Productivity and Growth Over the Years at BPEA

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Why did U.S. productivity growth decelerate in the late 1960s and why did it revive in the late 1990s? Why are some countries so rich and others so poor, and why do growth rates differ so much among nations? BPEA has a long history of concern with productivity as a source of growth in potential GDP for the U.S. economy and also with economic growth more generally as it differentiates the world's more and less successful economies.

To choose among the many papers on these two topics – productivity growth in the U.S. and growth differences among nations – I have divided papers into two corresponding groups. The first concerns productivity and potential output growth in the U.S context. In this group I begin with two papers from the 1970s written early in BPEA's formative decade and then follow with three papers written after 1980 that are chosen for their relatively large number of citations. The second group includes papers on economic growth more generally as it differs among nations. Since there were no such papers in BPEA's first decade I limit coverage to three papers written after 1980, also selected by the criterion of citations.

Citations and the History of BPEA

Because I used citation counts to choose among papers written after 1980, I couldn't help but notice a few interesting aspects of the citations. First is the inequality across decades, as shown by Figure 1, a bar chart providing mean citations per paper for each of the five decades. It is very striking that the 1990s were the golden decade for BPEA citations, with the average paper receiving more than 1,000 citations. The 2000s come next, with the other decades far behind.

While I don't have a good explanation for the relatively low citation counts for the recent articles of the 2010s, other than their youth, I can suggest some aspects of the first decade of the 1970s that limited citations per article. First was the short-run orientation of the early papers. Quoting from the editors' introduction to the first issue, 1970:1, "particular attention is devoted to recent and current economic developments that are directly relevant to the contemporary scene. . . " (1970:1, p. 1).

Another aspect was the initial conception of a panel of experts on particular topics that could be thought of as equations in a large-scale U.S. macroeconometric model. Thus in the first two issues there were papers on components of aggregate demand – consumption, inventory investment, homebuilding, and the federal budget, on monetary and fiscal policy, and on interactions between demand and supply in the form of papers on inflation and unemployment. This equation-by-equation approach tended to exclude a host of topics that did not fit into that framework.

Third and perhaps most important in limiting citations per article was that in the first year three of the papers in each issue were full length and the remaining four were short so-called "sector reports", providing updates on topics for which authors had already written longer papers or would write longer papers in subsequent issues. Those sector reports were often quite short and were not assigned formal discussants. If sector reports were excluded, citation counts per paper for the 1970s would be considerably higher.

Not only are citation counts per article unequal by decade, but they are highly unequal across papers. The top three percent of papers, 20 out of the total of 646, accounted for 20% of the total citations (the cutoff to make the top 20 is 1,239 citations; mean citations per article are 250 and median citations are 103).

This made me wonder, is the distribution of BPEA citations more or less unequal than the distribution of U.S. income? Taking data for 2014 from a paper by Piketty, Saez, and Zucman (2018), we obtain Figure 2. Shown in three groups of bars are the percentage of citations and income accounted for by the top 0.1, top 1, and top 10 percent. In the top two groups (0.1 and 1 percent) income is slightly more unequally distributed than citations, but for the third group (10 percent) BPEA citations are a bit more unequally distributed than U.S. income. Overall, we conclude that if BPEA authors were paid in proportion to their citations, the resulting inequality of BPEA authors' income would approximate the inequality of the U.S. income distribution. We might also conclude that inequality of outcomes is inherent in many aspects of productive activity, from the stratospheric heights of wealth owned by the founders of today's internet giants to the more plebeian precincts of 1775 Massachusetts Avenue.

Productivity Growth

When BPEA began in early 1970 the U.S. had enjoyed relatively rapid growth in labor productivity and in potential GDP for many decades, and this was expected to continue. As I showed in my recent book, 1970 was the year that marked the end of a remarkable 50 years in which labor productivity growth in the total U.S. economy had averaged 2.8 percent per year (Gordon, 2016, p. 14). And productivity growth in the private sector was somewhat faster than that, roughly 3.2 percent, a number that had been codified as the acceptable rate of real wage growth in the Kennedy/Johnson era program of wage-price guideposts.[1] Thus BPEA began in an environment in which productivity growth around 3 percent was normal and could be expected to continue, and any recent shortfalls in observed productivity growth below 3 percent were worthy of note. As for potential GDP, as late as 1972 the official measure was estimated to be growing at 4.3 percent per year.[2]

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[1] Private business sector productivity growth was 3.2 percent between 1948 and 1965. See Baily and Gordon (1988, Table 5, p. 364). The current estimate from the BLS web site is 2.97 percent for 1948-65.
[2] Nordhaus (1972, p. 526) cites the contemporaneous *Business Conditions Digest* as the source of the official estimate of potential GDP growth of 4.3 percent per annum.

For perspective both on the two early productivity papers written in the early 1970s and those that later attempted to explain the post-1995 growth revival, Figure 3 presents annual growth rates of U.S. output per hour for selected intervals since 1948. It is important to note that these numbers refer to the total U.S. economy including the agriculture, government, and household sectors, not the more narrowly defined nonfarm private business (NFPB) sector that is the universe covered by the regularly published BLS quarterly productivity data.[3]

The attention here to the total economy rather than the NFPB sector reflects the coverage of the two early BPEA productivity papers reviewed here, both of which covered the total economy.

In Figure 3 the pre-1970 period is divided at 1965, reflecting the break point chosen to mark the beginning of slower productivity growth that attracted the early BPEA papers on productivity growth, and shows that growth slowed from 2.85 percent per annum in 1948-65 to 2.11 percent in 1965-70. Then came a long interval between 1970 and 1995 of even slower growth, broken into 1.43 percent for BPEA's first 1970-80 decade and 1.50 percent for 1980-95. Then arrived the remarkable revival to 2.58 percent during 1995-2004 followed by a two-step slowdown to 1.68 percent in 2004-2010 and the lamentable 0.82 percent rate recorded in the last pre-pandemic near-decade of 2010-2019.

The initial slowdown in 1965-70 was soon noticed in the first BPEA paper to review the determinants of productivity and potential output growth, "Labor Force Structure, Potential Output, and Productivity", written by BPEA co-editor George Perry in 1971. He began by decomposing growth of the three main components of actual output growth – employment, hours per employee, and output per hour – over the 1948-70 period divided up into three sub-intervals with breaks at 1955 and 1965. He showed that productivity growth had declined by more than half, from 3.4 percent in the first 1948-55 interval to 1.6 percent in the third 1965-70 interval. Output growth had declined, but by less than productivity due to faster growth of employment. Notice that the 1.6 percent growth rate for 1965-70 in Perry's contemporaneous data is substantially lower than the 2.1 percent growth rate for the same interval in today's retrospective data.

In order to understand the slowing trend, Perry highlighted the shift in the composition of the labor force toward two groups, women and teenagers, who were paid lower wages than adult men and worked fewer hours per week. He assumed that their lower observed wages reflected true differences in productivity and created new series that weighted each age-sex group by its relative wage and number of weekly hours, so women and teenagers were given a smaller weight. Then he took the age-sex weighted series for employment and hours per employee and created the cyclical adjustment needed to translate actual growth in employment, hours of work, and productivity into potential (i.e., cyclically adjusted) growth rates.

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[3] Output per hour in the total economy is defined here as the average of Gross Domestic Product (GDP) and Gross Domestic Income (GDI) divided by hours of work in the total economy, an unpublished series that I obtain each quarter from the BLS.

Perry's most striking finding was that *all* of the decline in the potential productivity growth of -0.4 percent per year could be attributed to the effect of the changing age-sex mix, so cyclically adjusted productivity with a constant age-sex mix would have grown at a constant rate of 2.9 percent per year over 1948-70 with no slowdown. Since *actual* productivity growth as noted above had declined by 1.8 percent per year between the initial 1948-55 interval and third 1965-70 interval, Perry's detailed analysis interpreted 0.4 percent of the 1.8 point slowdown as caused by the age-sex effect, 0.7 to the cyclical impact of the large GDP gap of the terminal recession year 1970, and the remaining 0.7 percent as a residual error due the unexplained low value of productivity in the year 1970.[4]

Because he explained away the large observed drop in productivity growth as the result of shifting age-sex weights and a cyclical effect in the terminal year 1970, and because he projected little further change in the age-sex mix, Perry concluded by extrapolating constant 2.9 percent productivity growth and 4.3 percent potential output growth into the future decade of the 1970s. We know in retrospect that his forecasts were too optimistic. Actual output growth between 1971 and 1980 was not his projected 4.3 percent per year but a much slower 3.2 percent, and as shown in Figure 3 actual productivity grew not at his projected 2.9 percent but at only half that rate, 1.43 percent.[5]

Eighteen months after Perry's paper, William Nordhaus tackled the slowing productivity growth conundrum in his 1972 paper "The Recent Productivity Slowdown." This was entirely devoted to productivity growth without considering data on employment or hours per employee as had Perry. Nordhaus divided up the 1948-71 period into three eras with the same 1955 and 1965 dividing points that Perry had chosen. In Nordhaus' data productivity growth slowed between the first 1948-55 interval and the last 1965-71 interval from 3.1 to 1.9 percent per year, an overall slowdown of 1.2 points, less than Perry's 1.8 point slowdown.[6]

In a brief survey of explanatory hypotheses for the observed productivity growth slowdown, Nordhaus considered but rejected Perry's hypothesis based on the age-sex employment mix. He disagreed with Perry's assumption that the lower wages of these groups reflected lower true productivity and instead argued that their lower wages reflected discrimination against them. Instead, he proposed and tested an industry composition hypothesis, that changes in the employment share of individual industries explained the slowdown, and he devised a decomposition that predicted a slowdown of 0.9 points out of the 1.2 points actually observed. His analysis isolated differences among industries in the level rather than the growth rate of productivity as responsible for the slowdown and highlighted the

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[4] Perry (p. 559) provides a decomposition for the single year 1970, and I have translated this into the implications for the slowdown in growth rates between the initial 1948-55 interval and the terminal 1965-70 interval.

[5] The actual growth rate of 3.2 percent refers to the average of the current BEA estimates of GDP and GDI between 1970:Q4 and 1980:Q4.

[6] Using current data half of the difference in the measured slowdowns can be attributed to the 1965-70 interval used by Perry and the 1965-71 interval used by Nordhaus.

role of agriculture and FIRE, and to a lesser extent durable manufacturing and the government sector. Can Perry's emphasis on the age-sex distribution be reconciled with Nordhaus' analysis of industry composition? Robert Solow, a formal discussant of both papers, suggested that much of the influx of women and teenagers was into low-productivity industries that contributed to Nordhaus' composition effect.

Like Perry, Nordhaus predicted future productivity growth through 1980. His forecast for 1972-80 of 2.1 percent was the same as his cyclically corrected rate of 2.1 percent for 1965-71. How accurate was that forecast? Today's data for 1972-80 registers a productivity growth rate of only 1.2 percent per year, so Nordhaus in retrospect was too optimistic, although not as much as Perry.[7] From my perspective this is because both the Perry demographic hypothesis and the Nordhaus industrial composition hypothesis ignored the role of early postwar catchup in the exploitation of what I have called the Great Inventions, the implementation of which had been delayed by the depression and war. By this interpretation productivity growth slowed after the first postwar decade as this backlog of previous inventions worked its way through the production process.

We now turn to three papers on productivity that were written after 1980 and are chosen on the basis of citation counts. The first of these in chronological order was co-authored by Martin Baily and myself in 1988, "The Productivity Slowdown, Measurement Issues, and the Explosion of Computer Power." Written 16 years after the Nordhaus contribution, the paper began by pointing to a productivity growth slowdown in the nonfarm private business sector of 1.6 percentage points when 1973-87 was compared to 1948-73.[8]

Much of the analysis searched for measurement errors that could explain the slowdown. The claim was not that BEA and BLS had changed their methods to make measurement worse after 1973, but rather that the economy had changed in ways that made pre-existing measurement errors more important. The authors emphasized that many measurement errors concern intermediate goods and just shuffle measured productivity growth among industries without explaining the aggregate slowdown. To make a contribution an error must influence the measurement of final goods output or total labor input.

The authors concluded that measurement issues could explain about one-third of the 1.6 point slowdown. This estimate of a 0.5 point measurement contribution combined errors in business services, airline fare discounts, and issues involving labor quality including the age-sex adjustments that Perry emphasized together with evidence of declining labor quality based on test scores. They found plenty of other measurement errors, e.g., for construction price deflators and unmeasured quality improvements in medical care, but these applied both before and after 1973 so did not help explain the slowdown. Much of their analysis unearthed

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[7] Like Perry, Nordhaus' concept of productivity was for the total economy including agriculture and government, not the nonfarm private business sector. The 1.2 percent figure quoted in the text is the growth rate for 1971:Q4 to 1980:Q4 of the same series used to create Figure 3.
[8] The slowdown from 1948-73 to 1973-87 is a somewhat smaller 1.46 percent in today's published BLS data.

measurement errors at the level of individual industries, and they emphasized that quality and convenience improvements in finance, communications, and transportation should more appropriately be credited to durable manufacturing. Overall, they concluded that the pattern of industry slowdowns was consistent with "the impetus to productivity advance in the early postwar years, perhaps a backlog of innovations and investment opportunities delayed by depression and war, followed, after the mid-1960s, by a depletion of opportunities" (Baily-Gordon, 1988, p. 420). This is an early statement of the theme of innovation depletion that I have developed further more recently (Gordon, 2000, 2016).

The last two papers on productivity growth, chosen by the citation criterion, were both published in 2002. The first of these marked William Nordhaus' return to the productivity topic in his paper "Productivity Growth and the New Economy," which shared with his paper of 30 years earlier an attention to the industry composition of productivity growth. To achieve this he constructed for 1977-2000 a new income-side database on output, hours worked, and productivity for each industry that added up to income-side total output or GDI. This allowed him to distinguish between a pure productivity effect that sums the industries with fixed output shares, a "Baumol" effect of shifting output shares, and a "Denison" effect of the interaction between shifting shares of hours and output. In contrast to his 1972 paper which attributed most of the post-1965 productivity growth slowdown to shifting shares, the new paper found the Baumol effect to be near zero throughout the post-1977 interval.

Nordhaus' most important and widely cited result was that, in contrast to most research on the post-1995 productivity revival by Jorgenson, Oliner, Sichel, and others, the acceleration was not entirely or even primarily driven by the new economy ICT sectors of computer hardware, communications, and software. Instead, Nordhaus showed that the revival in 1995-2000 as compared to 1977-1995 had an ICT contribution of 33 percent for his preferred income-side measure, of only 17 percent for the conventional nonfarm business sector product-side concept, and 38 percent for the subset of industries that he classified as "well-measured."[9] The headline result of a 17 percent new economy contribution thus leaves as unexplained the majority of the post-1995 productivity growth revival.

In the usual BPEA fashion, the discussant remarks shed substantial light on the sources of the differences between Nordhaus' relatively small ICT contribution to the revival and the much larger contribution attributed by other authors. Leaving aside technicalities including income-side vs. product-side concepts, time period definitions, and data revisions, the most important source of the reconciliation was the limitation by Nordhaus of the ICT contribution to the ICT-producing industries without counting at all the contribution of ICT capital to productivity growth in the ICT-using industries.

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[9] These percentages come from the Gordon discussion of Nordhaus (2002, p. 248). The larger contribution of the new economy for the well-measured portion of the economy occurs because all of the new economy sectors are considered to be well-measured.

Speaking of ICT, the final productivity paper reviewed here also appeared in the 2002 BPEA: "Intangible Assets: Computers and Organizational Capital" by Erik Brynjolfsson, Lorin Hitt, and Shinkyu Yang. Written in the midst of the 1995-2004 revival in productivity growth highlighted in Figure 3 that many had attributed to an upsurge of investment in ICT capital, the authors investigated the relationship at the firm level between computers and their payoff in the form of faster productivity growth and higher firm market value. Their basic message was that the effectiveness of computers depended on changes in firm organization and business practices. Their study, based on data for hundreds of firms over 11 years, and limited to computer-using firms rather than those creating computer hardware or software, interpreted organizational assets as being much like other types of assets that contribute to long-term growth in output, productivity, profits, and market value.

One of their most striking findings was that financial markets placed substantially more value on installed computer capital than on other types of capital. The extent of that additional valuation depended on the implementation of reorganization – use of teams and team-based incentives, more broadly defined jobs, individual decision making authority, and investment in skills and education. Firms with higher levels of both computer investment and these organizational characteristics had a higher market value and higher measured productivity than firms that invested only in computers or only in organizational change.

A big issue that concerned the authors and discussants was the huge size of the regression coefficient on computer capital -- $1 in computer capital produced $15 in market valuation – and the addition of the organization variable did not decrease this by much. This anomaly led to consideration of reverse causation in the form of firms with highly successful business models, including internal reorganization, having plenty of market value available to buy computer capital. The paper and its discussants cited the example of Wal-Mart as a highly valued and productive company which combined organizational change, including the big-box store format, with wide-ranging investment in computers that allowed much greater control of inventories and the supply chain than had previously been possible.

The Growth of Nations

We now turn to three highly cited papers written between 1995 and 2003 that approach the topic of economic growth more generally as an inquiry into the reasons for differences in growth rates across countries and the failure of poor countries to converge to the output per capita level of rich countries. The continuing gigantic gap in living standards between rich and poor countries has been called the most important topic in economics, and Robert Lucas once famously wrote that when one starts thinking about it, "it is hard to think about anything else."

The first in this group of three is Greg Mankiw's 1995 paper "The Growth of Nations." Mankiw contrasted the enormous differences in standards of living between a group of rich countries including Germany, Japan, and the U.S. and a group of poor countries including India, Indonesia, and Nigeria. What were the fundamental factors that made some countries so

rich and others so poor? Mankiw noted that this question had long been neglected but by the time of his paper in 1995 had emerged as a subject in economics as important as the study of business cycles.

Mankiw's paper began by enumerating the central well-known deficiencies of the neoclassical Solow growth model when contrasted with reality – it predicted lower magnitudes of international income differences, faster rates of conditional convergence, and larger differences in the marginal product of capital. However, if capital's share in the Cobb-Douglas formulation was around two-thirds instead of one-third, these problems of matching theory with reality faded away, and a consideration of human capital as well as externalities from physical capital easily justified a high capital share. Regarding endogenous growth theory, Mankiw made the bold claim that it added limited value to cross-country studies, because knowledge models were hard to check with international data. In addition, endogenous growth models did not apply well to East Asia, where the primary source of growth was capital accumulation rather than TFP.

Turning to cross-country regressions, Mankiw noted several difficulties. As models became more subtle it became harder to distinguish among them empirically. For instance multiple models predicted conditional convergence. More important, cross-country regressions suffered from simultaneity (explanatory variables were the result of growth themselves), multicollinearity (explanatory variables were too closely correlated among themselves), and low degrees of freedom (too many variables and too few years of observation).

Mankiw concluded by finding the neoclassical Solow model still useful when supplemented by a broader view of capital that raised the numerical value of capital's share and when joined by endogenous growth theory as a useful supplement to identify the sources of increases in knowledge. But he ended on a pessimistic note. The neoclassical emphasis on differences in capital accumulation as the source of growth outcomes shifted the spotlight to the question of why some countries saved and invested so much more than others, and little progress had been made to answer that question.

Mankiw was just as pessimistic about policy implications. If capital accumulation was the key to growth, then policymakers should encourage more saving and investment from domestic and foreign sources. But beyond that economists had not developed persuasive methods of measuring the externalities from capital accumulation, and the lack of such measurements could lead to "haphazard policy, which is surely worse than no policy at all." Further, "policymakers who want to foster economic growth would do well to heed the first rule for physicians: do no harm" (Mankiw, 1995, p. 309).

The second highly-cited paper to tackle differing growth rates across nations appeared in BPEA in 1998 -- "Geography, Demography, and Economic Growth in Africa" by David Bloom and Jeffrey Sachs.   The authors took a different approach from many studies of

economic growth in Africa that focused on macroeconomic policy, market liberalization, and institutions. Instead they created a convincing case for geography and demography as factors that had substantially limited economic growth in Africa.

Geography was a hindrance because the climate near the equator was humid, temperatures were high, and there was no monsoon to provide irrigation. These factors severely limited agricultural productivity, leading African countries to specialize in cash crops (coffee, mangoes) that were suitable for the climate, requiring much food to be imported. The hot and humid climate was a natural host for infectious diseases, such as malaria and yellow fever, which took a direct economic toll and deterred foreign settlement and investment.

Geography did not just involve climate but also topography. Africa lacked deep harbors as dot the coastlines of Europe and North America and also in some regions lacked great navigable rivers. Thus transportation costs were high, made worse by the fact that most of Africa's population lived inland where numerous countries were land-locked. Both the presence of malaria and being landlocked were isolating, and isolation was a major cause of slow growth

As if geography were not a sufficient barrier to growth, Africa also suffered from unfavorable demography. A combination of high fertility rates with better public health practices that had improved survival rates had led to rapid population growth and a high ratio of dependent youths. A larger population strained the availability of natural resources, while the youth of the population limited saving and investment. Solutions to excess population growth were difficult to achieve, as contraceptives were not widely available. Further, Africans actively desired large families in part due to persistent social norms and a lack of education.

Bloom and Sachs concluded that policy and governance were not the most important factors impeding the achievement of more rapid economic growth in Africa. They argued that causality ran strongly from geography, demography, and public health to growth with little reverse causation. Their rough estimate was that two-thirds of the explanation of Africa's slow growth could be traced to these underlying structural factors and only the remaining one-third to economic policy and institutions. They lamented the relative lack of international research on tropical health issues and the relationship between geography and agricultural productivity.

The authors noted that Africa was the only region in the world to experience an absolute decline in real exports per capita between 1980 and 1996. They called for a major shift, particularly in coastal cities, to the types of low capital intensive manufactured exports that had formed the backbone of rapid growth in east Asia. They also emphasized the need for infrastructure, which could be financed privately rather than by "cash strapped state monopolies." In good BPEA fashion, the discussants strongly disagreed. One pointed to a whole array of issues that were amenable to policy changes, including dictatorship, civil wars, a lack of electricity, poor contract enforcement, poor information caused partly by an abysmal

telephone system, and the perception of foreign investors of a high political risk of expropriation.

The last of the trilogy of highly cited growth papers is the 2003 contribution by Barry Bosworth and Susan Collins, "The Empirics of Growth: An Update." The authors examined two methods of studying growth – growth accounting and regressions – and attempted to reconcile widely divergent findings from these two methods regarding the sources of growth across nations. Findings differed on whether physical and capital accumulation were the main underlying sources of growth or whether the main source was advances in TFP.

Bosworth and Collins pointed to measurement issues that largely explained these different conclusions. For instance it mattered whether the capital stock was directly evaluated or whether it was approximated from investment rates, a practice of which the authors disapproved. Likewise the failure to find an association between educational attainment and output growth may have reflected measurement errors in educational quality. The authors examined several data sets on educational attainment used in previous studies and found them poorly correlated with each other.

The main contribution of the paper was to improve the measurement of the key variables by constructing a new data set for 84 countries accounting for 95 percent of world GDP over the four-decade interval of 1960-2000. The authors concluded that both growth accounting and regressions were useful tools, conditional on correct measurement of variables, cleaning up differences in data and definitions, and – in regression analyses – inclusion of previously omitted variables. They found that the contribution of capital had been understated in some previous studies due to the flawed practice of using investment series as a proxy for capital input. Somewhat surprisingly, they found a limited role for educational attainment, partly due to the difficulty of finding adequate measures of educational quality.

Besides an emphasis on capital accumulation, Bosworth and Collins pointed to initial conditions and government policy as important explanations of high or low growth. There was a strong negative correlation between growth and initial per-capita income, supporting conditional convergence. Life expectancy in the initial year as a measure of health also had a significant positive correlation with growth. Governmental institutions were strongly correlated with growth, including law and order, absence of corruption, and protection of property rights. While this emphasis on institutions went against the structural handicap hypothesis of Bloom and Sachs, those authors were supported by the finding that a tropical climate hindered growth.

Bosworth and Collins supplemented their positive conclusions with several negatives – there appeared to be no relationship between growth and either macroeconomic policies or openness to trade. And they admitted that their set of variables shed little light on one of the main puzzles treated in their paper, the sharp slowdown in world growth from the two decades before 1980 to the two decades after 1980 in most of the world outside of India and China.

Conclusion

As shown in Figure 3, growth in labor productivity in the U.S. is delineated by four postwar eras – fast 1948-65, slow 1965-95, fast 1995-2004, and slow again after 2004 with a second wave of retardation after 2010. Some combination of a changing age-sex mix and altered industry composition, as in the early Perry and Nordhaus papers, makes a partial contribution to understanding the initial phase of the slowdown from pre-1955 to 1965-70. But the overoptimistic forecasts of these authors for the decade of the 1970s which were based on holding constant the age-sex and industrial shares, suggest that something more profound was going on. My more recent suggestion (Gordon, 2000, 2016), that this omitted factor was diminishing returns to innovation and depletion of important innovations developed in a fruitful earlier era, was originally set forth in the 1988 Baily-Gordon paper summarized above.

The 1995-2004 productivity growth revival is widely attributed to the invention of small powerful computers and of the internet, together with an explosion of investment in ICT capital (at least through the year 2000). Nordhaus in 2002 understated the contribution of ICT capital but pointed to something important, the strong post-1995 revival of industries that were not intensive users of ICT equipment. His position became stronger in the data that emerged from 2002 to 2004, after he wrote, when productivity growth remained strong despite a sharp decline of ICT investment.

As for the fourth era of slowdown after 2004, and particularly since 2010, we return to the diminishing returns argument, this time applied to the wave of ICT innovation that reached its peak in the late 1990s. But at least two qualifications need to be introduced to the implied pessimism about future U.S. productivity growth. First, there is very little correlation between productivity growth in one decade vs. the next, and so we could be on the cusp of another revival propelled by robots and artificial intelligence. Second, Brynjolfsson and others have recently shown that the invention of the smartphone and tablet have produced vast amounts of consumer surplus that can be measured in consumer surveys, raising questions about the adequacy of conventional output measures.

The papers on international growth range from Mankiw's skepticism that empirical research can uncover the sources of growth, to Bloom-Sachs insistence that structural impediments are more important than policy or institutions, to the demonstration by Bosworth and Collins that regressions can provide a convincing decomposition of the sources of growth. As a spectator to the international growth literature, I emerge from this review with some frustration that even the best efforts of Bosworth and Collins could not explain why worldwide growth slowed down from 1980 to 2000, not to mention why India and China were exceptions to that slowdown. The sources of the stunning growth achievement of East Asia over more than four successive decades still raises questions about the relative role of investment, government oversight, and culture. For future generations of BPEA authors there are plenty of new puzzles that arise in the experience since 2000, including why worldwide growth in

emerging economies regained momentum, and why it surged even in a significant number of African countries.

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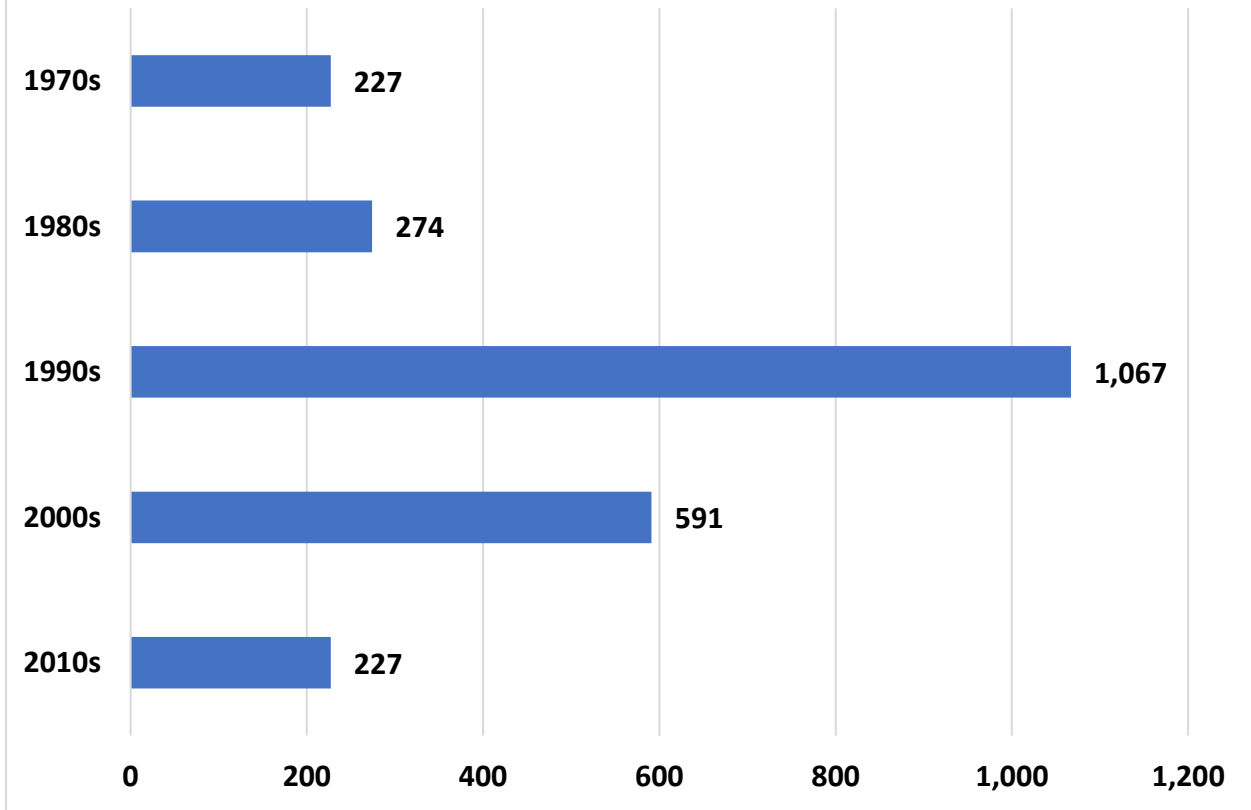
Figure 1. Mean Citations of BPEA Papers by Decade

Decade	Mean Citations
1970s	227
1980s	274
1990s	1,067
2000s	591
2010s	227

Figure 2. Distribution of BPEA Citations Compared to the Distribution of Income in the U.S.
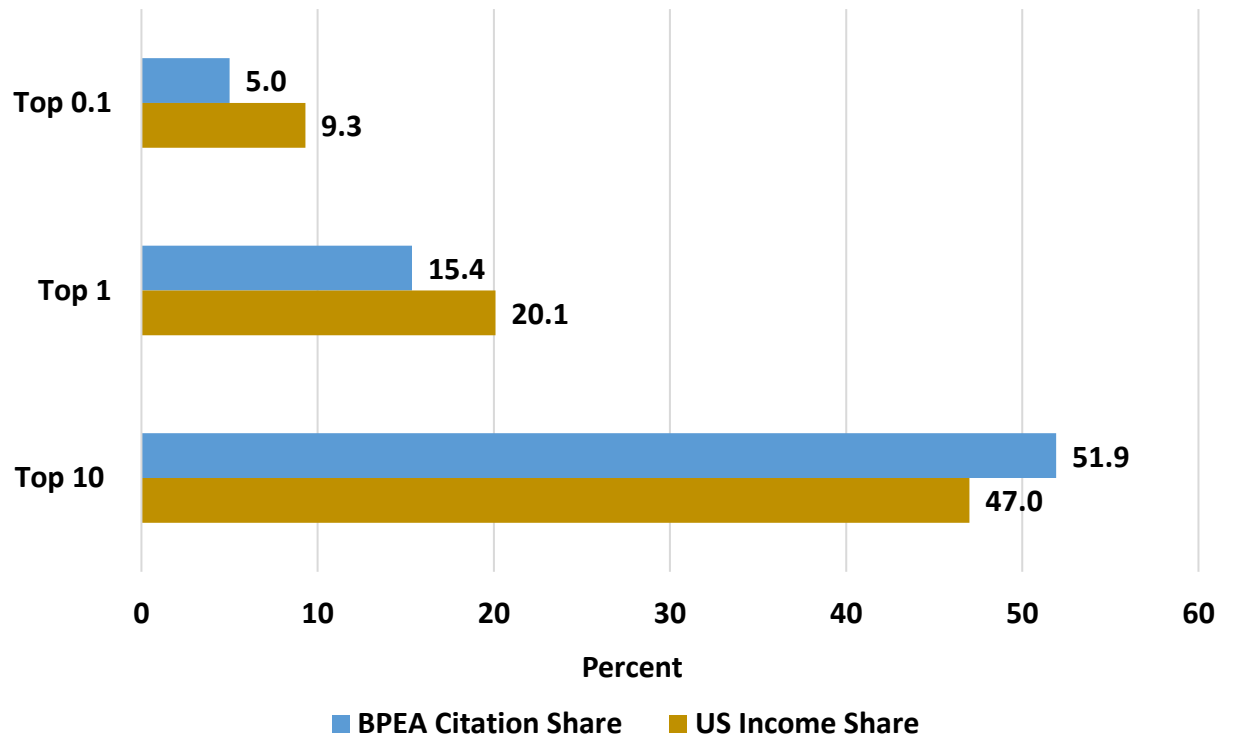
**Figure 3. Annual Growth Rate of Output per Hour,
U.S. Total Economy, 1948-2019, Selected Intervals.**