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Productivity of Labor

in Peace and War

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Summary: This paper considers the factors that affect output per manhour during peace and war. The forces operating during peacetime have resulted in a trend in labor productivity that rises rather steadily and is marred by few lapses in progress. During wartime, however, enormous changes occur in the character of output, in the composition of the labor force, in the conditions of working and living, and in the haste with which things are done. Powerful forces thus arise which make for decline in the average productivity of labor. In the War of 1914-18, the evidence indicates, such a decline in labor productivity occurred. It is likely that history will repeat itself during the present conflict. But this is not certain. Whether output per manhour will decline and at what rate depends, in fact, on the steps that are taken to avert such a decline. And this, in turn, will depend on how well we come to understand the intricate problems of expanding output, and how we weigh the alternative means by which production may be expanded.

FACTORS AFFECTING PRODUCTION

AS A NATION turns from the pursuits of peace to the waging of war, its aggregate output of goods and services is altered and their character modified. One factor accounting for change in the size and composition of output is change in labor productivity. The difference between wartime and peacetime characteristics of labor productivity may best be understood if we first examine all the factors affecting production.

To begin with, the nation's output will be expanded if the proportion of the population engaged in economically productive effort is increased by finding jobs for all members of the usual labor force and by drafting into the sphere of production persons not usually gainfully occupied — retired workers, women, students, idlers. Second, hours of labor may be stretched; the working day itself may be lengthened, and Saturdays, holidays, even Sundays may cease to be days of relaxation. These two steps lead in the direction of more workers and longer work periods. Output may be augmented also by a rise in labor's productivity, that is, by an increase in the amount each man produces each hour he works. Indeed, if labor productivity should fall despite efforts to maintain or increase it, added manhours of work will be more or less offset, and the national product may expand less than is expected, or even decline.

So much for the total national product, which consists not only of goods ready for use in peace or war consumption but also of capital goods. In addition to the three ways mentioned, the production of commodities and services for the waging of war and the satisfaction of immediate human needs in wartime may be expanded by diversion of effort ordinarily devoted to augmenting the capital stock of the country. Even the effort required merely to *maintain* the nation's capital resources, including household capital, may be shunted to the production of civilian and war

goods. As the manufacture of durable civilian goods is prohibited, consumers will have to make their stocks last longer, buy at thrift shops, or go without. The bride who would like brand new furniture may have to content herself with second hand pieces and will not be able to set up housekeeping in a new house; nor will a shiny new automobile be among her wedding gifts. Expenditure of time, energy, and money on education and training may be deferred. Similarly, the stock of capital goods held by business concerns may be drawn upon to swell the supply of goods ready for final use. Inventories, equipment, intangible resources (trade connections, patents, and copyrights) may be under-maintained and the resources thus freed turned to other uses. Diversion of this sort may occur without necessarily diminishing productive capacity immediately, though sooner or later the effect on capacity must be adverse.¹

The number of *units* of commodities and services ready for use may be multiplied further by deliberate adulteration. Less durable or less decorative clothes will satisfy certain needs as well or nearly as well as better clothes, and will cost less.

The output of goods and services especially useful in war may be expanded not alone by the above methods but also, of course, by curtailing the quantity of perishable or semidurable civilian goods and services produced. Clothing may be rationed, and even the consumption of food and fuel cut down.

Although change in labor productivity is the theme of this paper, we must consider the other factors affecting the nation's output, for the various changes are not unrelated to labor productivity. Beyond certain limits, for example, we cannot add to the working force without interfering with the formation of intangible human capital and thereby with the efficiency of labor: young men taken out of school and put to hard work cannot be expected to learn

as much as they would otherwise, and cannot be expected to be as useful as better trained persons. Nor can men work excessively long stretches: at some point output per man-hour begins to fall. And as the work week is lengthened, more of civilian goods, such as food, is consumed and the cost of maintaining capital equipment rises. Conversely, if we cut civilian consumption of food, shelter, and transportation too much we undermine labor productivity: labor efficiency is sapped when workers live in uncomfortable, inconveniently located houses, and, after riding on crowded busses and street cars, are already tired when they arrive at their jobs.

Because of this interdependence there are economic as well as absolute limits beyond which it would be unwise to push any one of the several methods of expanding the national product. For the same reason, no really definitive statement can be made about the future development of any one of the variables since we do not know exactly what is going to happen to the others. Indeed, our knowledge of the *relationships* among the variables is far from exact; moreover, it is likely that the relationships themselves are variable. But while we cannot be exact in our conclusions, we need not confine ourselves to a purely historical, descriptive statement of labor productivity in peace and in war. We do know a little about how the variables other than labor productivity will behave, or at least their range of values, and we can make some plausible guesses about a few properties of the interrelationships between them and labor productivity.

COMMENSURABILITY OF WARTIME AND PEACETIME PRODUCTS

When we attempt to compare productivity in war and in peace we soon realize that we are faced with the task of comparing national products produced under radically different conditions. Because the whole scheme of values basic to the determination of the national product is quite

different in war and in peacetime, there is a fundamental ambiguity in the statistical measures of labor productivity. Note must be taken of this before we begin our recital of changes in output per manhour.

Readers who have threaded their way through discussions of concepts of national income, as in the early sections of Simon Kuznets' treatise, *National Income and Its Composition*,² are aware of the difficulties of defining and measuring the national product. These difficulties are challenging when one is dealing with a reasonably stable peacetime economy; they become exasperating when the task is to compare war and peace economies. I could go through the whole list of controversial points (Dr. Kuznets devotes some fifty pages to them) and show how the no-man's land bordering each widens vastly when we compare peace production with war. But all that is possible or desirable here is a brief review.

In time of war the kind and relative importance of non-market goods shift considerably. We spend less time amusing ourselves and more time acting as air wardens, selling government savings bonds, collecting scrap, or working as dollar-a-year men; some war production is thus provided at the expense of civilian production without passing through the war budget. As housewives become taxi-drivers and factory workers, the calculated national product may rise more rapidly than the national product inclusive of housewives' services. The common procedure of ignoring most non-market goods in the calculation of the national product may be relatively innocuous in peacetime. It leads to trouble when economic and social life changes radically, and especially when war descends upon a country.

Moreover, the unit of valuation is fundamentally altered. Price fixing during wartime, the provision of free goods such as gas masks, government supply contracts based on cost-plus rather than the usual market mechanisms, the granting of subsidies rather than higher prices for scarce

materials—these lead to a system of prices quite different than that existing in peace. Which system of prices is most suitable for rendering commensurate the immense pile of heterogeneous goods that comprise the national product? How to select the base prices with which to compute the index of real national output, or analogously, how to deflate the current values in which national income is measured, becomes an acute issue. Prices at any one time are never quite appropriate to evaluate output at some other time. When war transforms the value system, the always more or less illogical device of index numbers touches even the tough sensibilities of the statistician. Peace prices are no more applicable to war production than war prices to peace production; a cross or combination of the two is not wholly applicable to either.

The computation of imputed rents on durable goods also becomes hazardous when we compare national output in peace and in war. On some types of durable consumer goods rents are seldom computed. When those on which rents are calculated gain in relative importance, as housing does during wartime because it is needed in new war industry centers and because it is more durable than most other consumer goods, incomparabilities arise in the measurement of national products at two points in time. In addition, the imputed rental rates become incomparable because of under-maintenance and price fixing. Whether to impute rent on government-owned property becomes another serious issue, for such property, especially that devoted to war, expands enormously in volume.

The difficulties of measuring capital consumption, apparent even in peacetime, grow more troublesome with the advent of war. Puzzles in calculating depreciation and obsolescence, which ordinarily may be ignored, become too insistent to be easily disposed of. Besides the tangles caused by intensive use of some types of equipment and under-use of others, and by variation in the rate of obso-

lescence, a serious difficulty results from the drastic change in the implicit rate of discount basic to all computations of capital and capital consumption. The value of future goods of many kinds drops far below that of present goods. An airplane or machine tool five years in the future (or even, sometimes, five weeks) may be worth as little compared with an airplane or machine tool today as the proverbial winter ice in comparison with ice when the temperature is in the 90's. The treatment of capital gains and losses also becomes complicated.

Government services are no less difficult to evaluate than rent on government-owned capital goods. Shall we value soldiers' and sailors' labor at their cash pay? Are these and other government services to be considered finished or unfinished? That is, are they to be considered a part of the national product or merely an expense incurred in its creation? I assume that all war commodities ready for use against the enemy and war services actually so used are final goods, and therefore part of the national product.³ To treat them otherwise would leave little point to the question what happens to labor productivity during the transition from peace to war; for, when guns are produced at the expense of butter, the output of peace goods alone definitely declines in relation to manhours applied to all production.

Obviously, not much can be done to dispose of these difficulties satisfactorily. However, the differences between the factors that affect labor productivity in war and in peace suggested by the foregoing review cannot be disregarded. We now know also that while we must note what the statistics can teach us, too much reliance cannot be placed upon estimates of the aggregate product of the economy, no matter how good the basic statistical data or how carefully compiled. Conceptual difficulties will infect our statistics. For this reason, and also because estimates of the national product are not thoroughly consistent in concep-

tual structure or degree of accuracy,⁴ I shall refer also to estimates of labor productivity in the several branches of industry for which they have been computed in the studies of production and productivity made at the National Bureau of Economic Research.⁵ These, though they do not cover all industry, are conceptually less ambiguous for our purpose, and statistically more reliable than most estimates based on national income.

I shall not, however, confine discussion to the statistics. We are really interested in the *factors* affecting productivity and production, for unless we know them we can reason only crudely by analogy or extrapolation. Such reasoning is dangerous because conditions change; alternatives are always open, and those selected now may be different from those chosen in the past. My main objective, therefore, is to understand factors and to state hypotheses concerning changes in labor productivity in peace and war.

PRODUCTIVITY IN PEACE

That the national product per employed worker has risen over the years can be read in the records of all nations fortunate enough to possess them. In the United States it rose from about \$1,400 in 1899 to about \$1,850 in 1937, the cyclical peak year preceding the war boom, or some 30 to 35 per cent.⁶ (These values per worker are both expressed in 1929 prices.) Per manhour, of course, the rise has been greater. If hours were cut as much as one-fourth, on the average, and this does not seem unlikely,⁷ total output per manhour actually worked must have gone up about 75 or 80 per cent.

The records are not thoroughly consistent in respect of the exact increment in total output per manhour. If we look at the more reliable series for certain branches of industry, we find still more striking changes. For manufacturing, output per manhour tripled during the first four decades of the 20th century. For mining, the increment was

even greater, 270 per cent between 1902 and 1939; for steam railroads, over 185 per cent between 1899 and 1939; for electric light and power, about 500 per cent between 1902 and 1937. For agriculture alone is the percentage increment less than for the entire economy: in this division output per manhour rose some 65 per cent between 1899 and 1939.

It is rather surprising that all except one of the percentages cited indicate higher annual rates of increase than that for the economy at large. Though exact knowledge is lacking, several explanations can be offered for this apparent inconsistency.⁸ And this much is certain: within any reasonable margins of error that we may assume, we find a substantial increase in the average product per manhour. If we could take into account improvements in the quality of goods and services during the last four decades, the rise would seem even more substantial.

To understand the growth of labor productivity during peace we must note two salient and related characteristics of a developing economy. First, changes in technology (as well as in the number of workers, capital, economic organization, and character of demand) are ordinarily slow. A stimulus arising in one part of the economic system is transmitted to other parts before the system has fallen far out of gear. Needs are matched by sources of satisfaction before they have gotten out of hand, and new means of production, if really useful, eventually succeed in creating demands for their services. Second—and this is precisely because of the gradualness, spread, and interrelationship of peacetime economic changes—the advance in national output per manhour is the result of a process affecting all industries, though some more than others. The bonds among them are so many and so strong that change in one segment of industry must in time affect other segments.

Increase in labor productivity can of course be approached in terms of developments within individual in-

dustries. We can take it to be the sum of changes in the various segments of the economy and turn to each industry for an explanation of the change in it. Evidence of growth in the capital stock, improvements in equipment and in methods of arranging production, trends toward standardization, progress in labor management, could readily be accumulated. But it would not be long before the investigator came to realize that he could not fully understand or explain the changes in any single industry when viewed in isolation. For example, changes in the kind and quality of raw and semi-processed materials have seldom occurred at a rate so rapid that users could not make the requisite adjustments. And gains in the labor productivity of industries consuming materials often reflect changes in the industries producing these materials. Advances from time to time in the processing of steel sheets in steel plants have enabled the large number of industries using ferrous materials to modify their processes and products in such a way as to lessen the work to be done by them per unit of product. Similarly, industries supplying equipment have helped raise the productivity of other industries. The factory-made tractor gradually set free the farm labor formerly needed to care for draught animals. The railroad industry benefited from the trend toward lighter and stronger freight cars and locomotives, and higher powered fuels. Year in, year out, such forms of non-manufacturing endeavor as engineering and independent research have made their contribution to manufacturing. Ideas concerning organization and management have not remained secrets of the industries that originated them. Though they spring up in different areas of our industry as well as abroad, they gradually flow into a common pool, drawn upon and, after experimentation, adapted to the special needs of all types of enterprise.

The spread of the railroad system led to the development and intensive exploration of the regions opened up,

enabling us to tap new sources of raw materials, animal, vegetable, and mineral. The highly concentrated localization of factory industries, with the fine division of labor and other advantages it implies, was accompanied by the development of cheap and efficient transportation both from source of supply to factory and among specialist plants. Advances in water transportation and in other industries facilitating foreign trade have done much to bring materials and machines to our industries and open up markets for their products, fostering the growth of world-wide trade. The expanding scale on which production is carried on, if it proceeds at a deliberate pace (as it does during peacetime), in itself makes for greater productivity.

Not only are the means of advancement in labor productivity more or less shared, but industries' incentives to search out and utilize these means are mutually stimulated. The discovery and application of advanced techniques and subsequent growth in new industries exerts pressure on the older ones that are relatively stable or quiescent. The latter attempt to cut costs in order to stem the tide of rising competition. Though seldom successful in the effort to retain their old position, they do manage to become somewhat more efficient. Output per manhour thus advances in mature and decadent industries along with those in industries young and growing.

I have already cited the figures for several major branches of industry. Reference may be made also to minor branches of mining and manufacturing. Remarkably enough, in practically none, not even in mining, has output per manhour failed to show a net rise during the last three or four decades. Even the two apparent exceptions to the general trend in manufacturing, locomotive construction and shipbuilding, are to be explained in terms of huge quality changes, or of changes in the degree to which the fabrication of the final product is carried on in the industry where it is assembled.

In peacetime, therefore, gain in productivity is part of an organic process of growth. And in this process the rate is seldom sufficient to create unbalance. Growth may be very rapid indeed in some industries, of course. Automobile output went up between 1899 and 1914 many thousand per cent, and between 1919 and 1937 rayon production mounted one hundredfold. But because these high rates were not *general*, labor, materials, capital, and capital equipment could be obtained fairly readily by the expanding industries and transport facilities were not choked.

I have minimized the presence of haste and unbalance in the peacetime development of the economy. Often, however, even in peace there is a haste that leads to disequilibrium, as the records of business cycles indicate. During the upturn in business, as expansion leads into prosperity, forces are set in motion that make for declines in labor productivity. Professor Mitchell has stressed those related to the bringing into production of less efficient workers, machines, and establishments as output grows; the waste and inefficiency when output is large, labor is scarce, and hours are long; and the delays in getting materials and making shipments. Usually outweighing these forces, however, are increases in quantity and improvements in quality of capital equipment, advance in other aspects of technology, big orders making possible longer runs on a particular machine set-up, and elimination of the dis-economies that some industries suffer when they operate at low percentages of capacity. Before the system has expanded beyond the point where the net balance between these sets of forces is negative, recession seems to set in. Economic factors, functioning through the encroachment of costs on gross income and the subsequent fall in profits, prevent too much unbalance in a free enterprise system. During recession the factors that make for greater productivity when business is rising work less intensively or even in the opposite direction. Advances in quantity and quality of

capital equipment are retarded or cease, while low utilization of capacity reduces the efficiency of some industries in terms of manhours per unit of product. But it is during recession too that the factors that affect labor productivity adversely in times of expansion now favor it. Inefficient production factors are taken out of operation, and waste is eliminated. It is precisely during recession and depression that business men have the opportunity to plug up sources of waste and seek other means of enhancing economy of operation—means that often become permanent sources of savings in labor and other factors. As a result, output per manhour seems to go forward at a more or less steady pace during both prosperity and depression, at least in terms of annual periods.⁹ National income per person engaged (expressed in 1929 prices), the one overall measure of labor productivity, available in reasonably accurate form only for 1919-38, shows no response to the recessions of 1920-21, 1923-24, and 1926-27.¹⁰ The appreciable decline from 1929 to 1932 may reflect no more than the drop in hours of labor that occurred between these two years. The short term fluctuations in most of the National Bureau series on manufacturing and mining productivity are mild and seem to be unrelated to cycles in general business. The same is true of the labor productivity index for railroads, which seems to have responded to the recession of 1929-32 alone, and weakly at that.

In peacetime the changes that require adaptation on the part of business men, workers, and consumers occur within the limits of a fairly stable set of institutions. We do not have to think how to behave every time someone gives us an order for merchandise. We act in accordance with habits acquired through decades of training. Schumpeter's graphic picture of the profound role of habit and experience in the circular flow of economic life applies also to ordinary economic development. We are supported by our investment in intangible capital as well as by our labor. Carrying

us along through the relatively quiet course of economic activity without excessive strain on our powers of adaptation, our intangible capital becomes obsolete only by degrees, not so rapidly that we cannot maintain it by moderate effort.

PRODUCTIVITY IN WAR

Contrast this situation with that of wartime, when we are a "nation learning new trades".¹¹ Not only are there formidable changes in output; even its composition is transformed. Into the process of turning from one product to another goes much of our energy. As Dr. Mitchell pointed out in 1918: "Had war production consisted of supplies like those turned out in 1913, the volume might have grown much faster." The altered character of products is not the only innovation when war comes. Fundamental changes occur also in materials, in the organization and control of industry, in marketing, transportation, and methods of finance. And there is little time for adaptation. Everything is hurried. Speed rather than cost is the criterion of efficiency. As noted earlier, the rate of time discount is very high. In the shift from peace to war production time is so pressing that it is often more economical to throw some workers into idleness, temporarily or even for the duration, than to move slowly through a smoother transition to what might eventually have been a higher level of war production. Bottlenecks are evaluated primarily in terms of time rather than cost; in peace, the reverse is true. Normal schemes of valuation no longer apply when the fate of the nation is at stake. Even in a long war, stability and balance seem always out of reach.¹²

This is perhaps the basic factor tending to reduce productivity during wartime, and one that sometimes begins to exert its influence even before the actual outbreak of hostilities. In addition, of course, there are related specific factors that operate, on a modest scale, even in peacetime.

But they operate with deepened intensity as the war progresses. The influx of untrained or inexperienced workers dilutes labor skill. If unemployed for some time, even experienced older workers become relatively inefficient and require some retraining. Again, some trained workers needed in the essential war industries are permitted to enlist or are indiscriminately drafted into the army, despite what was learned in the 1914-18 war. Excessive overtime, unaccustomed surroundings, inadequate food — in some countries, at least — eventually lead to fatigue, illness, and labor inefficiency. Experience with trying to get the last ounce out of workers, both in this country and in Britain during the first World War, suggests that there are economic limits on the length of the work day.¹³ If these limits are exceeded, increases in hours are more than offset by declines in output per manhour; indeed, output per worker begins to decline even before these limits are reached. The strains of wartime work are aggravated because the worker must learn to deal with unfamiliar materials, different specifications, special machines, and often strange supervisors. Wage rates must be set on labor applied to new machines and products, and this process, always a delicate one, may lead to friction and grievance, especially when everyone is under war pressure.¹⁴

High cost mines and plants are brought into production. Much has already been made of the situation in the copper industry, and one reads today of the reopening of iron mines that had not been operating since 1918. Reversing a trend begun in the 1890's, beehive coke ovens are built, despite their waste of byproducts.

Bottlenecks and breakdowns in transportation lead to delays in supplies and materials, and in fact, inconveniences all along the line. Sinkings in coastwise trade and on the high seas and long waits for convoy are expensive. Nor should we forget damage to industrial and consumer property done by the enemy.

Some emphasis may be placed on the difficulties of obtaining materials, especially those formerly imported. Efforts to save scarce materials and cut waste are costly. *Ersatz* materials not only yield inferior products, as a rule, but are expensive to produce. When the law of comparative advantages in international trade is 'violated', the penalty is declining output per unit of labor effort.

These adverse factors affect all industries, though in different degree. Industries producing consumer goods requiring materials needed for war are disturbed by priorities and rationing, and their under-utilization of capacity is sometimes accompanied by a decline in labor productivity. These and other consumer goods industries (even those not affected by scarcities of materials) are disrupted also by a dwindling labor supply, lack of equipment, and many transportation difficulties.¹⁵ Industries producing basic materials (steel and copper, for example) must expand rapidly, even modify the character of their output in some degree. Industries engaged directly in the production of war materials are virtually transformed, with all the pains of birth and adolescence entailed.

So much for the factors making for declines in output per manhour. There are, of course, certain counteracting forces. When new plants have to be constructed, they may be plants using the latest equipment. But they are not necessarily optimum in respect of labor: other factors are speed, availability of materials, and shoddiness of construction in anticipation of a short war. Nor are they necessarily optimum in relation to peacetime standards. War plants are, or should be, built with an eye toward protection from attack: they should not be too close together; they may have to be built away from the coast, which may mean away from transport facilities, sources of supply, labor markets, and delivery points; and their structure should provide for blackouts and similar wartime exigencies. Aside from the qualifications attaching to the efficiency of spe-

cially built war plants, we must remember that plants converted from peacetime use (and these must inevitably constitute a preponderant proportion of all wartime factories) are by that very fact below the standard of a specially constructed plant. As for new plants, there is a risk, because of inexperience, that what looks optimum on the blue-print may not turn out to be so; yet the pressure of time precludes much advance planning and experimentation.

The transition from peace to war production may mean a shift from industries that have already made the most of their opportunities to industries still in the stage of increasing return, in the dynamic sense. Current management and engineering literature abounds in striking instances of technological developments in the war industries as custom production methods are supplanted by mass production.¹⁶ However, there is doubt that the shift from mature to young industries will in fact contribute to greater national output per manhour. A transfer of resources from the technologically well advanced automobile industry, for example, with its moving belts, labor subdivision, and special tools, to the relatively backward airplane industry, with its hand-assembly and intensive use of skilled labor, may indeed mean a new burst of advance in labor productivity. Airplane manufacturers, faced with the demand that they spawn airplanes, may begin to introduce all the devices and arrangements already so well developed in the peacetime mass production industries. But this upward trend in airplane manufacture may be from a level of productivity lower than the level of automobile and other peacetime manufacture, and will no more than retrieve the initial loss following the transfer of resources. The breakneck speed may prevent even the productivity level of the peace mass production industries from being reached.¹⁷ However, too close an analysis is not warranted, for soon we are caught in the old dilemma — incommensurability of output in peace and in war.

Also contributing to labor efficiency is popular enthusiasm for the war effort; labor troubles are fewer. The pooling of ideas, blue-prints, patents, and equipment, and drives toward standardization likewise help productivity.

The shift of workers from submarginal farms, automobile service stations, and shops to industry (a shift possible in peacetime but proceeding slowly, if at all) may lead to a more intensive use of low cost enterprises in these fields of activity. Houswives may move from the inefficient kitchen to the efficient factory. In general, war may bring a reshuffling of jobs and workers to attain the maximum utilization of talent and training, not only in terms of the new situation but even in terms of the old. Whether this will in fact occur depends, for example, on the pliability of labor union policy as well as on how carefully we plan and how earnestly we try to carry out our plans (and this in turn depends on the other urgent demands on our creative and administrative resources). Then there is another possibility: the transformation of the character of output during war may bring with it a shift of workers to industries that yield larger output per worker than those from which the workers came, a shift that would of itself tend to augment output per worker. Although merely a conjecture based upon little information, this result could come about without added investment if equipment in the relatively growing industries could be used more intensively.¹⁸

It is hazardous to guess what the net result of the interplay of these various factors may be, partly because our knowledge of the factors themselves is still very meager, and partly because there are still other factors in the situation, economic and non-economic. If the services of the military and naval forces and the output of war material are included in the measure of output, national output *per capita* might be expected (on the basis of the present discussion) to be greater during war, on the average, than during the preceding period of peace. Per *employed per-*

son, however, a decline would seem to be more probable. The chances seem strong that per *manhour* (our measure of labor productivity) there will sooner or later be a drop, though it may come only after an initial spurt of activity, within the limits of the former peace set-up of equipment, organization, etc., during which labor productivity may rise.

The statistics, though they do not help us resolve all our doubts, suggest that these expectations are probably sound. At any rate, they do not contradict them. In the United States national product per person employed rose about 15 per cent from 1914 to 1916, but during the period of our participation in the war it declined 5 or 10 per cent.¹⁹ It is very likely, moreover, that the decline per manhour from 1916 to 1918 was greater than per man.²⁰ A similar story can be told for Australia and Sweden, according to Colin Clark's remarkable collection of statistics.²¹

What happened to physical output per manhour in the several sectors of American industry must be inferred in some cases from data on output per man. In manufacturing, output per man employed rose sharply from 1914 to 1916, then declined as rapidly. Hours of labor presumably rose during 1914-16 and could scarcely have fallen during 1917-18. It is probable, then, that factory output per manhour rose slightly between 1914 and 1916, and fell from 1916 to 1918. In mining, there was a more certain decline in output per manhour from 1915 to 1918, although before and after the war it rose rapidly. In agriculture, the rate of growth in output per man seems to have slackened; but the figures for this industry, on both output and employment, are not too meaningful for a short run analysis.²² In steam railroads, output per man increased sharply during 1914-17, then declined during 1917-18.

Whether the experience of the first World War will be repeated now can merely be conjectured. Perhaps there is today, as contrasted with former war periods, a mitigating

circumstance in the greater ease of transition from peace to war production. The highly developed skills of engineers, plant control men, and tool makers may be less 'specific' than formerly. Adaptability to changes in auto models also means, to some extent at least, adaptability to even greater changes in the product. The same may be true, too, of the unskilled and semi-skilled worker. Very fine division of labor implies that new work can be learned more readily. If a man's job is merely to put a nut on a bolt, it may not matter much whether the bolt is in the frame of a passenger car, a truck, a tank, or an airplane. Yet at most the difference between peace and war today as compared with 1914 or earlier must merely have been lessened; it can hardly have been eliminated. Moreover, *total* war means a far greater diversion of resources than was needed even in the war of 1914-18 and therefore necessitates a greater degree of adjustment.

In this war we already hear complaints that output per worker is falling because experienced men are growing scarce and inexperienced workers must be hired. Perhaps this lament is not yet typical. The Federal Reserve index of output, which, because of certain assumptions underlying its construction, can be used to measure labor productivity only with qualification, indicates (in conjunction with employment and hours data of the Bureau of Labor Statistics) a rise in output per manhour of about 9 per cent between 1938 and 1939, 5 per cent between 1939 and 1940, and 3 per cent between 1940 and 1941. For certain individual manufacturing industries somewhat more reliable data are available.²³ For 26 of these I have computed changes in output per manhour from 1938 to 1941. (Unfortunately, none is strictly a war industry, though they do include steel and non-ferrous metals.) Output per manhour rose in 25 industries from 1938 to 1939; in 20 from 1939 to 1940; and in 19 from 1940 to 1941. It seems that during 1941 many manufacturing industries were still in the stage

when output obtained per manhour of work had not yet stopped rising.

If one may judge from the Department of Commerce estimates of national income, deflated by the Bureau of Labor Statistics cost of living index,²⁴ and expressed *per capita* of the employed population as defined by the National Industrial Conference Board, product per worker rose about 8 per cent from 1938 to 1939, 5 per cent from 1939 to 1940, and some 4 per cent from 1940 to 1941. The differences should not be taken too seriously; it is safe to say merely that output per worker has apparently not yet begun to fall, on an annual basis.²⁵ In terms of *manhour productivity*, however, the situation is different since hours of labor have risen. (Hours in factories rose 1 per cent from 1939 to 1940 and almost 7 per cent from 1940 to 1941; though these changes in the work week are probably not typical for all industry.²⁶) Output per manhour may already have stopped rising. An actual fall in productivity per worker as well as per manhour is not outside reasonable expectation for this year, in view of the so-called 'priorities unemployment' period through which we have been passing, the costly manufacture of synthetic rubber and other substitutes, the bringing into production of high cost copper and other mines, the continued dilution of the labor force, etc. Further lengthening of the work week also may contribute to a decline in productivity.²⁷ Indeed, the forces making for decline in labor productivity are perhaps just now beginning to gain momentum. During 1940 and 1941 we may have been in much the same stage as in 1914-16. Labor productivity may not rise at all this year, just as it did not in 1917-18.

This war may last much longer than World War I. May not therefore labor productivity again rise when a certain stability has been reached in the war industries, that is, when we have learned the new trades? I do not doubt that this particular factor will then tend to raise labor pro-

ductivity. But almost all the other factors making for lowered productivity will become intensified, sooner in Europe than here, of course. The first burst of enthusiasm may die out, and labor efficiency wane; also the continued strain of a long work week, curtailment of consumption, and exposure to danger, may begin to be felt. Under-maintenance of capital equipment in many consumer goods industries, in the railroads, and elsewhere also may finally materialize in declines in labor productivity. The exhaustion of stocks of scarce materials accumulated in anticipation of war, and increasing damage done by the enemy, may help to tip the scales in the direction of lower labor productivity. Indeed, any decline in output per manhour during the next few years may well be small in comparison with the declines that will eventually set in if the war drags on to the point of exhaustion. But the statement of this possibility, like other surmises made here, can hardly be accompanied by a probability value.

It is tempting to sound another note by referring to the postwar period, dangerous though speculation may be. There will be, I suppose, another era of reorganization as we swing back to the production of peace goods, and one also of uncertainty as we turn again to individualistic enterprise. During the initial adjustment productivity may fall, as it seems to have done in 1919. After this transition, however, we may hope that a real revival will come in productivity together with a boom in output, such as occurred during the 1920's. Replacement, renovation, repair, and new additions to industrial equipment will presumably take place at a technological level above the prewar average. The new trades we shall have learned may turn out to be of value in reconstruction. These changes, plus the accumulation of ideas held back from fruition by the war, may help us to gain some of the advance that peace would have brought us, and make up for some of the loss incurred through the war itself.

Whatever happens to labor productivity during the next few years, it is important to remember that it is product that counts: consumption goods that nourish us and war goods that will bring us victory. Changes in productivity are important today only so far as they bear on the size of the product; and the analysis of productivity is significant today only so far as it throws light on the factors affecting output. Moreover, the course of labor productivity is not entirely beyond our control. When we push up employment and hours and cut capital formation in order to expand available output, we cannot afford to overlook the deleterious effects on productivity. When we reduce civilian consumption in order to expand war output, we must at the same time try to avoid reducing output per manhour by an amount greater than is commensurate with the price we are willing to pay to attain our objectives, or greater than the price we need pay if we choose another means open to us. If we neglect their present or ultimate effects on labor productivity, some of our efforts to expand output may be self-negating.

Notes

1 Capital is diminished not only when the *number* of machines, etc., is cut but also when the average *durability* of existing equipment is reduced (as when it is replaced by less durable goods or is simply allowed to age), and when the average *quality* of equipment is lowered (as when it is replaced by less efficient equipment, requiring more materials, labor, or supplies for operation). A two-year old truck represents less capital than a new truck: as does a truck consuming excessive amounts of fuel compared with an efficient truck, yet all may carry the same maximum loads.

2 National Bureau of Economic Research, 1941.

3 To avoid duplication in measuring aggregate war output it is necessary to consider war services that merely contribute to the production of other war goods and services as unfinished and therefore not 'final' goods.

4 No series on national income is continuous for the period since 1899. And chaining several differently constructed estimates fails to solve the problems, not altogether academic, that arise from conceptual and statistical incomparabilities.

Another serious difficulty is that of passing from current to fixed-base prices. Even Dr. Kuznets' series for 1919-38, conceptually the most satisfactory, is not free from all qualification. The earlier National Bureau series, those of the National Industrial Conference Board, and the Department of Commerce series (it is to these we must turn for information concerning the war periods) suffer from crudity of deflation, especially serious because they relate to periods of extreme fluctuation in prices. Even moderate percentage errors in the deflators may mean very considerable percentage errors in the series finally derived on real national product.

Still a third difficulty is lack of thoroughly reliable and comprehensive data on employment, especially before 1919. Data on hours of labor actually worked are no better than those on employment.

5 Detailed reports based on these studies, made possible by funds granted by The Maurice and Laura Falk Foundation of Pittsburgh, will be published by the National Bureau of Economic Research. I am indebted to Harold Barger, J. M. Gould, Hans Landsberg, and Sam H. Schurr for the statistics drawn from the reports being prepared by them.

6 The average annual rate implied by this percentage does not differ materially from the average rate computed for the 38 years exclusive of the war period, 1914-18 or 1917-18. The figures cited are based on R. F. Martin, *National Income in the United States, 1799-1938* (National Industrial Conference Board, 1938), and Simon Kuznets, *op. cit.*

7 In manufacturing, hours per week were reduced about a third between 1899 and 1937; in mining and steam railroads, about a fifth; and in the building trades, about 30 per cent. according to various sources examined in the National Bureau studies of production and productivity. Instead of the notoriously long hours formerly worked in retail trade, something close to the 40 hour week has become customary, owing to the growth of

large stores and the concomitant displacement of self-employed entrepreneurs by hired workers. It is likely that the decline in this branch has been at least as large as in manufacturing. Even in agriculture it seems that hours have declined slightly. One estimate puts the decline at about a tenth. Average hours for the entire economy have also been reduced because of the decreased relative importance of farming, with its relatively high level of hours per week.

⁸ It is possible that the measures for the several branches of industry, since they are based on gross physical output, may in some cases overstate somewhat the increase in net physical output per unit of labor expended. (For a discussion of the distinction between gross and net physical output see Solomon Fabricant, *The Output of Manufacturing Industries, 1899-1937*, Ch. 2; National Bureau of Economic Research, 1940.) If allowance were made for increases in depreciation, fuel, and other costs associated with purchases from outside industries (which for that reason should be deducted from gross output to obtain net output, whether measured in pecuniary or in 'physical' terms), the increases in the labor productivity of agriculture and possibly also in mining would probably be smaller; but the reverse is more likely for manufacturing and electric power, and perhaps also for railroads. However, even an appreciable reduction in the figures for all these industries would not remove the apparent inconsistency between them and the even cruder measure for the entire economy.

It may be, too, that in branches of industry for which no indexes are now available (construction, other utilities, trade, service, real estate and finance, and government) labor productivity has not advanced as rapidly as in the industries for which we have data; indeed, such a view seems quite plausible, though one cannot say more.

Mention of the service industries brings to mind another consideration: the shift toward greater relative importance, in terms of employment, of these industries, as the statistics on the distribution of workers by occupation and industry indicate quite clearly. If the service industries were characterized by a product-labor ratio lower than the average, we would have another factor helping to account for the apparent inconsistency between the estimate for the total and for the several parts. This is apparently not the case, however. The service industries, even if we exclude real estate (which has a very high product-labor ratio), do not seem to contribute a significantly different amount of national income per worker than most other industries. Moreover, agriculture, with a product-labor ratio lower than any other major industry, lost very considerably in relative importance.

Of course, we may always fall back on errors of estimate as an explanation of these inconsistencies: errors in measuring national income, in the price index used for deflation, in employment, in physical output, etc., etc. For example, the common practice of using the cost of living index (or any other single index) to deflate the entire national income is subject to serious qualifications, especially when price changes are great (as they are

during and following wars) and when capital formation is fluctuating violently.

⁹ Monthly data might show somewhat more obvious cyclical alterations in the rate of change in labor productivity.

¹⁰ Simon Kuznets, *op. cit.*, p. 153.

¹¹ Wesley C. Mitchell, *History of Prices During the War: Summary* (War Industries Board Price Bulletin 1, 1919), p. 46.

¹² When preparations for war are prolonged, as in Germany and Russia, the distinction between peace and war is less marked, of course. Productivity is less affected because of the slower pace of preparations; but when war comes, the inevitable disturbance takes its toll.

¹³ No assertion is implied that these limits have already been reached in this country in the present war.

¹⁴ For a statement devoted especially to these difficulties see E. C. Robbins, War-Time Labor Productivity, *Harvard Business Review*, Autumn 1940.

¹⁵ For example, the Bureau of Labor Statistics notes (in various mimeographed reports dealing with World War I, prepared under the direction of Stella Stewart) that the wool products, dried fruit, and shoe industries lost experienced workers to war industry in 1917-18; and cotton goods manufacturers found it difficult to get materials and make deliveries because of strained transport facilities.

¹⁶ See the interesting summary prepared by Lenore A. Epstein and Irving H. Siegel of the Bureau of Labor Statistics: Increasing Productivity and Technological Improvements in Defense Industries, *Monthly Labor Review*, Jan. 1942.

¹⁷ "Mr. Nelson showed little sympathy with manufacturers who delay work while they seek more efficient ways of turning out their products. 'Why not start inefficiently and figure out more efficient methods as you go along?' he went on. 'Get the stuff moving and get it moving now!'" *N. Y. Times*, Jan. 31, 1942.

¹⁸ Here the relevant measure of output per worker is, of course, net value added per worker, not gross value of product per worker. Evidence that the latter may be higher in war industries is therefore irrelevant.

¹⁹ No satisfactory measures of national income, at least according to present-day standards, are available for 1914-18. King's figures (*National Income and Its Purchasing Power*, National Bureau of Economic Research, 1930) on aggregate payments to individuals, in constant prices, per person employed (employment estimated by the National Industrial Conference Board in its *Economic Record* for March 20, 1940) show a rise of 3 per cent, 1914-16, and a fall of 12 per cent, 1916-18.

The original National Bureau estimates of national income in constant prices (*Income in the United States, 1921 and 1922*), give two results, one based on income by sources of production and another on incomes received. These show identical rises per worker employed of 16 per cent for

1914-16, and declines of 15 and 13 per cent, respectively, for 1916-18. The declines in 1916-18 are less of course if the army, navy, and marines (3 million in 1918 and less than a quarter of a million in 1916) are excluded from the number employed (even if their salaries and subsistence are not excluded from the national income); nevertheless, they remain declines.

²⁰ The slump in productivity, while appreciable, did no more than cancel the rise in the preceding two years. Output per manhour in 1918 and in 1914 was almost the same.

²¹ *The Conditions of Economic Progress* (Macmillan, 1940). The figures he gives for Japan for that period, which show a very sharp drop from 1914 to 1915 and very sharp rises after 1915, seem too erratic to be significant.

²² On the statistical side the data on output are heterogeneous in that some products are on crop-year bases (which vary from crop to crop), others on calendar-year. On the economic side, the major short run factor affecting output is the weather.

²³ These are indexes prepared at the Bureau of Labor Statistics by I. H. Siegel and issued in mimeographed form.

²⁴ Since wholesale prices have risen more rapidly than the cost of living since 1940, deflation by the former, or by a combination of the two, would show practically no change in real national product per worker between 1940 and 1941.

²⁵ The employment figures include men in the armed forces and exclude emergency employment (WPA, etc.). If emergency employment is included, the percentage increases become 9, 6, and 5, respectively. If, further, the armed forces are excluded, they are 10, 7, and 7, respectively.

²⁶ Data collected by the Bureau of Labor Statistics (published currently in the *Monthly Labor Review*) indicate that hours in manufacturing, mining, and construction rose 5-7 per cent between 1940 and 1941, but that in trade, service, and the utilities the changes were negligible. The general average rise was therefore probably less than 5 per cent.

²⁷ The moderate increases in hours cited in the preceding footnote should not lead one to understate their possible effects on labor productivity. It is the level of hours in particular industries that counts, not the level of the averages. A long work week in military production may be balanced by a short week in consumer goods industries, and the average may be moderate. Yet the inefficiency resulting from a long work week in military production will not be balanced by extra efficiency in the industries with a shorter week.

Just what the most efficient or desirable work week should be in an industry depends on the character of the industry concerned as well as on many other factors, and no general statement can be made. The discussion above is not intended to imply that present levels of hours are or are not excessive.