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The Paradox of Planning in the United States during World War II*

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For Discussion Only

I. Introduction

The conventional view of the mobilization of the United States in World War II is that mobilization was a brilliant success, and that to a great extent this was produced by replacing the market with central planning. The success of the U.S. mobilization is evident in the figures on munitions production. The United States, according to Harrison's (1990, 587) recent estimates was producing munitions in 1940 at about the same rate as the U.K., the USSR, or Germany.² But at its peak in 1944 the United States was producing about 30 percent more than the three European powers combined, probably more than the rest of the world combined.¹ Other nations achieved outstanding successes in increasing production. The USSR increased munitions production 54 percent between 1940 and 1941, and 61 percent between 1941 and 1942, despite the German invasion. And Germany increased her production 32 percent between 1941 and 1942, and 44 percent between 1942 and 1943 despite the Allied bombing campaign. But none of the major powers matched the increases in the United States: 76 percent between 1940 and 1941, 126 percent between 1941 and 1942 and 54 percent between 1942 and 1943.

Mobilization got off to a rocky start, according to the standard accounts, because the Roosevelt administration initially failed to take the necessary steps of suspending the price system, creating a government bureaucracy with the power to command resources, and placing a dynamic executive in charge. But in the long run, according to the conventional view, these steps were taken, if only in the nick of time: the War Production Board

(hereafter the WPB) was created, Ferdinand Eberstadt was brought in (although he was never made chief executive as he should have been), and he installed the famous Controlled Materials Plan (hereafter the CMP) that finally solved the problem of allocating scarce resources to their most productive uses.

This story presents an important challenge to mainstream economic thinking because economists still tend to believe, despite all the qualifications and special cases that have been identified, that markets will be more efficient at allocating resources than central planners. World War II seems to be a counter-example; when the chips were down, United States abandoned the market and relied on orders from Washington. A number of thoughtful attempts have been made to resolve this paradox. John Kenneth Galbraith (1952) argued that by 1940 the world of atomistic competition had disappeared and that the economy was dominated by large corporations that "planned" their markets. It was a small step for the government, then, to enlist these large corporations in a joint effort to plan the whole economy.

Lionel Robbins (1956), writing admittedly about the somewhat different British case, offers several reasons why the state can and must take a more active role in the direction of the economy during an all-out war.² First, there is the simplification of the goals of economic activity. Military necessity determines the mix of tanks and planes and guns to be produced. So one of the main benefits of a market economy, that it generates information about consumer demands, is not needed. Second, increases in prices may be

insufficient to move resources where they need to be moved. And third, the market may not respond with sufficient speed to the new and highly uncertain conditions created by war. Where speed is of the essence, commands are more efficient than incentives.

Nor should we forget the man-and-woman-in-the-street explanation that patriotism made planning workable: People put aside their petty economic interests to achieve a common goal. Recently, Casey Mulligan (1994) has provided compelling evidence that work effort did rise by substantially more during the war than can be accounted for by pecuniary incentives.

Here I offer a different resolution of the paradox. I argue that the assumption that an ineffective mobilization was saved by the CMP is mistaken: the CMP was too little and too late. The mobilization, I suggest, was coordinated primarily in the old fashioned way: by the market. Rationing and price controls were used, but mostly after the basic economic problem, the shift of resources from the civilian sector to the military sector, had already taken place, and with the purpose of ameliorating the effects of rapid mobilization on the distribution of income.

II. The Traditional Assessment of the Mobilization

The most influential account of the mobilization is undoubtedly Eliot Janeway's The Struggle for Survival. For Janeway, the CMP was no less than the masterstroke that won the war.

"It [CMP] quickly balanced the input of economy energy and the output of fire power. In 1942 the war economy produced something over \$30 billions of finished munitions. In

1943, at virtually the same price level, munitions production fell just short of \$60 billion ... CMP flooded the fighting fronts with firepower." (Janeway 1951, 316)

Partly because of Janeway's influence, the ultimate success of wartime planning in general, and the CMP in particular, has been widely endorsed by historians of the war. Alan S. Milward, perhaps the leading international economic historian of the war, writes: "The central priority decisions were only made effective by the introduction of the Controlled Materials Plan." He goes on to suggest that there would not have been enough steel for landing craft had it not been for the CMP (1977, 123-24). William L. O'Neill in Democracy at War, a sophisticated and wide ranging general history of the war, is almost as enthusiastic as Janeway: "Little known at the time and quickly forgotten, CMP was critical to the entire war effort" (1993, 91). Clive Ponting in Armageddon, one of the most provocative of the recent spate of books about the war, claims that "the Controlled Materials Plan finally forced consumers of raw materials to plan coherently" (1995, 108). R. Elberton Smith's normally restrained official history, The Army and Economic Mobilization (1959, 568), rises to Janeway like heights: "Just as D Day was later to represent the supreme Allied effort on the military front, so the launching of CMP represented the supreme effort on the war production front."

Turning to the textbooks we find the view that mobilization was planned successfully by the WPB endorsed again and again. A recent textbook for general history courses, Out of Many: A History of the American People by John Mack Faragher, et al, tells the

student (1995, 493) that "The speed with which wartime production accelerated could also [in addition to America's abundant resources] be attributed to the massive reorientation and management of the economy by new government agencies." In George Brown Tindall's highly regarded America: A Narrative History, we find the WPB, overseeing "a wild scramble" for supplies (presumably something negative) that lasted until it instituted the CMP "which allocated scarce items to claimants according to its [the WPB's] best judgment of need" (1984, 1136). Current, Williams, Freidel, and Brownlee (1976, 308) add some specific details.

As late as the summer of 1942, bottlenecks were halting some assembly lines. On July 4 the vital shipbuilding program had to be cut back because of scarcities of raw materials like steel plate and glass, and of components like valves, turbines, and engines. The WPB eventually broke most of the bottlenecks through the Controlled Materials Plan, which established a balanced production of finished products and allocated precise quantities of raw materials to each manufacturer.

Robert Puth (1993, 589), in one of the leading economic history texts, while not specifically citing the CMP, states flatly that "The mobilization process was essentially a substitution of government planning for the normal direction of the economy by market forces." Sidney Ratner, James Soltow, and Richard Sylla (1993, 494-496) make the argument implicit in their chronology. First, they discuss "war production: problems and achievements," stressing the high levels of munitions production. Then they discuss "government control of the economy," describing the WPB and related agencies, and, I would argue, leaving it to the reader to

infer that the war agencies were the cause of the high level of production.³

To put the matter in a longer time frame, we can turn to William H. McNeill's The Pursuit of Power. This grand survey of sees the economics of war in the twentieth century returning to the command model, after greater or lesser reliance for a 1000 years on the market! His account of World War II does not mention the CMP explicitly. Nevertheless, after taking note of the early "quarrels over the allocation of scarce resources and raw materials" in the United States, McNeill reports that the "end result was a spectacular increase in American output of war materiel, and of other goods needed to supplement British, Russian, and other Allied economies as well." The explanation: "The kind of scheduling required to keep a complicated assembly line running smoothly in a great factory was, in effect, applied to the entire national economy of the United States" (McNeill 1982, 355).

The favorable impression of the CMP probably derives in part assertions made by the WPB itself shortly after it was instituted. But the WPB's claim for the CMP, it is interesting to note, was restrained.

Comparison of percentage increases in the supply of controlled materials with the increased output of major military and essential civilian items indicates that the proper channeling of materials to production has helped accelerate war output.

Major accomplishments of CMP which have permitted this increased production are:

(1) Provision of realistic end-product programs which are feasible within the available supply of basic raw materials.

(2) Provision of balanced flows of

materials and parts to assembly lines for final fabrication into completed items.

Experience has demonstrated that CMP provides the mechanism for both balancing and timing war production -- and consequently has aided in increasing output of war products. (War Production Board, Advance Release, Feb. 10, 1944; quoted in Harris, 1945, pp. 285-286).⁴

The elevation of the CMP into the masterstroke that won the war is the work of subsequent historians. One cannot help but think that they were carried away partly by the name. The words "controlled," "materials," and "plan" are loaded with an exciting ideological resonance that has little to do, as we will see, with the actual content of the CMP.

One might have thought that the apparent success of the CMP would have strongly reinforced the faith of liberals in a command economy. But as Alan Brinkley shows in The End of Liberalism, this did not happen. Brinkley endorses the view that the CMP was highly successful in allocating materials. He quotes a letter from Bernard Baruch (the administrator of the War Industries Board in World War I and a major behind-the-scenes player in World War II) to Eberstadt: "Everybody who knows and thinks about it feels that the Controlled Materials Plan is what brought order out of chaos in the War Production Board" (Brinkley 1995, 189). But Brinkley shows that the failures of the WPB prior to the CMP from the point of view of the agency's liberal critics -- its failure to wrest control of the economy from the military and from big corporations, and its failure to allocate resources to small businesses -- doomed it, as far as liberals were concerned, as a model for the postwar economy.

Brinkley's thoughtful reinterpretation of the political legacy of the mobilization is persuasive, but the economic question remains, why was it that a governmental attempt to allocate resources by command was so successful in World War II?⁵

III. From the War Resources Board to the CMP

The bureaucracy responsible for munitions production evolved as a compromise between two contending views.⁶ On the one hand, there was the argument, made repeatedly in the interwar period by Baruch, that the price system should be jettisoned (prices should be frozen) and allocative decisions should be made by a single all-powerful government bureaucracy on the basis of priorities set by the bureau. The bureau should be headed by one masterful executive (Baruch?) who should be granted whatever power it took to get the job done. Baruch saw this as the clear lesson to be drawn from the experience of the War Industries Board in World War I; New Dealers saw it as the logical implication of the failure of capitalism revealed by the Depression. And this argument undoubtedly struck a responsive chord in the general public. Who should be in charge, and how various interest groups should be represented, were matters of debate, but that someone should be "in charge" commanded wide agreement.

Roosevelt, however, was reluctant to go down this road, or at least to go down it quickly, preferring instead to keep his options open, and to keep contending interest groups uncertain about their influence, by creating the usual alphabet soup of agencies.

Roosevelt may have had a variety of additional motives: he may have seen a powerful administrator as a potential rival; he may have been skeptical about the utility of such an all powerful bureau. We don't know. But, in any case, the evolution of the bureaucracy did not follow the straightforward path advocated by Baruch.

The first step was taken in August 1939 after the outbreak of the war. Roosevelt created the War Resources Board to survey the nation's resources and to suggest a plan for mobilizing them. Roosevelt appointed Edward Stetinius Jr. from United States Steel to head the Board, and a number of other businessmen to serve with him. The Board immediately, and predictably, drew the fire of liberals, agriculture, and labor all of whom wanted to be represented. The Board wrote a report, for Roosevelt's eyes only, that claimed that America had abundant resources to meet any conflict -- expansion of capacities in steel and aluminum, for example, were not needed -- and that advocated that in the event of U.S. involvement, mobilization be entrusted to an all powerful bureaucracy along the lines suggested by Baruch. This wasn't what Roosevelt wanted to hear. In November 1939, the Board was dissolved, its members were thanked, and its Report was filed, to be made public after the war.

In May 1940 Roosevelt established the National Defense Advisory Commission. It included William S. Knudsen, President of General Motors, Sidney Hillman, of the United Ladies Garment Workers, and representatives of other interest groups. Its purpose was to expedite the awarding of contracts for munitions and to plan

future policies. The members of the Commission, although nominally advisors, quickly built up staffs that became the nucleus of subsequent agencies.

The deteriorating situation in Europe increased the pressure on Roosevelt to create a more powerful agency. In November 1940 he created the Office of Production Management, which began operations in January 1941, taking over the functions and personnel of the National Defense Advisory Committee. Roosevelt stoutly resisted pressures to appoint a single executive to head the agency insisting that there was no need for a "Poobah, Czar, or Akoond of Swat." Instead he appointed Knudsen as Director-General and Hillman as Associate Director-General -- insisting that the question of who was the head man was irrelevant.

The most important problem that the new agency faced was the priority system. Priorities in theory were very simple. A government agency -- the Army-Navy Munitions Board, the new Office of Production Management, or another agency -- would rate contracts according to their importance for the war effort. Manufacturers were required to fulfill contracts with higher ratings ahead of contracts with lower ones, tanks before jukeboxes. But the system was rapidly becoming clogged with high priority contracts, the beginning of "priorities inflation," a problem that would dog the priority system for the remainder of the mobilization.

Initially, priority ratings consisted of three letters A, B, and C each divided into 10 numerical bands, A-1, A-2 ... A-10, and so on. The natural tendency for any bureaucrat was to award an A-1

priority to all of the contracts coming across his desk, thus avoiding any blame if a project was not completed on time. Prime contractors were permitted to place ratings on subcontracts. In theory the rating on the subcontract was supposed to reflect the rating on the prime contract. But again the natural tendency was to place an A-1 rating on every subcontract. The A-1 rating quickly became merely a "hunting license" for materials. In November 1941 the A-1 rating was broken into A-1-a through A-1-j. Later still, higher ratings were added. Eventually, the system stabilized with ratings of AAA and A-1 ... A-4, although raw materials were relatively abundant during most of the time in which this set of ratings was used.

In August 1941, in the midst of the priority crisis, Roosevelt created the Supply Priorities and Allocation Board. This Board brought together representatives of the various agencies issuing priorities including the Army-Navy Munitions Board and the Office of Production Management, to set, hopefully, overall policy. Donald Nelson, a Sears executive who was working for the Office of Production Management, was made executive director. The administrative structure of the agency was heavily criticized at the time: Knudsen was a member of the Supply Priorities and Allocation Board and in that capacity superior to Nelson whose job was to implement the Board's decisions; but Nelson then gave orders to the Office of Production Management, thus making him in that capacity, superior to Knudsen. As far as I know, no one of importance questioned the general faith in the ability of the

government to improve the efficiency of the war economy by replacing prices with priorities.

The continuing problem of priorities inflation (and Pearl Harbor) led to the establishment of the WPB in January 1942 with Nelson becoming the sole director. The press greeted the new organization enthusiastically: at last someone was "in charge." Almost immediately (in March and April) Nelson reached "concordats" with the Army and Navy that ceded to them the right to place orders for munitions without prior approval by the WPB. There may well have been little else he could do. The WPB did not have a bureaucracy in place that could evaluate the enormous number of contracts that was flowing from the military. But as most historians of the mobilization have recognized, the crucial control over production thus passed from Nelson's hands, never to be regained.

Nelson's honeymoon with the press was short lived. Munitions production was below expectations, spokesmen for small business complained that big business was getting all the contracts, and the priorities mess was growing worse. By the spring of 1942 it was clear that the priorities system had broken down and had to be replaced.

The first attempt was the Production Requirements Plan. Under this plan manufacturers would file detailed reports with the WPB showing their contracts (including preference ratings), and their inventories of raw materials. The WPB then would decide on the amount of raw materials the manufacturer was allowed to buy, and

the preference ratings that it could assign to those purchase contracts. The Production Requirements Plan still made use of priorities, but it promised improvement along two lines. First, it took the power to issue priorities for raw materials away from prime contractors (one of the sources of priorities inflation) and secondly, it created a flow of information from which the WPB might hope to compute aggregate priorities and supplies.

In effect, in fixing prices and adopting the priorities system the government had created a new money and then freely handed out the right to print it. Now the government proposed to reclaim that power and concentrate it in the WPB. The Production Requirements Plan, however, turned out to be a failure, and was quickly abandoned. Novick, Anshen, and Truppner (1949, 129-135) attribute the failure to the inadequacy of the bureaucracy set up to administer the Plan -- it wasn't big enough and wasn't given enough time to get organized -- and to opposition to the Production Requirements Plan by the military and elements within the WPB.

In August 1941 Ferdinand Eberstadt, the hero of conventional accounts of the mobilization, was brought from the Army-Navy Munitions Board to the WPB. He immediately went to work on CMP.

IV. The Controlled Materials Plan

The CMP, although complicated in detail, was essentially a system for rationing three important raw materials: steel, copper, and aluminum.⁷ The system, although modified over time, went ahead for the most part according to an outline issued in November 1942

when the plan was announced (U.S. War Production Board, 1942). The idea was relatively straightforward, at least in comparison with earlier plans. (1) Each "claimant agency" was to submit estimates of its requirements for controlled materials to the WPB. Initially, there were seven claimant agencies: the War Department, Navy, Maritime Commission, Aircraft Scheduling Unit, Office of Lend Lease Administration, Board of Economic Warfare, and the Office of Civilian Supplies. (2) The WPB would then evaluate these estimates of demands in the light of its estimates of existing supplies. (3) The Requirements Committee of the WPB would then decide on monthly allotments of controlled materials for each of the claimant agencies. (4) The claimant agencies would then be notified of their allotments to which they would have to adjust their programs. (5) Each claimant agency would then divide its allotments among its major contractors. Each suballotment would be accompanied by an allotment number, in effect a ration ticket, showing the program and month. (6) These allotment numbers would then move from contractors to subcontractors, accompanying orders for raw materials, eventually reaching the mills where they would be honored. (7) The mills would then report their shipments to the WPB. (8) Cheaters were guilty of a criminal act, subject to a \$10,000 fine, a year in prison, or both.

All of this applied to "A" products, those manufactured by major government contractors and their subcontractors who were typically closely tied to one claimant agency. It was recognized that some manufacturers sold products, sometimes in small

quantities, to a wide range of firms on the open market. Producers of these "B" products could get their allotments directly from the WPB.

A substantial period was allowed for the WPB, the other agencies involved, and for industry to prepare for the expected volume of paperwork. The plan went into operation on a trial basis in April 1943 and on a compulsory basis in July.

The CMP was, despite its name, a retreat on several fronts from the attempts at micro-managing production that preceded it. The CMP was restricted to three materials, steel, copper, and aluminum; the Production Requirements Plan was based on a much longer list of materials, including a long list of chemicals. The CMP left decisions about how much major contractors would get to the claimant agencies, and how much subcontractors would get to the major contractors; the Production Requirements Plan centralized these decisions in the WPB. In principle, moreover, the CMP specifically excluded attempts to expedite the supply of controlled materials to individual projects (Novick, Anshen, Truppner 1949, 170). Thus, the CMP was not the final stage in a process of ever more detailed central planning; it was really just the opposite, an acknowledgement that detailed planning was unworkable.

Why was the CMP expected to have dramatic effects? In the first place it was expected to have the usual positive effects of rationing when prices are fixed: reducing the mad scramble for raw materials, reducing hoarding, saving resources spent searching the market or bribing suppliers, and so on. But the hope was that the

effects would extend far beyond the controlled materials. The basic problem in the mobilization -- the cause of many of the examples of wasted resources identified by critics -- was believed to be the excessive demands being placed on the economy, what was known as the "feasibility problem." It may have been first identified in a March 1942 memo written by Simon Kuznets.⁸ The CMP would attack the "feasibility problem," it was hoped, because demands for uncontrolled materials (chemicals, plastics, other metals, and so on) and for labor would be scaled back when claimant agencies scaled programs to make them consistent with allocations of controlled materials.

Table 1 explains how the CMP worked. The table shows the estimated supply of raw materials (which turned out to be quite close to the amount produced), the amount requested by claimant agencies (Stated Requirements, available only for the fourth quarter), the amount allocated to claimant agencies (Budget Allotment Balance), and the amount allocated by claimant agencies to prime consumers (Allotments Issued to Prime Consumers), typically major defense contractors.

Stated requirements of the claimant agencies always exceeded expected supplies. In the fourth quarter, for example, stated requirements for carbon steel (the amount the claimant agencies said they needed) was 19.599 million short tons, exceeding supply, as it was then estimated, by 27.5 percent. This was to be expected for two reasons. First, the purpose of the CMP was to force cutbacks in what were viewed as overly ambitious programs. And

Second, claimant agencies naturally overstated their needs in order to get as large an allotment as possible. In the case of carbon steel in the fourth quarter the WPB allocated only 16.898 million short tons, about 85 percent of what had been asked.⁹

But another aspect of Table 1 is surprising: the quantities allocated to claimant agencies exceeded by substantial amounts the quantities reallocated to prime consumers. In the third quarter, for example, only 93.2 percent of the carbon steel allocated to claimant agencies was reallocated. In some cases allotments to prime consumers even turned out to be less than the available supply -- copper and copper-base alloys in the third quarter and copper and aluminum in the fourth quarter. This phenomenon was referred to as "allotment attrition." In the third-quarter Controller's Report it was treated as a surprising, and perhaps alarming development. It appears, moreover, although no figures are available, that attrition was the rule throughout the production process: Quantities allocated to prime consumers in turn exceeded orders placed against metal mills and orders placed against mills exceeded shipments.

Smith (1959, 590) discusses a number of reasons for attrition: (1) overstatement of requirements, (2) reductions in requirements after the issue of allotments, (3) hoarding, both voluntary (for emergency reserves) and involuntary, and (4) alternative sources of controlled materials.¹⁰ Only (3) is consistent with the existence of shortages of controlled materials. The value of a ration ticket depends on the amount of excess demand and the elasticity of

demand. The tendency of the ration tickets to get lost along the way, especially for reasons such as (1), (2), (3) [in the case of involuntary hoarding] and (4), suggests that they weren't very valuable, and therefore that supplies of and demands for controlled materials were close to being in balance at the official price.

Production figures confirm that supplies of controlled materials were abundant after the CMP was put in place. If demand greatly exceeded supply, the cancellation of contracts would have led simply to a reduction in the shortfall. In fact steel production peaked in March 1944, 8 months after the CMP became mandatory; aluminum production peaked in October of 1943, only three months after the CMP became mandatory; and copper production peaked in June of 1943 while the CMP was still being put in place (Dewhurst & Associates 1947, 778). Production fell simply because of cutbacks in orders; mill capacity was more than adequate.¹¹

During the time that the CMP was being put in place tensions between Nelson and Eberstadt had been growing. According to Nelson the differences were technical: Eberstadt wanted the WPB to focus on materials allocation; Nelson wanted the WPB to focus on the scheduling of production, a job for which he brought in Charles Wilson of General Electric. Nelson may also have felt that Eberstadt was a potential rival. By February 1943, after the announcement of the CMP, but before it went into effect, criticism of Nelson reached a high point. Roosevelt had decided to replace Nelson with Baruch. But Nelson got wind of the threat, and (hours

before Roosevelt was set to offer the job to Baruch) Nelson fired Eberstadt and announced it to the press. Roosevelt, unwilling to appear to side with Baruch and the military, kept Nelson on at the WPB. Thus, Eberstadt was fired before the plan which made him famous went into effect.

Historians have assumed that Nelson was concerned solely with defending his turf and have given short shrift to his criticism of the CMP. The assumption concerning Nelson's motives may be correct, but that doesn't automatically invalidate his criticism. In fact, what he has to say about the CMP (Nelson 1946, 383-84) is consistent with the allotment attrition revealed in the controller's reports "... by the time requests came in for materials under CMP the contracts had been let and the manufacturers were in the market actively seeking supplies. Control simply could not be exercised at the CMP level."

V. The CMP and War Output

Ultimately, the claim that the CMP was the key to war production must be tested by data on war output. But measuring war output involves some vexing index number problems. The basket of goods produced during the war differed radically from what had been produced before the war and what would be produced afterwards. And technological progress was extremely rapid during the war because improvements resulting from scientific advances or battlefield experience were rapidly fed into arms production. (Of course, measured by the ability to defeat enemy weapons, technological

progress was slower because improvements in weapons -- thicker armor on tanks, faster speeds for aircraft, and so on -- often merely offset similar improvements in the enemy's weapons.)

In a market economy we can solve analogous measurement problems by using prices. Automobiles, telephones, and apples can be added by using their market values. The value of technological improvements can be measured (sometimes) by how much the market is willing to pay for them. The pricing of most war output, however, took place under circumstances that raise serious questions about using delivery prices of tanks, bombers, and submarines to produce price indexes of war output.¹² Many contracts in the United States were on a "cost-plus" basis so that the delivery prices in military contracts represented a small fraction of the resources transferred to contractors (Higgs 1993). Technological progress occurred so rapidly, moreover, that prices carried over from peacetime or brought back from the postwar era (when they might have been more like market prices) might be questionable.

Table 2 shows several annual series on war production. The first set of estimates was computed by the WPB and are closely related to their index of the physical volume of munitions that will be analyzed below. The second set was computed by Kuznets in order to adjust for pricing problems in the war sector. These also will be analyzed in more detail below. The third set were computed by John Kendrick. As you can see, Kuznets's estimates of gross war production, when adjusted for inefficient production in the war sector fall considerably below the WPB's estimates. For example,

his estimate of gross war production at factor prices in 1943 is quite close to the WPB's estimate of a similar concept. But when Kuznets goes from resource costs to final product prices he reduces his estimate by 40 percent.

Nevertheless, while Kuznets's cautionary tale is well taken, the series agree on the substantial increase in production between 1942 and 1943. The WPB's index of total munitions (line (1) in table 2) grew from 31.6 billion in 1942 to 56.4 billion at constant prices, a factor of 1.78. These are probably the figures that Janeway had in mind. But the other series show similar increases. Kuznets's estimate of gross war output at final product prices (line 4) increased from 28.7 billion to 48.2 billion, a factor of 1.68.

One could point out, if one were in a critical mood, that there was an even larger percentage increase between 1941 and 1942 under the collapsing priorities system than there was between 1942 and 1943 after the CMP was put in place. But the real problem with Janeway's argument is its reliance on annual data. We need monthly or at least quarterly data. Fortunately, two adequate series are available: the WPB's monthly index of the physical volume of munitions production, and Kuznets's quarterly estimates of net war output.

A. The Physical Volume of Munitions

Figure 1 shows the index of total munitions production and vertical lines for the month in which the CMP was introduced on a

voluntary basis (April 1943) and the month in which it became mandatory (July 1943).¹³ The story now appears very different from that suggested by the conventional evaluation of the CMP. Total munitions production was in fact already close to (86 percent of) its wartime maximum when the CMP became mandatory. Given the rapid rate of increase in munitions production up to July 1943 it is hard to believe that the economy could not have come close to its maximum even if the CMP had never been introduced.

The component indexes of the munitions index show some interesting variations. This can be seen in figure 2 which plots six of the seven component indexes computed by the WPB: aircraft, ships, guns, ammunition, combat and motor vehicles, communication and other electronic equipment, omitting only the "other supplies" category. While some of the series reach their peak at about the same time as the overall index (November 1943) two -- aircraft (March 1944) and ammunition (January 1945) -- peak later. It seems unlikely, however, that these late bloomers were the result of a reallocation of scarce materials made possible by the CMP. In fact, as we noted above, the supply of aluminum and copper was better relative to demand than was the case for steel.

Instead, several other factors probably explain the late peaks in aircraft and ammunition. Loss of aircraft from enemy action was high. And the rapid pace of technological progress meant that models built early in the war became obsolete and had to be replaced by newer models incorporating the latest developments suggested by research and battlefield experience. The late peak in

the ammunition series probably reflects the relatively late involvement of the U.S. in heavy fighting in Europe and an underestimate of the willingness of the Germans and Japanese to continue resisting until the bitter end.

B. Kuznets's Estimates of War Output

Kuznets provides the most thoughtful set of reflections on the problems of measuring output in a war economy in National Product in Wartime.¹⁴ He discusses not only the index number problems but also some of the larger philosophical issues inherent in defining "final product" in a war economy.

Kuznets's solution to the index number problem is ultimately rather simple. He develops estimates (guesstimates) of the relative level of efficiency in war industries relative to comparable nonwar industries in 1939. His estimates make war industries only about 75 percent as efficient as comparable nonwar industries in the first half of 1943. A tank factory, to give a concrete example, might be only 75 percent as efficient as a farm-tractor factory because the latter had a much longer time to work out the most efficient way of doing things. The estimates of relative efficiency are then combined with factor prices to produce an index of final product prices for war goods. Kuznets's adjusted estimates of net national war output are based on numerous conjectures that he is careful to point out. Nevertheless, it brings us closer to the truth to recognize that the pricing problem exists and then make whatever adjustments for it we can.

Kuznets's preferred estimates of real net war output and the unadjusted estimates are plotted in figure 3. Kuznets constructed several variants, but they all lay between these two lines. As before, the graph contains vertical lines showing the voluntary and compulsory beginnings of the CMP. And as before, the figure shows that real net war output was already leveling off by the time the CMP was put in place. Kuznets's estimates of real net war output increase only 2.3 percent between the second quarter of 1943 and the fourth quarter.

There are two possible objections to the timing argument that are worth considering. First, since the CMP was announced in November 1942, it is natural to ask whether anticipations of the program could have had a positive impact. This seems unlikely. The credibility of the WPB was at a low ebb when the plan was announced. The Business Week article reporting the announcement of the CMP referred to the final plan with quotation marks around final. In these circumstances it is hard to believe that manufacturers would suddenly alter their behavior without concrete evidence that the latest plan was going to be successful. In many cases, moreover, the incentives set up by the announcement would have been perverse. Knowing that supplies of steel were going to be strictly rationed 8 months hence, for example, might well have encouraged hoarding in the interim.

A second possible objection is that even though the bulk of the peak rate of munitions production was achieved before the CMP was installed, the plan may have played a role in sustaining a rate

nearly that high for a considerable period after the peak was reached. Usually in macroeconomics, however, we assume that once the economy has reached a certain level of production it can maintain that level provided aggregate demand is adequate, a possible exception being massive supply shocks. That assumption makes sense here. Once an airplane factory had been built, the workers assembled and trained, technological problems solved, sources of raw materials secured, and a high rate of production achieved, it is hard to see why that level couldn't be maintained, provided orders for planes were forthcoming.

C. Second Order Effects?

Although the timing evidence rules out a massive impact on war production, it is conceivable that the CMP increased the efficiency of the war sector, for example by reducing the hoarding of controlled materials. This is tested in figure 4 which shows total munitions production relative to steel ingot production and relative to nonferrous metals production -- both indexes adjusted so the monthly average for 1943 equals 100.

The munitions-steel ratio peaks in December 1943 after a minor spurt that might be attributed to the CMP. But even this attribution is questionable because the ratio was moving upward steadily before the CMP, and had spurted in a similar way previously. There was a more important spurt in the munitions-nonferrous-metals ratio about six months after the CMP. This spurt, however, was the result of the decision by aircraft manufacturers

to run down their inventories because cutbacks in orders and favorable war news suggested that drastic procurement cuts were in the offing (Goldstein 1946, 42).

To test more systematically for an impact on the efficiency of production, I regressed monthly percentage change in munitions production on a constant, lagged values of the percentage change in munitions production, lagged values of the monthly percentage change in steel production, and a dummy variable that was set at one in the months following the implementation of the CMP up to the peak in the series.¹⁵ Table 4, which shows regressions incorporating one lagged value of munitions production and one lagged value of steel production, displays a typical set of results. I also tried longer lags of munitions production and steel production, and percentage changes in nonferrous metals production at various lags, but the additional variables were usually not significant, and the results with respect to the dummy for the CMP were similar.

In Table 4, the CMP variable is negative and insignificant in the total munitions regression. Indeed, it is positive and significant in only one of the eight regressions, ammunition. This correlation, however, may be accidental: Ammunition production was deliberately stepped up in late 1943 and 1944 when it was realized that the Axis intended to fight to the bitter end. Overall, the results indicate that the CMP had no identifiable impact on the process of munitions production.

There is not enough data to compute continuous measures of

labor or total factor productivity for the munitions sector as a whole. From time to time the government published estimates of employment in munitions industries. But from the description this series, it appears to have been a makeshift. For what they are worth the available estimates of employment and a simple index of labor productivity are given in Table 3. The general picture appears to be one of rapidly increasing productivity that levels off at the end of 1943. There is, possibly, a small acceleration in labor productivity growth in the last quarter of 1943, that could be associated with the CMP.

VI. Two Case Studies

To explore the timing and productivity issues in greater detail, we can look to two industries, the only two that I am aware of, for which more detailed data is available: ships built by the U.S. Maritime Commission and Aircraft.

A. The U.S. Maritime Commission

The U.S. Maritime Commission, which built civilian transport (the famous Liberty ships) and some military ships, kept detailed records for every ship it produced on costs, labor hours and related variables (Fischer 1949). These data were used by Leonard Rapping (1965) to estimate production functions for Liberty ships.¹⁶ The Maritime Commission was also extremely fortunate in its historian, Frederic Chapin Lane, whose Ships for Victory

(1951), may well be the best history of any component of the mobilization. The Maritime Commission is also important for our purposes because it was a major user of carbon steel, probably the controlled material in tightest supply.

Figure 5 plots several series of interest with respect to merchant ships: total output (Displacement Tonnage of Shipsworth Produced), the Ships component of the WPB index of munitions, labor productivity (Displacement Tonnage of Shipsworth Produced divided by Labor Hours), and Steel in Inventory (Months of Current Consumption). For convenience in reading the figure, the series have been indexed so that 100 is the monthly average of the output series for 1943, 50 is the average for the productivity series, and 25 is the average for the inventory series.

The output of the U.S. Maritime Commission shipyards follows quite closely the total shipbuilding program reflected in the WPB munitions index. Both series peak a few months after the CMP became mandatory. Labor productivity fell initially (because less experienced workers were being employed and because new types of ships were being built?) but toward the end of 1942 it began to rise steadily, peaking (temporarily) at about the same time as total production. The increase in productivity between the time the CMP became mandatory and the peak was about 12 percent. So this is an upper bound on what the CMP could have added. Productivity then fell, perhaps reflecting a delay between cutbacks in production schedules and the release of personnel, before reaching a second peak in 1945. But the latter peak must have reflected, at least in

part, a reorganization of the shipyards in the wake of the scramble produced by the initial drives for maximum output, as well as any residual effect from the CMP.

It seems likely, moreover, that the true contribution of the CMP to productivity must have been considerably less than 12 percent because the rise in productivity seems to have been mostly the result of economies of scale achieved through long production runs. Rapping (1965) found that cumulated production substantially improved the fit of Cobb-Douglas production functions to data on Liberty ships. Henry Gemery and Jan S. Hogendorn (1993) documented a similar story for destroyer production, and by talking with people who worked in the shipyards (!), were able to discover some of the sources for economies from long production runs, for example the use of standardized patterns for cutting parts.

The Maritime Commission data are especially valuable because they contain information on inventories of steel. Steel inventories (measured relative to current consumption) fell to a minimum in August 1943 and this could plausibly be attributed to the CMP. Even this attribution, however, is far from clear. Inventories began dropping after May 1943 and the drop may have been the result mainly of the push to obtain maximum production. Inventories then began to rise stabilizing at levels reached in the first phases of the program. If the drop in inventories had been the result of more efficient management forced upon the shipyards by the CMP, we would expect the low levels of inventory to have continued for the remainder of the war.

In any case, Lane (1951, 344) tells us that in 1944 the Maritime Commission program turned toward faster cargo and military ships and that as a result "propulsion machinery and skill in labor or management became more important as limiting factors than steel." So at most the contribution of the CMP to ship production, was limited to the third and fourth quarters of 1943.

B. Aircraft

Aircraft production and output per labor hour are plotted in figure 6. The output data is indexed so the monthly average in 1943 is 100, and to make reading the graph easier, the productivity data is indexed so the 1943 average is 50. The two series on output -- the WPB index and Middleton's index for the Department of Labor of Airframes Produced -- agree reasonably well. Both peak in March 1944. The Department of Labor index was based on the weight of planes produced, which rose as production shifted toward long range bombers, and this may explain why this series rises somewhat higher, and does not fall off as fast, as the WPB series.¹⁷

Labor productivity in aircraft production surged strongly in 1943 and 1944. Middleton (1945, 219-220) cites a number of causes. Initially, aircraft factories hired inexperienced workers anticipating future demands, and experienced workers spent considerable time training the new recruits, reducing measured productivity in 1942. In 1943 a number of new plants came on line, specialized in individual models, and achieving, as in the case of shipbuilding, economies from long production runs.¹⁸ These factors

surely explain most of the growth in labor productivity in airframe production. Yet judging by the official starting date for the CMP one could not rule out some impact on productivity from the CMP, because labor productivity continued to surge for several quarters after the CMP was made mandatory.

But aircraft production, at least in part, was one of several cases in which the WPB was unable, initially, to enforce the CMP. The Aircraft Resources Control Office at Dayton, Ohio, which was responsible for allocating aluminum extruded shapes, apparently operated for a time with what Novick, Anshen, and Truppner (1949, p. 199) refer to as a "double set of books."¹⁹ As I read their account, the Control Office overstated its requirements of aluminum extruded shapes in order to get as large an allocation as possible. Since stated requirements exceeded the amount allocated by the WPB (an amount based on actual production) this should have meant, according to the theory of the CMP, a cutback in planned aircraft production. But the WPB did not force the issue during the early phase of the operation of the CMP. Reported requirements and production were brought into line, according to Novick and Anshen, after two quarters, a point I have marked on the graph, perhaps somewhat unfairly, as the end of double bookkeeping. But this point was reached three months after the production of aluminum had peaked and only two months before production of aircraft peaked. It is hard to believe, then, that the CMP had anything to do with the success of the aircraft production program.

VII. An Alternative Metaphor

If the CMP doesn't explain the success of the mobilization, what does? Here I will simply set out somewhat dogmatically what I believe to have been the underlying economic process and briefly suggest why I prefer it to the most likely alternatives. The reader will recognize that this section is speculative. It depends partly on evidence that space does not permit me to present, and partly on conjectures about what future studies of the mobilization will reveal.

The national defence period, from the outbreak of war in Europe to Pearl Harbor, can be characterized as a traditional aggregate-demand boom that moved the economy toward its production possibilities curve. This phase, however, was largely over by the end of 1941. Cars were pouring off the production lines at a record pace; unemployment (in December 1941) was down to 6 percent.

For the period after Pearl Harbor we need a different metaphor. The next 18 to 24 months, I believe, are best characterized as the gold rush of 1942-43. Under the classical gold standard the government paid a fixed price for all the gold that private entrepreneurs could produce. During the mobilization private firms did even better. The government paid a high price for all of the gunpowder, planes and tanks that private entrepreneurs could produce and paid many costs of production as well. When gold was discovered in California in 1848 the favorable relationship between the price the government would pay for gold and the cost of producing it was recognized immediately. Men and women stopped

plowing, unhitched their horses, and headed for California. No one coordinated the mobilization of resources. There were shortages, and overcrowding, and many people who hoped to get rich didn't. But in a few years a flood of gold was changing economic conditions throughout the world.

Something similar was true in 1942. Once the favorable relationship between the prices the government would pay for munitions, or for factories to produce munitions, and the cost of producing them was recognized the rush was on.²⁰ Alcoa, for example, was criticized for not expanding capacity fast enough in the late thirties through 1941. But when Defense Plant Corporation contracts were made available that provided substantial profits at little risk, Alcoa went to work building new plants. Production tripled between 1941 and 1943.

Labor, of course, responded to the availability of high wage jobs. Here is Janeway (1951, 172) on one episode. "At Charlestown in Southern Indiana, du Pont went to work on a major powder project. Attracted by the atmosphere of boom, swarms of unskilled labor swelled the population from 800 to 5,000, to 15,000, to a mass of unabsorbed and unhoused workers spread over all the neighboring towns." Bret Harte would have recognized the scene.

There were, of course, important differences between the two gold rushes. For one thing, there were more centers of production during the war, although California was a magnet in 1942 as it had been nearly a century before. The main difference, for our purposes, was that in 1942 public opinion held that the

mobilization ought to be centrally controlled, both to assure the speed and efficiency, and to ameliorate unwanted effects on the distribution of income. For that reason the government became far more involved in the gold rush of 1942 than it had in the gold rush of 1849.

In 1849 as in 1942 the government was, let me emphasize, an important part of the story. It was the government's policy of a fixed price for gold that sustained the boom in the early 1850s and the government's willingness to finance munitions production that sustained the boom in the early 1940s. Gold production was financed ultimately by increases in the demand for money and by a tax on cash balances as inflation eroded the real value of existing money holdings. Similarly, munitions production was financed partly by selling bonds to the Federal Reserve creating new money that satisfied increased demands for money at current prices and created inflation.

Gold-rush economics cannot be described as pure Laissez Faire, but it does use the pursuit of profit to coordinate the allocation of resources. One can imagine, for example, gold production being carried out by federal employees in nationalized mines, just as one can imagine munitions production in nationalized arsenals. But this was not the way of 1852 -- or 1942.

The most important way that the economy differed from a classical gold rush is to be found in the relationships between the government and the contractors. In a gold rush the relationship was restricted by a simple rule: the government must buy all the gold

presented by anyone at the official price. But in the munitions boom considerable finesse had to be exercised, in some cases, to land desirable contracts. Often industry outsiders with good connections in Washington were among the first to profit from the new structure of the economy. Richard C. Reynolds, for example, used his political connections to secure an RFC loan and enter aluminum refining (Smith 1988, 217). The most spectacular success was Henry Kaiser, who became Roosevelt's favorite businessman, and used the war to enter shipbuilding, magnesium, steel, and aircraft production.²¹ As Berliner (1962, 374-375) noted a similar reliance on connections developed in the Soviet economy in peacetime where expeditors who knew the ropes in Moscow were known as "tolkach;" they relied partly on explicit payoffs, but more often on "blat," or personal relationships.

A gold rush (with tolkachi) is not the only alternative to a story that stresses the CMP. The WPB used many other policies, such as orders limiting civilian production, and there were many other agencies besides the WPB that were attempting to speed the mobilization. The Office of Price Administration was fixing prices. The War Manpower Commission was wrestling with complaints about labor shortages and high turnover rates in munitions factories.²² The National War Labor Board was setting wages. The Selective Service System was exempting some war workers and drafting others. The Rubber Reserve Company was financing synthetic rubber plants. The Petroleum Administration for War was trying to ration petroleum. The list could go on and on. It is conceivable that each

agency separately made a small and on average positive contribution so that in the aggregate it was true that massive government intervention can explain the rapid pace of mobilization.

Space does not permit a detailed evaluation of the impact of each agency on its own sector and on neighboring sectors. My conjecture is that in many cases studies of the type conducted here would lead to similar conclusions: that efforts at centralized control did not reach fruition until the mobilization was well advanced.

VIII. Conclusion

Virtually all accounts of the U.S. mobilization in World War II agree that its success was the result of the introduction by the War Production Board of its famous Controlled Materials Plan. But a close look at the plan and the course of production shows that this was not the case. The CMP, a system for rationing certain important metals was, despite its name, a retreat from efforts to plan in detail, and was, in any case, imposed too late to have had more than a marginal effect on the ultimate level of the mobilization. The increase in production was coordinated mostly, I suggest, by private entrepreneurs seeking the enormous profits provided by war contracts -- it was a gold rush.

It is not surprising that a journalist following events in Washington, or that a political historian of a later generation might mistake a tardy liberalization of controls for a decisive centralization. But sophisticated analysts such as Janeway are more

troubling for my thesis. After completing most of this article I reread Janeway's classic Struggle For Survival. There is no doubt that Janeway placed great store in the CMP; and there is no doubt that Janeway believed that more and earlier planning would have produced more and better weapons. But there is another theme that runs through the Struggle For Survival.

"What Roosevelt stirred up by the adroit mingling of politics with principles and principles with politics was nothing less than the dormant energies of democracy. Even before Pearl Harbor these energies had begun to provide the affirmation of faith by works which generated the momentum of mobilization."²³

Janeway's term "the dormant energies of democracy" may be intended to encompass more than what I call gold-rush economics. He may be including voluntary efforts, actions by local governments, and so on. But I suspect that even he would agree that the pursuit of profits supplied a good share of those "dormant energies."

All of this merely proves, of course, that the CMP had very little to do with the ultimate volume of munitions produced, and that, perhaps, market forces played a much larger role in the mobilization than has been recognized. It does not prove that the path followed was the best. Other countries, including the Soviet Union, also achieved outstanding records of munitions production. A close look at the mobilization of resources in the United States, in other words, does not prove that a gold rush was the most effective mechanism for organizing the mobilization, but it does show that it was adequate to the task.

*. I am indebted to Michael Bordo, Michael Edelstein, Stanley Engerman, Stefano Fenoaltea, Robert Higgs, and Eugene White for comments on previous drafts. I also learned a great deal when I

presented the paper to the Development of the American Economy section of the NBER in July 1995, and at seminars at The University of Maryland, Harvard, and Yale. The remaining errors are mine.

2. Harrison's findings differ from those of earlier writers primarily because he makes an effort to solve the index number problem inherent in comparing the output of nations producing very different mixtures of weapons. The United States not only produced more weapons than other nations, but it also produced an array more heavily weighted toward high-tech weapons such as long range bombers and aircraft carriers.

1. Harrison's most recent estimates do not include Japan. Older estimates (Harrison 1988, 172) show Japan producing about 14 percent as much as the United States in 1944, and the effect of Harrison's adjustments is to reduce, sometimes by substantial amounts, the level of munitions output in other countries relative to the United States.

2. See Mills and Rockoff (1987) for a comparison of British and U.S. price controls.

3. The most extreme statement on the effectiveness of the CMP that I have found is, predictably, in Eberstadt's biography. "Eberstadt's plan, put into operation by Roosevelt on November 2, 1942, created a miracle that broke up the major bottlenecks in little more than a month and flooded the fighting fronts with firepower." (Perez and Willet 1989)

4. The quote, incidentally, is from a book by Seymour Harris (1945). Even Harris (1945, p. 285), although normally a strong enthusiast for controls, notes War Production Board may have given too much credit to the CMP.

5. I could cite myself among the mistaken majority, for I adopted the conventional interpretation of the CMP in my earlier work on price controls, Rockoff (1984, 115). My mistake doesn't fatally undermine the relatively favorable portrait I drew of the impact of controls under the "Hold the Line" order. That story runs mainly from 1943 to 1945; here I am concerned mainly with 1940-1943. Nevertheless, I must admit that at the time that I wrote I did not fully appreciate the extent to which the basic economic problem of the war, the shift of resources into the munitions sector, had already been solved by the time that effective price controls were placed on the civilian sector. Were I to rewrite my chapters on WWII today, the picture would be somewhat different.

6. The basic facts chronicled in this section are available in a number of places. The U.S. Bureau of the Budget's The United States at War (1946) is a good official history, although better on facts than interpretations.

7. The files labelled Controlled Materials Plan in the Eberstadt papers deal almost entirely with staffing. It was evidently extremely hard to find men experienced with materials control who were willing to go to Washington on a full time basis. Reading these files, one can see how much more difficult it would have been to put together a bureaucracy capable of administering the much more ambitious Production Requirements Plan.

8. I am indebted to Michael Edelstein for this information.

9. This amount still exceeded the estimated supply by a substantial amount, 9.9 percent. It is not clear why the WPB chose to allocate more steel than it thought would be produced. The Controller's Reports suggest that the idea was to maintain the pressure on the mills to maintain maximum production.

10. See Goldstein (1946, 39-40) for a similar list with respect to aluminum. He notes (1946, 39) that "past-due unfilled orders [for aluminum] showed no substantial change" under the CMP.

11. U.S. Department of Commerce (1950, 78) says that throughout the CMP period mill capacity for ferro-alloy steel exceeded orders placed.

12. Serious questions have been raised about the use of market prices for valuing civilian output. Higgs (1992) is the most skeptical. Prices of military hardware were even farther removed from market prices.

13. The index, with some exceptions, consists of physical component series (aircraft, ships, etc.) weighted by 1943 values. It is described in Copeland, Jacobson, and Lasken (1945).

14. Kuznets served with the WPB in WWII and it may be that his discussion was intended as a cautionary tale about the inherent limits of the figures being generated at the time by the WPB.

15. If the dummy variable is maintained at one in months after the peak in the series, the coefficient becomes negative. To prevent this effect from biasing the results against the CMP, I omitted post-peak months from the dummy variable.

16. Searle (1945) also used the data to measure labor productivity.

17. Middleton (1945, 217) describes his index as follows: "derived from airframe weight of complete planes and spare parts accepted, divided into two categories: (1) Combat planes and heavy transports and (2) trainers, liaison planes, and light transports. The two groups were weighted by approximate average man-hours required per pound of airframe in each category."

18. Armen Alchian (1977 [1963]) explored the statistical properties of "Progress Curves" that related labor productivity to cumulated output.

19. Novick, Truppner, and Anshen in the passage cited describe the problem in only one category of aluminum. But subsequent remarks (1949, 385-86) suggest that the problem was general.

20. Corporate profits after taxes (at 1939 prices) rose as follows.

1939	\$6,109	1943	\$9,264
1940	6,836	1944	8,673
1941	5,975	1945	7,611
1942	9,018	1946	10,566

Profits in millions and the GNP deflator are from U.S. Historical Statistics (1976, 925, series V138; 224, series F5).

21. I thank Stephen Adams for allowing me to read several chapters of his forthcoming book Mr. Kaiser Goes to Washington: Rise of a Government Entrepreneur that document Kaiser's rapid response to the incentives created by the war.

22. Flynn's (1979) assessment of the effectiveness of the War Manpower Commission is favorable. He suggests, for example (1979, 69) that the West Coast Plan eased labor recruitment at key plants.

23. Janeway, The Struggle for Survival, p. 8.

References

Alchian, Armen. "Reliability of Progress Curves in Airframe Production." Economic Forces at Work: Selected Works by Armen A. Alchian (Indianapolis: Liberty Press, 1977): 335-360. Reprinted from Econometrica 31 (October 1963): 679-93.

Berliner, Joseph. "Managerial Incentives and Decisionmaking: A Comparison of the United States and the Soviet Union" In Readings on the Soviet Economy, ed. Franklyn D. Holzman. Chicago: Rand McNally & Company, 1962.

Broadberry, S.N. "The Economic History of the Second World War: An Accounting Framework" (Mimeo, 1993).

Brinkley, Alan. The End of Reform: New Deal Liberalism in Recession and War. New York: Alfred A. Knopf, Inc., 1995.

Bureau of the Budget, War Records Section. The United States at War: The Development and Administration of the War Program by the Federal Government. 1946.

Cain, Louis and Neumann, George. "Planning for Peace: The Surplus Property Act of 1944." The Journal of Economic History 41(March 1981): 129-135.

Copeland, Morris A., Jerome Jacobson and Herman Lasken. "The WPB Index of War Production." Journal of the American Statistical Association 40 (June 1945): 145-59.

Current, Richard N., T. Harry Williams, Frank Freidel, and W. Elliot Brownlee. The Essentials of American History. Second Edition. New York: Alfred A. Knopf, 1976.

Denison, Edward F. Accounting for United States Economic Growth, 1929-1969 (Washington D.C.: The Brookings Institution, 1974)

Dewhurst, J.Federic and Associates. America's Needs And Resources. New York: The Twentieth Century Fund, 1947.

Eberstadt Papers. Princeton University Library.

Faragher, John Mack, Mari Jo Buhle, Daniel Czitrom, and Susan H. Armitrage. Out of Many: A History of the American People, Brief Edition. Englewood Cliffs, NJ: Prentice Hall, 1995.

Fischer, Gerald J. A Statistical Summary of Shipbuilding Under the U.S. Maritime Commission During World War II. Washington D.C: GPO, 1949.

Flynn, George Q. The Mess in Washington: Manpower Mobilization in World War II. Westport CT: Greenwood Press, 1979.

Galbraith, John Kenneth. A Theory of Price Control. Cambridge, Mass: Harvard University Press, 1952.

Gemery, Henry A. and Jan S. Hogendorn. "The Microeconomic Bases of Short-run Learning Curves: Destroyer Production in World War II." In The Sinews of War: Essays on the Economic History of World War II, eds. Geoffrey (yes, one "f") T. Mills and Hugh Rockoff. Ames, Iowa: Iowa State University Press, 1993.

Goldstein, Mortimer. "War-time Aluminum Statistics." Journal of the American Statistical Association 41 (March 1946): 34-52.

Harris, Seymour E. Price and Related Controls in the United States. New York: McGraw-Hill, 1945.

Harrison, Mark. "Resource Mobilization for World War II: the U.S.A., U.K., U.S.S.R., and Germany, 1938-1945." Economic History Review 41 (1988): 171-192.

_____. "The Volume of Soviet Munitions Output, 1937-1945: A Reevaluation." Journal of Economic History 50 (1990): 569-89.

Higgs, Robert. "Wartime Prosperity. A Reassessment of the U.S. Economy in the 1940s." Journal of Economic History 52 (1992): 41-60.

_____. "Private Profit, Public Risk: Institutional Antecedents of the Modern Military Procurement System in the Rearmament Program of 1940-41." In Geoffrey Mills and Hugh Rockoff, eds., The Sinews of War: Essays on the Economic History of World War II. (Ames, Iowa: Iowa State University Press, 1993).

Smith, George David. From Monopoly to Competition: The Transformation of Alcoa, 1988-1986. Cambridge: Cambridge University Press, 1988.

U.S. Department of Commerce. U.S. Bureau of Foreign and Domestic Commerce, Office of Industry and Commerce, Iron and Steel Division. "War Production Board's Steel Divisions's Experience with World War II Controls Particularly Under the Controlled Materials Plan," by Kenneth H Hunter, and Edward L. Hogan, September 1950.

Janeway, Eliot. The Struggle for Survival: A Chronicle of Economic Mobilization in World War II. New Haven: Yale University Press, 1951.

Kendrick, John W. Productivity Trends in the United States. New York: National Bureau of Economic Research, 1961.

Kuznets, Simon. "National product War and Prewar." New York: National Bureau of Economic Research, Occasional Paper 17, 1944.

Lane, Frederick C. Ships for Victory: A History of Shipbuilding Under the U.S. Maritime Commission in World War II. Baltimore: Johns Hopkins Press, 1951.

McNeill, William H. The Pursuit of Power: Technology, Armed Force, and Society since A.D. 1000. Chicago: University of Chicago Press, 1982.

Middleton, Kenneth A. "Wartime Productivity Change in the Airframe Industry." Monthly Labor Review 61 (August 1945): 215-225.

Mills, Geoffrey and Hugh Rockoff. "Compliance with Price Controls in the United States and the United Kingdom During World War II" Journal of Economic History 47 (March 1987): 197-213.

Milward, Alan S. War, Economy and Society, 1939-1945. Berkeley: University of California Press, 1977.

Mulligan, Casey B. "Pecuniary and Nonpecuniary Incentives to Work in the U.S. during World War II." (Mimeo, 1994).

Nelson, Donald M. Arsenal of Democracy: The Story of American War Production. New York: Harcourt Brace, 1946.

Novick, D., Anshen, M., and Truppner, W.C. Wartime Production Controls. New York: Columbia University Press, 1949.

O'Neill, William L. A Democracy at War: America's Fight at Home and Abroad in World War II. New York: The Free Press, 1993.

Perez, Robert C. And Edward F. Willet. The Will to Win: the Biography of Ferdinand Eberstadt. New York: Greenwood Press, 1989.

Ponting, Clive. Armageddon: The Reality Behind the Distortions, Myths, Lies, and Illusions of World War II. New York: Random House, 1995.

Puth, Robert C. American Economic History. Third Edition. Fort Worth: Dryden Press, 1993.

Rapping, Leonard. "Learning and World War II Production Functions." Review of Economics and Statistics 48 (1965): 81-86.

Ratner, Sidney, James H. Soltow, and Richard Sylla. The Evolution of the American Economy: Growth, Welfare, and Decision Making. Second Edition. New York: The Macmillan Publishing Company, 1993.

Robbins, Lionel. The Economist in the Twentieth Century. London: The Macmillan & Co Ltd., 1956.

Smith, R. Elberton. The Army and Economic Mobilization. The United States Army in World War II, the War Department, gen. ed. Kent

Roberts Greenfield. Washington D.C: Department of the Army, Office of the Chief of Military History, 1959.

Rockoff, Hugh. Drastic Measures: A History of Wage and Price Controls in the United States. New York: Cambridge University Press, 1984.

Searle, A. D. "Productivity Change in Selected Wartime Shipbuilding Programs." Monthly Labor Review 61 (December 1945): pp. 1132-47.

U.S. Bureau of the Budget, War Records Section. The United States at War: The Development and Administration of the War Program by the Federal Government. Washington D.C.: GPO, 1946. [Reprinted, New York, Da Capo Press, 1972]

U.S. Bureau of the Census. Historical Statistics of the United States, Colonial Times to 1970, Bicentennial Edition. Washington D.C: GPO, 1975.

U.S. Employment Service, Dept. of Labor. A Short History of the War Manpower Commission. (Mimeo, June 1948)

U.S. War Production Board. "Controlled Materials Plan." Washington D.C.: GPO, 1942.

Table 1				
Allocations Under the Controlled Materials Plan July-December 1943				
	Estimated Supply	Budget Allotment Balance [Stated Requirements]	Allotment Issued to Prime Consumers	Percent Allotments Issued to Supply
Third Quarter, 1943				
Carbon Steel (million short tons)	14.750	16.383	15.261	103.5%
Alloy Steel (million short tons)	2.503	2.758	2.566	102.5
Copper ^a (million pounds)	355.000	383.081	337.407	95.0
Copper-Base Alloy (million pounds)	1,749.000	1,871.023	1,747.229	99.9
Aluminum (million pounds)	659.900	697.107	663.852	100.6

Table 1				
Allocations Under the Controlled Materials Plan July-December 1943				
Fourth Quarter, 1943				
Carbon Steel (million short tons)	15.376	16.699 [19.599]	15.890	103.3
Alloy Steel (million short tons)	2.409	2.607 [2.944]	2.417	100.4
Copper (million pounds)	345.000	363.752 [450.393]	330.979	95.9
Copper-Base Alloy (million pounds)	1,819.000	1,895.821 [2,175.483]	1,823.440	100.2
Aluminum (million pounds)	782.467	728.023 [803.445]	685.731	87.6
<p>Notes. For the third quarter "estimated supply" appears to be the initial estimate, for the fourth quarter it appears to be closer to actual shipments. Stated Requirements are not available for the third quarter. Copper, Copper-Base Alloy, and Aluminum were subdivided into more specific categories.</p> <p>Sources. U.S. War Production Board, <u>Controller's Report: Operation of the Controlled Materials Plan, Third Quarter 1943</u>, pp. 77-78; and <u>Fourth Quarter 1943</u>, pp. 78-79.</p>				

Table 2 Alternative Measures of War Output Annual, 1940-1944					
	1940	1941	1942	1943	1944
(1) War Production Board Total Munitions (Billions, 1943 unit costs)	\$ 2.8	8.5	31.6	56.4	61.3
(2) War Production Board Munitions, War Construction, and War Facilities Expansion (Billions, 1943 unit costs)	\$ 10.8	30.1	66.1	79.8	73.6
(3) Kuznets Gross War Output Disregarding Efficiency (Billions, 1943 Resource Costs)	\$ 4.1	16.1	55.4	81.3	NA
(4) Kuznets Gross War Output Preferred Efficiency Assumption (Billions, 1943 Final Product) Prices)	\$ 1.7	7.4	28.7	48.2	NA
(5) Kendrick National Security Expenditures (Billions 1943 Final Product Prices)	\$ 3.0	14.4	51.7	80.4	92
(6) Kendrick Gross Domestic Product (Billions 1943 Final Product Prices)	\$ 135.4	155.2	173.2	190.7	205.6
(7) Kendricks's National Security Expenditures as a percentage of GDP	% 2.2	9.3	29.8	42.1	44.7
Sources. (1) and (2) (Dewhurst 1947, 5); (3) and (4) (Kuznets 1945, 90); (5), (6), (7) (Kendrick 1961, 291-2, 300-1).					

Date	Employment in Munitions Industry (millions)	Productivity (September 1943 = 100)	Monthly Rate of Growth
April 1940	4.0	NA	NA
September 1940	4.4	13	NA
September 1941	6.1	27	%5.96
September 1942	8.4	79	9.01
September 1943	10.2	100	1.96
December 1943	10.3	109	2.97
June 1944	9.6	103	-.95
September 1944	9.3	111	2.33
December 1944	9.1	113	.72
July 1945	7.9	102	-1.44

Sources. Employment in Munitions Industry: U.S. Employment Service, 1948, attachment A; Monthly Labor Review (Feb. 1945), p. 289.

Note. The munitions industries were defined as "all metal-using industries, rubber industries, and selected chemical industries and government manufacturing arsenals and Navy Yards." The productivity index was calculated by setting the ratio of the total munitions index to employment in munitions industries equal to 100 in September 1943.

Table 4
CMP and the Rate of Growth of Munitions Production

Dependent Variable (Month when Production Peaked)	Constant	Dependent Variable Lagged Once	Percentage Change in Steel Production Lagged Once	CMP	Adjusted R ²	Durbin's h
Total Munitions (November 1943)	-.76 (.90)	.93 (8.30)	1.77 (4.95)	-1.34 (.49)	.80	-.26
Aircraft (March 1944)	-3.98 (2.05)	1.84 (9.20)	2.26 (2.74)	-.69 (.16)	.76	na
Ships (December 1943)	.17 (.21)	.60 (5.13)	.93 (3.22)	.56 (.22)	.48	.62
Guns (November 1943)	-.89 (1.16)	.88 (8.92)	.90 (2.90)	.34 (.14)	.76	-.53
Ammunition (January 1945)	-5.90 (2.47)	1.32 (7.00)	2.66 (3.04)	6.15 (1.72)	.74	na
Vehicles (December 1943)	-1.06 (.54)	.74 (5.40)	4.61 (6.60)	-1.84 (.31)	.66	-.91
Communication Equipment (December 1943)	.15 (.08)	.60 (4.17)	2.70 (3.42)	.52 (.10)	.54	.69
Other Supplies (November 1944)	-.40 (.44)	.74 (6.18)	1.34 (4.70)	1.01 (.76)	.64	-.63

Sources. Production: War Production Board Indexes of the Physical Quantity of Munitions, see text; and the Federal Reserve Board Index of Steel Production.

Notes. Absolute value of t statistics in parentheses. The regressions were estimated with a first order autocorrelation adjustment, not shown.