 'Most Technologically Progressive Decade'; 'Technological Change'). A corollary is a greater skepticism about the rosy supply side picture typically painted of the impact of the war years.

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. The conventional (Kendrick) data do show TFP higher in 1948 than it had been in 1941, although as I show at the end of the paper, much of the gap is eliminated if one makes a cyclical adjustment to take account of the fact that the economy in 1941 had not yet fully reattained potential output. The question I wish to pose is whether 1948 levels were higher than they would have been in the absence of the war. Stated alternately, one can ask 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 (Field, 'Most Technologically Progressive Decade'; 'Technological Change'; 'Equipment Hypothesis'; 'Interwar Years and the 1990'). Thus the rate of increase of TFP between 1941 and 1948, even without a cyclical adjustment, is lower than is commonly realized.

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 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, 'Depression Unemployment'), 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, within the military and much of the civilian sector, approached a command economy (U.S. Civilian Production Administration, *Mobilization for War*).[4] 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 microwaves and advances in electronics that benefited the nascent computer industry industry. But there were opportunity costs, and the overall effect of the Second World War 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 of potential output that had been achieved during the Depression years, largely fueled by advance of TFP.

II.

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.[5] The military build up, which was only beginning 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 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 3.8 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 Fabricant, 'Armament Production'; Backman and Gainsbrugh, 'Productivity and Living Standards'). 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 productivity 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, 'Armament Production', 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 ABOUT HERE

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 Kendrick and others who followed his example used 1937 (Kendrick, *Productivity Trends).* 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 as close as 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 (3.8 percent).[6] 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 buildup 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. Departments of the Army and the Navy spent $1.8 billion on military manpower, structures, equipment, and other ordnance in 1940, and $6.3 billion in 1941 (Table 2, column 2; 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 Army and Navy spending in 1940 and 1941 represented just 3.2 percent of the 1940-46 cumulative total.[7] Adjusting for price changes makes virtually no difference in these calculations. Column 1 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 (column 3) is still just 3.2 percent of the cumulative 1940-46 total.[8]

The picture is slightly modified if one considers a broader measure of spending on national defense, including Lend Lease, and spending by the Defense Plant Corporation, a subsidiary of the Depression era Reconstruction Finance Corporation. By this measure, a total of about 5 percent of cumulative 1940-1945 military spending had taken place prior to Pearl Harbor (Table 2, columns 4 and 5).

TABLE 2 ABOUT HERE

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

FIGURE 1 ABOUT HERE

The pattern observed in military manpower is also evident in the time series for US military aircraft production (Figure 2). 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 ABOUT HERE

This pattern is even more pronounced for ship production (Table 3), 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.

TABLE 3 ABOUT HERE

Finally let's consider 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 (U.S. Bureau of the Budget, *Statistical Abstract 1946*, p. 104).

FIGURE 3 ABOUT HERE

Federal Reserve Board industrial production data (Figure 4) also show that the wartime expansion of industrial production was almost exclusively a durable goods phenomenon. These data show industrial production, both total and war related, peaking in 1943. Total industrial production peaked in October, when manufacturing accounted for a larger share of U.S. value added than it ever had before or ever would again, and fell precipitously after February of 1945.[9]

FIGURE 4 ABOUT HERE

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.

III.

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.[10] Tables 4 and 5 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 4) and between 1943 and 1948 (Table 5). 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.

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 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 thousand 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 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 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.

TABLE 4 ABOUT HERE

Table 5 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 left this category. The huge increase in the military would make the outflows from government larger for an analysis based on a 1944-1948 transition.

TABLE 5 ABOUT HERE

The standard expenditure data (Figure 5), expressed as proportions of gross national product, show that during the war rising proportions of Government spending crowded out domestic private investment, net exports, and consumption (the current account went into deficit largely because of unilateral transfers, including Lend-Lease). These

numbers do show the absolute value of consumption rising in real terms throughout the war, except in 1942, although Higgs ('Wartime Prosperity', 'Regime Uncertainty', 'Central Planning to the Market') 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.

FIGURE 5 ABOUT HERE

Although the question of how much real consumption rose or dropped during the war remains at issue (see Rockoff, 'Ploughshares to Swords'; Edelstein, 'War and the American Economy, p. 400), 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.

FIGURE 6 ABOUT HERE

Several conclusions are apparent from these charts. First, residential construction, the sick child of the U.S. economy throughout much of the Depression (see Field, 'Uncontrolled Land Development'), had by 1941 laboriously climbed back to within

striking distance of its 1929 level. 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.

FIGURE 7 ABOUT HERE

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.[11] It continued to do so afterwards. Thus the 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

IV.

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 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 fall, 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 of 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.

FIGURE 8 ABOUT HERE

The Depression years, in fact, were one of those periods evidencing strongly procyclical productivity, as Figure 8 clearly shows. Table 6 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 6 ABOUT HERE

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

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

(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, or close to a percentage point, with every percentage point increase in the unemployment rate doing the opposite. 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 that it 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, over which women went wild when it was first introduced in 1939, before the war, diverting its use from stocking to parachute production, made it a scarce civilian commodity. 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 (3.8 percent).

Unemployment in 1948 was 6.1 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 5.61 percent higher than it was (-.0092 * -6.1 = .0561). TFP in 1948, measuring using natural logs, was 9 percent higher than 1941. So close to two-thirds of the productivity gap between 1941 and 1948 would be eliminated if we make a cyclical adjustment to the 1941 data.

TABLE 7 ABOUT HERE

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 5.61 percent adjustment implied by the above analysis, we are at a cyclically adjusted 1941 level of 139.6. The level for 1948 is 144.5, implying less than a half a percent growth (.49 percent per year) between 1941 and 1948, as compared with 2.78 percent per year between 1929 and 1941.[12] Table 7 revises the numbers reported in Table 1 to include rates of growth based on a cyclically adjusted productivity level for 1941. It is notable, and quite remarkable, that the calculated growth in output per hour between 1929 and 1941 is just short of that registered during the golden age (1948-73), even in the complete absence of any private sector capital deepening during the earlier period. 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 '$45 billion of Investment Mislaid'; Rockoff, 'Ploughshares to Swords', 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.[13]

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 1929-41 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 on adding the 2.83 intercept term from the equation, for one year of additional growth based on the peacetime trend growth rate, to the 5.61 percent cyclical adjustment, the predicted increase in TFP from a drop in the unemployment rate of 6.1 percentage points.

Summing these two terms leads to a predicted level of TFP in 1942 8.4 percent higher than 1941, just shy of the measured 1948 level.[14]

On average, there were 5.560 million unemployed in 1941. Had the unemployment rate been at its 1948 level of 3.8 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 (U.S. Bureau of the Census, *Statistical Abstract 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.

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. Both of the

adjustments discussed strengthen the relative importance of productivity advance between 1929 and 1941, and weaken its likely magnitude between 1941 and 1948.

V.

By 1948 the US economy had demobilized, the civilian economy was booming, and unemployment stood at the low peacetime rate of 3.8 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 underlying 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 to military production were often low (U.S. Bureau of the Budget, *United States at War*, p. 433). Some of what one is seeing is improvement from this base. 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 probably had a greater contribution to the success of economic mobilization than the latter did to postwar productivity levels. Even on the technical (as opposed to production side), it is notable that there was not a single combat aircraft seeing major service produced during the Second World War that was not already on the drawing boards before it began.[15]

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. Few of the ships and aircrafts about which so much has been written (Liberty Ships or B-29's, for example)[16] were produced after the war. Even those for which the production of civilian counterparts continued, such as the C-47/DC-3, had much smaller postwar production runs. Other dual use vehicles, such as trucks, had fewer units produced annually between 1942 and 1945 than had been the case in 1941 or even 1937 (U.S. Bureau of the Census, *Historical Statistics*, Series Q-150, p. 716). Here again, it is much more likely that success in producing these vehicles in volume derived from prewar experience in civilian manufacturing, as opposed to the war contributing dramatically to postwar capabilities.

To the degree learning by doing took place in war industries, it involved innovations in workplace organization, materials flow, sequencing of tasks, and the acquisition of job and product specific human capital. Because of the shrinkage of the other transport goods sector and the disappearance of many of the wartime products from

the postwar output mix, little of this learning would have had much influence on 1948 productivity levels.[17]

The second component of the thesis emphasizes spillovers from military research and development. Items often referenced include microwaves, advances in electronics benefiting the computing industry, atomic power, and techniques for mass producing penicillin. Unlike learning by doing producing Sherman tanks, the penicillin experience clearly had more peacetime applicability, as did improved techniques learned on the battlefield for treating trauma. But with computers, 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 incidental to the war effort, and entailed opportunity costs in the forms of disruptions of the trajectory of technical advance in the civilian economy. It is unlikely on balance 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, 'Twentieth Century', p. 814), and both Schmookler (*Invention and Economic Growth*) and Mensch (*Stalemate in Technology*), 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 U.S. experience during the Second World War is the typical poster child for this point of view. The effect of detailed research into the effects of armed conflict, however, has usually been to produce more nuanced interpretations. For example, an earlier tradition (Hacker, *Triumph of American Capitalism*) 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, 'Cost of the Civil War'). In that spirit, the research reported on in this paper represents a revisionist approach to the analysis of the Second World War, although one which is not entirely unanticipated.[18] 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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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.

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

	1	2	3	4	5
	Price Index National Defense	Army and Navy		All National Defense	
		Nominal	Real	Nominal	Real
1940	100.0	1.8	1.8	2.5	2.5
1941	106.7	6.3	5.9	14.3	13.4
1942	104.4	22.9	21.9	51.1	48.9
1943	105.5	63.4	60.1	84.2	79.8
1944	103.8	76.0	73.2	94.5	91.0
1945	104.5	80.5	77.0	82.0	78.5
TOTAL		250.9	240.0	328.6	314.2

Sources: Column 1: www.bea.gov, National Income and Product Accounts, Table 1.5.4; accessed 4/3/2005.
Column 2: the sum of outlays by the Departments of the Army and the Navy: U.S. Bureau of the Census (1975), Series Y 458, 459, p. 1114.
Column 3: Column 2/Column 1.
Column 4: total national defense spending. Source: www.bea.gov, National Income and Product Accounts, Table 3.9.5, accessed 7/13/2006.
Column 5: Column 4/Column 1.

Table 3
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
Auxiliaries	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.

Table 4
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: National Income and Product Accounts of the United States, 1929-1982.
Washington: Government Printing Office, 1986, Table 6.7a, p. 275.

Table 5
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	

Source: See Table 4.

Table 6
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	3.8	-6.1

Sources: Kendrick, 1961; Lebergott, 1964.

Table 7
Compound Annual Growth of Total Factor and Labor Productivity, United States, 1919-2000, with Cyclical Adjustment for 1941

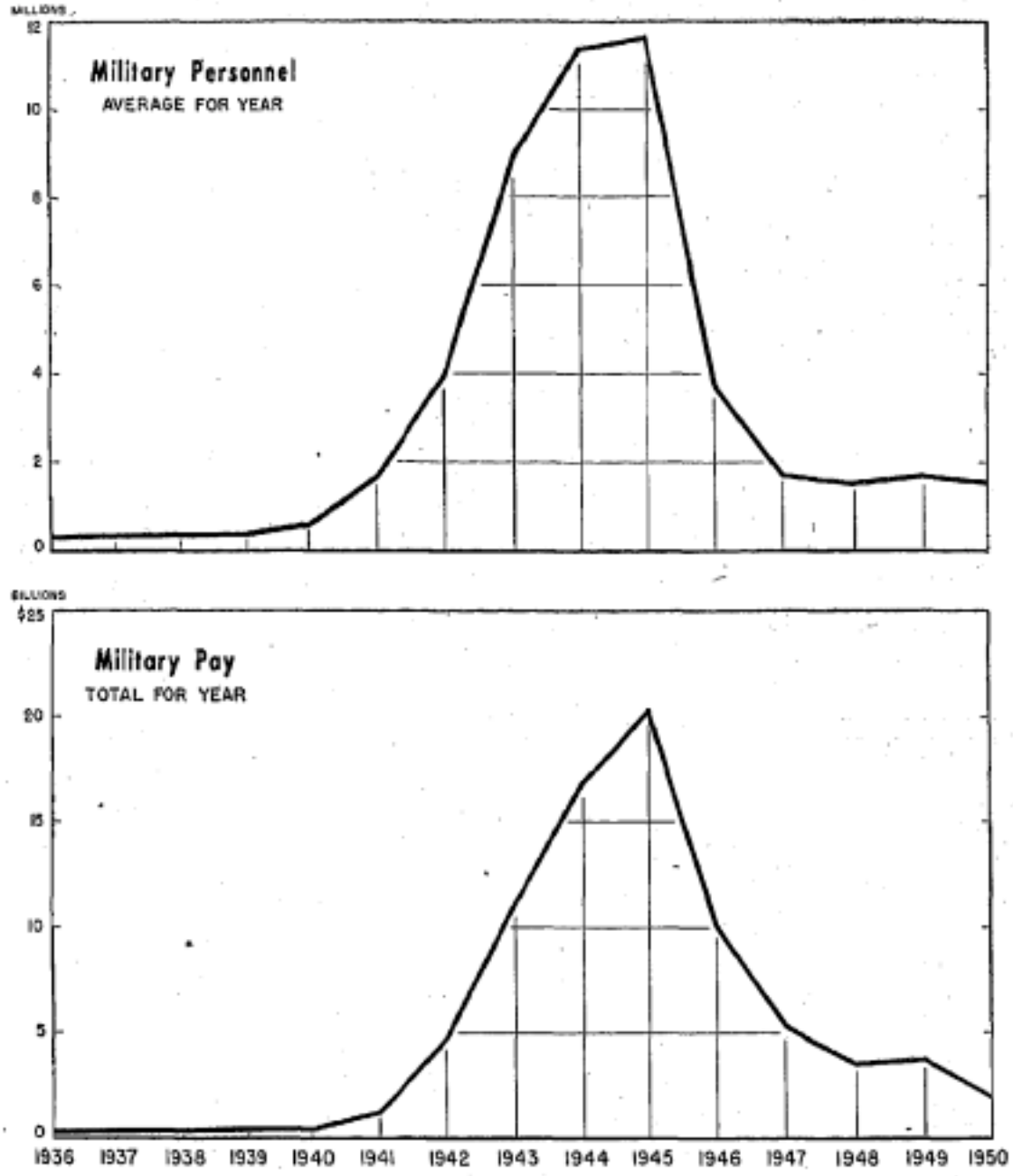
	TFP	Output/Hour
1919-29	2.02	2.27
1929-41	**2.78**	**2.83**
1941-48	**.49**	**.91**
1948-73	1.90	2.88
1973-89	.34	1.34
1989-2000	.78	1.92

Sources: See Table 1, text. Data are for the private nonfarm economy.

Figure1

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

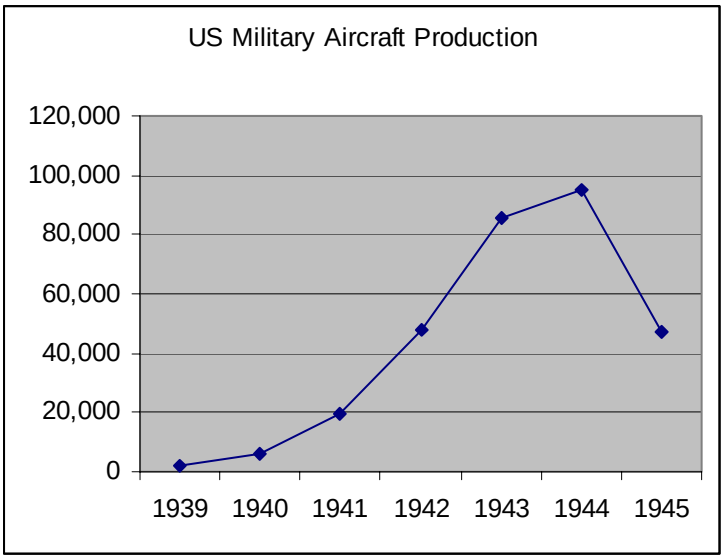
[1950 data for Jan.–June only. See table 248]



Source: Department of Labor, Bureau of Labor Statistics.

U.S. Bureau of the Census, Statistical Abstract of the United States, 1951, p. 210.

Figure 2



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

FIGURE 3

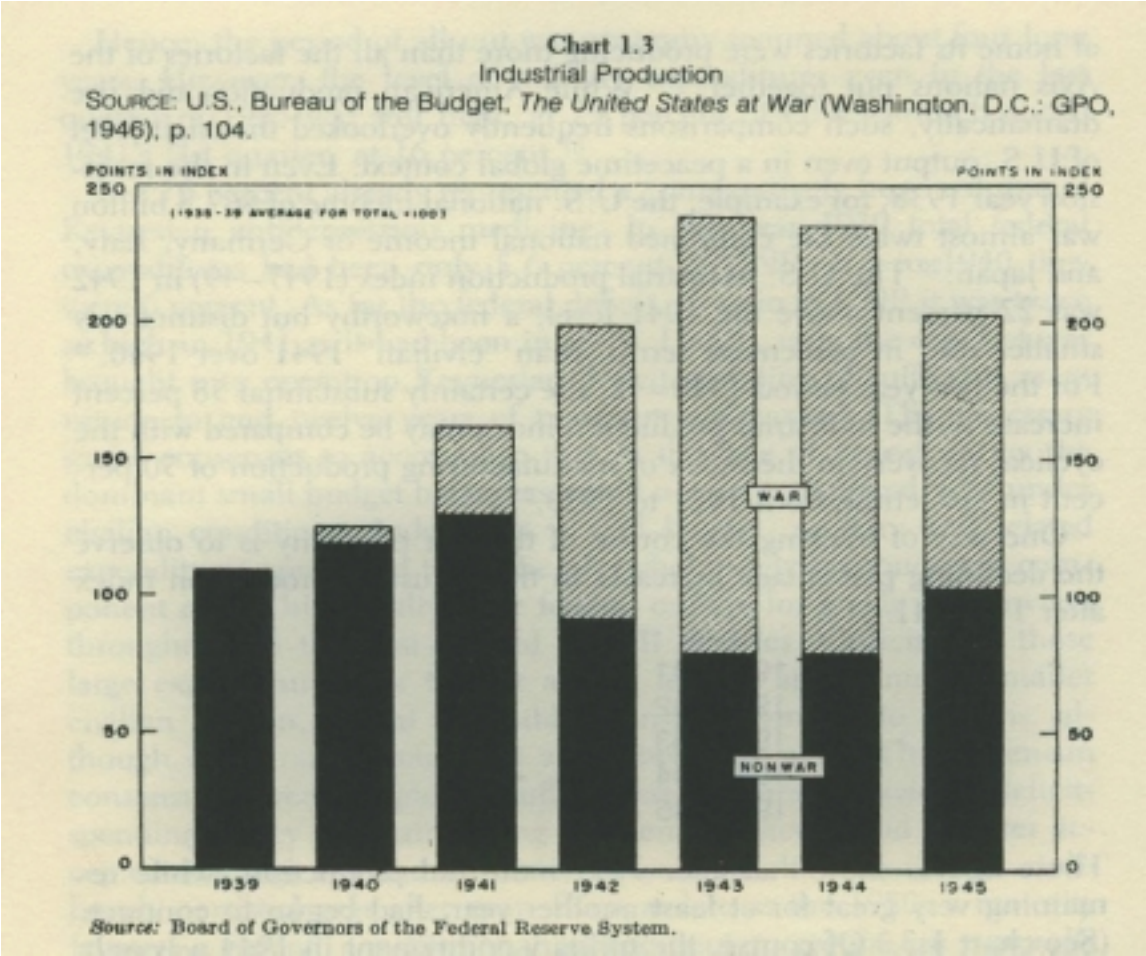
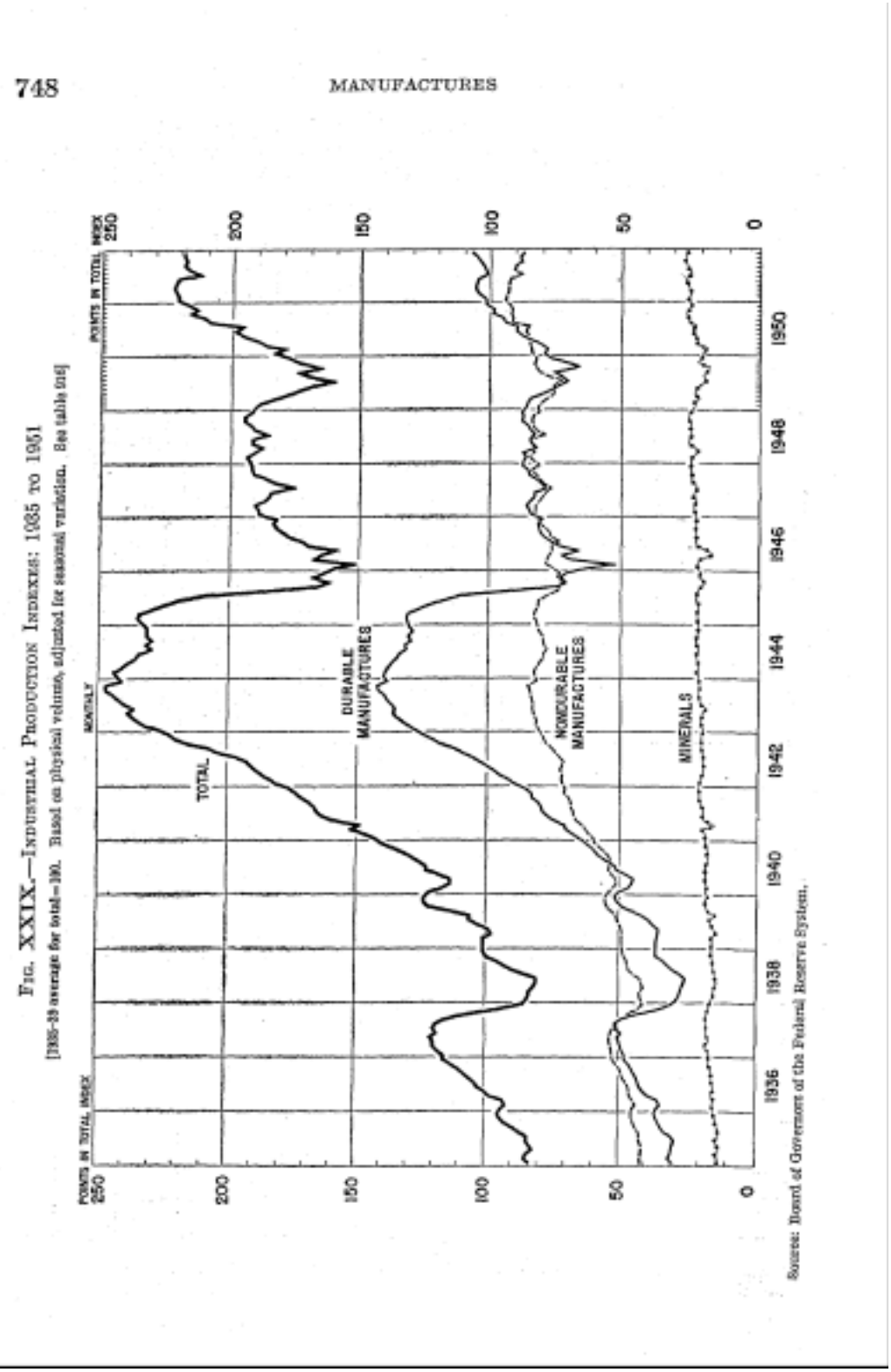


Chart 1.3
Industrial Production

SOURCE: U.S., Bureau of the Budget, *The United States at War* (Washington, D.C.: GPO, 1946), p. 104.

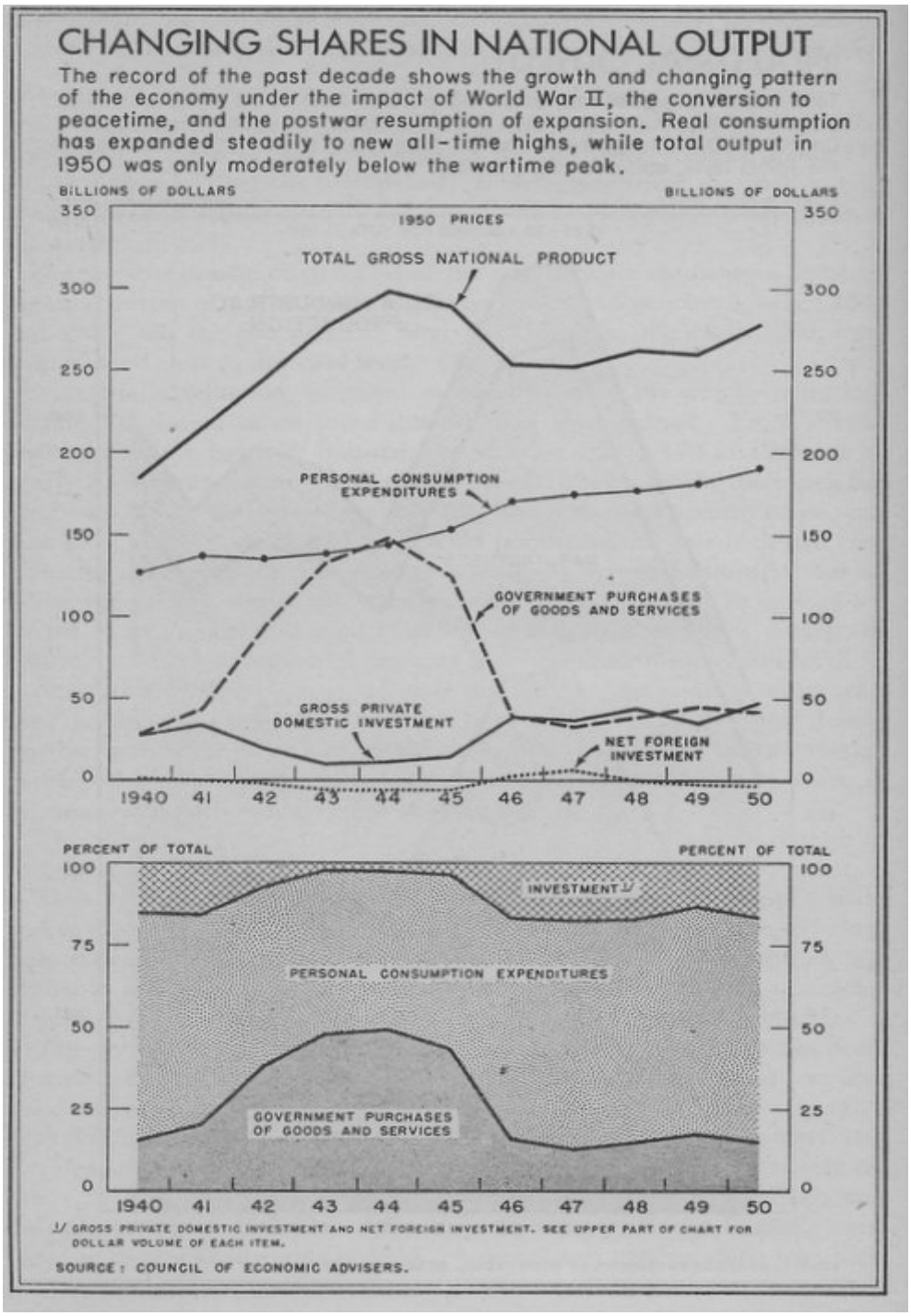
Source: Board of Governors of the Federal Reserve System.

FIGURE 4



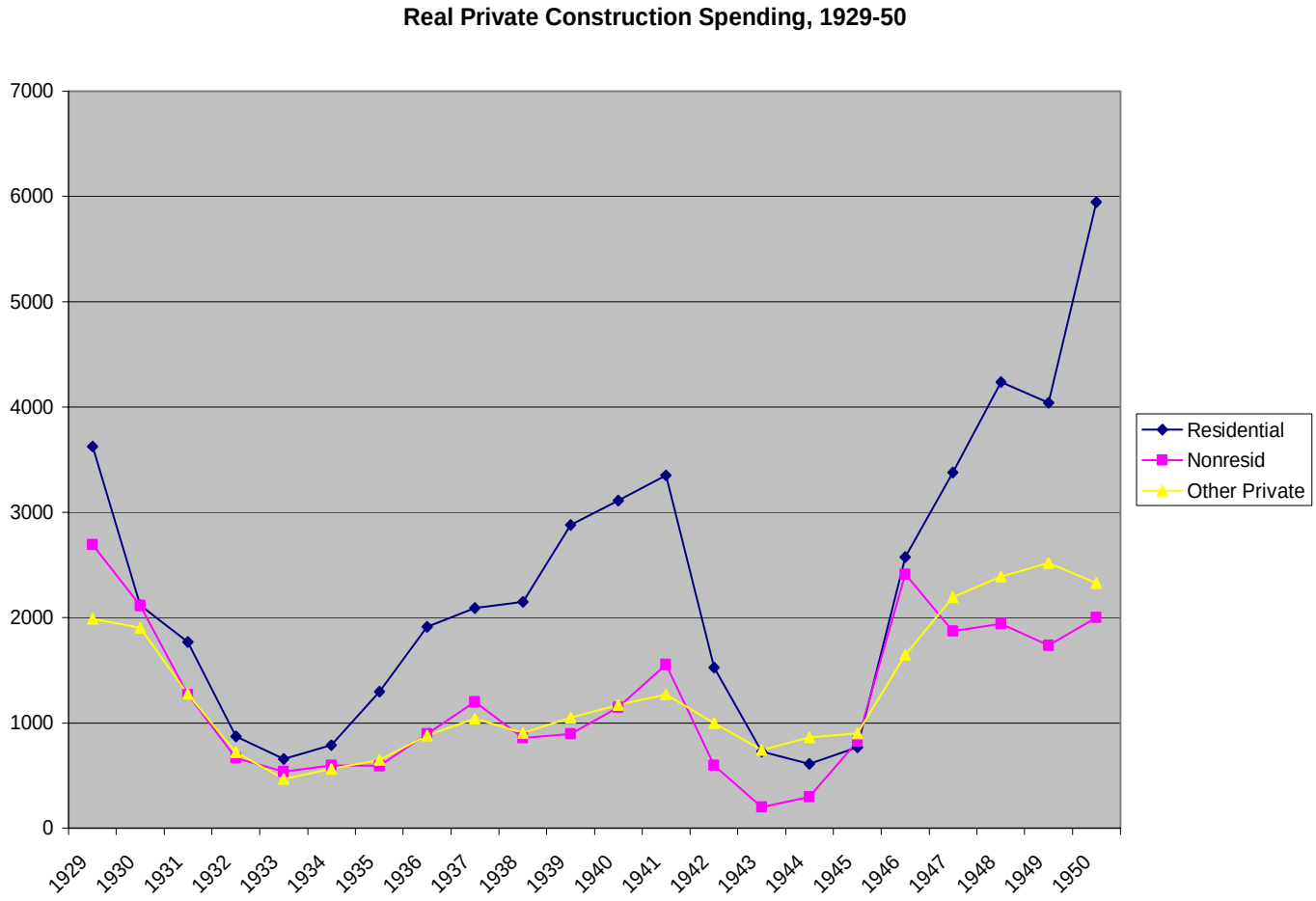
Source: Statistical Abstract of the United States, 1951, p. 740.

Figure 5



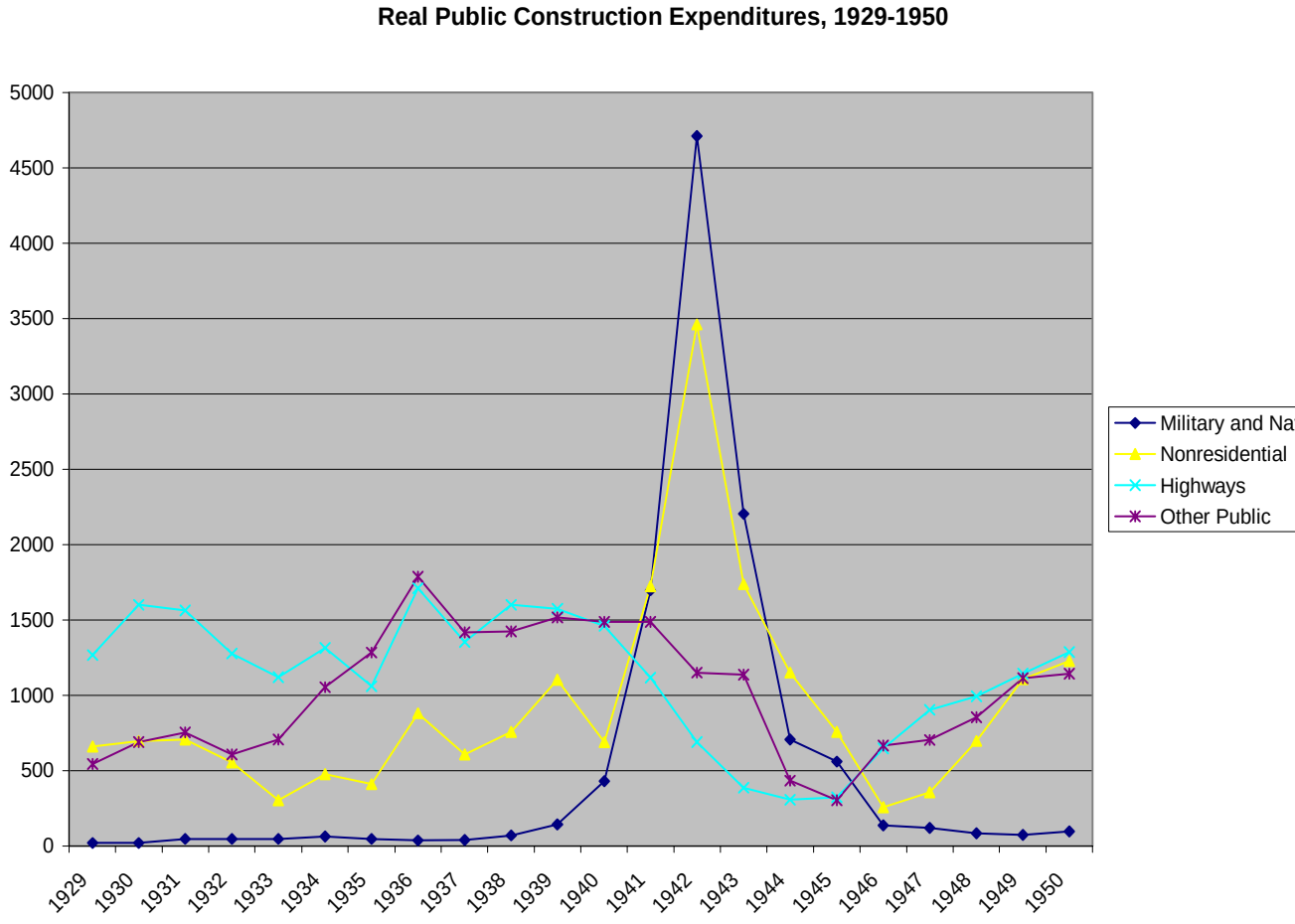
Source: Economic Report of the President, 1951, p. 56.

Figure 6



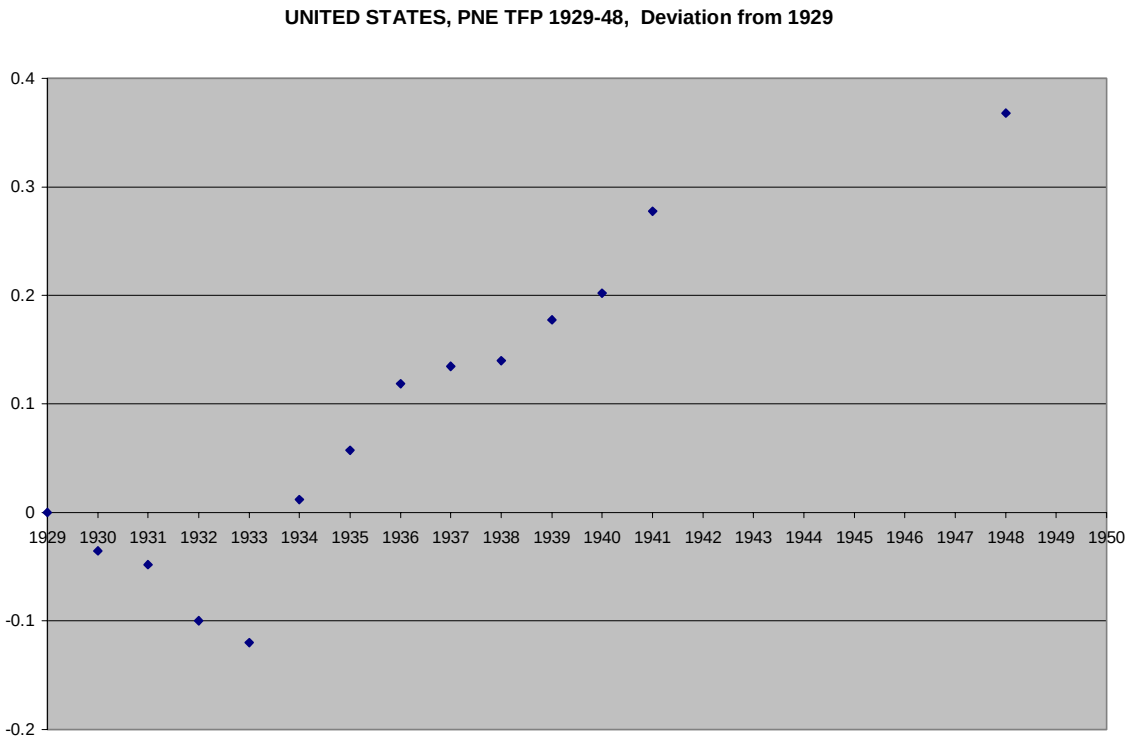
Sources: See text. Nominal Data: Economic Report of the President, 1951, Table A-18, p. 188.
Deflators: www.bea.gov, accessed April 2, 2005.

Figure 7



Sources: See Figure 6.

Figure 8



Source: See Table 6. Data points plotted are ln (t) - ln (1929).

NOTES

[1] This paper has benefited from presentations at the CEPR-CREI workshop on "War and the Macroeconomy" in Barcelona, Spain, June 29-30, 2005 and the ASSA meetings in Boston, Massachusetts, January 7, 2006, as well as comments from seminar participants at Stanford University, Columbia University, Humboldt University (Berlin), Universidad Carlos III (Madrid), All Souls College (Oxford University), the London School of Economics, and the University of California, Riverside.

[2] The demand side argument is widely understood, and not the main focus of this article; details of the magnitude of the fiscal and monetary stimulus can be found in Edelstein, 'War and the American Economy'. The supply side story is frequently more implicit, but equally common. Optimism about the supply side effects of war is reflected, for example, in Baumol's comment in 1986 that "... except in wartime, *for the better part of a century,* U.S. productivity growth rates have been low ..." (Baumol, 'Productivity Growth', p. 1073). For a more recent illustration, see Ruttan, *Is War Necessary.* Presumptions about the long term economic benefits of war have, perhaps understandably, been somewhat less prevalent in Europe.

[3] This demand shock was sufficient to end the Depression, in the sense that it drove unemployment from 9.9 percent in 1941 to under 2 percent within two years. But was it necessary? By the end of the 1930s (and certainly by 1941) the private economy was on the road to recovery, and might have continued in that direction, even in the absence of the growing stimulus from the government sector. Of all components of autonomous spending, residential construction took the longest to reapproach levels experienced

during the 1920s (Field, 'Uncontrolled Land Development'). 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; housing had actually peaked in 1926)). 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, only a small fraction of cumulative war spending had actually taken place at the time Pearl Harbor was attacked.

[4]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 (see Higgs, 'Wartime Socialization'). As Figures 5, 6, and 7 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 plants 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.

[5] Military spending and manpower tripled between 1940 and 1941, but it did so from a very low base, and only a small fraction of cumulative war expenditure had actually taken place at the time of the Japanese attack. As a consequence, war related spillovers and learning by doing cannot have had much to do with achieved 1941 productivity levels.

[6] For further discussion, see Field, 'Most Technologically Progressive Decade'; 'Technological Change'.

[7] Data for the Lend-Lease program itself show a similar pattern. The legislation was passed on March 11, 1941, and shipments did take place prior to Pearl Harbor; their rate of growth starting from a base of zero was of course astronomical. But 1941 shipments comprised only about 3.2 percent of the cumulative total for the program between 1941 and 1945; more than 96 percent occurred after 1941 (see U.S. Bureau of the Budget, *United States at War*, Chart 49, p. 412).

[8] Although many of the institutional foundations for war and postwar military procurement were established between May of 1940 and the declaration of war in December of 1941 (U.S. Bureau of the Budget, *United States at War*; Higgs, 'Private Profit, Public Risk'), the actual impact of government regulation and control on the economy was relatively minor prior to 1942. Effective control of retail prices, for example, did not begin until the General Maximum Price Regulation of May of 1942 (Harris, *Price and Related Controls*, p. 9)

[9] Corroborative evidence for a peak in industrial production in late 1943 comes from data from the War Production Board, which show production of munitions alone peaking in the fourth quarter of 1943. Production of aluminum, magnesium, zinc, and chemicals all peaked in 1943, as did new merchant marine tonnage (U.S. Bureau of the Budget, *United States at War*, Chart 15, p. 137, Chart 38, p. 300; Chart 41, p. 319).

[10] A somewhat analogous treatment of the disruptive effects of the war on capital accumulation (investment flows) can be found in Higgs, 'Wartime Socialization'.

[11] The evidence for this can be found in the very high rates of TFP growth in trucking and railroads, and to a lesser extent in wholesale and retail distribution (Field, 'Technological Change'. The build out of the surface road network created substantial spillover effects in both trucking and railroads. Trucking successfully substituted for rails for certain routes and commodities. But the two modes were also highly complementary, and trucking's flexibility contributed to improved productivity in the railroad sector even in the presence of capital shallowing. One important mechanism was the smoothing of seasonal fluctuations in the demand for freight cars (see Field, 'Origins').

[12] 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.

[13] On the other hand, the physical capital stock was used intensively during the war, and the depreciation allowances applied by government statisticians may not adequately account for the effects of wear and tear and deferred maintenance. This consideration could counterbalance an underestimate of the value of GOPO capital transferred to the private sector. See Higgs, 'Wartime Socialization', pp. 515-517).

[14] Although there is no way of knowing if peacetime advance would have continued at the same rate throughout the 1940s in the absence of the war, had TFP advance between 1941 and 1948 persisted at the rate of 2.78 percent per year rather than .49 percent, TFP in 1948 would have been 17.4 percent higher than it actually was.

[15] "In World War II, no combat plane that had not been substantially designed before the outbreak of hostilities saw major service" (Galbraith, *New Industrial State*, p. 18).

[16] See Searle, 'Productivity', or Alchian 'Reliability', for detailed discussion.

[17] Even with respect to general human capital formation, one must keep in mind that many of the war production workers, particularly women, left the labor force after the war.

[18] See especially the series of articles by Higgs already referenced, as well as work by Edelstein and Rockoff.