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12.1. INTRODUCTION

This chapter has two main sections and an appendix. The first section provides an overview of what lay behind record productivity growth in the US economy between 1929 and 1941. The second considers the role of rigidities and other negative supply conditions in worsening the downturn and slowing recovery. While I argue consistently that the overarching explanation of the Great Depression will and should continue to emphasize a collapse and slow revival of the growth of aggregate demand, I spend relatively little time on what drives this since these issues are dealt with in detail elsewhere in the volume. The chapter instead concentrates on the aggregate supply side—both the broad array of positive shocks that I argue propelled potential and, eventually, actual output forward, and the negative conditions which, in interaction with aggregate demand, may have increased the size of the output gap and prolonged its persistence. An appendix offers detail discussion and updated calculations of productivity growth rates for the critical period from 1929 to 1941.

12.2. GROWTH AND CYCLES

Economic growth and business cycles are two of macroeconomists' central concerns. In principle, this should be no less true in studies of the Great Depression. Yet for perhaps understandable reasons, the preponderance of academic scholarship has focused on the persistent output gap and high unemployment that marked the 1930s. In other words, it has focused on cycles.

This chapter examines the years 1929–41 in the United States with a focus on the growth of actual and potential output during this period as well as the expansion and contraction of the output gap—the difference between actual and potential.[1]

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[1] Potential output, sometimes referred to as natural or full employment output, is the highest level of output sustainable without so stimulating the economy through monetary and/or fiscal policy that

A principal theme is that potential, and, eventually, actual output rose very rapidly over this 12 year period, almost entirely as the consequence of the growth of total factor productivity.[2] It was this growth that made possible the successful prosecution of the Second World War as well as what Walt Rostow (1960) called the age of high mass consumption that followed. In other words, I argue that the infrastructural, organizational, and technological foundations of the golden age (1948–73) were already largely in place by 1941. This contrasts with the standard narrative which suggests that the war somehow magically transformed the doom and gloom of the Depression years, so that, like a phoenix rising from the ashes, the US suddenly, in 1948, stands a colossus astride the world economy. Given that the United States was involved in the war for less than four years, with full scale war mobilization lasting perhaps sixteen months, this narrative warrants re-examination.

The Depression years were disastrous from the standpoint of capacity utilization, and I do not mean to downplay any of this. Bank failures and financial crisis were associated with an 87 per cent decline in real gross private domestic investment between 1929 and 1932. Construction spending never recovered from its 1920s peaks until after the war. 1929 vehicle production was not reattained until 1949. The Dow Jones Industrial Index dropped 89 per cent from its August 1929 peak to its trough in July of 1932, with many of the twentieth century's largest one day *increases* occurring during that volatile and sickening slide. Real GDP declined more than 27 per cent and unemployment rose from 3.2 per cent in 1929 to 25 per cent in 1933, while consumption declined 18 per cent in real terms. Double digit unemployment for more than a decade represented a terrible waste of human and other resources, and untold hardship for the millions of people out of work.[3]

And yet the Depression years were also a triumph of American ingenuity, inventiveness, and hard work. Fuelled by an explosion of research and development, government infrastructure investment, and creative response to adversity, scientific, technological, and organizational advance expanded the capabilities—

an acceleration of the inflation rate ensues. Generally speaking, when one is below potential, that is, in the presence of an output gap, an increase in nominal income will result mostly in increases in output and employment. As an economy approaches potential from below, additional stimulus begins to be experienced as price increases rather than output growth. With labour and physical capital now in short supply, inflation accelerates and, in the face of further increase in aggregate demand, growth in output and employment will stall.

[2] Total factor productivity (TFP) is the ratio of output to a combined measure of capital and labour input. Labour productivity, in contrast, is the ratio of output to the number of workers or worker hours. The growth of TFP is the difference between the growth of output and a weighted average of the growth of inputs, with the weights corresponding to the shares of the two factors in national income. For the Depression years, the precise weights don't matter much, because neither labour nor private sector physical capital inputs grew noticeably between 1929 and 1941. Thus, all of the substantial output growth between these years can be attributed to an increase in total factor productivity. For details, see Field (2011: introduction and appendix), as well as the appendix to this chapter.

[3] Investment, consumption, and output data are from <http://www.bea.gov>, National Income and Product Accounts, Table 1.1.3, accessed 22 January 2012. The unemployment data are from Lebergott (1964). Construction data are from Carter et al, (2006), series Dc262. For the Dow Jones Industrial Index, see: <http://stockcharts.com/freecharts/historical/djia19201940.html>.

the potential output—of the economy.[4] What I have called the country's Great Leap Forward (Field, 2011) helped the United States win the war and set the stage for a quarter century of post-war prosperity. It is part of the explanation, along with wartime destruction in other countries, for why the US loomed so large in the world economy in 1948, and high post-war growth rates in Europe and Japan represented, in part, catch up to a frontier that had been pushed out in the United States during the 1930s (Abramovitz, 1986).

This expansion in potential and, when demand conditions permitted, actual output was fuelled by several tributaries. The first was the maturing of a privately funded research and development system that had begun with Thomas Edison in Menlo Park, New Jersey. Then, as now, most private sector R&D was conducted in manufacturing, and we have good data on activity in this sector because of surveys conducted by the National Research Council in 1927, 1933, and 1940. R&D employment, which stood at 6,274 in 1927 had, by 1933, after four of the worst years of the Depression, climbed to 10,918. In 1940, after another seven years of double digit unemployment, that number stood at 27,777. Data on the number of labs established, and actual spending, paint a similar picture, with particularly dramatic increases after 1935 (Mowery and Rosenberg, 2000: 814; Field, 2011: 56, Table 2.4).

A second tributary reflected spillovers from the government funded build out of the surface road network. The US produced more than four million passenger vehicles in 1929, a level of production not reached again for twenty years (Carter et al., 2006, series Df343). By the second half of the decade the growth of vehicle registrations had outrun the capabilities of the road infrastructure. A strong political coalition pressed for better roads. Farmers wanted them, complaining that their French counterparts moved grain at half the cost over a superior surfaced road network, while American agriculturists faced the equivalent of a mud tax. Bicyclists wanted them, car owners and car makers and suppliers to the auto industry (plate glass makers, tyre makers, steel makers) wanted them, as did the petroleum, asphalt, and motel industries. Truckers wanted them, as did, perhaps surprisingly, railroads, which saw themselves as evolving a symbiotic relationship with truckers in which they (the railroads) would be the senior partners (Paxson, 1946; Finch, 1992; Goddard, 1994).

But the location of a national road network was a contentious business, because it would mean (as did the building of the interstates three decades later) the making and breaking of many local communities. State highway departments had to reach agreement with each other and the federal authorities over what routes would be national. By November of 1926 a treaty had been negotiated, its terms reflected in the publication of a detailed map showing the proposed US route system. The country then started building or improving streets, highways, bridges, and tunnels, and if one just looks at the data for such expenditures, it is hard to tell that the country had a depression (there were moderate declines in spending,

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[4] The full dimensions of that expansion were first appreciated when war planners, in particular Simon Kuznets, began, after Pearl Harbor, to reckon how much guns and butter the US economy could produce, and were not fully revealed until the massive fiscal and monetary stimulus associated with the Second World War closed the remaining output gap.

relative to the late 1920s, in 1933, 1934, and 1935).[5] By 1941, the US route system was complete, and, because of its growth, productivity in transportation (both trucking and railroads) as well as wholesale and retail distribution had risen dramatically (Field, 2006, 2011: chapter 2).

Finally, some sectors, like railroads, benefited from the kick in the rear of adversity that generated creative responses. In the 1920s, railroads had been able to solve their problems essentially by throwing money at them. But, in the 1930s, access to cheap 50-year mortgage money dried up, and by the middle of the decade roads responsible for more than a third of first track mileage were in receivership (Schiffman, 2003). Rationalization, including major advances in freight interchange, meant big gains in efficiency. Progress toward unlimited freight interchange began with gauge standardization in the 1880s and continued during the First World War when, as troops operated the rail system, the government pressed for standardization of equipment and operating procedures. The US had a national rail network, but it consisted of individual lines owned and operated by private firms. The question of what happened when, for example a freight car went into 'foreign' territory had important economic consequences. Was it necessary to break cargo? Could a car delivering outside of its system pick up a new load for the return trip in a competitor's region? If locomotives or rolling stock broke down, could they be repaired in a foreign yard?

Developing uniform procedures and tariffs governing interline transactions allowed huge efficiency gains. The number of employees, locomotives, freight cars, and passenger cars each dropped by a quarter or a third between 1929 and 1941. Yet revenue freight ton miles in 1941 were slightly higher than in 1929, and passenger miles were almost as high. These ratios translated into very significant productivity gains (Stover, 1997; Field, 2011: chapter 12, 2012).

It is natural to ask, given the coincidence of the greatest economic depression and the most rapid productivity growth of the twentieth century, whether there is a necessary connection between depression and rapid productivity growth. There is no simple answer. Much of the coincidence reflects serendipity. A number of technological paradigms were ripe for exploitation at the time, and a good deal of what happened would have happened without the Depression. If it were true that economic downturns laid the foundations for higher productivity growth in the future, we could console those out of work with the thought that their sacrifices were laying the foundation for a better tomorrow. To argue thus would, however, be both cruel and largely unjustified, because the response of economic organizations to adversity, like that of individuals, varies greatly. Some sectors did respond in ways that generated persisting benefits, and for the 1930s the railroad sector is the poster child for this style of argument, providing the best support for Richard Posner's suggestion that depressions may have a silver lining (Posner, 2009). There is anecdotal evidence that this dynamic may also have affected parts of the manufacturing sector.[6]

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[5] See Carter et al. (2006), series Dc371.

[6] 'In the automobile industry particularly, but in other manufacturing industries as well, improvements in plant layout appear to have been greatly stimulated by the depression, with resulting better continuity of the flow of work and savings in direct and supervisory labor, equipment, floor space, and inventories' (Weintraub, 1939: 26).

Technological change during the 1930s involved both product and process innovations: the development, introduction, and refinement of dramatic new products, as well as more mundane changes in how they were made or services delivered, that cumulatively and in the aggregate made a big difference. Some Depression era advance involved refinements of products already available in the 1920s (automobiles and mechanical refrigerators are examples). In other instances (nylon a case in point), entirely new materials and products made from them were both developed and rolled out during the Depression years. Finally, research and development restocked the larder for the post-war period, by replenishing the storehouse of only partially or minimally exploited innovations, such as television.

In the latter category, Philo T. Farnsworth's development of what would be the signature new consumer product of the post-war period was financed during the 1930s by San Francisco venture capital. After a lengthy patent dispute, in which Farnsworth prevailed, television was introduced to the public by RCA at the 1939–40 New York World's Fair, at the same time as commercial broadcasts began. Although production and diffusion was interrupted by the war, take-up was extremely rapid beginning in the late 1940s, as is typical for new entertainment as opposed to labour saving consumer appliances (Bowden and Offer, 1994; Field, 2010b).

Advances in aeronautical innovation impacted a nascent industry during the Depression at the same time as they laid the foundation for war production as well as the post-war aviation sector. In 1936, Donald Douglas introduced the DC3— arguably the world's most famous and successful aircraft (it had a starring role in the closing scenes of the movie Casablanca, alongside Humphrey Bogart and Claude Rains). Over 16,000 were produced, including over 10,000 C-47s—a military version with strengthened floor and cargo doors, built during the war. Several hundred are still in operation. A reflection of the state of aeronautical advance during the 1930s (as well as the relatively short period of US involvement in the war) is this: all US aircraft that saw major service operation in World War Two were already on the drawing boards ('substantially designed') in December of 1941 (Galbraith, 1967: 22).

Other products, developed and rolled out during the Depression, achieved high penetration before the war began. In 1928 the DuPont Corporation lured Wallace Caruthers away from his laboratory at Harvard to Delaware, where he began to develop blockbuster new materials including neoprene and nylon. The company introduced nylon stockings to a ravenous female population on 15 May 1940, selling almost 5 million pairs the first day, and 63 million pairs the first year, before production was diverted towards parachutes and mosquito netting for the Pacific campaigns. Caruthers unfortunately did not live to see any of this. Suffering from depression of a different kind, he committed suicide in 1937 (Hermes, 1996).

The 1930s also saw major refinement of products already available to a limited audience in the 1920s. During the 1930s, mechanical refrigerators moved from a 'bleeding edge' product to a mass production and mass consumption item. In the 1920s, if you asked members of an American household whether they had refrigeration, and they answered affirmatively, it usually meant they had an icebox—literally. A huge infrastructure supported an industry that cut frozen water from northern lakes and ponds during the winter, stored the product in insulated warehouses, and distributed it throughout the year.

Entrepreneurs commercialized two systems of mechanical refrigeration for homes during the 1920s. The first, powered by gas, silent and involving no moving parts, was arguably the superior technology (the Servel Corporation continued to manufacture these into the 1950s). The other, whose descendants cool our food today, involved mechanical compressors driven by an electric motor. Electric utilities were involved in marketing the new product, and favoured the latter technology. But they did not push home refrigeration hard until the 1930s.

During the 1920s, both types of refrigerators were boutique products, produced by hundreds of small companies, and achieving low penetration. The appliances were prone to breakdown and required a great deal of after sales service. Although mechanical refrigeration was available, by the end of the decade, it was in use in only a small fraction, perhaps 3 per cent, of American households (Tobey, 1996: 17–19).

In addition to questions of reliability, the state of wiring in American households placed serious obstacles to diffusion. By the end of the 1920s a large fraction of urban US households were 'electrified'. What this typically meant, however, was that there was one light fixture in the ceiling of each room and perhaps one wall or 'utility' outlet per room. The outlets and the electrical feed could handle a floor lamp or a small radio, but the heavier loads demanded by refrigerators or washing machines would almost certainly blow a fuse.

By 1941, many houses had upgraded wiring, mechanical refrigerators were much more reliable, and with experience and mass production, their cost had come down. By 1940, 44 per cent of US households had mechanical refrigeration: 56 per cent of urban households, 39 per cent of rural non-farm households, and 15 per cent of farm households (US Bureau of the Census *Statistical Abstract of the United States, 1948*: 813, Table 914). This diffusion is a concrete manifestation of the fact that if you kept your job during the Depression, your real hourly wages went up, and quite dramatically, rising at a rate equal to or exceeding what occurred in the post-war period.

In contrast with mechanical refrigerators, automobiles had achieved mass market status in the 1920s, with registrations increasing from 6.7 million to 23.1 million over the decade. Because of the Depression and the war, car production did not reattain its 1929 peak until 1949. US car makers nevertheless produced 33.3 million passenger vehicles during the twelve years of the Depression (1930–41 inclusive), slightly more than the 32.7 million manufactured during the eleven years 1919–29. Registrations grew by 6.5 million (Carter et al., 2006: series Df340, Df343). Stated another way, there was enough automobile production during the Depression to replace every car registered in 1929 at least once, as well as add millions to the stock of those on the road by the time the war began.

And the cars were much improved. Radios, heaters, and four wheel hydraulic brakes were now standard. Automatic transmission, power steering, and more powerful engines became options. Tyres moved from the narrow profile high pressure products of the 1920s—reflecting the birth of the automobile in the bicycle industry—to the low pressure balloon tyres upon which most of us roll today. Vehicles were streamlined and more aerodynamic, with headlights and trunks (boots) incorporated into the body rather than add-ons. Raff and Trachtenberg (1997) see the decade of the 1930s as the last in which major innovations in vehicle design took place.

Although the absolute numbers were smaller, the percentage increase in truck and bus production and registrations was even larger. Truck registrations grew from 3.5 million in 1929 to 5.2 million in 1941, and bus registrations almost quadrupled, from 34,000 in 1929 to 120,000 in 1941. Combined truck and bus production between 1929 and 1941 inclusive totalled 7.5 million, as compared with 4.9 million between 1919 and 1929 inclusive (Carter et al., 2006: series Df341, Df342, and Df345). As was the case for automobiles, there was enough production during the Depression to replace every truck and bus on the road in 1929 at least once, and add millions more to the transportation system. These newer vehicles were, on average, larger, more powerful, and more reliable.

Although perhaps less visible to the consumer, the 1930s were also a great age of process and materials innovations. There were big improvements in thermal efficiency, as well as gains based on the exploitation of square–cube relationships in the construction of, for example, larger boilers. In 1941, US output of electricity was 87 per cent above its 1929 level, driven largely by improvements in productivity, as well as government expansion of hydropower. The bulk of the industry, however, relied then, as it does today, on fossil fuel to drive steam turbines. Here, topping techniques used the steam from high pressure boilers to heat lower pressure boilers. Topping raised capacity by 40 to 90 per cent with no increase in fuel costs or labour. More generally, throughout industry, exhaust gasses from stacks were used to preheat air to improve combustion, preheat materials for subsequent fabrication, or generate steam (Weintraub, 1939: 20).

Improvements in thermal efficiency also benefited from attention to low cost, but often high payoff, investments in insulation. Similarly, modest investments in instrumentation yielded big efficiency gains, facilitating automatic process control, which lengthened the life of equipment, and reduced downtime and maintenance costs. The cost of instruments was often trivial compared to the improvements in capital and labour productivity they enabled. In the 1920s, cracking units in petroleum refining needed to be cleaned every four to five days. Instrumentation cut this to every one or two months. Hand controlled boilers required rebricking every three months; instrument controls eliminated the need to do so entirely. Engineers and chemists also made great progress in finding new uses for solid and liquid by-products, thus performing the alchemy of turning industrial excrement into gold.

Machinery became larger, which often resulted in scale economies. Industrial locomotives sold between 1932 and 1936 averaged 11.4 tons, versus 7.4 tons between 1924 and 1927. The capacity of a power shovel rose from 1.73 cubic yards in 1920–23, to 1.90 in 1924–27, to 2.51 in 1928–31, to 3.28 cubic yards in 1932–36. Square–cube relationships meant that capital and operating costs per unit of output dropped when capacity increased. This dynamic could also be observed in electric power generating units as well as in the spiral conveyer screws used to move materials in flour mills (Weintraub, 1939: 17).

Advances in chemical engineering and the use of new materials made contributions as well. Better treatments extended the life of wooden railroad ties from eight to twenty years. Quick drying lacquers reduced the time needed to paint a car from more than three weeks in the early 1920s to a few hours, with consequent reductions in inventory costs. Stainless steel reduced oxidization on railway cars, while chrome plating lengthened the lives of tools and moving parts. Carbon steel

blades had to be removed and resharpened after cutting 60 feet of plastic. A tungsten carbon alloy blade could cut 10,000 feet without refitting. Substituting plastics for wood or metal parts saved in fuel, fabrication, and capital costs (Weintraub, 1939: 21, 23).

The 1930s also saw the tail end of the revolution in factory layout and design that had produced such extraordinary TFP gains in manufacturing between 1919 and 1929 (over 5 per cent per year). That revolution involved replacing systems for distributing power internally within a factory. Nineteenth-century systems were mechanical, relying on leather belts and mechanical shafts and gears to move power from a prime mover, usually either a steam engine or a water wheel. The canonical nineteenth-century brick factory building was four or five stories tall. Multi-story buildings represented an engineering solution to the problem, given the energy losses from friction in mechanical power distribution, of minimizing the sum of runs from the central power source. Since many of the new factory towns were on greenfield sites, building up was rarely dictated by high land values.

In a process that gathered momentum in the second decade of the twentieth century, and continued at an accelerated pace during the 1920s, businesses replaced mechanical systems with networks of electrical wire and small individual electric motors. The transition removed a straightjacket from factory design. Twentieth-century factories are typically one or two stories, with skylights to improve lighting and ventilation, as well as overhead systems for moving sub-assemblies or power tools. Even without a new building, ripping out the shafts and belts produced immediate and large gains. Under the old system there was prime real estate directly under the shafts—but much of the rest of the floor space was low value—used for storage or otherwise wasted. With electric wiring and small electric motors, space could be used much more efficiently (Field, 2011: chapter 2; Devine, 1983). And freed finally from the dirt, grime, and lubricating oils dripping from overhead shafts, factories could become much cleaner.

By 1929, roughly three-quarters of US industrial capacity had already experienced this transition,[7] with results reflected in strong TFP growth across all two digit manufacturing industries (Field, 2011: 52–3, Table 2.2). This transition could propel manufacturing TFP to permanently higher levels but, as the Solow growth model reminds us, could not permanently increase growth rates. Still, as the 1930s began, there was some juice left in this fruit. In 1933, for example, Cadillac consolidated production of drive trains from four floors onto one, leaving the other three available for other uses. In 1934, Packard cut in half its floor space

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[7] Within manufacturing, electric motor horsepower more than doubled between 1919 and 1929, from 15.613 million in 1919 to 33.844 million, and increased further to 45.291 million in 1939 (this includes motors driven by purchased electricity as well as those that used electricity generated onsite). Other power used directly in production in 1929 included 9.157 million horsepower from steam engines, 1.203 million from internal combustion engines, and 1.557 million from hydroturbines and water wheels. Manufacturing also exploited 7.410 million of steam turbine horsepower, but most of this was probably used for onsite generation of electricity rather than directly in the production of motive power. Bringing these numbers together, we can conclude that, in 1929, 33.844 million out of a total of 45.761 million horsepower used directly to produce motive power (74 per cent) was provided by electric motors. This slightly underestimates that share since most of the hydroturbines (included in the data with water wheels) were probably also used for onsite electricity generation rather than directly for motive power (US Bureau of the Census, *Statistical Abstract of the United States, 1948*: 828, Table 927).

requirements per unit of output, freeing an entire building, and similar improvements were reported by Westinghouse and Western Electric. And by rearranging machinery in a linear pattern and changing the way materials were handled, the textile industry garnered high rates of productivity growth during a period in which spinning and weaving technology remained largely unchanged. In other industries, electrically driven conveyer belts saved labour, but also saved capital through the elimination of waste, reduction of spoilage, and shortening of time in process (Weintraub, 1939: 24–25).

Nevertheless, as the gains in manufacturing from this source waned, TFP growth in the sector would inevitably weaken. And indeed, manufacturing TFP growth declined by almost half, comparing 1929–41 with 1919–29, although remaining world class by any standard of comparison other than the 1920s (Field, 2011: 54, Table 2.3). An important question is what kept it from falling further. The answer is to be found in the remarkable development of a privately funded R&D system, some of whose contributions we have already discussed.

In the 1920s, almost all (about four-fifths) of the 2 per cent per year TFP growth in the private non-farm economy is attributable to the 5 per cent per year sectoral growth in manufacturing (Field, 2011: 69 Table 2.10). It is true that the manufacturing share of national income grew in the 1930s, but since its TFP growth rate was declining, it is obvious that the explanation for a higher private non-farm economy (PNE) TFP growth rate in the 1930s must be found in part in other sectors.

The other major source, as noted, was spillovers in transportation and distribution resulting from the build-out of the surface road network. High rates of productivity growth in trucking, railroad transportation, and trade, weighted by their sectoral shares, in the aggregate made a contribution to PNE TFP growth in the 1930s roughly equal in magnitude to that of manufacturing. Railway productivity soared, in part because of institutional and organizational changes involving freight interchange, but also because the paving and extension of the road network solved a critical peak load problem that had plagued the system in prior decades.

Railways depended on surface roads to move merchandise the final mile to households, but many of these roads were impassable because of snow or mud during much of the year. Thus, the demand for freight cars exceeded capacity for four months of the year, while the system had to carry excess capacity for the remainder. Road improvements largely solved this problem. The developing symbiotic relationship with the flexible and rapidly growing trucking system meant that railways performed much better in the Second as opposed to the First World War, when they were taken over and operated by government troops. Another contributor to better performance during 1941–45 was that it was a two front war—in the Pacific as well as the Atlantic—thus solving the backhaul (east to west) problem that had bedevilled the system in 1917 and 1918. The trucking industry, in turn, grew very rapidly, experiencing high rates of productivity advance. Together, these improvements allowed big gains in efficiency in wholesale and retail trade (Goddard, 1994; Field, 2003, 2011: chapter 2).

By 1941, the US route system was complete, and the beginnings of a network of controlled access highways could be seen in the Pennsylvania Turnpike and the Pasadena Freeway. Although the almost exclusively two lane US route system would eventually be overshadowed by the Interstate system begun fifteen years

later, at the time the US system represented a huge improvement over what it replaced, both in the engineering standards to which it was built and in the simple fact, in many parts of the country, that it was paved.

These developments, and others like them, underlie what we see in aggregate measures of output and productivity. A rough measure of the technological and organizational progressivity of an era is how much more rapidly output grows than a weighted average of the growth of labour and physical capital (structures and equipment). That difference, or residual, represents the growth of total factor productivity. The basic arithmetic of growth accounting over the twelve years of the Depression is fairly simple. In the PNE, which excludes agriculture and government but covers almost everything else—about three-quarters of GDP—labour hours grew not at all between 1929 and 1941, and the private sector capital stock remained also, in the aggregate, basically unchanged. Yet real output in 1941 was between 33 and 38 per cent higher (the difference depends upon whether or not we use the newer chained index estimates of output—see the appendix). The result is a TFP growth rate of between 2.3 and 2.5 per cent per year in the PNE.

These rates of increase are before a cyclical adjustment. Since at least the end of the nineteenth century, TFP growth has been pro-cyclical, which means it tends to fall when the output gap rises, and increases as a recession ends (Field, 2010a). Ideally, to abstract from these cyclical influences, we would measure from business cycle peak to business cycle peak. This is not entirely possible for the Depression because, although 1929 can be considered a peak, the unemployment rate in 1941 was still 9.9 per cent. If we use chained index estimates of output, and make a cyclical adjustment as described in the appendix, both TFP and labour productivity growth approach 3 per cent per year across the Depression years. Since private sector input growth was effectively absent, *all* of the growth in output was on account of TFP advance. And since there was virtually no capital deepening, almost all of the growth in output per hour (labour productivity) can also be attributed to TFP growth.

Output growth in the vicinity of 3 per cent per year between 1929 and 1941 is not, per se, unusual. The long run 'speed limit' for the US since at least the end of the Civil War has been a little over 3 per cent per year. But in other periods much of that is due to input growth. What is unusual about the Depression experience, from a growth accounting perspective, is that almost all is attributable to TFP advance.

12.3. THE OUTPUT GAP

The increase of potential (and, as the output gap closed, actual) output across the Depression years was quite high, with most of the gain, especially in the former, driven by record breaking TFP advance. At the same time, the 1930s were distinguished by high unemployment and a very poor record of capacity utilization, particularly between 1929 and 1933. In this section, I consider three related issues. First, the causes of the rising unemployment and sharp decline in output between 1929 and 1933. Second, the failure of the output gap to close completely

Table 12.1. Annual growth rates of TFP, labour, and capital productivity, private non-farm economy, United States, 1869–2010, including a cyclical adjustment for 1941

	TFP	Output/ Hour	Output/Adjusted Hour[b]	Output/Unit Capital Input	Capital/ Labour[c]
1869/78–1892[a]	1.95	2.36	1.89	0.28	2.08
1892–1906	1.11	1.66	1.48	0.15	1.51
1906–1919	1.12	1.89	1.63	−0.16	2.05
1919–1929	**2.02**	**2.27**	**2.33**	**1.09**	**1.18**
1929–1941	**2.97**	**2.92**	**2.78**	**3.56**	**−0.63**
1941–1948	2.08	2.54	2.32	1.36	1.28
1948–1973	1.88	2.75	2.64	0.16	2.59
1973–1989	0.36	1.28	1.06	−1.25	2.53
1989–2000	0.79	2.07	1.57	−0.91	2.98
2000–2007	1.40	2.60	2.26	−0.51	3.11
2007–2010	0.72	2.72	2.10	−1.91	4.63
1995–2005	1.46	2.92	2.62	−0.78	3.70
2005–2010	0.59	2.15	1.58	−1.30	3.45

[a] Kendrick includes annual index numbers in levels going back to 1889, and then index numbers for the ten year periods 1879–88 and 1869–78. One way to calculate growth rates leading up to the 1892 business cycle peak would be to centre the 1869–78 observation on 1873.5 and simply calculate a continuously compounded growth rate. This yields 2.38 per cent per year. But this estimate is too high because 1873.5—indeed the whole period of post civil war adjustment—is not a business cycle peak, and this procedure will bias upwards a TFP calculation since we will measure from a trough to a business cycle peak. An alternate procedure is to run a regression through the logged values of 1879–88 (centred on 1873.5), 1879–88 (centred on 1883.5), and annual observations from 1889–1907. This returns a trend growth rate over the entire period of 1.59 per cent per year. To be consistent with the estimate of 1.59 per cent per year from 1869–78 to 1907, we need a trend growth rate of 1.95 per cent per year between 1869–78 and 1892. That is, TFP growth of 1.95 per cent from 1873.5 to 1892, and 1.11 per cent thereafter, is consistent with 1.59 per cent per year over the whole period.
[b] Output per adjusted hour uses an hours index that has been augmented to reflect changes in labour quality or composition. In creating this index, different categories of labour are weighted by their sectoral wage rates. TFP calculations are made using the adjusted hours series. For details on the cyclical adjustment for 1941, please see the appendix.
[c] Rates of capital deepening are approximately equal to the difference between the growth rate of capital productivity and the growth rate of labour productivity.
Sources: 1869–1929: Kendrick (1961, Table A-XXIII). The unadjusted data are from the column headed output per man hour, the adjusted data from the column headed output per unit of labour input. Capital Productivity is output per unit of capital input.
1929–1948: See appendix.
1948–1989, Bureau of Labour Statistics, 'Net Multifactor Productivity and Costs, 1948–2002' (1 February 2005).
1989–2010: ⟨http://www.bls.gov⟩. Data are drawn from the multifactor productivity section of the website, accessed on 22 February 2012. Output per adjusted hour is real value added in the private non-farm business sector divided by labour input, which includes the compositional adjustments.

until 1942, in spite of strong growth between 1933 and 1937 and again between 1938 and 1941. And finally, the causes of the sharp recession of 1937–38.

In the 1930s, John Maynard Keynes developed a mordant and compelling critique of the then (and again, until relatively recently) dominant view that the normal tendency of an economy, free from interference from unions, business cartels, or government, is toward full employment. If the views against which Keynesian thinking was (and sometimes still is) opposed are correct, we do not really need the concepts of full employment or an output gap. Employment is always, in a sense, 'full', and the distinction between voluntary and involuntary unemployment moot. Lower employment to population ratios can be attributed to individuals' dynamic reallocation of labour supply over the life cycle. An

economy tends automatically to produce at potential, and the only meaningful way we can speak of an output gap is as a measure of the difference between what the economy is actually producing and what it could produce absent the deleterious interventions of governments or unions.[8]

When the economic downturn began in 2008, the stream of modern macroeconomics developing out of the real business cycle tradition unfortunately had very little constructive contribution to policy discussions. Faced with a developing financial crisis, and potentially catastrophic decline in aggregate demand, policy makers in the United States pulled out their intermediate macroeconomics textbooks, dusted off their IS-LM analysis, and began to calculate how large multipliers might be and what kind of fiscal and monetary stimulus was needed to avoid disaster. The experience of countries such as Britain where, ironically, policymaking was less influenced by Keynesian thinking, and indeed often operated in antagonism to its tenets, provides additional evidence that the framework Keynes developed for thinking about the performance of an economy in the short run remains as relevant as ever. Political constraints limited the size of the fiscal response in the United States. These constraints were, however, even more severe in Britain, which weathered a downturn whose depth and duration was comparatively worse than that in the United States.

The best overarching explanation for the Depression continues to be that it resulted from a collapse and slow revival of aggregate demand. To make this argument in its starkest form, we lack a plausible explanation of how potential output could have fallen so much between 1929 and 1933. There is little evidence that a large fraction of the US labour force decided between 1929 and 1933 voluntarily to reallocate its labour supply to subsequent years, or that Henry Ford suddenly forgot how to run an assembly line, or that a substantial portion of the population fell prey to a mysterious virus, or that war destroyed a major portion of the country's capital stock. All such hypotheticals would indeed have lowered potential output, but nothing remotely comparable occurred during this time frame.

To say that the Depression was principally caused by a decline and then slow revival in the growth of nominal income does not, however, preclude attention to supply-side conditions with which this interacted. In particular, we can ask to what degree obstacles on the supply side may have worsened the downturn or provided obstructions to revival, and to what degree these were the consequence of government action.

There is a venerable tradition in macroeconomic and monetary theory focused on whether or not money is 'neutral' in the short as well as the long run, that is, whether it can have real effects on output and employment. The way the question is typically posed reflects acceptance of a key premise in Milton Friedman's monetary framework (1971), the proposition that the demand to hold cash

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[8] Writers within this tradition have remained somewhat ambivalent about the role of cartels or monopolies. Many dismiss their possible effects in limiting output and employment as of little empirical significance (Harberger, 1954), and are therefore sceptical of the value of antitrust policy. This attitude seems to soften considerably, however, when, as in the case of the National Industrial Recovery Act, it is the government that may be responsible for the cartelization. In such instances, combinations in restraint of trade are seen as quite damaging.

(money) is a stable function of a limited number of variables, and moreover, that there is little interest elasticity to the demand for money. Friedman's work provided much of the intellectual underpinning for attempts by central banks in the late 1970s and early 1980s to adopt constant growth rate of the money supply rules.

Such rules, and monetarism as a coherent intellectual philosophy, have been largely abandoned today and replaced with an operational emphasis on interest rate targeting, influenced by some version of the Taylor rule.[9] One of the reasons for the demise of monetarism as a guide to policy is that the demand for money or near monies has in fact proven to be quite unstable, subject, particularly in times of uncertainty or financial instability, to large perturbations based on sudden increases in the demand for liquidity, as well as flexibility in the face of changes in nominal interest rates.

A broader and more encompassing way of framing questions of neutrality is to ask whether fluctuations in *nominal income* are neutral in both the short and long run. Nominal income (GDP) is the product of real income or output and the GDP deflator. It is also arithmetically the product of the stock of money and the income velocity of money, with velocity defined as nominal income divided by the money stock. The money stock, in turn can be understood as the monetary base (high powered money), as M1, or as whatever aggregate one chooses, as long as income velocity is defined in a corresponding manner.

Nominal income and its growth fluctuate, as Friedman emphasized, because the level or growth rates of nominal money change. But they can also fluctuate because of changes in velocity, which can be due to perturbations in the demand to hold money, or particular forms of cash, as well as changes in fiscal variables (government tax and spending programmes) or changes in private sector spending propensities, especially those associated with the acquisition of investment goods (structures or equipment) and consumer durables.[10] Friedman's neutrality question, redefined, becomes whether, when for any of the reasons described above, nominal income falls, or its rate of growth decelerates, this has real effects on output and employment, and, if so, how large they are. Rigidities and/or negative changes on the supply side can make a difference in terms of the size of such effects.

Here it can be useful to partition these supply-side conditions into two categories: those that could in principle be overcome, either temporarily or permanently, by reversing the decline or slow growth of nominal income, and those that could not. For example, downwardly inflexible wages would not contribute significantly to an output decline in the absence of nominal income decline. In contrast, a

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[9] The Taylor rule, developed by John Taylor of Stanford University, attempts to capture how central banks do, and perhaps should, respond to their dual mandates of controlling inflation and fostering full employment. Taylor posited that central bankers aspire to 2 per cent inflation (the ideal would be no inflation, but given that this is an imperfect business, they prefer a 2 percentage point buffer to reduce the likelihood of undershooting, which could yield deflation—which can also have deleterious consequences). Assuming a long run real interest rate of about 2.5 per cent, their base target is 4.5 per cent nominal, increased in the presence of higher than desired inflation, decreased in the presence of a persisting output gap.

[10] Only when velocity is invariant do questions of monetary and nominal income neutrality become the same.

negative aggregate supply shock that caused a third of the population and labour force to become permanently incapacitated, or a sudden, overnight change in workers' preferences in favour of leisure over work, or work five years from now versus work this year, could not be overcome, in terms of their effects on real output, simply by higher nominal income growth. The problem of lower real output in these latter cases would not be that there has been a widening of the output gap, but rather that potential output had, in a real sense, actually declined.

In terms of developments in the latter category, however, there is, as noted, no smoking gun on the supply side that can explain the rise of the unemployment rate from 3.2 per cent in 1929 to 25 per cent in 1933 and the 27 per cent decline in real output between these years. This cannot plausibly be attributed to a rise in the natural rate of unemployment because of changes in the demographic composition of the labour force, or increases in the attractiveness of living on the dole, or civil war, or some sudden collective amnesia about how to manufacture steel. That is why, in discussing the Depression, we talk in terms of an increase in the output gap. It is why we describe most of that unemployment as involuntary.[11] And it is why we continue to explore the role of changes in spending propensities, liquidity shocks, bank failures, inadequate Federal Reserve response, and other factors in bringing this about.

Distinguishing between these categories of supply conditions can matter when we move into discussions of proximate and ultimate cause. Suppose, for example, we believe that Irving Fisher's debt deflation mechanism is important in prolonging depressions. Obviously, without a deflationary impulse, debt deflation could not operate. But equally obviously, that mechanism depends on a system of borrowing and lending in which interest payments are fixed in nominal terms. In an imagined world of fully indexed debt contracts, the results for the economy would differ. In this case, however, it is still appropriate to describe the downturn as being caused by the shock to nominal income, not the absence of indexed loan contracts. The potential output of the economy would not rise with the introduction of fully indexed loan contracts (although its vulnerabilities to recessions might decline).

Similarly, if institutional changes have increased the downward inflexibility of money wages, and output falls in the face of a deflationary demand shock, it is appropriate to say that the output loss has been caused by the demand shock, not the absence of a completely flexible nominal wage system in which the spot price of labour rose and fell with demand conditions as does the price of wheat. The introduction of a regime of more downwardly flexible money wages would not

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[11] Thus, while I am broadly sympathetic to many of the conclusions of Hatton and Thomas (2013), I find implausible their suggestion that the NAIRU (non-accelerating inflation rate of unemployment) rose 12 percentage points, from 4.2 to 16.9 per cent in the US during the Depression. Every period of elevated unemployment in the United States has brought forth a literature suggesting that this has been caused by a rise in the NAIRU. For the 1970s see, for example, Tobin (1977). I am receptive to the argument that the NAIRU may temporarily rise as the consequence of an economic downturn hysteresis due to atrophying of labour market attachment among the long term unemployed. But I am sceptical when large increases in the unemployment rate are attributed after the fact to rises in the NAIRU, that is, when the causal roles are reversed.

mean that the potential output of the economy had actually risen, nor would downward inflexibilities mean that it had fallen.[12]

In a series of papers, Lee Ohanian (2003, 2009), sometimes in collaboration with his co-author, Harold Cole (Cole and Ohanian, 2000, 2002, 2004), has argued that government-induced negative supply shocks explain much of the Depression's depth and duration. Although the specific culprits and particular emphases have differed as this research programme has developed, three policies have borne the brunt of the blame. First, a meeting organized by President Hoover in November of 1929 in which the president encouraged manufacturers to hold the line against nominal wage cuts in the face of what was then anticipated as a likely recession. Second, the passage in 1933 of the National Industrial Recovery Act. And third, the passage of the Wagner Act establishing the National Labour Relations Board in 1935, providing a more favourable environment for union organizing.[13]

If the Cole and Ohanian papers have a common thread, it is the claim that the main explanation for the Depression is not that nominal income was too low, but that wages were too high. In particular, they argue, between 1929 and 1933 (or at least through 1931), jawboning by Hoover kept nominal wages from falling. After 1933, New Deal policies not only kept them from falling, but caused them to rise. In both instances, policy actions allegedly made the Depression worse.[14]

The evidence indicates, however, that wages were not downwardly inflexible, even between 1929 and 1931. In *Historical Statistics of the United States*, there are two main series covering hourly wages during the Depression, one for unskilled workers, and one for production workers. Figures 12.1 and 12.2 present these, along with the CPI (consumer price index), and their ratio, which measures real wages. Let us begin with the evidence for unskilled workers.

Nominal wages fell in 1930, 1931, and 1932, for a total decline of approximately 18 per cent. Almost all of that loss was recovered between 1933 and 1934, after which nominal wages rose modestly before jumping again between 1936 and 1937. They then grew modestly through 1940, increasing sharply between 1940 and 1941. While nominal wages fell between 1929 and 1932, output declined dramatically, and while nominal wages grew, after 1933, output rose dramatically.

It is true that the CPI fell further than nominal wages during the worst years of the Depression. This meant that if you managed to keep your job and your hours, your real standard of living actually improved slightly between 1929 and 1933. Real wages then began to rise very sharply after 1933, along with economic recovery, as a large output gap began to close. Perhaps the suggestion is that if nominal wages had fallen even further, real wages could have declined, and the Depression thus avoided.

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[12] Except in the sense that even in a dynamic economy with positive but low inflation, the flexibility might facilitate sectoral readjustment.

[13] Cole and Ohanian's work is part of a larger body of work intent on blaming recessions on government action. Other examples include Jude Wanniski's (1978) attribution of the Depression to the Smoot–Hawley tariff, or Robert Higgs' emphasis on the second New Deal, especially the work of the Temporary National Economic Committee, often interpreted as hostile to big business, as well as the more aggressive enforcement of antitrust policy.

[14] I interpret their argument in terms of nominal wages, because that is all an employer can set; real wages can only be known after the fact.
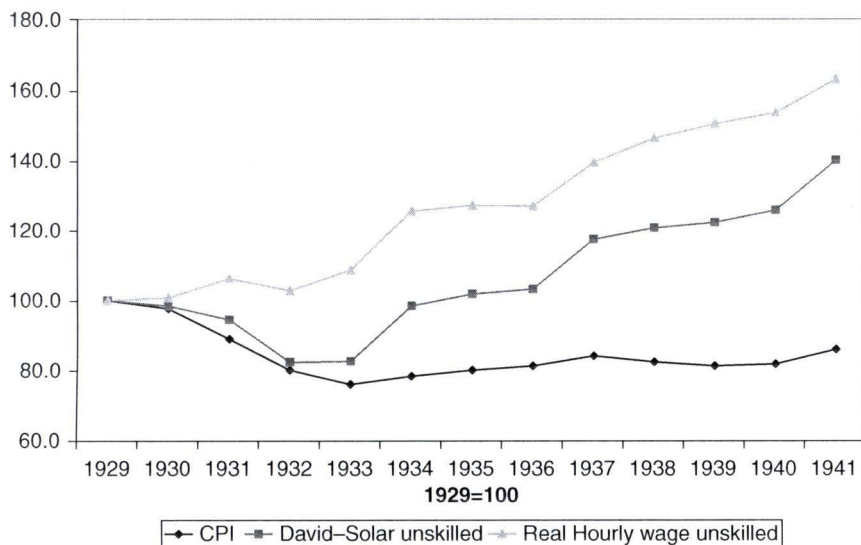
Fig. 12.1. Real hourly wages of unskilled workers, United States, 1929–41

Sources: Carter et al., 2006: Series Ba4218 and Cc1-2.

Is this likely? In answering this question, Fisher's analysis is relevant. During the seven years of rough CPI constancy between 1922 and 1929, much debt had been contracted based on the expectation of continued price stability. When prices plummeted between 1929 and 1933, real interest rates on existing and newly issued debt soared, even as nominal rates dropped. It is hard to see how a more severe deflationary impulse would have ameliorated this dynamic. Indeed, it would likely have made it worse.

Cole and Ohanian are, however, sceptical that the standard explanations of nominal income decline—bank failures, the absence of adequate Fed response, high real interest rates, and disruptions to the credit machinery—had much to do with the downturn. In support of this view, they cite the rise in the loan to output ratio between 1929 and 1932 as evidence that loanable funds were actually quite abundant during these years (Ohanian, 2003: 1212).

This, however, misinterprets what was actually happening during a period in which prices were falling and hundreds, indeed thousands, of banks were failing. Since most loan obligations were fixed in nominal terms, with deflation we would expect this ratio to have risen even if there had been no new loans to be had at any price after 1929. The numerator would have declined moderately as existing loans ran off, but the denominator would likely have been dropping even more rapidly (nominal GDP declined 46 per cent between 1929 and 1933).[15] The trend in this ratio is simply reflective of the operation of Fisher's debt deflation mechanism: the real burden of debt rose with unanticipated deflation. The rise in the burden of debt, and the increase in its value for those to whom it was owed, is consistent with

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[15] <http://www.bea.gov>, NIPA Table 1.1.5.

the fact that despite loan defaults, bond interest was the only category of income to capital to rise between 1929 and 1933 (Field, 2011: 269).

The data on wages for production workers paint a very similar story. These numbers are perhaps even more relevant for the Ohanian argument, since they pertain to workers who would presumably have been most affected by restraint on the part of the captains of industry upon whom Hoover was, allegedly, effectively leaning. Here we see nominal wages dropping 10 per cent between 1929 and 1931, the period most emphasized in Ohanian's analysis, and 21 per cent between 1929 and 1933.

Neither of these series suggests that nominal wages were downwardly inflexible. Ohanian may wish that wages had fallen more, or suspect that absent Hoover, they would have fallen more. It is, however, questionable whether a faster rate of nominal wage decline would have lessened the cumulative output loss between 1929 and 1933, particularly in a world of non-indexed loan contracts and interest rates that cannot go below zero. There is, moreover, some question whether Hoover's jawboning had any significant effect on the course of nominal wages. Rose (2010) finds no evidence that industry attendance at the December 1929 conference affected the timing of reductions in nominal wages.

With respect to the 1933–41 period, our analysis can be somewhat more nuanced. We can grant the Cole–Ohanian premise that New Deal policies and legislation played a role in raising both nominal and real wages. But we should also take exception to their characterization of the recovery from 1933 as 'weak' (Ohanian, 2003: 1205). Post 1933 recovery, particularly between 1933 and 1937 (which includes the period of the NRA (National Recovery Administration)), was in fact extraordinarily strong, with rapid rises in output, employment, and income to capital as well as labour. The stock market increased by a factor of five from its trough in 1932 to its peak in 1937. Growth in real output was also strong from 1938–41, following the Wagner Act and big increases in unionization, although stock market gains were lower. Overall, output, wages, and income to capital all grew very rapidly between 1929 and 1941, and particularly between 1933 and 1941. We should not be surprised by this coincidence, since national income accounting identities tell us that the sum of income flows must approximately equal the flow of output.

How exceptional was this growth? In 1937 real output was 43 per cent higher than it had been in 1933 (NIPA, Table 1.1.6). Over those four years the economy grew at a continuously compounded rate approaching 9 per cent per year. Real output in 1941 was 91 per cent higher than in 1933—almost twice as high—a continuously compounded rate of growth of 8 per cent per year over a period that included the sharp recession of 1937–38. It is of course true that the output gap was not finally closed until 1942, which is why Ohanian can use, as evidence of weak recovery, the observation that output in 1939 was 'below trend'.

The proximate cause of recovery after 1933 was revival in the growth of aggregate demand; the particular contributors to this are discussed elsewhere in this volume. One important factor was the removal of the straightjacket on monetary growth resulting from the abandonment of the gold standard. Policy measures ended the deflation, allowing real interest rates to decline, and invest-ment, output, and employment to begin growing again. But backstage, as the drama of this revival unfolded, potential output grew by leaps and bounds,
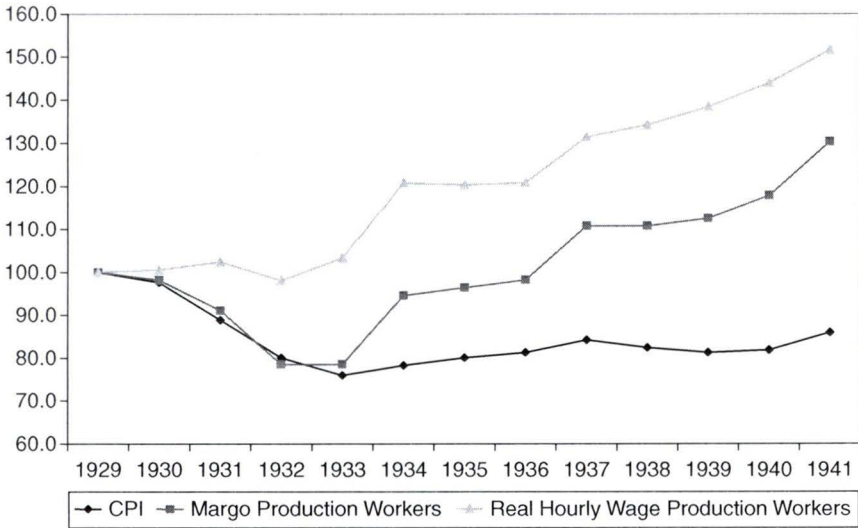
Fig. 12.2. Real hourly wages of production workers, United States, 1929–41

Sources: Carter et al., 2006: Series Ba4361 and Cc1-2.

helping to sustain an output gap that did not close completely until after the US entered the war. Its persistence can partly be attributed to supply-side obstacles to recovery in sectors such as construction (see below in this section). But it was also the case that productivity advance, which reduced the inputs required to produce a given output, contributed to slower employment growth. Concerns with technological unemployment were widespread during the Depression and, although in a well managed economy these should not be an issue over the longer run, worries about the effects of innovation on job growth had a basis over the short to medium term.[16]

There is no historical necessity that labour will share, or share proportionately in productivity gains. Institutions, politics, and culture matter. To take an extreme case, in a slave system, improvements will devolve almost entirely to the benefit of the owning class. Slave prices may be bid up, perhaps providing some additional incentives for better housing, food, and medical care, but most of the gains go to the owners. 'Free' labour markets are not all of one kind, and can be governed by quite different legal and institutional rules affecting, for example, how easy it is for labour to organize and bargain collectively.

Twentieth-century evidence suggests that there is a range of correspondence between wages and productivity—both levels and rates of growth—that can allow

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[16] Capital also suffered from (or enjoyed) technological unemployment. With strong rises in capital productivity, the need for (and demand for) investment spending beyond that needed to replace worn out building and equipment was attenuated. Along with the effects of obstacles to renewed residential housing construction, this resulted in increases in gross private domestic investment that were lower than they otherwise might have been. Even after 1933, weak private capital formation hindered, from the aggregate demand side, a closing of the output gap.
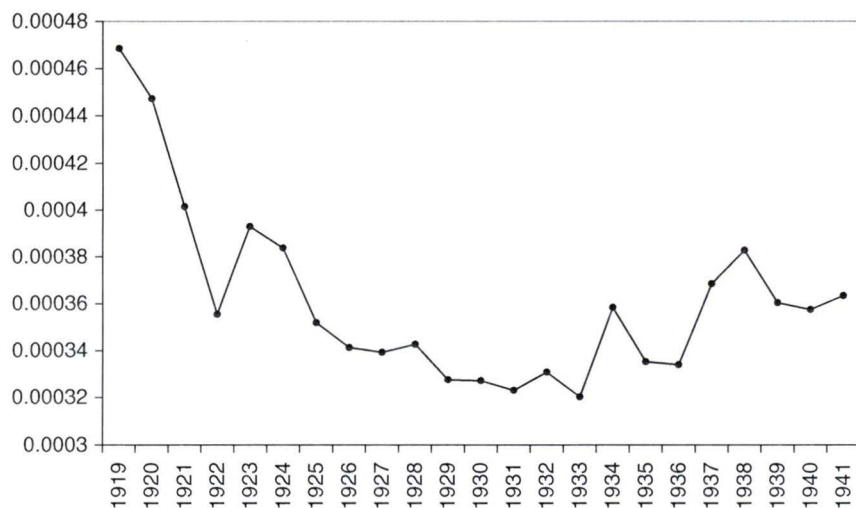
Fig. 12.3. Ratio of real hourly production worker wage to manufacturing productivity, United States, 1919–41

Source: Carter et al., 2006: Series Ba4361; Kendrick, 1961: 465–6 Table D-2.

full employment, the accumulation of physical and human capital, and healthy economic growth. In the 1960s, for example, as governments and companies in the United States and Europe dealt with strong organized labour movements, a consensus emerged that a workable course of action was to agree—at the national level, if possible—that wage gains would rise roughly alongside productivity gains. That incomes policy was considered within the realm of political discourse testifies to the fact that, under different circumstances, wage gains might or might not keep up with productivity gains, or might exceed them.

Cole and Ohanian do not dispute that productivity rose sharply, particularly after 1933. But they emphasize that wages rose faster, arguing (2002: 30) that the ratio of wages to productivity between 1929 and 1939 increased in the United States by 25 per cent, and implying that the New Deal policies that allowed labour to reap a disproportionate share of productivity gains were an impediment to full recovery. A look at Figures 12.1 and 12.2, in conjunction with Table 12.1, does indeed show that wages increased even faster than measures of productivity.

But the rise in this ratio has to be understood in the context of what had transpired in the 1920s. The 1920s were a period of high and rising income inequality, leading to levels rivalled only by what we have been experiencing in the most recent decade. If we look at the ratio of the real hourly wage of production workers to Kendrick's estimate of output per hour in manufacturing across the entire interwar period, we place in perspective the increase in the ratio to which Cole and Ohanian call our attention (see Figure 12.3). What we see is that, in terms of real hourly wages, labour shared hardly at all in the very large productivity gains in manufacturing during the 1920s. Workers did benefit from relatively full employment, which sustained household income, and increased opportunities for buying on credit allowed consumption to rise. It is nevertheless

fair to say that capital reaped almost all of the gains from productivity growth in the 1920s.

This underscores the political dimension of Hoover's November 1929 meeting. A concern about labour peace was understandable, since the insult of widespread unemployment was about to be added to the injury of having received in the 1920s, in the form of increments to real hourly wages, a very small share of the preceding decade's productivity gains. This was understood at the time, if not precisely in these terms. As Hoover argued in 1931, '[w]ages during Prosperity went nowhere near so high, comparatively, as commodity prices, business profits and dividends; therefore they should not come down with the general decline' (*Time*, 13 April 1931, cited in Ohanian, 2009: 16). Following a decade in which labour reaped virtually none of the gains from prosperity, the economy in 1929 was poised to go into a devastating depression, in spite of wages then prevailing that were low in comparison with what they would have been had labour shared in the 1920s gains. Cole and Ohanian's criticism seems to be that Hoover did not do more to insure that real wages declined even further relative to productivity levels.

Before leaving Cole and Ohanian, it is worth mentioning a notable paper that recently appeared in the *Journal of Economic History*, because it goes to the heart of the real business cycle approach that informs their work. Inklaar et al. (2011) apply a methodology pioneered by Basu et al. (2006) which extracts from the Solow productivity measures that portion due to systematic pro-cyclicality. Because of the inability of the private sector as a whole to get rid of physical capital in a downturn, and thus avoid ongoing depreciation and holding costs, the economy tends to experience short run increasing returns to scale as the output gap closes (see Field, 2010a).[17] This is different from saying that the economy is subject to long run increasing returns to scale. What it means is that, while TFP really does go down (or experiences a reduced rate of growth) during a recession, this is not because of technological regress.

If we 'purify' measures of TFP by removing these cyclical effects, we can then test whether there is any discernible short run relationship between purified TFP and input levels, a key prediction of the RBC approach. Inklaar et al. (2011) show that for US manufacturing between 1919 and 1939 there is none. Their work is consistent with the view that the pro-cyclicality of TFP is principally driven by aggregate demand fluctuations, which, as one goes into recession, cause declines in output that are greater than the reduction of inputs, especially those associated with physical capital, particularly structures. By and large, observed TFP pro-cyclicality is the consequence of business cycles, not their cause.

Although it is doubtful that Hoover's and Roosevelt's labour market policies were responsible for much of the Depression, there were supply-side problems standing in the way of full recovery. Perhaps most important was the legacy of premature subdivision and fractionated land ownership that resulted from the

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[17] Voluntary labour hoarding is the more typical explanation for pro-cylical productivity. It is clearly relevant in some instances—particularly in early stages of a downturn where it may not be clear how long the recession will last. But I question the persistence and generality of the phenomenon, emphasizing instead the involuntary dynamic with respect to physical capital as the more fundamental and general cause. See also Field (2010c).

uncontrolled land boom of the 1920s. I discuss the details of this at length in Field (1992); see also Field (2011: chapter 11). Neither commercial nor residential construction reattained its 1920s peaks until after the war, although commercial came back somewhat more robustly than residential. The slow revival of commercial construction is partly attributable to capital saving innovation that made more efficient use of floor space, particularly in manufacturing. The obstacles to increased residential construction were different. They included large transactions costs associated with tracking down owners of record, clearing up tax liens, and paying mortgage obligations on properties comprising failed 1920s subdivisions, many of which had been poorly designed from the standpoint of automobile transportation.[18] If we are searching for supply-side obstacles to full employment, their contribution to the collapse and slow revival of spending on residential construction is a stronger candidate.

The idea that construction held the key to understanding incomplete recovery is not novel, and was widely shared by economists both before and after the war. As Kenneth Roose, writing in 1954, said,

> ...many believed construction bore a heavy responsibility for the low level of economic activity in the 1930s. This belief was held by analysts with widely differing theoretical approaches to the recession and business fluctuations in general. Thus the National City Bank of New York, *The Economist*, and [Alvin] Hansen attached importance to the weakness of the building industry... [Hansen] concluded "It is in this area that one finds the explanation for the incomplete recovery of the thirties" (1954: 14).

In Field (2011: 271), I calculate that the low level of residential and, to a lesser degree, non-residential construction spending relative to a 1920s baseline was responsible for approximately half of the output gap remaining at the local peak in 1937. Had potential output grown at its long term rate of approximately 3 per cent per year, it would have increased from $87.2 billion (I take 1929 actual as potential) to $110.9 billion in 1937 dollars. This can be compared with actual 1937 output of $91.9 billion; the difference is the output gap. Had residential and non-residential construction spending each retained the rough equality with equipment spending characteristic of the 1920s, there would have been an additional $5.8 billion of gross private domestic investment in 1937 dollars.

Based on the ratio of changes in real output to changes in the sum of the components of autonomous planned spending, I estimate a multiplier of 1.78 for the period 1933 through to 1937 (Field, 2011: 240, Table 10. 1).[19] This additional construction spending would, therefore, have brought actual output to $102.2 billion, bridging roughly half the distance between actual and potential in 1937. Had exports and consumer durables been at their 1929 levels, output would have been another $2 billion higher, getting us to $104.2 billion. The remainder of the gap

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[18] It is the absence of zoning and land use regulation, the result of inadequate rather than excessive regulation, that lies at the heart of this supply-side legacy of the 1920s for the 1930s.

[19] Keynesian multipliers, to the degree that they estimate the impact of changes in autonomous spending on real output and employment, have their greatest relevance when an economy is in recession or depression, and there is slack labour and capital available to produce additional output. This was surely one of the instances in which we should expect crowding out.

could have been closed by an additional injection of less than $4 billion in government or private infrastructure or equipment spending.

The final issue to consider concerns the causes of the sharp recession between 1937 and 1938. Here again, the overarching contributor is likely to have been a contraction in the growth of nominal income. The role of increases in reserve requirements, emphasized by Friedman and Schwartz (1963) has recently been questioned (Calomiris et al., 2011). Excess reserves were so large at the time that even the higher requirements were not binding. Irwin (2011) has emphasized the empirical significance of the Treasury's gold sterilization policy in restraining the growth of the money supply. But there is a problem with this argument. We can agree that absent sterilization, high powered money would have grown faster. But if Calomiris et al. are right, and reserve requirements were not binding, banks might well simply have held more excess reserves. For these reasons, and although its impact has been questioned by Romer (1992: 776), fiscal policy seems a better candidate if we are to emphasize a role for aggregate demand in explaining the downturn. There can be little doubt that comparing 1937 with the previous year, the fiscal posture changed from one of expansion associated with veterans' bonus payments, to contraction, associated with the introduction of payroll taxes to finance the new social security system as well as lower government spending on goods and services (NIPA, Table 1.1.6).

That said, other factors were also operative. Joshua Hausman (2011) has argued that the traditional emphasis on monetary and fiscal policy short-changes supply-side factors, in particular those affecting the motor vehicle industry. He notes that the coefficient of variation of changes in state-level private non-farm employment during the recession of 1937–38 was approximately twice what it was in other severe recessions, including 1929–33 and 2007–09. This was the consequence of particularly steep declines in manufacturing employment in states within which the auto industry was concentrated, such as Michigan, Ohio, and Indiana.

Hausman's story is that car production was hit by a negative supply shock in the form of the unionization of GM and Chrysler and higher raw material costs, leading to price increases in 1938. These increases were anticipated, leading to a shift forward of car sales to the 1937 model year at the expense of 1938 model year purchases. Motor vehicle and parts sales fell more than a third during this recession.

Christina Romer (1992: 763) raises some doubts about this argument, noting that producer prices fell 9.4 per cent. But as Hausman points out, car prices rose, and that is where the big employment losses were. Romer also argues that construction expenditures fell in late 1937, and that interest rates spiked, suggesting clear evidence of monetary tightening. The annual construction data do not seem to be consistent with this story. An index of overall construction contracts awarded (1923–25 = 100) rose from 55 in 1936, to 59 in 1937, to 64 in 1938, to 72 in 1939 (US Bureau of the Census, *Statistical Abstract of the United States, 1941*: 945, Table 929). Housing units starts (in thousands) rose from 304.2 in 1936, to 332.4 in 1937, to 399.3 in 1938 (Carter et al., 2006: Series Dc510). Residential investment, which declines in almost all recessions, actually increased slightly across this downturn, although of course, as already noted, it remained quite depressed relative to what had prevailed in the 1920s, and the monthly data do show some effect of the

recession.[20] Still, the somewhat anomalous behaviour of residential construction during the 1937–38 downturn suggests that this was not entirely a garden variety recession, such as 1982, in which slowed growth in aggregate demand accounted for almost everything. As for interest rates, the annual data show declines across the board, comparing 1938 with 1937, rather than the spike posited by Romer (Carter et al., 2006: Series Cj1224 and 1231). Nor do the monthly data on short term rates show any evidence of monetary stringency in the fall of 1937 or winter of 1938 (*Banking and Monetary Statistics 1914–1941*: 451, 464, Tables 120, 125).

Finally, we can mention Robert Higgs's argument that the downturn after 1937 is attributable to the second New Deal, and Roosevelt's adoption of more vigorous antitrust enforcement, the Temporary National Economic Committee hearings, and more populist rhetoric (Higgs, 1997). Supposedly owners of capital went on a capital strike, refusing to invest because of their dislike of Roosevelt or concerns about insecure property rights. There is no doubt that a segment of the electorate hated Roosevelt, although there is little evidence their animosity was worse in 1937 than it had been in 1933. The facts are that owners of capital did much better under Roosevelt than they did under Hoover. And, after falling dramatically in 1938, real gross private domestic investment in 1939 exceeded 1936 levels, and in 1940 exceeded the 1937 peak. These data are hardly consistent with the notion of a 'capital strike' during Roosevelt's second term (USDC, NIPA, Table 1.1.6). And again, the biggest shortfalls remained in residential construction spending. One might have expected the effect of regime uncertainty, or Roosevelt hatred, to have been more apparent, for example, in producer durables spending.

Higgs and Ohanian are, of course, part of a continuing tradition aimed at fixing the responsibility for business cycles on government. That tradition includes Jude Wanniski's 1978 attempt to attribute the Great Depression entirely to the passage of the Smoot–Hawley tariff. The unifying theme in this literature is that depressions are the result of government intervention in the workings of the 'free market' system. There is no doubt that some of the policies discussed did have the potential to generate efficiency losses. But arguments that might make sense if economies always operated at potential often cease to hold in a world where output gaps are a real and continuing problem. In Economics 1, students are taught that there's no such thing as a free lunch, that everything has an opportunity cost, that if you want more guns you have to have less butter. Such pieties simply do not apply when, in a recession, one is operating well within the production possibility frontier.

Thus, in principle, David Ricardo was right: tariffs reduce global welfare and output by impeding the international division of labour. But in a world of slack resources, such damage may be small, and by redirecting purchasing power towards import competing domestic producers, tariffs during recessions may actually have a mildly stimulative effect (Eichengreen and Sachs, 1985). And whereas the theory of monopoly suggests that the policies of the NRA, which

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[20] Monthly data on the value of construction contracts awarded in 37 states suggest a roughly half year slowdown running from September of 1927 through to February 1938 (US Bureau of the Census *Statistical Abstract of the United States, 1941*: 945 Table 928).

encouraged cartelization and wage and price increases, could have reduced output and damaged consumer welfare, in the presence of deflation and large scale unemployment they may have done the reverse, by helping to break the back of deflationary expectations (Eggertsson, 2008).

Finally, note that while Cole and Ohanian attack the NRA for fostering monopoly, Higgs criticizes the second New Deal for trying aggressively to restrict it. One can either take the view that the efficiency losses from monopoly are small, in which case one might conclude that the concerns about the NIRA are misplaced, or one can take the opposite view, which would undercut Higgs' position. But one cannot consistently endorse both Higgs and Ohanian unless one believes that the fostering of monopolies is necessarily damaging when done by governments but not so when done by private enterprise.

The facts of economic performance in the United States between 1929 and 1941 have not changed, but many of the same issues continue to be relitigated in the literature. Much of the 'new' focus on negative government-induced supply shocks represents an attempt to refocus attention away from the gap between actual and potential output and towards efficiency losses associated with different kinds of government intervention. In 1977, James Tobin, surveying a related set of arguments concerning economic policy and performance in the 1970s, opined that '[i]t takes a heap of Harberger triangles to fill an Okun gap' (Tobin, 1977: 468). Tobin meant that the welfare losses from tariffs, taxes, and other government regulations were often small compared to those associated with operating an economy below capacity in the case of the Depression for more than a decade.

12.4. CONCLUSION

Although our emphasis in understanding the depth and duration of the Depression will and should continue to be on aggregate demand, more attention to aggregate supply is welcome and overdue. The dominant story here is of a broad array of positive shocks that caused potential, and, as the output gap closed, actual, output to grow rapidly between 1929 and 1941. In contrast, research associated with the real business cycle tradition has emphasized negative shocks resulting from deleterious actions by government and unions. These, it is argued, help account for the duration of the downturn. Although the Flint sit down strike and other labour disturbances likely played a role in the decline of output and employment during the 1937–38 recession, the influence of labour policy in prolonging the Depression has been exaggerated. Much of what happened rectified in part the unbalanced distribution of gains from productivity growth during the 1920s. The resulting moderation in inequality, which became especially apparent after the war, persisted through the 1970s and, as the post-war experience suggests, should not have posed an obstacle to full recovery in the late 1930s had there been adequate growth in nominal income. Obstacles on the supply side did play a role, but the impediments to the revival of residential construction, reflecting the hangover from the 1920s boom, were more important.

What lessons can we draw for the twenty first century? From the standpoint of long run growth the most compelling question is whether there is necessarily a

silver lining to recession in the form of a productivity windfall. It is a question, unfortunately, without a clear answer. Productivity growth was unusually strong across the worst downturn in US experience, but this coincidence was in part an historical accident. Preliminary data indicate modest TFP growth from 2005 or 2007 up through 2010, although labour productivity growth after 2007 has been stronger (see Table 12.1). These data are, however, subject to revision, and we do not yet know how much of this may reflect cyclical influences. Part of the more robust growth in output per hour is the consequence of a rapid rise in the capital-labour ratio attributable to slow employment growth. As the output gap closes labour productivity growth may experience retardation unless compensated for by strong TFP advance. Even in the event the longer term TFP trajectory turns out to be favourable, it will be difficult to assess whether much or any of it can be attributed to the recession per se.

Considering shorter term supply-side effects, in both instances legacies from the boom retarded recovery, and in both instances construction was implicated. But the mechanisms differed. In post-war housing booms, including the saving and loan boomlet of the late 1980s as well as the more severe cycle of the 2000s, zoning and land use regulation ameliorated the problems of premature subdivision, without, of course, preventing overbuilding. Thus, the physical and some of the legal obstacles to recovery are today less severe than they were during the Depression, a positive contribution of government regulation, albeit at the local level, to macroeconomic stability. This contribution was offset, nevertheless, by the deterioration of effective regulatory efforts in the financial sector, and the financial wreckage from the prior construction boom remains worse in the 2010s than it was in the 1930s, which suffered more from the legacy of a highly leveraged stock market boom (see Field, 2011: chapter 10, 2013).

This chapter has focused attention largely on the supply side. As far as aggregate demand is concerned it is fair to say that, in both instances, the cumulative output gap could have been less had more aggressive government action counteracted the persisting shortfalls in nominal income growth resulting from weak private investment spending, as well, to a lesser degree, from cutbacks in household spending on consumer durables. Monetary policy, at least subsequent to 2008, gets better marks in the more recent episode than during the Depression, although fiscal policy stimulus, particularly on the expenditure side, could have been stronger in both instances. The rapid closing of the remaining output gap in 1942 makes this point effectively for the Great Depression. And contrary to political claims that the 2009 stimulus programme (the American Recovery and Reinvestment Act) did not work, its main defect was simply that it was too small. Without it, the unemployment rate would have been as much as two percentage points higher.[21]

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[21] Congressional Budget Office, 2011. A larger stimulus might have devoted more funds to revenue sharing with state and local governments, which faced plummeting tax revenues on account of the downturn, without much of an option of running deficits. While real federal spending increased 14 per cent between 2007.4 and 2011.4, real state and local spending fell 7 per cent over the same period (NIPA Table 1.1.6, accessed 21 February 2012). Because state and local spending was higher in the aggregate than federal spending on goods and services (74 per cent higher in 2007.4), these changes were largely although not entirely offsetting.

APPENDIX: PRODUCTIVITY GROWTH IN
THE UNITED STATES: 1929–1948

This appendix describes the calculations underlying the Table 12.1 productivity estimates for the US PNE over the intervals 1929–41 and 1941–48. The raw materials are series on output, capital, and hours. In calculations in Field (2011) and earlier work, all three of these series are drawn from Kendrick (1961). The updated numbers reported in this chapter are based on newer series for output and capital and show stronger gains in productivity growth for these periods than those reported earlier. The output series is based on the latest chained index estimates from the National Income and Product Accounts (NIPA) tables provided by the Bureau of Economic Analysis (BEA). This series grows more rapidly than that used by Kendrick, and is the principal reason the productivity growth rates reported here are higher. The capital stock series is drawn from the fixed asset portion of the BEA website, and differs slightly from what Kendrick used. The labour hours series is the same as that used by Kendrick in 1961; it has not been updated in the half century since he published.

The substitution of the newer output and capital series yields an unadjusted PNE TFP growth rate of 2.54 per cent per year between 1929 and 1941, which can be compared with an unadjusted 2.31 per cent per year, calculated directly from Table A-XXIII of Kendrick (1961). With a cyclical adjustment, the newer estimate rises to 2.97 per cent per year, as compared with a cyclically adjusted 2.78 per cent reported earlier (Field, 2011: 43, 100). Most of the difference between these two sets of growth rates is attributable to the faster growth of the chained index output series.

Chained indexes try to resolve the fundamentally unresolvable differences between Paasche and Laspeyres quantity indices by taking a geometric average of the growth rates from one year to the next calculated using each type of index, and then creating a linked series. Chained index methods are better for calculating the growth of aggregates over time than the older procedures of sticking with base period prices for a number of years, and then switching to a new base year. The problem with this approach is that every time a new base year is introduced, the calculated growth of aggregates changes, requiring us, in a sense, to rewrite periodically our economic history even though the underlying data are not changing.

Although chained index methods are better for measuring the growth of aggregates over time, they are not as useful for estimating the relative shares of components of the aggregates, since these shares, if calculated using the same procedures, will not necessarily continue to sum to the aggregates year after year. Since measures of TFP growth involve relationships between the growth of aggregates, however, it is appropriate to ask how the use of series not

Without the stimulus, the decline in state and local revenue, and thus expenditures, would have been even greater, and one would have also lacked the benefits of federal infrastructural spending as well as the weaker support for consumption provided by the tax reductions included in the American Recovery and Reinvestment Act and such programmes as 'cash for clunkers'. By 2011.4, state and local spending was 46 per cent higher than federal spending (NIPA Table 1.1.5, accessed 21 February 2012).

available to Kendrick in 1961 affects the quantitative narrative. I begin with the Bureau of Economic Analysis National Income and Product Accounts (BEA NIPA) Table 1.1.6, available at <http://www.bea.gov/>, which gives chained index estimates of annual GDP going back to 1929.

The aggregate used in Table 12.1 is the PNE, a subset of the national economy excluding agriculture and government. The logic of excluding these two sectors from studies of long term productivity growth is that the value of much of the former (government product) is set at its cost of production, precluding by convention any productivity improvement. And output in the latter sector—agriculture—is often affected by supply shocks (floods, hailstorms, temperature changes) that have little to do with improvements in efficiency. Because of these exclusions, I need to adjust downward the annual levels of real GDP from NIPA Table 1.1.6 so that they correspond roughly to the PNE.

Kendrick (1961: 298–300, Table A-III) provides annual estimates not only for GDP but also for government and farm product separately. I subtract the latter two subtotals from the former to get estimates of the PNE in 1929 dollars, and use the ratios of the PNE to GDP in the Kendrick data to adjust the BEA NIPA Table 1.1.6 numbers for the entire economy to approximate those for the PNE. According to the chain weighted series, 1941 GDP was 39.8 per cent higher than the comparable 1929 figure (2.79 per cent growth per year). Using the PNE/GDP ratio from Kendrick as described above to calculate PNE levels for the chained index series, I estimate that real output in the PNE was 37.7 per cent higher in 1941 than in 1929 (2.67 per cent growth per year).

I then go to the BEA Fixed Asset Table 2.1 for levels of private fixed assets (structures and equipment) during the period 1929–41. Since Kendrick provides estimates of the capital stock for the private domestic economy (1961: 334–7, Table A-XXII; this includes farm output) as well as for the PNE (1961: 338–40, Table A-XXIII), I use the ratio of the latter to the former to adjust the BEA private fixed asset data to get estimates of private non-farm chained index capital. This series grows very slightly rather than, as had been the case with Kendrick's, declining very slightly between 1929 and 1941. Kendrick had PNE capital about 1.6 per cent lower in 1941 than 1929, while the newer BEA series with the adjustment to approximate fixed capital in the PNE shows a small increase (1.5 per cent) over the 12 year period. Substituting the newer capital series for the one used by Kendrick will slightly reduce calculated TFP growth by slightly increasing the growth of the combined input measure. In the calculations that follow, however, this effect will be more than swamped by the substantially higher growth in output using chained indexes.

I then proceed to calculate revised indexes of TFP levels (A) for 1929, 1941 and 1948. The assumed functional specification of the production function is Cobb–Douglas, with constant returns to scale:

$$Y = AK^{\beta}N^{1-\beta}$$

Y = real output
N = labour hours
K = capital input

Rearranging, we have

$$A = Y/(K^{\beta}N^{1-\beta})$$

Using lower case letters to represent continuously compounded growth rates, we have a version of the fundamental growth accounting equation. This equation tells us that TFP growth (a) is the difference between output growth (y) and a weighted average of capital (k) and labour (n) growth.

$$a = y - \beta k - (1 - \beta)n$$

β, the elasticity of output with respect to capital, as well as capital's share, is assumed to be 0.25, and that of labour, $(1 - \beta)$, 0.75. These are the shares Kendrick assumed for 1929–37 (Kendrick, 1961: 285, Table A-10). He used an even smaller capital share (0.23) for 1937–48, but I am assuming most of the small drop in the share occurred after the start of the war, and to keep matters simple, use 0.25 for the entire 1929–41 period. As already noted, because the growth of labour and capital input both remain close to zero between 1929 and 1941, changes in these weights will make almost no difference in calculated TFP growth rates.

The PNE TFP levels resulting from these calculations show TFP 35.7 per cent higher in 1941 than in 1929 (2.54 per cent growth per year). Recall that real output in the PNE was 37.7 per cent higher (2.67 per cent growth per year). Once again, almost all of the growth in output can be attributed to TFP growth, not growth in inputs conventionally measured. This is not surprising. Since we are using the same series for labour hours input as did Kendrick, and the capital input series has received only a slight upward adjustment, combined private sector input growth over the 12 year period is still very close to zero.

This estimate of 2.54 per cent per year PNE TFP growth is before a cyclical adjustment. The adjustment is based on a regression of differences in logs of annual levels of TFP ($\Delta\ln(\text{TFP})$) on a constant and the change in the unemployment rate in percentage points for the period 1929–41. The coefficient on the constant term (0.0306, or 3.06 per cent per year) provides a rough gauge of the trend growth rate of total factor productivity across the Depression years. The coefficient on the change in the unemployment rate (−0.0084, or −0.84 percentage points) estimates how much the PNE TFP growth rate tended to decline (rise) if the unemployment rate increased (decreased) one percentage point.[22] The econometric specification assumes that fluctuations in the unemployment rate (and, implicitly, the output gap) during this period are driven primarily by fluctuations in aggregate demand; the hypothesis maintained is that TFP pro-cyclicality is almost entirely a consequence of business cycles, rather than their cause (see the main body of the chapter). The regression results are as follows (t statistics in parentheses).

Dep. Var.	Years	n	Constant	ΔUR	R^2
$\Delta\ln(\text{TFP})$	1929–41	12	0.0306	−0.0084	0.617
			(3.34)	(−4.01)	

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[22] That coefficient is remarkably stable across the entire period 1890–2004, even though trend growth rates have varied substantially. See Field (2010a).

One way to cyclically adjust would simply be to replace the 2.54 per cent with the 3.06 per cent coefficient on the constant in the above regression. I use a related procedure that yields something very close to this. Since unemployment in 1941 was still 9.9 per cent, I ask, in light of the cyclicality coefficient, what the level of TFP in 1941 would have been had unemployment in that year been what it was in 1948 (3.8 per cent). Based on the regression results, the natural log of the 1941 level of TFP would have been 0.0512 higher (-6.1 * -0.0084) had unemployment in 1941 been at the 1948 rate of 3.8 per cent. That also implies that the difference in the log level from any earlier year would have been 0.0512 higher. Dividing by 12, this would mean an additional 0.427 percentage points per year added to the continuously compounded growth rate measured from 1929 to 1941.[23] Thus, with a cyclical adjustment, the TFP growth rate for the PNE rises from 2.54 per cent per year to 2.97 per cent per year. This is the rate reported for 1929–41 in Table 12.1.

The cyclical adjustment strengthens my argument about the magnitude of a Great Leap Forward between 1929 and 1941. But it is not essential for the narrative since the dominance of that period stands out even without the adjustment, and, for that matter, even with the somewhat lower unadjusted TFP rate calculated directly from Kendrick. No other period in US economic history exhibits a comparable rate of growth of total factor productivity.

With the cyclically adjusted level for 1941, we can now also calculate 1941–48 TFP growth, which comes in at 2.08 per cent per year, close to estimates for the golden age (1948–73), higher than that reported in Field (2011: 43), but still almost a third below the estimated rate of growth for 1929–41.

Let us consider now how the use of the chained index numbers affects other productivity measures. Using chained index output and capital, labour productivity (output per hour in the PNE), grew 38 per cent between 1929 and 1941 (2.68 per cent per year). Output per adjusted hour (adjusted hours take into account possible changes in labour quality) was 35.7 per cent higher (2.54 per cent growth per year). Because Kendrick's implied measure of labour quality grows slightly over the Depression years, output per adjusted hour growth is slightly lower than growth in output per unadjusted (raw) hours.

These growth rates are before a cyclical adjustment. Specifying the appropriate counterfactual here is trickier than with TFP. We know that labour productivity growth is also pro-cyclical, although not as strongly so as is TFP (Field, 2010a). We also know, from a rearrangement of the fundamental growth accounting equation, that labour productivity growth is equal to the sum of TFP growth and capital's share times the rate of capital deepening:

$$y - n = a + \beta(k - n)$$

This equation tells us that labour productivity growth ($y-n$) is affected by two influences in principle distinct: technological and organization innovation (reflected in the (a) term), and increases in the ratio of physical capital to labour, or capital deepening, reflected in the ($k-n$) expression. Capital deepening results when an economy allocates part of its annual GDP to produce buildings and

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[23] With the cyclical adjustment, the 1941 level of TFP would have been 42.8 per cent higher than in 1929, as compared with the actual 35.7 per cent higher.

equipment. So long as gross private domestic investment exceeds depreciation (the annual wear and tear on the existing stock), the physical capital stock will grow, and when it grows faster than labour or labour hours, the ratio of physical capital to labour increases. We say that capital has deepened ($k - n$ is positive), and on this account alone, output per hour should rise. A road construction crew using heavy construction equipment should, for example, be able to move more cubic metres of earth per hour than a crew using pick axes and shovels. The transition from digging with shovels to digging with backhoes requires capital accumulation, and its contribution to growth in output per hour is at least conceptually distinct from a technological or organizational innovation that adds to a nation's book of available blueprints.

We have already calculated that, with the chained index output and capital numbers, and under a counterfactual in which 1941 unemployment was 3.8 per cent rather than the actual 9.9 per cent, the rate of growth of TFP between 1929 and 1941 would have been 2.97 rather than 2.54 per cent per year (0.43 percentage points per year higher). Since TFP growth is one of two key influences on labour productivity growth, this cyclical adjustment to TFP, by itself, would contribute a similar bump to growth in output per hour. But we also know that capital tends to 'shallow' in a recovery: the growth of the capital–labour ratio, and quite possibly its level, decline as one approaches potential output from below (in the short run, the denominator (labour) grows faster than the numerator (capital)). Capital shallowing weakens labour productivity growth during a recovery, partially counterbalancing the positive influence of pro-cyclical TFP. From a growth accounting perspective, this counterbalance is the main explanation for why labour productivity growth is more weakly pro-cyclical than TFP growth.

From a regression of the change in the natural log of the capital–labour ratio on a constant, and the change in the unemployment rate over the entire 1890–2004 period, we can estimate the cyclicality coefficient for the capital–labour ratio at 0.0151: roughly speaking, K/N declines by 1.5 per cent for each one percentage point decline in the unemployment rate (Field, 2010a).

Dep. Var	Years	n	Constant	ΔUR	R^2
Δln(K/N)	1890–2004	114	0.0163	0.0151	0.741
			(7.53)	(16.70)	

Had the unemployment rate been 6.1 percentage points lower in 1941, we can posit that the natural log of K/N would have been lower in that year by 0.092 ($-6.1*0.0151 = -0.092$). Dividing this by 12, we conclude that this would have lowered the continuously compounded growth rate of the capital–labour ratio (K/N) between 1929 and 1941 by -0.77 percentage points per year per year. Since the contribution of capital deepening to labour productivity growth is weighted by capital's share, this would have reduced the growth rate of labour productivity by $0.77*0.25 = 0.19$ percentage points per year.

Summing the effect of the hypothetically higher TFP growth rate (0.43 percentage points per year) and the effect of the hypothetically lower (negative) growth rate of the capital–labour ratio (-0.19 percentage points per year), we conclude that the appropriate cyclical adjustment for the labour productivity growth rate between 1929 and 1941 is 0.24 percentage points per year (0.43–0.19). Adding this to our initial estimate of the growth of (actual) output per adjusted labour hour,

we reach a cyclically adjusted rate of growth of output per hour of 2.92 per cent per year. Using the hours series that has been adjusted for improvements in labour quality we get, using the new output series, a cyclically adjusted rate of growth of 2.78 per cent.

This is a striking result, since it tells us that the growth of output per hour between 1929 and 1941 was at least as high as it was across the quarter century generally viewed as the golden age of US living standard improvements (1948–73). It is important contextually in understanding the discussion in the second part of this chapter about the growth of real wages during the Depression.

Finally, let us consider how the introduction of these two new series affects calculations of capital productivity (output per unit of capital). Using the new capital and output series, adjusted as described to correspond with the PNE, we have output per unit of capital rising 35.6 per cent between 1929 and 1941 (2.54 per cent per year). This is once again before a cyclical adjustment. We know that capital productivity is very strongly pro-cyclical (and indeed it is this pro-cyclicality, even more than the weaker pro-cyclicality of labour productivity, that in an accounting sense, drives TFP's strong pro-cyclicality). The regression below, for the period 1890–2004, shows that, while there is no long term trend in capital productivity (the constant term is approximately 0, confirming one of Nicholas Kaldor's stylized facts about economic growth), a one percentage point decline in the unemployment rate typically adds about 2 per cent to that year's growth in output per unit of capital (Field, 2010a). This pro-cyclicality is because, when an economy comes out of a recession, output grows much faster than physical capital.[24]

Dep. Var.	Years	n	Constant	ΔUR	R^2
Δln(Y/K)	1890–2004	114	0.002	−0.0200	0.654
			(0.0061)	(−14.52)	

Since the counterfactual we have been exploring involves 1941 unemployment at 1948 levels (3.8 per cent), which is a 6.1 percentage point difference from actual, this suggests that had 1941 been at or close to potential, the natural log of 1941 capital productivity would have been 0.122 higher that year. Dividing by 12, that would have added 1.01 percentage points to the continuously compounded growth rate of capital productivity between 1929 and 1941, yielding a cyclically adjusted rate of growth of 3.56 per cent per year. A check on the reasonableness of this calculation can be made through another rearrangement of the fundamental growth accounting equation, which tells us that TFP growth must be equal to a weighted average of capital productivity and labour productivity growth. (To persuade yourself of this, multiply out, eliminate the βy terms which cancel out, and rearrange the remaining terms).

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[24] I am approximating the service flow from the capital stock by assuming that it is proportional to the stock. For mechanical machinery, depreciation can be affected by hours of operation or start-stop cycles. But mechanical machinery is a small fraction of the fixed asset stock, the bulk of which consists of structures. For the canonical physical capital good—a building—the rate at which a roof wears out, or exterior paint oxidizes, is almost entirely independent of how full or empty it is, or how rapidly goods and people move through it. For further discussion of this approximation, see Field, 2010a,c.

$$a = \beta(y - k) + (1 - \beta)(y - n)$$

Noting that the relevant labour input series in both Kendrick's and my revised calculation is adjusted hours (adjusted for labour quality growth), we can deduce an implied rate of capital productivity advance $(y - k)$ consistent with our estimates of TFP and labour productivity advance. Since we have already calculated cyclically adjusted estimates for a and $y - n$, these numbers are easily backed out. For the 1929–41 period, this comes in at 3.54 per cent per year, very close to what we arrive at using the cyclicality coefficient from the 1890–2004 regression.

Output, both actual and potential, grew substantially between 1929 and 1941 with only minimal increases in private sector physical capital, which is to say that the capital to output ratio declined, since the output to capital ratio rose. There are other periods in US economic history in which labour productivity grew as rapidly as during the Great Depression. There is none in which this was true for capital productivity. The uniqueness of this development is brought into strong relief when we remind ourselves that there is no long run upward trend for capital productivity.

Making an upward adjustment to the 1941 level of the output to capital ratio will of course raise the 1929–41 growth rates, and reduce the growth rate for 1941–48. In this case, the cyclical adjustment lowers capital productivity growth between 1941 and 1948 from 3.07 per cent per year (using the unadjusted level of capital productivity in 1941) to 1.34 per cent (using the adjusted level). As a check, the calculation using the formula above relating TFP growth, labour productivity growth, and capital productivity growth comes in at 1.36 per cent.

As already discussed in describing the cyclical adjustment for 1941 labour productivity, a cyclically adjusted level for the 1941 capital–labour ratio is based on a regression of the log difference of the capital–labour ratio on a constant and the change in the unemployment rate in percentage points. The regression shows that the capital–labour ratio has risen over the long run at about 1.6 per cent per year, but there has also been strong cyclical variation. In particular, as an economy recovers, labour input grows much more rapidly than capital input so the capital–labour ratio falls. Without a cyclical adjustment, the capital–labour ratio in the PNE rises very slightly (0.14 per cent per year) between 1929 and 1941. We have already calculated that had the 1941 unemployment rate been 3.8 per cent, the natural log of the 1941 capital–labour ratio would have been 0.092 lower, which would have reduced the annual growth rate of the ratio by 0.77 percentage points per year, yielding a cyclically adjusted growth rate of -0.63 per cent per year. With a cyclical adjustment, the ratio then grows at a rate of 1.28 per cent per year between 1941 and 1948. We can check on the reasonableness of these calculations by observing that the difference between the rate of labour productivity growth and capital productivity growth should yield the rate of capital deepening:

$$y - n - (y - k) = k - n$$

To summarize, the pivotal number in all of these calculations is the TFP growth rate for the PNE. Using output, hours, and capital input from Kendrick (1961), TFP growth is 2.31 per cent per year, continuously compounded (with a cyclical adjustment: 2.78 per cent per year). Using the same hours series, but the newer chain weighted output series and the chain weighted capital stock series, we get

2.54 per cent per year. A cyclical adjustment raises this to 2.97 per cent per year. These cyclically adjusted growth rates approximate, using the different data series as described, what TFP growth between 1929 and 1941 would have looked like had there been no remaining output gap in 1941. A TFP growth rate approaching 3 per cent per year is unmatched in any comparable period of US economic growth, and can be decomposed into a rate of labour productivity growth equal to or exceeding that realized during the golden age, combined with a rate of capital productivity growth far exceeding that in any other period.

Several concerns might be raised about the conclusion, to borrow from the title of my 2003 *American Economic Review* article, that the 1930s were indeed 'the most technologically progressive decade of the century'. First, could some of the high rate of TFP growth be due to the ramp up in military spending prior to US entry into the war in December of 1941? Only in the sense that, as noted, TFP growth displays strong pro-cyclicality, and increased military spending prior to the war accelerated the closing of the output gap through traditional aggregate demand mechanisms. Thus the actual growth rate of TFP between 1940 and 1941 is affected by the narrowing of the output gap associated with war preparations. But what is relevant here is not the growth in TFP from 1940 to 1941, but rather the growth as measured from 1929 to 1941, preferably adjusted to account for the cyclicality of TFP.

Still, is it possible that the military build-up prior to Pearl Harbor not only helped close the output gap, but also augmented potential output? One must keep in mind the relative magnitude of what happened before the US entered the war. It is true that military manpower and spending, including Lend Lease, grew dramatically from 1939 to 1941. For example, men in uniform almost tripled, from 600,000 to 1.8 million. But this is dwarfed by maximum military manpower in 1944 of over 12 million. The US was effectively demilitarized during the 1930s, and military disbursements to the end of 1941 were less than 5 per cent of what would be expended cumulatively between 1939 and 1945 (Field, 2003). The United States was not fully mobilized for war until sometime in mid-1942. Given these timelines, there is far too little opportunity for cumulative output and learning by doing in war-related production to have generated technological and organizational spillovers with enduring impact on the economy's potential output (Field, 2011: chapter 3). Thus, it is unlikely that the measure of the TFP trend growth rate between 1929 and 1941 is influenced by the military build-up.

A second concern is whether or to what degree TFP growth might be based on improvements in human capital or labour quality. As can be seen from the second column of Table 12.1, which shows the growth of adjusted labour productivity, the overall growth of labour quality was modest during the Depression years, and thus the numbers for output per hour and output per adjusted hour growth are quite similar. Human capital mattered, but the contributions of the rather small number (in comparison with the total labour force) of workers in R&D labs was probably more important than any general upward trend in the quality of labour. And whatever the position one takes on the empirical relevance of selective retention of higher quality labour in economic downturns (Margo, 1991), this is simply not relevant for comparisons between the years 1929 and 1941. Although private sector hours were effectively unchanged, because of a reduction in hours per person, there were actually 11 per cent more persons employed in the latter year

than in 1929 (Kendrick, 1961). Any effect of selective retention that might have been in play between 1929 and 1933 would have been more than reversed by the rapid growth of the economy and the increase in persons employed between 1933 and 1937 and again between 1938 and 1941.

A third concern involves the extent to which these calculations overlook the influence of public sector infrastructural investments. Are we, for example, simply seeing a statistical artefact, the effect of the substitution of publicly owned street and highway capital for privately owned railway capital? Including economically relevant public capital, which, unlike private sector capital, did grow over the Depression, will, of course, reduce the calculated TFP growth rate, because combined input growth will be positive and higher. Recalculating TFP growth rates for the last three-quarters of the twentieth century using an augmented capital input series that includes economically relevant public sector capital does, as expected, show the Depression years with TFP growth rates that are lower than those calculated using private sector capital alone. But this dynamic affects other periods as well, and 1929–41 still stands out as exhibiting significantly higher TFP growth than the 1920s or any of the post-war periods (Field, 2003, 2011).

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