Two Centuries of Economic Growth: Europe Chasing the American Frontier*

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I. Introduction

This paper is about the gap between the economic performance of the United States as contrasted to the main western European countries over the last two centuries.[1] First, why has the U. S. represented the frontier of economic performance for most of the last two centuries? Second, given that the U. S. was at the frontier, why did Europe not catch up steadily and converge to the U. S. level, as implied by many growth models? Why did Europe fall so far back beneath the frontier and take so long to catch up? Third, how do we interpret data showing that Europe has recently almost caught up with the U. S. in the level of output per hour (labor productivity) but remains significantly behind in output per capita? How could Europe be so productive yet so poor?[2]

The analysis of U. S. at the frontier and Europe's falling behind combines many elements of analysis that, singly or in groups, have appeared in the literature before. But they have not yet been combined in the fully comprehensive tableau provided here. We divide the sources of U. S. advantage both chronologically (pre- and post-1913) and by cause, separating the subset of factors that were related to political and economic unity, i.e., that Europe could have achieved in a hypothetical "United States of Europe" (USE) in effect after 1870, from the set of advantages of the U. S. that were independent of political and economic unity. We

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1. As detailed in the Data Appendix, "Europe" consists of four large countries (France, Germany, Italy, and the U.K.) and eight small countries (Austria, Belgium, Denmark, Finland, Netherlands, Norway, Sweden, and Switzerland).

2. My own interest in the interplay between American and European growth performance originates in three sources. As a graduate student at Oxford in the early 1960s I witnessed first hand the backwardness of the British economy and the inferiority complex that Britain had long developed about its slow rate of productivity growth compared to the U. S., and I learned there about the various "productivity commissions" that had travelled to Detroit and elsewhere to learn the secrets of American superiority. Then in graduate school I became interested in the post-1920 increase in the output-capital ratio as well as data paradoxes about World War II — how had the U. S. produced so much with a capital stock that, according to the official data, declined steadily between 1929 and 1946? Finally, in a conversation sometime around 1984, Moe Abramovitz introduced me to the historical record on the *ratio* of European to U. S. productivity that later appeared in print (Abramovitz, 1986, Table 1) and spurred my interest in learning about the explanations of both the numerator and denominator of that ratio.

also separate those sources of early U. S. advantage in the nineteenth century that were reversable and non-reversable, and then integrate the reversable factors into a new analysis of the European catch-up after World War II. In contrast to some recent papers that place disproportionate emphasis on the performance of the U. S. manufacturing sector in the 1920s, we highlight the golden age of U. S. productivity growth in the 1930s and 1940s, culminating in America's production achievement in World War II.

Perhaps the most unique contribution of this paper is to examine the discrepancy between Europe's current position in the league table of output per capita, as contrasted to its much better standing in output per hour relative to the United States. Our welfare analysis requires that we weigh and assess the value of extra leisure time in Europe, whether the low hours of work per capita in Europe are entirely voluntarily, how much of low labor input per capita reflects involuntary unemployment and involuntary low labor force participation, and a host of other differences between "American Exceptionalism" and "European Exceptionalism" ranging from shop-closing hours and land-use laws to subsidies of public transport and mortgage interest rates.

II. The Evidence: Europe Chasing the U. S. Frontier

Thanks to the indefatigable achievements of Angus Maddison in developing, maintaining, and updating cross-country data on population, labor input, and real GDP adjusted to modern PPP concepts, we know quite a lot about the economic performance of Europe compared to the United States since 1820.[3] In this section we examine the basic data

3. Those who have met Angus Maddison in person will notice more than a passing resemblance to Winston Churchill, and I like to think of him as the "Churchill of economic growth data."

on output per capita and output per hour and then subsequently turn to the explanations. While doubtless many issues about the accuracy of the Maddison data could be raised, these are beyond the scope of this paper, and henceforth all the Maddison data will be treated as if they are absolutely correct.[4]

Plotted on a log scale for selected years that are "neutral" to the business cycle, i.e., excluding the influence of recessions, depressions, and wars, the most striking fact displayed in Figure 1 is the steady and inexorable advance of U. S. real GDP per capita.[5] While the growth rate is slower in the first 50 years, between 1820 and 1870, subsequent to 1870 there is surprisingly little variation around the 1870-2000 average growth rate of 1.81 per year, a rate sufficient to double the standard of living every 38 years. The major acceleration above the long-run trend comes, surprisingly, not in the early postwar years but in the decade 1963-73, followed by a retardation back to trend in 1987-94.

In Europe the average growth rate between 1870 and 2000 is a modestly slower 1.67 percent, but progress in Europe was much more erratic than in the U. S. Europe fell steadily behind the U. S. through 1913, then suffered downward dislocations associated with both world wars, followed by a sharp reversal and catch-up during the golden years 1950-73 and then an evident failure to close the remaining gap after 1973.

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4. An exception is that we do raise questions about the Maddison data on hours per employee, which may contain errors that distort the analysis of Figure 4 below. Also, a loose cannon on the deck of current assessments of long-term economic growth is created by the 1999 revisions of the U. S. national accounts (NIPA), which raise the growth rate of real GDP by more than 1.0 percent per annum for the interval 1929-48, as compared to previous NIPA estimates used by Maddison and everyone else. These revisions, which are not included in the analysis of this paper, greatly increase the magnitude of the "big wave" phenomenon emphasized in Gordon (2000a) and to a lesser extent in this paper.

5. As indicated in the Data Appendix, the lines in Figure 1 are log-linear interpolations between 1820, 1850, 1870, 1891, 1900, 1913, 1923, 1929, 1941, 1950, 1963, 1973, 1979, 1987, 1994, and 2000.

The equivalent record for labor productivity, i.e., real GDP per hour worked, is displayed in Figure 2 for fewer and longer intervals dictated by data availability.[6] The U. S. record of productivity growth is not as steady as for output per-capita and displays its strongest performance for the 1938-50 interval, with the 1950-73 interval in second rank and the 1973-92 "growth slowdown" period ranked far below any of the other sub-intervals shown. In the data of Figure 2, the growth rate of output per hour during the "big wave" sub-interval 1913-73 of 2.54 percent substantially exceeds that of 1870-1913 (1.90 percent) and is almost double that of 1973-2000 (1.37 percent).[7]

Partly because of the longer sub-intervals plotted, the European record on productivity in Figure 2 is smoother than for output per capita in Figure 1. Europe starts out well below the U. S. in 1870, grows much more slowly through 1950 (with a 1870-1950 growth rate of 1.50 percent compared to the U. S. 2.15 percent), but then with a sharp spurt during 1950-73 reachieves its relative position of the late 1890s and subsequently continues its catch-up, almost closing the gap by the year 2000.

The data in Figures 1 and 2 can be combined as in Figure 3, which plots the ratios of European to U. S. levels of output per capita (black line) and output per hour (grey line). This graphical format dramatizes several themes that are less obvious in Figures 1 and 2. The black

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6. Maddison (1995) presents output per hour only for 1870, 1913, 1929, 1938, 1950, 1973, and 1992. The Data Appendix explains the updating of his data to the year 2000. The real GDP data are the same as used in Figure 1, which are available annually after 1870, but Maddison's hours data have been developed only for the listed years.

7. Compared to the 1.37 percent cited in the text, the annual growth rate in the current BLS data for output per hour in the nonfarm private business sector over the 1973-2000 interval is 1.56 percent. This difference reflects the broader Maddison concept of real GDP per hour, which includes the government, nonprofit, and household sectors with their slower or nonexistent rates of measured productivity growth.

line shows that the Europe/U.S. ratio of output per capita declines steadily from 105 percent in 1820 to 93 percent in 1870 to 74 percent in 1913, with sharp war-related jolts taking the ratio down to its minimum of 56 percent in 1950. The upsurge from 1950 to 1973 brings the ratio back to 74 percent, a full recovery to the 1913 level, but after that there is little further progress, only to a ratio of 77 percent in the year 2000.

The Europe/U. S. ratio for productivity growth in Figure 3 begins in 1870 rather than 1820 and exhibits the same downward slide at about the same rate, from 79 percent in 1870 to 47 percent in 1950. Throughout the subinterval 1870-1950, the productivity ratio in Figure 3 is below the ratio of output per capita for comparable years, indicating that Europe had a higher level of hours per capita than did the U. S. After 1950 the relationship between the level and growth of the two ratios reverses completely, with much faster growth in the productivity ratio than in the ratio of output per capita, a continuation of that growth well past 1973 into the late 1990s, and perhaps most important, nearly complete convergence of the level of European productivity to the U. S. level by the late 1990s. Clearly, hours per capita in Europe nosedived relative to the U. S. in the last half of the twentieth century.

Much of the fascinating detail of Figures 1-3 is lost in a table that presents growth rates rather than log levels or ratios, such as Table 1. Many authors have presented tables for a selection of countries that looks like the two right-hand columns of lines 4 and 5 of Table 1. These numbers show that Europe achieved much faster productivity growth in 1950-73 and 1973-2000 than did the United States.[8] So what? Does that mean that the U. S. was falling

8. An example of such a misleading table appears in Landes (1998, Table 26.1, p. 459), which simply presents growth rates of GDP and of labor productivity in manufacturing for the U. S., U. K., Japan and Germany, for the years 1950-87 with no context at all, either in the form of levels or pre-1950 growth rates.

behind Europe or that Europe was catching up to the United States? Without information on the relative *levels* of these variables, growth rates are misleading or useless.

However, when accompanied by the levels and ratios of Figures 1 to 3, the growth rates in Table 1 are a useful complement. They quantify two aspects of the graphical data. First, they show how sharply the European/U. S. ratios for both output per capita and productivity turned around after 1950. Second, in the bottom line they display a contrast in the growth rate of output per capita compared to productivity, with negligible differences through 1950, followed by a sharp retardation of output per capita growth in Europe relative to productivity growth. Why did this occur?

By definition, real output *(Y)*, population *(N)*, hours of work *(H)*, and employment *(E)*, are related as:

$$Y/N = Y/H * H/E * E/N \quad \textbf{(1)}$$

which states that output per capita equals labor productivity times annual hours per employee, times employment per member of the population. In Figure 4 the black line is the Europe/U. S. ratio of output per capita divided by the Europe/U. S. ratio of output per hour, and this shows a decline from 109 percent in 1950 to a 83 percent in the year 2000. By definition any changes in this ratio must be completely explained by changes in the same direction in the product of the hours/employee and employment/population ratios, as shown by the light dashed and solid grey lines, respectively.

Both of these ratios contributed to the divergent behavior of productivity compared to output per capita. The surge in U. S. output per capita in the 1963-73 period that is evident

in Figure 1 above can be explained by an increase in the labor force participation rate of teenagers and females. Starting in 1950, hours per employee in Europe dropped faster than in the U. S., while the employee/population ratio plummeted during the 1973-92 sub-interval.[9] It is well known that postwar European governments have encouraged (and/or labor unions have demanded) longer vacations, contributing to the decline in hours per employee in Europe. There is also a vast literature on the higher equilibrium rate of unemployment in Europe (the "NAIRU") and its substantially lower rate of labor force participation.[10]

III. Welfare Aspects of the Europe-U. S. Comparison

My introductory question (in the context of Figure 3) "how could today's Europe be so productive yet so poor" was intended to provide a wake-up call to the difficult welfare comparisons suggested by the evidence. To the extent that Europe's standard of living (measured by its relative output per capita) is held down by lower hours due to longer vacations, then its citizens have chosen to use some of their prosperity to take longer vacations

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9. The hours/employee data are provided in Maddison (1995), Table J-4, p. 248. The employment/population ratio in Figure 4 is calculated as a residual, using the definition in equation (1). It is possible that in Figure 4 the decline in the H/E ratio is too slow and the residual E/N ratio is too fast, because Maddison's data on H/E show a surprisingly small difference between Europe (1524 hours per year) and the U. S. (1589 hours per year) in 1992. In contrast, an unpublished worksheet from the OECD, dated June 13, 1996, shows for 1995 a much great difference, with U. S. hours per employee at 1952 per year, and the average of France, Germany, and the U. K. at 1641, fully 16 percent lower compared to 4 percent lower in the Maddison data. These respective numbers for 1998, also from OECD sources, are quoted as 1966 for the U. S. and 1644 for the average of the same three countries, also a difference of 16 percent (see Mishel *et al.* 2001, Table 7.18, p. 400).

10. On the NAIRU, see *OECD Economic Outlook*, December 2000, no. 68, chapter 5, pp. 155-168. The NAIRU estimate (Table V.1, p. 158) for the Euro area is 8.8 percent, compared to 5.2 percent for the United States. For the labor force participation rate, Mishel *et al.* (2001, Table 7.17, p. 398) contrasts male rates of 71.6 percent for the U. S. with respective rates for France, Germany, and Italy of 57.3, 61.4, and 55.6 percent. For women the U. S. figure of 57.1 percent contrasts for the same three countries with 41.6, 29.3, and 43.6 percent, respectively.

in contrast to the overworked Americans. Or have they really chosen such long vacations voluntarily; could this outcome be the result of union or parliamentary politics? Europeans worked longer hours than Americans during the 1945-73 era of postwar reconstruction, so their passion for long vacations and short weekly hours of work is a recently acquired taste.[11] American workers seem happy to be bribed to work long hours for premium overtime pay; as the quip goes, "Compulsory overtime is an unmitigated evil that every one of my workers wants his fair share of."[12]

By definition, the remaining causes of Europe's low standard of living relative to its high relative productivity must be accounted for by some combination of a higher structural unemployment rate and a lower labor force participation rate. The higher unemployment rate in Europe is at least partly due to more generous unemployment compensation, and the welfare adjustment is not obvious. But part of the unemployment is related to laws that have lengthened vacations and shortened weekly work hours, making workers more expensive to employ. German firms are refusing to expand employment and capital investment in in Germany, preferring to invest in nearby formerly communist countries to the east and southeast, as well as such far-flung countries as Mexico, Brazil, and India.

Less clear are the causes of lower European labor force participation compared to America. Are Italian men who retire early or housewives sitting at home (some of whom are tending to their unmarried 30-year-old sons) doing this because they choose to, or because the

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11. In 1960 Germans and Italians worked about 2100 hours per year compared to 1900 hours for Americans. By 2001 the German number was down to 1470 hours, France and Italy were at 1550-1600, while hours in the U. S. had fallen only to 1830. See Rhoads (2002).

12. I owe the quip to Robert M. Solow, the discussant of an earlier version of this paper.

economy and society do not provide sufficiently rewarding jobs for them?[13] Looking back at Figure 3 and its gap between a Europe/U. S. ratio of 93 percent for productivity and 77 percent for output per capita, I would make a wild guess that about one-third of the difference represents voluntarily chosen leisure and the remaining two-thirds represents a lack of employment opportunities. This would imply that the "welfare-corrected" ratio in the year 2000 is neither 77 nor 93 percent, but something closer to 85 percent. In this deeper sense, Europe has not yet caught up after 130 years of falling behind the American frontier.

A considerable part of the U. S. advantage in cross-country comparisons of living standards must stem from the much larger size of average American dwelling units, both their internal dimensions and the amount of surrounding land. Fully three-quarters of the American housing stock consists of single-family detached and attached units. The median living area in the detached units is 1720 square feet, with an average acreage for all single-family units of 0.35 (equivalent to a lot size of 100 by 150 feet). Another figure that must seem unbelievable to Europeans is that fully 25 percent of American single-family units rest on lots of one acre or more. Available data, although spotty for Europe, suggest that the average American dwelling unit is at least 50 to 75 percent larger than the average European unit.[14] Since

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13. Roughly 52 percent of Italians between the ages of 20 and 34 live at home with their parents (Rhoads, 2002).

14. Average estimated useful floor space of dwellings in 1997 or 1998 was 2058 square feet for the United States and 995 for the average of Austria, Denmark, Finland, and Switzerland (none of the large European countries are listed). For newly constructed dwellings, "average living floor space" for Germany and Italy was 969. See United Nations, *Annual Bulletin of Housing and Building Statistics for Europe and North America 2000,* pp. 21 and 24, obtained from www.unece.org/env/hs/bulletin/00pdf/h10.pdf. An alternative measure for the United States in 1997 is a median square footage of all existing single detached and mobile homes (68 percent of all housing units) equal to 1720. For all newly constructed privately owned single-family houses in 1999 the median was 2030 and the average was 2225. See *Statistical Abstract of the United States: 2000*, Tables 1211 and 1197, respectively. The former table is the source of the average lot size data given in the text. All available data for the U. S. seem to refer only to single-family units and omit apartments in multi-family units, which presumably

construction of new units and imputed rent on old units are included in GDP comparisons across countries, our Europe/U. S. ratio of per capita output in Figures 1 and 3 already incorporates the superiority of the U. S. housing stock (as long as the cross-country PPP-based price indexes make adequate allowance for housing quality).

Yet a European might retort that, while the gap between U. S. and European standards already includes the housing difference, it also includes activities that are not welfare-enhancing. A significant fraction of GDP in the U. S. does not improve welfare but rather involves fighting the environment whether created by nature or man-made decisions. The American climate is more extreme than in Europe (excluding the ex-USSR), and this means that some of GDP is spent on larger air-conditioning and heating bills than in Europe to attain any given indoor temperature. Some of U. S. GDP is spent on home and business security capital and labor that are less necessary in Europe, not to mention the cost in U. S. GDP of maintaining two million people in prison. Who knows how much GDP is spent on extra highways and extra energy to support the dispersion of the American population into huge metropolitan areas spreading over hundreds or even thousands of square miles, in many cases with few transport options other than the automobile. European real GDP is held down by the correctly measured high price of petrol, but sufficient credit is not given for convenience benefits from frequent bus, subway, and train (including TGV) public transit.

While an economist's first reaction is that the dispersion of U. S. metropolitan areas must be optimal, since people have chosen to buy houses in the outer suburbs, a more careful reaction would be to view the American dispersion as related to public policy in addition to

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are smaller in size.

private choice, especially subsidies to interstate highways in vast amounts relative to public transport, local zoning measures in some suburbs that prohibit residential land allocations below a fixed size, e.g., two acres, and the infamous and politically untouchable deduction of mortgage interest payments from income tax. Europeans enjoy shopping from small individually owned shops on lively central city main streets and pedestrian arcades, and recoil with distaste from the ubiquitous and cheerless American strip malls and big-box retailers — although Carrefour, Ikea, and others provide American-like options in some European cities. To counter the effects of American land use regulations that create overly dispersed metropolitan areas, Europeans counter with their own brand of land use rules that preserve greenbelts and inhibit growth of suburban and exurban retailing.

Tastes are in part the result of circumstances and habit, and to the European critique many Americans would deliver a counter-retort. An American mother of two small children wants nothing to do with schlepping those kids through endless tunnels while making connections on the London or Paris subways, or with waiting in the rain for the next bus, or with shopping for groceries more often than once per week. The three-quarters of American households living in single-family units treasure their backyards, decks, and barbeques and do not want to be forced to go to a public park for outdoor recreation — whose barbeque grill would they use?

In this debate I lean on the side of Europeans largely on the grounds of excessive American energy use and the huge waste of constructing all those prisons.[15] While this set of

15. The observant visitor to Europe will notice many small ways in which Europeans save on energy use that are not related to housing density, including escalators that are activated by a foot pressure pad but are turned off when not used, public rest rooms in which lights automatically go off when not in use, and hotel rooms where electric power is activated by inserting one's key card (in such hotel rooms the naive American

considerations is inevitably subjective and culture-biased, I would conjecture that perhaps half of the remaining measured Europe/U. S. gap in living standards would vanish with a full balance sheet linking welfare to measured output. Since Europe produces its output with fewer hours per capita than the U. S., a complementary conclusion is that the Europe-U. S. productivity gap of 7 percent in Figure 3 might actually be reversed by a broader welfare measure.

IV. Sources of the American Advantage, 1870-1913[16]

The superiority of U. S. productivity performance in mid-century, around 1950, is not just a chimera displayed in possibly misleading macroeconomic statistics. It was real, and Europeans were far more intent than Americans in understanding its reality and puzzling over its sources. Viewed half a century later, what seems remarkable is that while Europe's post-1950 catch-up phase posted higher growth rates than the U. S., it did not fully catch up either by the measure of the living standard and or of productivity. For one country to retain international leadership for such a long period, since 1870 for the standard of living or before in the case of productivity, is, in the words of Wright (1990, p. 651), "anomalous." Here we provide an overview of some of the more convincing explanations. This section focusses on those sources of American leadership that were already evident in 1913; the post-1913 era is treated in a separate section below.

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visitor may discover when returning from the day's activities that his laptop computer has a dead battery, because it was left on all day with no power in the room plugs!)

16. This is *not* intended to be a pun on the frequent flyer program of any airline.

Advantages from American Political Union

Since most of the Europe/U. S. gap has now been closed, those explanations that contain an element of reversal are more convincing than those that do not. The different, overlapping, and mainly complementary hypotheses can also be sorted by asking which rely on the political union of a continent-sized country, the United States, in contrast to the political fragmentation of Europe. More precisely, would a United States of Europe established in 1870 have been able to keep up with the American productivity frontier?[17]

Natural Resource Intensity. An important explanation, partly because it is reversible, is offered by Wright (1990) and Nelson-Wright (1992). At the turn of the last century, the U. S. was by far the leading producer of every raw material essential to manufacturing, and its lead extended in the 1920s and 1930s through the discovery of massive domestic petroleum reserves. Wright's (1990) study of trade patterns shows that U. S. manufacturing exports were intensive in nonreproducible natural resources, and that this intensity increased from 1880 to 1930. This hypothesis ultimately rests on political union, as U. S. leadership in most raw materials was relative to individual nations in the fragmented European continent, not when compared to Europe as a whole.[18] U. S. leadership was sustained through World War II, but afterwards the U. S. relied more on imports of raw materials and less on domestic production.

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17. The United States of Europe (USE) "device" pops up throughout this paper. It is intended to focus attention on the role of open internal trade, migration, and finance, within the United States of 1870-1913. Clearly, a USE would have implied far more for the Europe/U. S. productivity ratio than just the consequences of openness, since a USE would never have gone to war with itself, both World Wars I and II would have been avoided, and the entire twentieth-century history of European economic performance would have been totally changed.

18. For instance, Wright (1990, Chart 5) shows that Europe as a whole had higher iron ore reserves than the United States in 1910.

A critic might argue against the Wright hypothesis that free trade before 1913 allowed any small nation to import all needed raw materials, and that Japan's meteoric rise after 1945 was achieved despite the near-total lack of a domestic raw materials base. While capital markets were open and passports were rarely necessary before 1914, it is seriously misleading to extend this image of openness to trade in goods. In the words of Landes, "the tenacity of the enemies of other people's trade fairly beggars the imagination." As late as 1863, Holland levied burdensome tolls on Scheldt river traffic in order to promote Rotterdam and "kill Antwerp as a seaport" (both quotes from Landes, 1998, p. 247). In addition to explicit trade barriers, international trade, even before 1913, involved risk not present in the open domestic market of the U. S.; to construct production and transportation facilities totally dependent on imports from a particular nation was less likely to occur when there was a non-negligible probability of war in the future. Would the Mesabi range in Minnesota have been so thoroughly exploited to provide iron ore for the steel plants of Northwest Indiana and Pittsburgh if there had been any chance of a future war between Minnesota and Indiana or Pennsylvania? Further, considerable research effort in Germany and perhaps elsewhere had an "entirely different orientation governed by the desire to find substitutes for expensive and uncertain imports" (Nelson-Wright, 1992, p. 1939), suggesting that the American common market was the foundation of its superiority in resource-based production.

A Single Domestic Market and Mass Production. Nelson-Wright (1992) concentrate too heavily on the manufacturing sector and virtually neglect the role of the agriculture, transportation, and trade sectors in pushing out the American frontier of productivity and

living standards. While they emphasize that the development of mass production was fostered by the availability and cheapness of raw materials, which encouraged development of efficient production techniques even if they wasted materials, surely the unique political achievement of the United States in creating a single continent-sized market was more important. The common U. S. market encouraged the early development not just of mass production but also mass marketing, with distribution made possible across the newly constructed national railway network. Abramovitz-David (2000, p. 53) emphasize that the large U. S. common market allowed pioneering "in the elaboration and replication of large, spatially distributed technological systems, including systems of business organization and public service provisions, " whether involving electricity supply, telephone systems, or much later, airline reservation systems.

The integration of the U. S. domestic market is crystalized in Cronon's (1991) epochal history of the central role of Chicago in the rise of American industry, agriculture, and raw materials during the 1870-1910 period. One Cronon vignette dramatizes the total change in the economics of retailing in an isolated community on the Missouri river in Nebraska, in 1859 isolated by dependence on a river system that was frozen for up to half the year, while only a few years later in 1872 the railroad and telegraph had arrived to bring instant price information and deliveries within three days from as far away as New York. Both information and distribution were further facilitated by the mail order catalogues which made possible reductions in retail markups, as well as mass production runs which cut the catalogue prices of bicycles and sewing machines by as much as two-thirds below prevailing retail prices during the period 1890-1910.

There is no better testament to the trans-continental American marketplace circa 1910 than a classic song from one of the greatest of all American musical comedies, Meredith Wilson's "The Music Man". The townspeople of River City, Iowa, have spotted the arrival into town of the Wells Fargo wagon:

> "Oh, the Wells Fargo wagon is a'coming down the street,
> Oh, please let it be for me,
> Oh, the Wells Fargo wagon is a'coming down the street,
> I wish I wish I knew what it could be,
> I got a bunch of maple sugar on my birthday,
> In March I got a great mackinaw
> once I got some grapefruit from Tampa,
> and Montgomery Ward sent me a bathtub and a cross-cut saw."

Later verses include receiving "salmon from Seattle" and "raisins from Fresno." Something similar might have occurred just as early with a hypothetical United States of Europe, but could not with the reality of distorted trade patterns of the real-world late-nineteenth century Europe, when each major imperial power focussed on trade with their growing empires in Africa and Asia rather than on intra-European trade. Manchester made textiles for Madras rather than for Madrid or Munich.

Advantages Going Beyond Political Union

There was more to the American leadership along its productivity frontier than merely having achieved political union in 1789 and maintaining it in 1861-65. There were other sources of American leadership that could not have been achieved by a hypothetical United States of Europe.

Land Intensity. The Nelson-Wright (1992) treatment of raw materials shows a surprising neglect of agriculture. If anything was different between Europe and America, it

was Europe's historical legacy of small fields carved up by ancient rules, in some places divided by old walls and hedgerows that not only limited the potential for adoption of modern agricultural machinery but also impeded construction of straight highways. America between the Appalachians and the Rockies was largely divided up by a boring but efficient system of square miles and quarter-miles.[19] The importance of land in the early development of the United States is underlined by the fact that, as late as 1850, fully half of all nonresidential investment consisted of clearing forests and making previously forested land suitable for agricultural cultivation (David-Wright, 2002, p. 12). Large farm plots fostered American leadership in agricultural machinery as early as the 1850s, although the full exploitation of the potential of farm machinery awaited the invention and refinement of the internal combustion engine.[20] America was rich not only in agricultural land, but in extensive forests covering much of the eastern part of the country, both north and south of the Mason-Dixon line. Wood served early Americans with the major source of fuel, the primary building material, and as an industrial raw material (Rosenberg, 1976).

Land intensity was responsible indirectly for the swift ascendancy of American manufacturing, because cheap land and scarce labor provided a strong motive to buy, install, and invent labor-saving machinery and develop mass production methods. Agriculture itself fostered the flourishing of those sectors of manufacturing devoted to the refining of

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19. Between 1860 and 1910 500 million acres were brought under cultivation in the United States (Johnson, 1997, p. 515). This is roughly 780,000 square miles, triple the area of France.

20. See White (2000), a book manuscript which shows that a single application of the invention of the internal combustion engine, namely the farm tractor, by the 1950s had boosted U. S. annual GDP by more than eight percent, more than the current share in GDP of the entire U. S. information technology industry, including computers, software, and telecom equipment.

agricultural crops; the largest single industry in the U. S. in 1860, namely flour and meal, was soon displaced by slaughtering and meat-packing, which remained the largest through 1914 (Johnson, 1997, p. 532). Land intensity is also related, of course, to the peculiar American custom of building large houses on large lots in dispersed metropolitan areas, as discussed above.

Newness. The United States had an inherent advantage that could not be matched by a hypothetical United States of Europe, and this was simply the fact that it was newly settled on a vacant continent. The fresh division of agriculture into large plots rather than irregular plots of medieval contrivance, together with prodigious gifts of free land to new settlers, is just the first example.[21] A common language is the second. The high motivation of newly arriving and self-selected immigrants is the third. Fourth is the labor mobility made possible by the lack of strong local ties and the readiness of immigrants to "move on." The absence of a royal or aristocratic upper class is the fifth, allowing for social mingling, intermarriage, and a greater sense of equality than in most European nations. America was a middle class nation from the start.[22]

Technology. Nelson-Wright (1992) emphasize the resource-intensity of the pre-1940 American economy, partly to argue that America would have risen to industrial leadership even if it had not achieved technological leadership. Yet their account also emphasizes the

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21. A perfect way to experience the enormous contrast in agricultural land quality, accessibility, and size, even today, is to fly from Chicago, departing from the land of flat black earth divided in square-mile rectangles, to Frankfurt with its medium-sized curvy fields lying along river bottoms and hills, to central Italy with its tiny plots divided into narrow slices shaped like string beans.

22. An overview of the role of America's more equal income distribution and its "egalitarian spirit" is provided by Abramovite-David (2000, p. 79).

mutual interplay of materials intensity and technical progress in developing new techniques to extract and refine materials, notably with the support of the U. S. Geological Survey and the American Institute of Mining Engineers. This interplay is summarized by Wright (1990, p. 665): "The abundance of mineral resources, in other words, was itself an outgrowth of America's technological progress." In turn, the large scale of the American market amortized the cost of developing large machinery for minerals extraction, thus creating positive feedback from technology and capital accumulation to minerals intensity (Abramovitz-David, 2000, p. 50). Much the same could be said of the role of the U. S. Department of Agriculture and its experimental stations in developing improved crops, fertilizers, and pesticides.

However, this linkage between technology and American resource intensity misses the independent rise of the "American system" of manufacture. Landes traces the initial British alarm over industrial competition from their ex-colonials back to the Crystal Palace exhibition of 1851:

> "The first hints of trouble came in American clocks and firearms, mass-produced with quasi-interchangeable parts. In 1854, the British government sent a mission to the United States to look further into this `American system'"(Landes, 1998, p. 449).

Contemporary observers noted that every farmer was his own mechanic, and even when the population was largely agricultural, there began a tradition of mechanical tinkering and striving for incremental improvement.

Policy. Americans may have distrusted government in the late twentieth century, an irony in light of the central role taken by government in promoting national economic expansion a century earlier. Both the federal government and the states gave hundreds of millions of acres to railroad owners to promote railroad expansion, eventually handing over

242,000 square miles, a territory larger than France. Likewise the 1862 Homestead bill and its successors distributed huge quantities of farmland to eager natives and immigrants alike and has been called "one of the most important laws in American history" (Johnson, 1997, p. 491). Invention was encouraged by an organized and well-enforced system of patents. Unique regulatory bodies like state public utility commissions encouraged investment by electric utility monopolies. High external tariffs encouraged the development of domestic manufacturing and a concentration on the domestic market.

This litany of American success stories should not be overdone. Europeans still led in many fields; Germans invented the internal combustion engine and the first automobiles, and dominated the world chemicals industry, in part as a result of close collaboration between industry and the pioneering German research universities. If America was rapidly developing, it was polluted, chaotic, dirty, and crude. In the words of Rudyard Kipling about Chicago, "Having seen it, I desire urgently never to see it again. Its air is dirt. (Bettman, 1974).

V. The "Great Inventions" and the post-1913 "Big Wave"

For the reasons reviewed above, the U. S. led every European country in both its standard of living and productivity in 1913.[23] Technological leadership has played only a minimal role in the story thus far, but after 1913 that verdict must change. In previous writing (1999, 2000a) I have linked the "One Big Wave" of rapid U. S. MFP growth during 1913-72 to the "great inventions" of the late nineteenth century, particularly electric light, electric

23. As noted above, the U. S. NIPA, by revising up the growth rate of U. S. real GDP substantially between 1929 and 1948, has reduced U. S. real GDP prior to 1929 by so much as to delay America's catch-up to Britain's standard of living from 1890 in the previous data to 1916 in the new data.

motors, and the internal combustion engine. The United States was directly involved in the invention of electricity through the work of Thomas A. Edison, as well as Alexander Graham Bell's telephone, George Eastman's roll film, and Lewis Waterman's fountain pen. The Germans Nikolaus Otto and Karl Benz played the major role in the development of the internal conbustion engine and automobile. Nevertheless, America soon dominated the development and exploitation of motor transport, not to mention the Wright Brothers' first flight in 1903 that led two decades later to commercial air transport.

American Exploitation of the Great Inventions. Between 1913 and 1929, as shown in Figures 1-3, Europe faltered while America soared, and a large part of this difference was America's ability to exploit the great inventions while Europe was distracted by World War I and the struggle to recover after the war. The percentage of American dwelling units with electric service jumped from 15.9 percent in 1912 to 67.9 percent in 1929.[24] The 1920s were the period when the electrification of manufacturing generated an unprecedented surge in manufacturing productivity growth at an annual rate of 5.4 percent between 1919 and 1929, and this can be linked to an increase in the percentage of factories using electric power from 25 in 1910 to 75 in 1930.[25]

But electricity was only part of the story. More than anything, it was the instant

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24. *Historical Statistics of the United States, Colonial Times to 1957,* 1960, series S71.

25. On electriciation, see Devine (1983). On manufacturing productivity growth in the 1920s, see Kendrick (1961), Table D-II, p. 465, the column labelled output per manhour. However, the great emphasis by David-Wright (1999) on the acceleration of U. S. manufacturing productivity in the 1920s seems to incorporate a cyclical rebound following a pathetic 1.1 percent growth rate during the previous decade, 1909-1919. An alternative hypothesis is that there was a major cyclical dislocation in the American economy in the immediate aftermath of the war, in 1919 and 1920. How else could the Kendrick growth rate of manufacturing suddenly switch from 10.9 percent in 1919-22 to 3.1 percent in 1922-29?

American leadership in the production of automobiles that caused the American standard of living to run away from the European during the 1920s. Taking the same years as for household electrification, U. S. motor vehicle registrations soared from 0.9 million in 1912 to 26.7 million in 1929. By contrast European auto production had failed to take advantage of the new technology, with 1929 European registrations only 20 percent of the U. S. level and production only 13 percent (Johnson, 1997, p. 723). Why automobile production took off in the U. S. and not in Europe has much to do with the technological genius of Henry Ford and Alfred P. Sloan, and other factors beyond the scope of this paper.[26]

The leading students of electrification and its impact on U. S. manufacturing productivity in the 1920s are Paul David and Gavin Wright (1999). They address the intriguing question as to the timing of the productivity growth explosion in U. S. manufacturing in the 1920s; why did it take so long to exploit Edison's inventions of the 1870s and 1880s?[27] A central answer is that the rate of price decrease of electricity had substantially accelerated in the previous decade of the 1910s, an interesting parallel to the accelerating rate of decline in computer prices in contributing to the "New Economy" boom of the late 1990s. Institutions mattered, as quirky local regulations on electric utilities were replaced by state public utility commissions that provided more protection to the property rights of electric utilities and encouraged them to invest. Another part of the answer is that old equipment

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26. For an illuminating account of the British failure in the automobile industry, see Landes (1998), pp. 461-4.

27. David and Wright (1999), in calling the productivity upsurge of the 1920s a "forgotten puzzle," cite the same quote from Solomon Fabricant's introduction to Kendrick (1961) ephocal book as is quoted in my own work (2000a) on the "big wave" of productivity growth. But the emphasis of David-Wright is quite different, since they discuss only the 1920s, mainly in the context of manufacturing, and they make no mention of the even more rapid increase in economy-wide MFP that occurred from 1928 to 1950.

based on steam and water power needed time to depreciate, and that the bullish macroeconomic climate of the 1920s provided an ideal environment for replacing old technology with new electricity-based technology. However enlightening on the role of electricity in the U. S. productivity acceleration after World War I, the approach of David and Wright (1999) is lopsided in its total neglect of the role of the internal combustion engine; the new flexibility in personal transportation made possible by automobiles, as well as by business transport made possible by trucks, accounts for much of the investment boom of the 1920s, with new one-story "greenfield" factories facilitating the reorganization of manufacturing production methods, not to mention the impetus to productivity growth in transport, wholesale tradee, and retail trade.

Immigration and the co-dependence of Productivity and Real Wages. It is striking that U. S. productivity growth was relatively slow in the late nineteenth century when immigration was important, and then again in the 1970s and 1980s when the baby boom and renewed immigration created rapid labor-force growth. This observation is related to Romer's (1987, Figure 1) demonstration that productivity growth and labor-force growth in U. S. history are negatively correlated over 20-year intervals since 1839. Thinking about immigration may be helpful in explaining why the U. S. MFP growth slowdown in the 1970-90 period was concentrated in nonmanufacturing. New entrants (teens and adult females in the 1970s and legal and illegal immigrants in the 1980s and 1990s) mainly went into unskilled service jobs and held down the real wage in services, in turn promoting the lavish use of unskilled labor in such occupations as grocery baggers, busboys, valet parkers, and parking lot attendants, jobs that barely exist in high-wage European economies. In contrast, immigrants to the U. S. in the

1890-1913 period were disproportionately employed in manufacturing, and their prescence probably dampened real wage increases and delayed the introduction of labor-saving equipment. The "big wave" period of rapid productivity growth coincides roughly with the shutting off of mass immigration in the 1920s and the slow labor-force growth of 1930-65.

Real wage convergence and divergence. Goldin and Margo (1992) have recently studied the sharp convergence, i.e., reduction in inequality, of real wages in the 1940s and subsequent divergence. If relative labor scarcity coincided with a technology that created a high demand for unskilled and semi-skilled workers, then the relatively high wages for low-skilled work in the 1940s may have in turn stimulated efficiency improvements that boosted productivity. The immigration and convergence stories are related, since immigration in 1880-1913 introduced much of the inequality in skills and real wages that Goldin and Margo (1992) show was substantially eliminated in the 1940s. Pro-labor New Deal legislation and the rise of labor unions in the late 1930s also contributed to convergence.

Barriers to Trade. Trade theory teaches that trade in goods, not just labor mobility, can lead to convergence of incomes. The idea is that trade simultaneously promotes convergence but also generates a slowdown of income growth in the leading country. In this context a contribution to the "big wave" in U. S. productivity growth may have been a movement away from free trade in the Fordney-McCumber tariffs of 1922 and Smoot-Hawley Act of 1930. This may possibly help to explain not just some portion of the "big wave" but also the backward slide of Europe relative to the United States noted above. Since Europe's only hope of duplicating the U. S. resource dominance was to trade resources freely among countries, the trade barriers of the 1920-50 period helped to solidify the U. S. advantage based on

materials-intensive production while depriving European manufacturers of access to cheap raw materials.

Education. The role of educational policy has been a subject of debate. Claudia Goldin (1998, p. 346) documents the revolution in secondary education attendance in the three decades after 1910, with enrollment rates rising from 18 to 73 percent between 1910 and 1940. She attributes to the secondary school revolution a substantial part of America's productivity advantage over European nations at that time.[28] In contrast, Nelson-Wright (1992, p. 1947) are skeptical of the role of secondary education in American industrial leadership. They argue that "as of 1950 there was no marked difference in average years of secondary education among the U. S., France, and Britain, all of them well behind Germany." In denying the importance of American secondary education, they also emphasize the large share of machine operatives in American manufacturing who were foreign born or the sons of foreign-born, although they do not explain why the foreign-born who immigrated as children could not have benefitted from U. S. secondary education, much less the subsequent generation. Nevertheless, Nelson-Wright, while perhaps leaning too far to minimize the role of secondary education, cite approvingly the American innovation of "professional management" staffed by a "cadre of professional, educated, middle managers, a phenomenon that seems to have been almost exclusively American." They also praise the early American superiority in broadly based higher education, the development of engineering schools, and

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28. "But the countries whose per capita incomes were closest to that of the United States in 1910 did not undergo an equivalent transformation at that time. Rather, their high school movements did not materialize for another thirty or more years. . . Not only was the high school movement from 1910 to 1940 a uniquely-American phenomenon, the secondary school as we know it today was a uniquely-American invention" (Goldin, 1998, pp. 349-50).

the development of world-class research universities which were both independent of business yet developed business-industry cooperation (Nelson-Wright, 1992, p. 1942).[29]

American Productivity Leadership Tested during World War II

Home production in World War II has a vast literature that treats every conceivable aspect of the American arsenal of democracy.[30] World War II and the immediate postwar period were the interval during which America achieved its greatest advantage in standard of living and productivity as compared to Europe, which is not surprising in view of the physical destruction in Europe and the distraction in Europe of diverting human and physical capital into the making of weapons rather than improved machines or consumer goods. However, World War II also led to a great leap forward in U. S. productivity (evident in Figure 2 and Table 1 above), and several of the supporting factors highlight the most important of the sources of U. S. leadership in 1929, 1913, and before.

Perhaps the most obvious source of America's ability to produce 200,000 combat aircraft and 100,000 tanks during the war was the previously cited fact that America produced almost eight times as many motor vehicles in 1929 as all of Europe. With machine tools adequate to produce in 1929 5.3 million motor vehicles, and those all important 5.3 million internal combustion engines, and a slightly smaller 4.8 million in 1941, why should we

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29. In his later incarnation as a co-author with Paul David (1999), Gavin Wright relented on the role of secondary education and cites approvingly the work of Goldin and Goldin-Katz on the expansion of secondary education and its provision of skilled workers to operate the new equipment of the 1920s.

30. Richard Overy (1995, Chapter 6) in a single brilliant chapter distills the essence of why the Americans and Russians produced so much and the Germans produced so little. Mark Harrison (1998) provides a longer but more tedious review of the relevant data for each country, including population and production capabilities. Francis Walton (1956) makes the American achievement come alive in a wealth of case studies and anecdotes.

surprised that Americans could produce a few hundred thousand military motor-powered vehicles and airplanes? The Russian army finally overwhelmed the Germans, carrying its supplies on 250,000 American trucks provided by lend-lease, but these were less than 10 percent of the American trucks produced during 1942-45. This motor-producing capacity was already in place in 1929 and greatly improved in quality during the 1930s.[31]

Second, the U. S. advantage in materials-intensive production was still intact. The unified U. S. common market enabled the production of 42 percent more steel in 1944 than in 1929 and 155 percent more than in 1913.[32] After the war a series of missions from western Europe came to learn the secret of America's industrial productivity. Foreign observers were stunned at the ease with which iron ore could be transported to the steel mills via secure inland waterways:

> "Men fully aware of the obstacles to such an obvious natural union as a French-Saar and German-Ruhr coal-steel community gaped in awe at the smooth, unimpeded flowing together of the iron-ore riches of the Minnesota ranges with coal from the Pensylvania and West Virginia fields into the steel-region facilities of Pennsylvania and Ohio. To the everlasting aid of America stood the wisdom of the founding fathers [to prevent restriction of trade across state lines]" (Walton, 1956, p. 552).

Another earlier theme ratified by wartime production was the "American system" of production. The use of mass production and interchangeable parts, which first alarmed the British in the 1850's, was formally codified in the two decades before World War II. Herbert Hoover led an industry-wide effort in the years after World War I to establish fixed standards

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31. There was a quantum leap in automobile quality in the United States from the Ford model T's and A's that dominated production in the 1920s to the sleek fully enclosed General Motors sedans that dominated sales in 1940-41.

32. *Historical Statistics of the United States, Colonial Times to 1957,* series P203.

that would allow such mundane manufacturing parts as screws and bolts to fit together, no matter which supplier or final assembler was involved, and as Secretary of Commerce in the 1920s he established a Division of Simplified Practice within the National Bureau of Standards.[33]

A third theme introduced above was the role of engineers and engineering education. In my reading about the production achievements of World War II, I am always amazed at how many stories of crisis and shortages are solved as in-house engineers ride to the rescue. The postwar Anglo-American Council on Production, charged with learning from the American miracle, noted the importance of engineers:

> "[They] pointed out the close cooperation of the engineer-scientists with production management. They held vital to the secret of American industrial success the prominent role of the engineer, his grasp of manufacturing techniques, and his complete integration with administration" (Walton, 1956, p. 545).

Other aspects of World War II in our previous list of pre-1913 advantages include natural resource abundance and self-sufficiency, particularly in agriculture and petroleum, labor mobility made possible by a common language, and the "American system" of mass production, interchangeable parts, close cooperation between business management and engineers, and a tradition of mechanical tinkering. Finally the World War II experience involved massive government subsidies reminiscent of the building of the nineteenth century railroads; the U. S. government paid for a massive expansion in the floor space of U. S. manufacturing and a doubling in the number of machine tools during 1940-45, yet the

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33. For the history of the drive to achieve standards for screws, bolts, and universal joints, see Walton (1956), pp. 532-33.

government left the management of this huge industrial capability to private enterprise.

VI. The Postwar European Catchup

Europe has achieved a faster rate of productivity growth than the U. S. over each of the long intervals since 1950, as shown in Figure 3 and Table 1. Yet without the previous information on levels and ratios of levels, the information on productivity growth rates alone leave us in the dark as to whether the U. S. entered a dark period of falling behind, or whether Europe was just catching up from its own previous dark period. We know from the previous discussion that Europe had fallen far behind the U. S. by 1950 for a combination of structural and temporary, war-related reasons.

The Easy Part of the Explanation

At first glance, it may seem obvious that Europe would easily be able to catch up to the U. S. as part of its postwar reconstruction. Yet this initial reaction that the European catch-up was "easy" or "obvious" ignores the powerful list of U. S. advantages, both before 1913, and those achieved between 1913 and 1950. Does the European catch-up indicate that the set of U. S. advantages had eroded? Another general issue in discussing the Europe catch-up is the contrast between the dismal performance of U. S. productivity growth between 1972 and 1995, and the brilliance of the U. S. "miracle economy" between 1995 and 2000. To be talking about the U. S. "falling behind" seems anomalous in the world of 2002 in which conferences are held in Europe almost every week to lament Europe's latest episode of falling behind in high-tech manufacturing and "what can be done" to counteract the long list of perceived U. S. advantages.

Repairing Wartime Destruction. The data underlying Figure 3 show that the Europe/U. S. ratio of living standards fell by 16 percentage points between 1913 and 1950 and by 18 percent over the same period for productivity. This reflects both the direct impact of wartime destruction and also lost opportunities to exploit the great inventions, as the U. S. had done. It is perhaps surprising that Europe's relative position did not decline by more as a result of the wars; the Europe/U. S. ratio for the standard of living in Figure 3 indicates a greater decline in the peacetime period between 1870 and 1913 than during the war-ravaged period of 1913-50!

The Delayed Exploitation of the Great Inventions. Much of the performance recovery in Europe was due to delayed technological innovation and was accomplished simply by mimicking the U. S. achievement of 1913-29, when the electrification of urban households and the mass marketing of the automobile had been largely accomplished. The primitive state of Europe after the war is evoked by Landes' (1998, p. 468) description of Paris in 1948:

> "Paris, empty of vehicles, needed neither traffic lights nor one-way streets; all cars had to be garaged at night; gas stations hand-cranked the pumps. Many small flats and houses had electrical services as low as 3 amperes, enough for a light bulb, a radio, perhaps an electric iron; anything more would blow the fuse wire. . . . Refrigerators were little known . . . . No point to a refrigerator unless one bought for several days at a time; no point to such shopping unless one could find all food needs in one place; and then only if one had a car to carry the comestibles home and an elevator in the apartment building to haul up the bags and bottles. . . . France had not really entered the twentieth century."

The transformation of western Europe achieved by electricity and the internal combustion engine began in the 1950s, almost 40 years after that in the United States. To take one example, the percentage of French households owning a car jumped from 22.5 percent in 1954 to 56.8 percent in 1970, mimicking the equivalent 1912-29 U. S. ratios roughly 40

years later. Superhighways, supermarkets, and modern mass production factories all arrived in Europe, decades later than in the United States and on a different schedule in each country. For instance, Germany had a head start with its interwar autobahnen that were only superficially damaged by the war. And, almost everywhere, Europeans went the United States one better by retaining rather than destroying the infrastructure of surface public transportation while largely duplicating the U. S. achievement in suburban and inter-city highways.

Erosion of the U. S. Natural Resource Advantage. The Nelson-Wright hypothesis of a U. S. resource-intensity advantage was cited approvingly above because of its reversibility. The discovery and extraction of oil in the Middle East and the North Sea greatly reduced the U. S. share of world oil reserves, and the U. S. became steadily more dependent on imports. The globalization of trade allowed Europe to gain access to exactly the same international sources of oil and other minerals as did the United States, and the reduction of transport costs associated with the building of huge mega-tanker ships brought Europe further onto an equal footing with the United States.

The United States of Europe. Starting with the Franco-German Coal and Steel Community of the mid-1950s, Europe made steady progress in ridding itself of the internal trade barriers that had distorted its industrial base since the early nineteenth century. Mass distribution and merchandising crept across the European continent, with different nuances in each country as the Germans clung to their shop-closing hours, the British fought suburban malls by protecting their green belts, while the French went the Americans one better with their suburban hypermarkets. The catching up to American mass production techniques was

eased by the transfer of technology from American-owned firms like Ford, Vauxhall, and Opel, not to mention the arrival of Japanese-owned auto factories in Britain and elsewhere.

Force-feeding Productivity Growth through regulations. Just as we have seen above that American productivity growth was held down in the service sector by an increasing supply of females, teenagers, and immigrants that made labor relatively cheap to employ, so some European countries forced up productivity through regulatory policy. A classic example is the French minimum wage, which boost productivity in restaurants by making it too expensive to hire bus boys and force capital-labor substitution by eliminating such American anachronisms as parking lot attendants and grocery baggers. In Germany stringent shop-closing hours, only recently relaxed, force consumers to do their shopping in a concentrated period, thus boosting retail productivity. In this and other ways, European institutions favor workers and American institutions favor consumers, explaining at least part of the substantially more even distribution of income in Europe. But as a negative counterpart, making labor expensive boosts the unemployment rate and accounts for part of the low level of hours per capita stressed earlier in the paper.[34]

Other Aspects of Catch-up. Almost every asset has a depreciation rate, and that includes the "newness" advantage of the United States. By the 1960s the U. S. was saddled with antiquated steel mills in Chicago, Youngstown, and Pittsburgh, while the national policy of fostering suburban dispersal of metropolitan areas and starving public transportation created a vacuum, with resultant obsolescence of capital, in many American inner cities, with

34. This tradeoff between unemployment and productivity and its role in explaining the gap between European and U. S. unemployment rates, is the main theme of Gordon (1997).

their shuttered storefronts and forelorn ghettos, that contrasted notably with the thriving inner cities in Europe. While America retained its leadership in higher education, Europe gradually closed most of its previous education gap, especially that based on class distinctions between the Oxbridge-bound aristocrats and the uneducable working classes.

Cited above as promoting rapid U. S. productivity growth during 1930-50 were barriers to trade, the temporary cessation of immigration, and pro-union New Deal legislation, all of which contributed to a narrowing of inequality and relatively high wages for unskilled and semi-skilled workers. This process went into reverse in the later half of the postwar era. Wages started diverging after 1970, with a sharp increase in inequality in the 1980s and 1990s that was reflected in a big jump in the rate of return to college education, mainly because the real wages of high school graduates fell. This process was the outcome of a complex process in which changing technology, an increased supply of cheap imported manufactured goods, and a renewed flow of immigration interacted to erode the rents previously earned by union members with high school educational attainment. This, in turn, partly reversed the stimulus to higher efficiency that took place in the 1940s.

The Remaining American Margin and Sources of Disadvantage

This leaves the remaining items on the pre-1913 list of American advantages still intact. While the American land/labor ratio was falling as the population grew, the U. S. still had a substantial advantage in agricultural productivity. The United States still had a common language that facilitated labor mobility, which in turn reduced the NAIRU, increased the labor force participation rate, and helped explain why in the context of Figure 4 the U. S. had a substantially higher ratio of employment to population. It still had its world-leading research

universities, and the constructive interplay between the government and the university sector mediated by peer-reviewed NSF, NIH, and Defense Department research grants rather than European-style block grants aimed at making university education tuition-free. It had developed a parallel collaboration between the research universities and the private sector, evident in the growth of electronics firms in Silicon Valley near Stanford and on Route 128 near Harvard and M.I.T.

Yet the growing inferiority complex that the U. S. developed about Japan in the 1980s reminds us that all was not well in U. S. manufacturing. The surge of Japanese auto imports and later transplant factories revealed a deep-seated failure of the U. S. automobile industry to produce cars at a competitive level of quality. The U. S. fell behind Japan and Europe in machine tools and other industries. A revealing recent statistic is that at year-end 2000 Japan had ten times as many industrial robots per capita as the U. S. and Germany had 3.5 times as many.[35]

The Late 1990s U. S. Producitivity Growth Revival

Despite its resurgence relative to the United States, especially in labor productivity, Europe today is in a deep funk. Across the continent, economists are forming commissions to ponder the apparent dominance of the U. S. in information and communications technology (ICT) and the revival of U. S. productivity growth after 1995. This resurgence is partly explained by the remaining American margin of advantage discussed above, especially the fruitful nexus of government-university-industry research collaboration. A more complete discussion of the U. S. ICT dominance (see Gordon, 2001) considers such issues as patent

35. Box labelled "robots," *Economist* economic and financial indicators, December 1, 2001, p. 96.

protection, securities regulation, the role of venture capital and investment banking in funding many American hi-tech companies, and the contrasts with Europe which differ across countries.

It is too soon to declare that the American productivity growth revival is a will-o-the-wisp, since the average annual growth rate has been almost as high since the peak of the New Economy boom in mid-2000 as it was from 1995-2000. However, profound questions relevant to this paper are raised by Europe's failure to experience a similar productivity growth revival. Part of this is an aggregation problem — some parts of Europe, e.g., Ireland, Sweden, and Finland, have experienced productivity growth rates in the 1990s much faster than the U. S. Europe is dragged down by its backward areas that have low penetration of personal computers and low MFP growth, most notably the "olive belt" consisting of Portugal, Spain, Italy, and Greece.

But another implication of the European experience is that the role of computers and software in the U. S. productivity revival may have been exaggerated. The retail trade sector, where much of the revival has occurred, illustrates the problem. Surely a major source of U. S. productivity growth in retailing has been the growth of Walmart, Home Depot, and Target at the expense of small ma-and-pa hardware and clothing stores. Yet the ma-and-pa stores have laser bar-code readers for consumer check-out and often are hooked up to a computer-intensive wholesaler. The productivity advantage of Home Depot surely involves more than just the use of computers, but rather reflects economies of scale that reduce costs and raise revenue by attracting customers through huge selection.

VII. Conclusion

Standing back from this comparison of Europe and the United States over a period of time that corresponds to the "long run" of economic theory, an initial question is where growth theory fits in, with its emphasis on the saving rate, capital-labor substitution, technical change, human capital, and research. Differences in saving rates play little or no role in explaining the growth gap between the U. S. vs. Europe. The much higher initial U. S. land/labor ratio boosted real wages, which in turn created pressure for substitution of capital for labor in the nineteenth century U. S. to a greater extent than in Europe. Technical change was clearly relevant, particularly the more rapid exploitation by the U. S. of the key inventions of the second industrial revolution, electricity and the internal combustion engine, in the period 1900-1950. Human capital plays a role, both in the expansion of U. S. secondary education in the early twentieth century and the rapid postwar increase in the percentage of the population completing college. Both human capital and research are involved in the international lead taken by American research universities in the era after World War II. Nevertheless, many of the central concepts of this paper barely surface in growth theory, including raw materials intensity, internal free trade, mass marketing, "newness," giveaways of free land to homesteaders and railroad barons, immigration, and international trade autarky.

Looking back at the long history of Europe falling behind the U. S. and then catching up, it is hard to avoid the conclusion that this topic has more to do with politics and history

than with economics.[36] The sources of U. S. advantage prior to 1913 center on its internal common market, an achievement of the Founding Fathers, Abraham Lincoln, and the Union Army, rather than any particular genius at business or technology, and free internal trade led in turn to exploitation of raw materials and leadership in materials-intensive manufacturing. Postwar Europe gradually rid itself of internal trade barriers and largely caught up to the American productivity frontier as a result. But America's nineteenth century advantage went far beyond its internal common market. Even a hypothetical United States of Europe, formed in 1870, could not have matched America's land-rich "newness" that fostered large-scale farms, internal mobility, a flood of immigrants without an overlay of class conflict, and a continuing effort to invent new machines and production techniques to replace scarce labor.

America's productivity advantage opened a wider gap with Europe during 1913-50, not just because the U. S. avoided wartime damage, but because it was able to exploit the great inventions, particularly electricity and the internal combustion engine, 30 to 40 years earlier than Europe. As open trade and immigration were cut off between 1930 and 1950, and New Deal legislation allowed unions to flourish, unskilled and semi-skilled labor was able to earn relatively high wages that created further incentives for capital-labor substitution.

As Europe recovered from war in the 1950s and 1960s, there was a rich menu of technology to exploit, and closing the gap with the American productivity frontier was only a matter of time. But closing the gap involved more than mere European mimickry of

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36. Given the cast of characters at this AEA session, I hasten to add, "That's why we have economic historians!"

previous American achievements. The U. S. lost not only its superior access to raw materials, but also its technological leadership in key areas of manufacturing, including automobiles and machine tools. The revival of immigration and return of open trade pushed down the relative wages of unskilled workers and promoted indiscriminate hiring of unskilled domestic and immigrant workers to perform menial jobs in the service sector that had largely disappeared in Europe.

The twenty-first century begins on an ambiguous note. Europe envies the U. S. high-tech boom of the late 1990s and its associated productivity revival. Try as it might, Europe can't duplicate the American productivity revival, no matter how much hardware and software it buys from Dell, Intel, and Microsoft. A plausible hypothesis is that the U. S. productivity growth revival since 1995 has relied less on a payoff from computer investment and more on a wide range of contributions that reflect longstanding U. S. advantages, from biotech research in collaboration with universities, to "Big Box" retail stores allowed under lenient U. S. urban land-use regulationsbut the U. S. productivity revival was short-lived. Over the five years 1995-2000 the U. S. briefly caught up to the European rate of productivity growth, but over any longer period, e.g., 1990-2000 or 1973-2000, the U. S. growth rate lagged behind. As one European nation after another overtakes and moves past the U. S. *level* of productivity, one might conjecture that in ten years conferences will be organized at American universities on "the sources of European advantage."[37]

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37. The data underlying Figures 2 and 3 show that in the year 2000, productivity levels compared to the U. S. were 6 percent higher in Belgium, 4 percent higher in France, 2 percent higher in the Netherlands, and virtually tied in Germany.

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DATA APPENDIX

Aggregation Series developed below for output per capita, output per hour, and hours per employee, are aggregated across the 12 European countries using 1913 real GDP (in 1990 Geary-Khamis dollars) weights from Maddison (1995), Table C-16a.

Output per Capita, 1820-1994 Madisson (1995), Table D-1a, covers 1820, 1850, and annual data 1970-1994 for the United States and the following 12 European countries: Austria, Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Norway, Sweden, Switzerland, and the U. K. Missing values are obtained by extrapolating 1870 data backwards to 1820 and/or 1850 for Finland using Denmark growth rates, and for Italy and Switzerland using France growth rates. All data are in real Geary-Khamis (multilateral PPP-corrected) 1990 dollars. The years selected for plotting in Figure 1 are 1820, 1850, 1870, 1891, 1900, 1913, 1923, 1929, 1941, 1950, 1963, 1973, 1979, 1987, 1994, and 2000.

Output per Capita, 1994-2000 IMF *World Economic Outlook,* May 2001, Table 4, p. 170, provides annual growth rates of real GDP per capita for the United States, France, Germany, Italy, U. K., and Canada. For the remaining countries, annual growth rates of real GDP are taken from *OECD Economic Outlook*, June 2001, no. 69, Annex Table 1, p. 231. Estimated population growth rates are obtained by extrapolating the population growth rate for 1986 to 1994 from Maddison (1995), Table A-3a. These growth rates of real GDP per capita are used to extrapolate the 1994 level to the year 2000.

Output per Hour, 1992 Maddison (1995), Table J-5 presents estimates of Output per Hour *1870-* for the United States and the same 12 European countries for these selected years: 1870, 1913, 1929, 1938, 1950, 1973, and 1992.

Output per Hour, 1992-2000 Output per hour is extrapolated from 1992 to 2000 using the average of 1990-95 and 1995-1999 growth rates for GDP per hour worked for each country from *OECD Science, Technology, and Industry Scoreboard: Towards a Knowledge-based Economy, 2001 Edition,* Figure D.3 (upper panel).

Hours per Employee Through 1992 from Maddison (1995), Table J-4. The resulting ratio for Europe/U. S. hours per employee is extrapolated through 2000 at the average annual growth rate for 1973-92.

TABLE 1

Real GDP per Capita and Real GDP per Hour,
Europe and the U. S.,
Selected Intervals, 1820-2000

	1820-70	1870-1913	1913-1929	1929-1950	1950-1973	1973-2000
Output per Capita						
Europe	1.05	1.25	0.97	0.79	3.61	1.77
U. S.	1.29	1.79	1.65	1.55	2.40	1.64
Europe - U. S.	-0.24	-0.54	-0.68	-0.76	1.21	0.13
Output per Hour						
Europe		1.49	1.76	1.35	4.44	2.40
U. S.		1.90	2.40	2.48	2.68	1.37
Europe - U. S.		-0.41	-0.64	-1.13	1.76	1.03
YpC / YpH						
Europe		-0.24	-0.79	-0.56	-0.83	-0.63
U. S.		-0.11	-0.75	-0.93	-0.28	0.27
Europe - U. S.		-0.13	-0.04	0.37	-0.55	-0.90

Sourœ: Same data as Figures 1-4, sources described in Data Appendix.

Figure 1
per Capita Real GDP, Europe and the United States,
Selected Years, 1820-2000

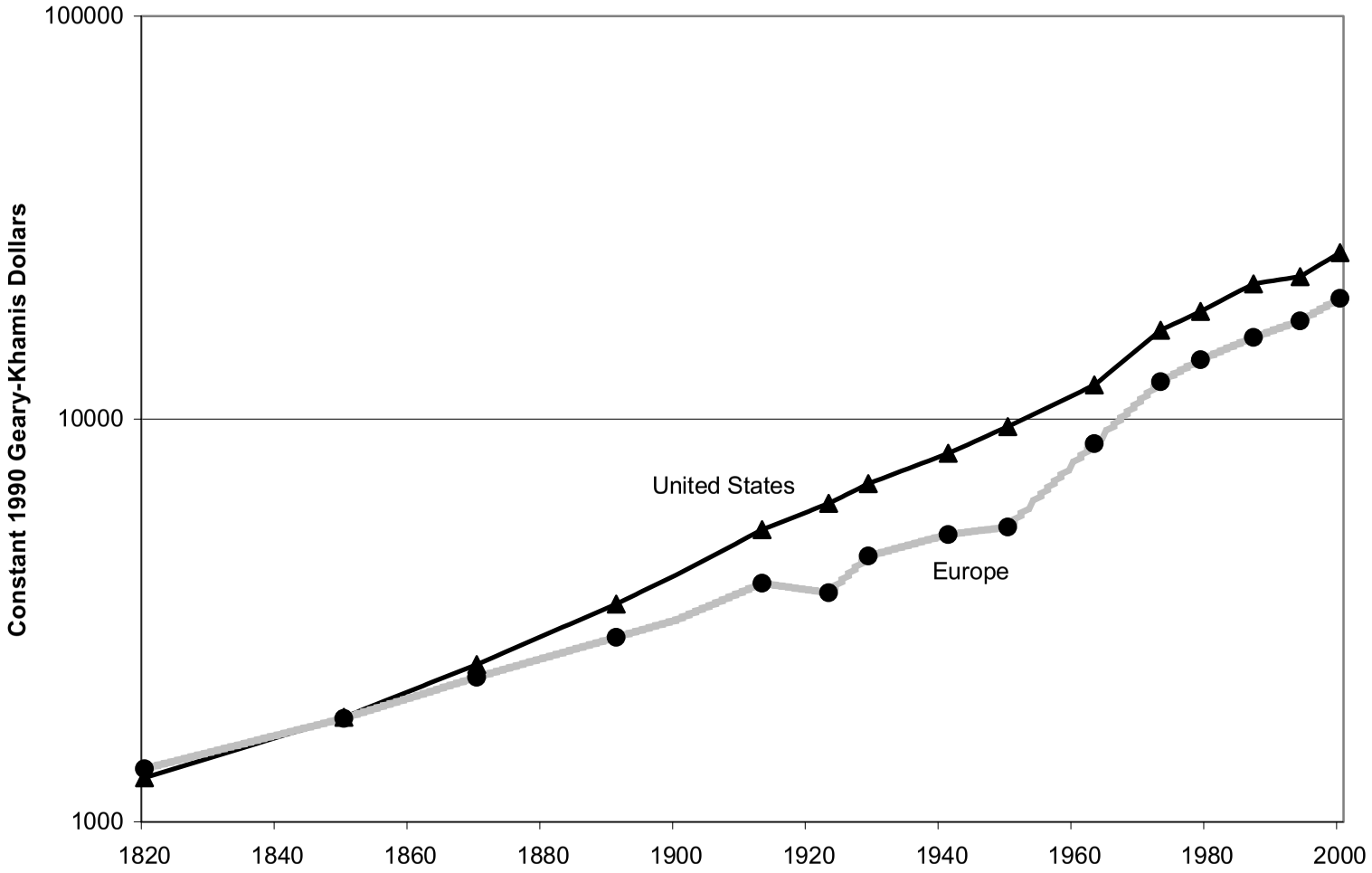

Figure 2
Real GDP per Hour, Europe and the United States,
Selected Years, 1870-2000

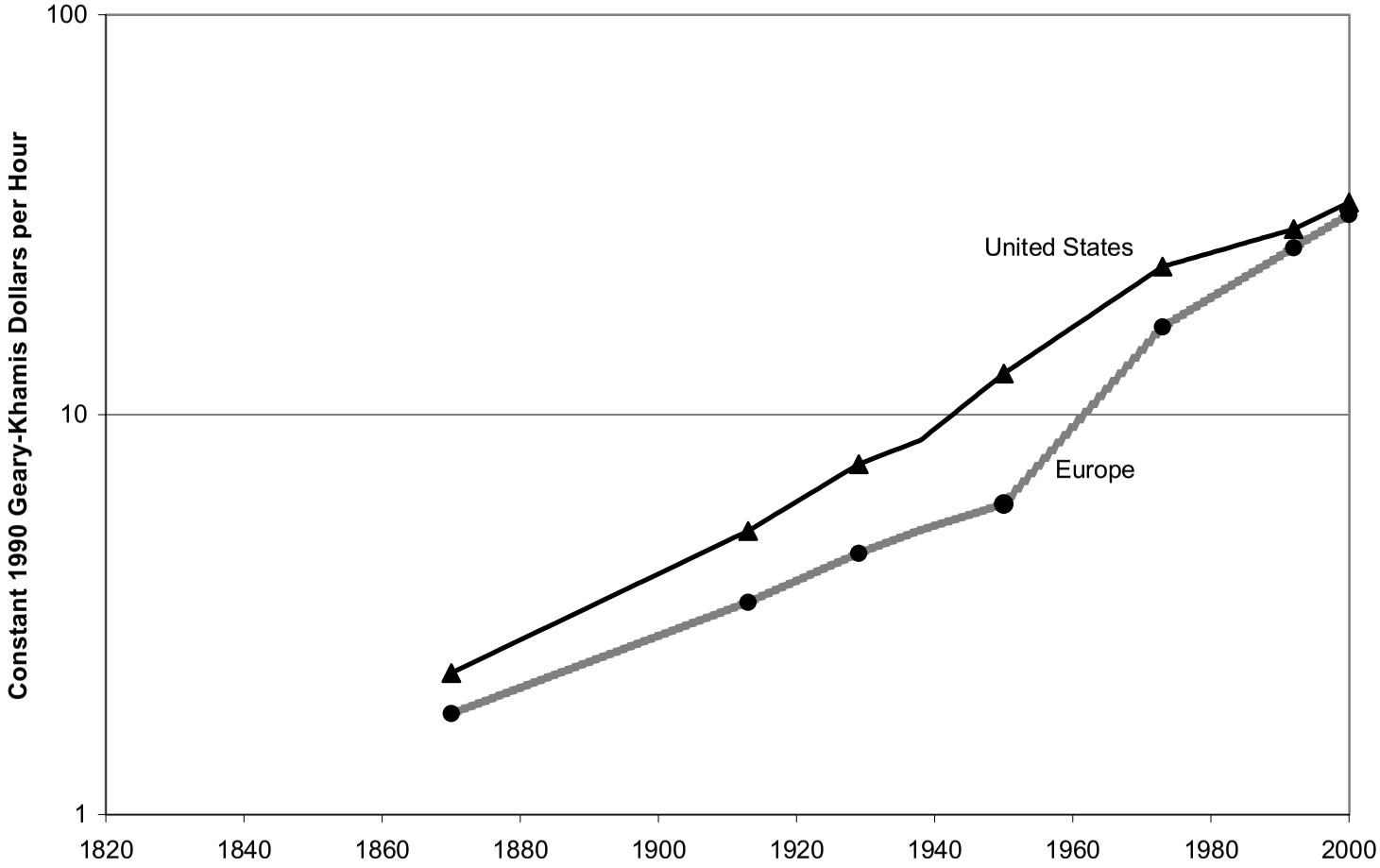

Figure 3
Ratio of Europe to the United States,
Output per Capita and Output per Hour,
selected years, 1820-2000

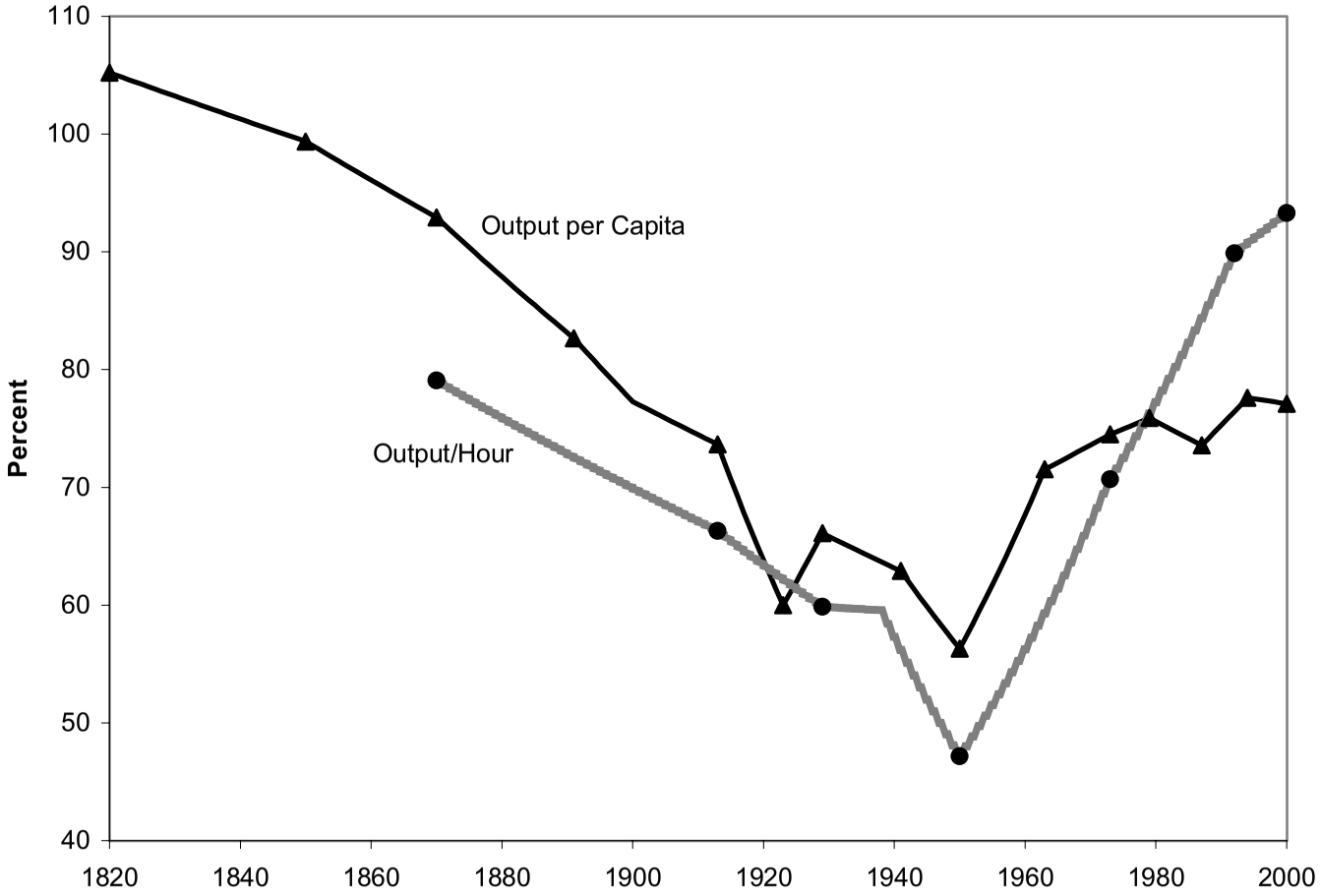

Figure 4
Ratio of Europe to the United States, Ratio of Output per Capita to Output per Hour, Decomposed into Hours/ Employee and Employee/Population Ratios, selected years, 1870-2000