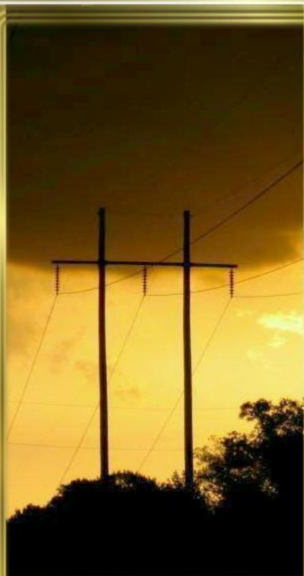
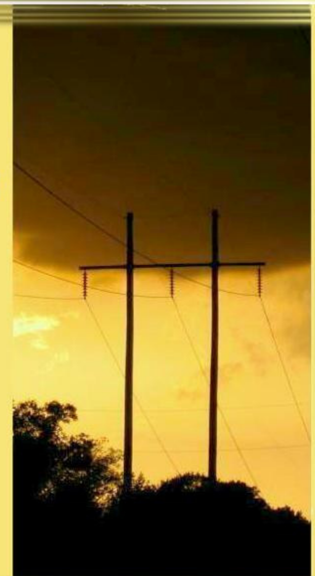


Environmental Regulation Versus Productivity Growth: United States Studies And A European Comparison



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Abstract

The Bush administration has pointed with pride to the recent rapid growth of productivity in America while its detractors were denouncing his administration's easing of American environmental regulatory enforcement and its halting of a formerly relentless intensification of environmental protection. In this paper, its author attempts to link the latest American productivity growth surge to the allegedly reduced environmental regulatory zeal of the Bush administration.

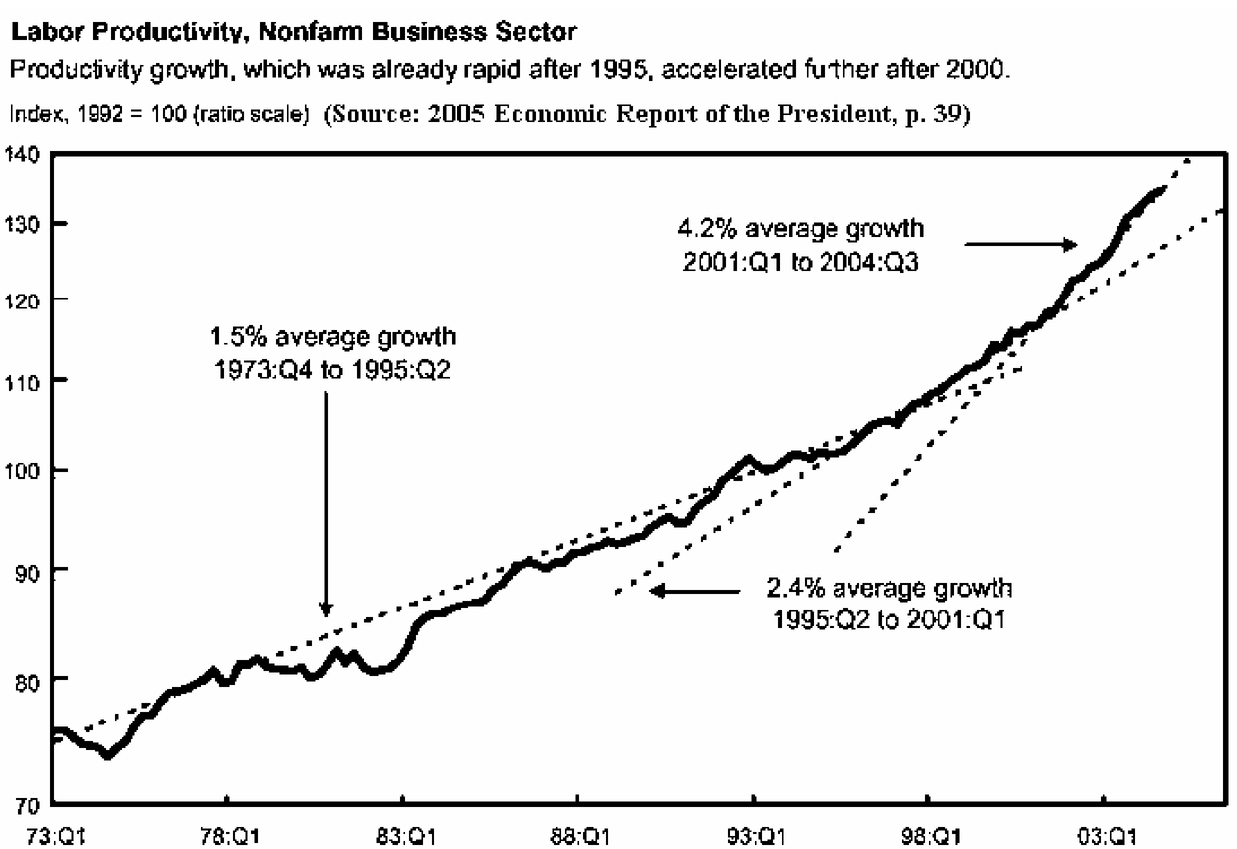
The celebrated IT revolution has not produced a similar recent productivity performance in Europe, where pervasive efficiency stifling regulatory constraints now prevail. Thus, America's experience sharply contrasts with a relatively stagnant Europe that has presently swung toward greater environmental militancy. Econometric studies repeatedly identified earlier American environmental regulations' stagnating impact.

This paper concludes with a cross-sectional data analysis revealing that the pattern of accelerating productivity growth in manufacturing during the Bush administration is the mirror image of the pattern of slowing manufacturing productivity growth accompanying the post-1973 ascent of environmental compliance costs.

A Regulatory Moderation Theory of the Productivity Boom

As is shown in Exhibit 1 below, the 2005 *Economic Report of the President* provides a graphic portrait of the behavior of productivity growth.

Exhibit 1



The 2006 *Economic Report of the President* (36) describes the 3.6 percent average annual growth rate of American labor productivity in the non-farm business sector since the business cycle peak in the first quarter of 2001 as "exceptionally vigorous". It has been "notably higher than during any comparable 4 ½ year period since 1948" (36). While capital deepening and an increase in organizational capital associated with the IT revolution may plausibly account for the 1995-2001 pickup in productivity growth, the 2006 *Economic Report of the President* (36) explains:

> In contrast, capital deepening (the increase in capital services per hour worked) does not explain any of the post-2001 increase in productivity; in fact, the growth of capital services per hour worked appears to have fallen off slightly in this period.

Moreover, the previous year's *Economic Report of the President* (39) explains that the informational capital deepening explanation is of little value in understanding the 2001 – 2004 greater acceleration because a slowing of both information technology (IT) and conventional capital investment characterized the period.

In this paper it is contended that because rigorous environmental regulation may have largely restrained American productivity growth after 1973, a moderation of its enforcement intensity may substantially explain productivity's allegedly remarkable acceleration after 2000. To narrow the focus, no attempt is made to prove that the Bush administration has greatly eased environmental protection efforts in America because other analysts--seemingly enthusiastically--have advanced that proposition adequately. Instead, taking shifts in regulatory stringency largely as given, this paper emphasizes the connection between productivity growth and environmental regulation. While sluggish employment growth may have diminished the benefits from such accelerating productivity growth in recent years, avoided in this paper is a broadening of its thesis into that issue. Whether rigorous environmental regulation decreased productivity growth is the major concern of this paper.

Robinson (1995) discusses alternative theories of the impact of environmental regulations on productivity growth. He concludes (387) that the data from the U. S. manufacturing sector do not support the theory that such regulation forces technological improvement, but rather, the data suggest that environmental regulation "diverts economic resources and managerial attention away from productivity-enhancing innovation." The early 1970s marked the beginning of a period of relatively rigorous environmental regulation in the U. S., and the administration of George W. Bush subsequently relaxed the administration and enforcement of such regulations at the beginning of the 21st century.

The first section of this paper has provided an introduction. The remainder of the paper makes an attempt to identify that a productivity growth slowdown resulted from the interim, pre-Bush Administration episode of comparatively strict environmental regulatory enforcement in the U. S., both by comparing the U. S. with Europe and by examining the pattern of the impact among the various industries of the U. S. manufacturing sector.

The next (second) section of this paper provides a more careful examination of the post 1973 productivity growth experience in the U. S. and in Europe. It is broken into two subsections: simple labor productivity (output per person-hour) and multifactor productivity (the residual after identifying capital and labor contributions to output growth).

The third section contrasts the rise and decline of environmental regulatory intensity in the U. S. with the European pattern of earlier environmental regulatory leniency followed by recent intensification.

The fourth section of this paper reveals that, although the IT revolution has pervaded both Europe and the U. S., recent productivity growth has been notably slower in Europe than in the U. S.

The fifth section summarizes a collection of published studies of environmental regulation's productivity growth slowing effects after 1973.

The sixth section presents a cross-sectional industry comparison study showing that the industries for which environmental regulation most slowed productivity growth were the industries in which productivity growth accelerated the most under the Bush Administration.

The seventh and final section summarizes the arguments and suggests some conclusions.

Productivity After 1973

Both labor productivity and multifactor productivity growth in the U. S. slowed substantially for over two decades after 1973, while European productivity growth did not exhibit this mysterious slowing. The apparent resumption of more rapid U. S. productivity growth in the latter half of the 1990s was due to a magnified productivity growth acceleration isolated in a small subset of the sectors of the U. S. economy. For the vast majority of the U. S. economy's sectors, stagnation persisted until the advent of the Bush administration. Thus, a widespread depressing of productivity growth pervaded the period from 1973 to 2001 in the U. S. Isolating, first, labor productivity, and, then, multifactor productivity, will help illuminate the pattern of this growth.

Taking labor productivity first makes it possible to measure accurately right up to the present time and avoids certain measurement issues. It is available for both Europe and the U. S. and over a long timeframe. A subsequent and separate discussion of multifactor productivity is shown in its own subsection so that its measurement controversies will not confuse the establishing of productivity's growth pattern seen in the simple labor productivity subsection. Multifactor productivity measurement provides a better picture of what was happening in the separate industries of the business or manufacturing sector.

Labor Productivity: Simple Output per Person-Hour

Leading the way toward intense environmental regulation, America experienced an extreme drop in productivity growth after 1973. While a thorough review of the multitude of explanations that attempt to connect slowing productivity growth and environmental regulation could make an entire paper in itself, the following can help spur the imagination.

The establishment of the U. S. Environmental Protection Agency in 1970 accompanied the Clean Air Act of 1970, and the Clean Water Act of 1972 followed. America adopted a command and control approach involving EPA enforcement of increasingly numerous technological requirements and quantitative limitations for many emissions, together with voluminous reporting requirements. Books such as Howard's *The Death of Common Sense: How Law is Suffocating America* (1996) explained how the business sector suffered a kind of resulting paralysis. Thousands of pages of regulations eventually confronted business firms attempting to comply with these acts.

Facing litigation or criminal sanctions to ensure compliance, businesses, in effect, were encouraged to avoid or reduce innovation in favor of adherence to production methods that became traditional wherever time proved them able to pass the scrutiny of America's regulatory bureaucracy. Breaking with traditional production methods risked accidental violations of a body of regulatory law that had become too large for would-be innovators to know or understand adequately, although bureaucrats in charge of enforcing them knew the regulations well enough to detect and punish infractions. This is not to suggest that such regulation was without benefits, but only that inhibiting innovation was one of its hidden costs.

The 2005 *Economic Report of the President* (45) states that, successive to growing at 2.5 percent per year from 1953 [Q2] to 1973 [Q4], the slowing of labor productivity growth to 1.5 percent from 1973 [Q4] to 1995 [Q2] also slowed real GDP growth from 3.6 percent per year to 2.8 percent. Likewise, Maddison, in his *Millennial Perspective*, (2001, 136) explains that U.S. labor productivity rose at an average annual rate of 2.8 percent year from 1950 to 1973, and then declined to 1.5 percent from 1973 to 1998, a slower rate than for any sustained period since 1870. American output growth did not decrease proportionately, partly due to the massive entry of women into the American labor force. As Maddison (2001, 135) explains:

> American economic policy since 1973 has been much more successful than that of Western Europe and Japan in realising potential for income growth. The level of unemployment fell to less than half of that in Western Europe, whereas in 1950–73 it was usually double the European rate. Labour force participation increased, with employment expanding from 41 per cent of the population in 1973 to 49 per cent in 1998, compared with an average European rise from 42 to 44 per cent (see Table 3–7). Working hours per person rose whereas they fell in Western Europe. High levels of activity were achieved with a rate of inflation which was generally more modest than in Western Europe.

Western European labor productivity growth also slowed in the 1973 to 1998 period, but only down to 2.3 percent per year and Maddison (2001, 131) explains that much of this slowing was inevitable because Europe was catching up with the United States. Slowing European output growth was only partly due to this slowing of European productivity growth, as, in addition, slowing population growth and a staggering rise in European unemployment contributed to it, according to Maddison (2001, 131). Nevertheless, Europeans were slow to initiate the kind of command and control environmental regulation that they saw emerging in America, and this is consistent with their better productivity performance after 1973. Other kinds of regulatory interventions, rather than environmental regulation, decreased their output growth performance more, as will be seen later in this paper.

The apparent acceleration of U. S. productivity growth from 1995 to 2000 seems to have been of questionable significance so that much of the post-1973 stagnation persisted until George W. Bush's election. Measuring labor productivity growth in terms of increases in output per person-hour does not eliminate all measurement issues. Adjusting for inflation, for example, involves making inferences from perceived changes in quality as technological progress alters goods from one year to the next. Gordon (Why was Europe, 12) cautions his readers that measurement issues are very significant in assessing the computer revolution. If 2003 computers sold for the same price as 1993 computers, but hedonic pricing models indicated a fourfold improvement in the quality of computers, then their 2003 contribution to real output would be four times as large as in 1993 if exactly the same number of "boxes" was produced. Moreover, if these computers were the only goods sold by retailers and the same number of people remained employed producing and selling these computers, then productivity would show a roughly 13.9 percent annual improvement in both computer manufacturing and in retailing over this period during which exactly the same number of "boxes" was produced and sold (Gordon, Why was Europe, 12). The change in computer related output growth may have reflected advances in measurement techniques more than a true burgeoning of production effectiveness. We count the computer on your desk – the "box," as Gordon calls it – as four computers by 2003, compared with having counted it as only one computer in 1993.

Multifactor Productivity

Examining multifactor productivity (or total factor productivity) growth reveals that the productivity growth slowdown pervaded most of the U. S. economy from 1973 to 2001, even though an upward jump in aggregate productivity growth occurred during the second half of the 1990s before the Bush administration came to power. The late 1990s jump was isolated in just a few sectors of the economy and most sectors remained stagnant under the continuing determined environmentalism of the Clinton-Gore administration.

Like simple labor productivity, U. S. multifactor productivity growth also slowed drastically after 1973, and it is conceptually an even more meaningful indicator of slowed technological progress than is simple labor productivity. Measurement issues, on the other hand, become more pronounced when multifactor productivity growth (or total factor productivity growth) is estimated – a measure consisting of the increase in output in excess of the increase that can be attributed to increases in inputs of capital and labor (and, optionally, other things such as energy, if one wishes to incorporate any of them).

Jorgenson (2005, 31-40) emphasizes the effect of how capital and labor inputs are measured. Labor, for example, is measurable in person-hours or in units of an index of constant quality (Jorgenson 2005, 36). He explains that Solow, in his famous 1957 growth accounting study, attributed the vast majority of past U.S. growth to increases in multifactor productivity because of the way Solow measured labor in “man-hours” (Jorgenson 2005, 34) and the way Solow measured capital and output. However, Jorgenson (2005, 38) explains that measuring capital and labor in constant quality index units changes this conclusion so that the vast majority of past growth appears to have been due to increases in inputs rather than increases in multifactor productivity. Solow (2000, 32) had provided a relevant discussion previously when he illustrated the theoretical usefulness of measuring labor in “efficiency units” so that “labor-augmenting” technological progress is visualized as imbedded in labor rather than as showing up as improvements in a separate multifactor productivity variable.

Measuring capital in “efficiency units” can also illustrate this argument. Therefore, it seems apparent that since capital and labor are subject to alternative methods of measurement, one source’s estimates (e. g., Jorgenson’s) may differ considerably from another’s (e. g., Solow’s or the Bureau of Labor Statistics’), particularly if estimates were prepared at different times with concomitant differences in the quality and detail of available data. The onset of vigorous environmental regulation, nevertheless, coincided with a marked productivity growth slowdown whether we measure simple output per person hour or multifactor productivity.

As the Bureau of Labor Statistics (BLS) measured it (2003), multifactor productivity growth had averaged 2.1 percent a year for the Private Business Economy from 1948 to 1973, and then it dropped to an average below 0.6 percent from 1973 to 1995. Weil (2005, 248) observes that this productivity slowdown “was one of the most puzzling phenomena of the of the post-World War II era.”

In his 2001 book, Maddison (136) points out that the United States achieved its better growth performance after 1995 partly due to new measurement techniques – aggregate productivity growth accelerated back to near its 1950-1973 rate because of the new way it was being measured. Then again, Maddison emphasizes that accelerated technological progress in computers and communications technology had its main productivity growth stimulating impact in the production of mostly these two categories of goods – a finding he attributes to Jorgenson and Stiroh, to Oliner and Sichel, and to Gordon.

Outside of the production of computers, semiconductors, and communications equipment, there seemed to have been little productivity growth accelerating spillovers propelling the numerous other sectors that were computer users, rather than computer producers, since the other sectors remained largely stagnant as a group (Maddison 2001, 139). Maddison (139) believed, nonetheless, that the other sectors might show greater progress after being given time to assimilate the new technology. Maddison's perceptions do not seem contradictory to the hypothesis that strict environmental regulation was simply holding back these other sectors until the Bush administration replaced the Clinton administration.

Jorgenson, Ho, and Stiroh (2003) analyzed U.S. sources of labor productivity growth through 2001. They (Jorgenson, et. al. 3) divided the economy into IT-producing (hardware, software and communications) and non-IT producing industries. They (Jorgenson, et. al. 20) reported that total factor productivity (TFP) growth fell from its 1959 to 1973 average of 1.16 percent per year to 0.26 percent a year from 1973 to 1995 and then rose to 0.4 percent a year from 1995 to 2001 (or 0.62 percent from 1995 to 2000). Decomposing the 1995 to 2001 total factor productivity growth showed that IT-producing industries contributed 0.41 percent a year to the TFP growth rate, while non-IT producing industries (the rest of the economy) contributed negative 0.01 percent to the TFP growth rate (2003, 20). Because the effort to increase efficiency is pervasive and relentless throughout virtually all industries, this negative TFP or multifactor productivity growth outside of the IT-producing industries must have resulted from one or more detrimental influences, which Jorgenson and company did not identify, working in the opposite direction.

A follow-up study, published a couple of years later, that lengthens the post 1995 period by just one additional year finds a markedly different picture for the contribution to productivity growth being made by non-IT producing sectors. Jorgenson (2005, 29-30) explains that, although IT production constitutes only about 5 percent of the GDP in 2002, "slightly more than half of the acceleration in productivity from 1989-1995 to 1995-2002 can be attributed to IT production." He (2005, 83 [Table 2.7]) decomposes average labor productivity growth into its various sources: capital deepening (IT and non-IT), labor quality, and total factor productivity (IT and non-IT output production). Jorgenson's Table 2.8 (Jorgenson 2005 84) shows that, from 1995 to 2002, producing IT goods contributed 0.47 percentage points of the 0.71 percentage points of annual total factor productivity growth, while the production of non-IT output contributed 0.24 percentage points of annual increase (Jorgenson 2005 27-28). Therefore, total factor productivity growth in industries outside of the IT products producing sector shows a tremendous increase when just a short amount of time under a regime of relaxed strictness of enforcing environmental regulations is added to the previous period.

Other investigators also find that productivity growth acceleration was quite isolated until the Bush administration era. According to Kask and Sieber (2002, 25), virtually the entire upward jump in the manufacturing part of the 1995 to 2000 jump in multifactor productivity growth occurred in the high tech manufacturing sector with the rest of manufacturing exhibiting almost no increase at all. Indeed, the McKinsey Global Institute sponsored a study under the leadership of Solow himself (and a team of appropriately qualified individuals) that found that just six sectors of the entire economy caused this upward jump in productivity growth, while the other 53 sectors, as a group, remained stagnant (McKinsey Global Institute 2001, 1). The six sectors that jumped upward were computer manufacturing, semiconductors, telecommunications, retail, wholesale, and securities. In another authoritative growth accounting quest for the significance of computers, Oliner and Sichel (2002, 20) likewise found that multifactor productivity growth was abysmal outside of the computer and semiconductor-producing sectors between 1995 and 2001. They felt that this was not for lack of benefit from using computers in these other sectors, but that it was due to some other cause, perhaps partly cyclical in nature. The persistence of wide-ranging stagnation seems evident beneath the late 1990s performance of aggregates that advancing computer technology is, along with many other elements of technological progress, otherwise probably tending to boost.

Environmental Regulations in Europe and the United States

Vogel (2003) compares at length the evolution of environmental regulation in America and Europe and the politics underlying it. He explains (2003, 1) that, from the 1960s through the mid-1980s, American environmental regulatory standards tended to be more stringent and comprehensive than in European countries. Conversely, since about 1990, a substantial reversal has occurred so that European consumer and environmental regulations became more precautionary than in America. A series of perceived crises and regulatory failures apparently strengthened popular support for such regulation in Europe and the European Union (EU) became more practiced at instituting such regulatory initiatives (Vogel 7). Moreover, Vogel (13) explains that, after 1990, environmental regulatory advancement greatly slowed in the United States, especially after 1994 when Republican control of at least one house of Congress began in the United States and American NGOs (non-governmental organizations) abandoned pushing new regulations and started trying to just preserve existing regulations instead. The Bush administration's rise to power, according to Vogel (14), resulted in a continuation of this American NGO emphasis on preventing the repeal of existing environmental regulations rather than trying, like the political entities in Europe, to increase consumer and environmental regulation. Prominent leaders of America's environmental movement appear more emotionally affected by alleged environmental policy adjustments from the Bush administration and do not, in describing them, show the restraint that Professor Vogel seems to exhibit.

Unlike Vogel, Pope and Rauber (2004) seem eager to avoid understating their impressions of the Bush administration's escalation of efforts to alleviate some of the extremes of traditional command and control environmental regulation. They (12-13) accuse the Bush administration of trying to restore the status quo that existed prior to President Theodore Roosevelt, claiming (131) that the Bush administration has stripped protections from more of the American landscape than any other president ever managed to put in place. Pope and Rauber (48, 58) accuse Bush's administration of replacing appointees in the environmental bureaucracy with lobbyists from regulated industries and with ideologues from right-wing think tanks, at a time when both houses of Congress have become full of anti-environmental ideologues. In their 2004 book (17) they analyze the motives at work:

> Yet greed alone cannot explain the depth and breadth of the current assault on the environment. Something of this magnitude can only be accomplished by people in the grip of an ideological fervor. This is what the American people do not know: the Bush administration is full of influential officials who believe from the bottom of their hearts, not just their wallets-that weaker laws on clean air, less funding to clean up toxic waste dumps, and national parks and forests run for private profit are actually good for the country.

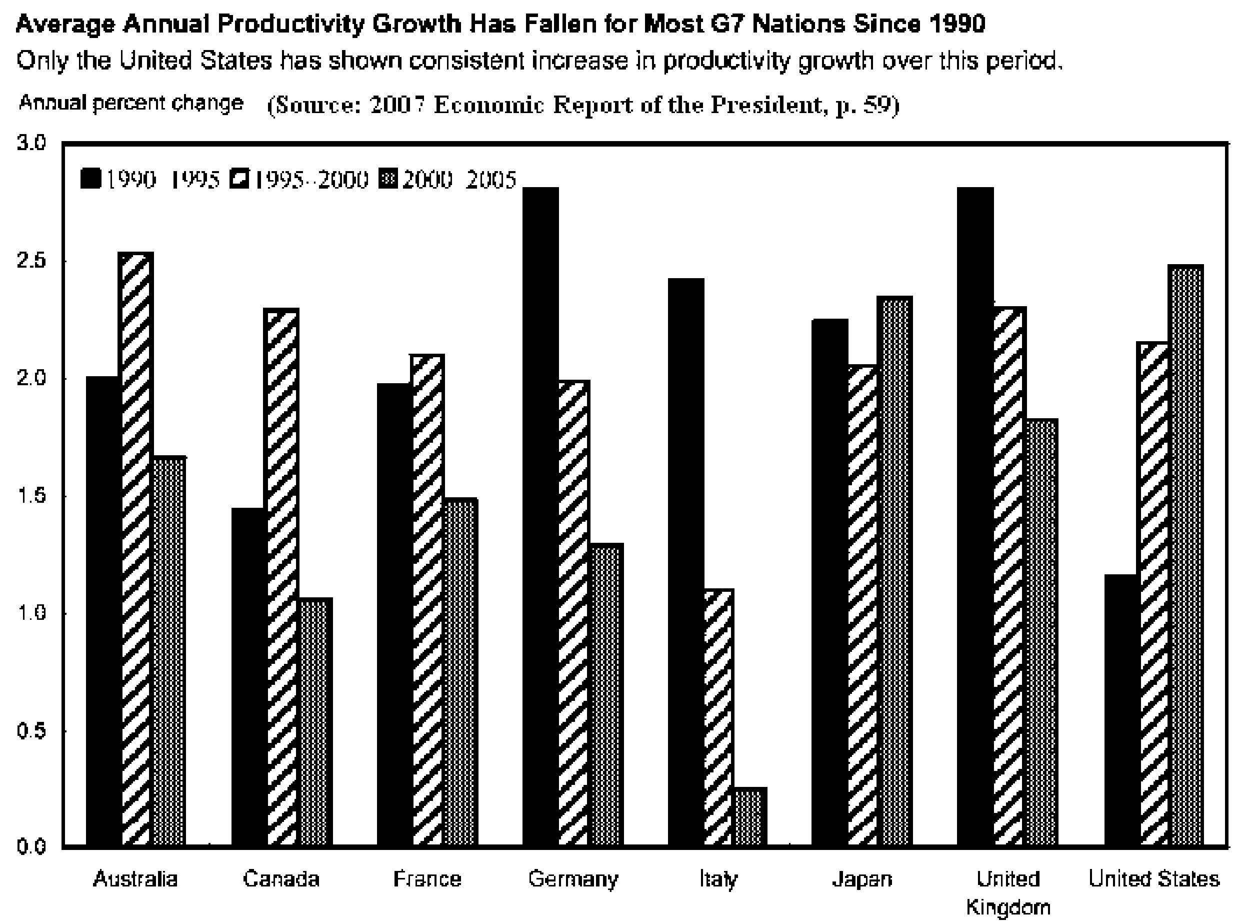
Pope and Rauber add in numerous particulars including that the Bush administration has removed protection from 234 million acres (131); reversed Clinton's late environmental executive orders (48); saved industry billions by lowering standards and facilitating processes (107); and invited regulated industries to sue the government so that amiable out of court settlements could be routinely granted by the government (185). Additionally, they contend that the Bush administration removed wetlands protection from "isolated wetlands" and "intermittent streams" constituting from 20 percent to as much as 60 percent of America's wetlands (88-89) and shifted to government the entire financial responsibility for Superfund cleanups (197). Bush's administration also, they emphasize, has withdrawn from Kyoto and from other international efforts to improve the global environment such as by controlling mercury emissions from power plants (215-216, 218), opened public forestland to timber harvesting (225), and opened for development half the land set aside for the protection of endangered species (26).

Anecdotal evidence helps illustrate differences in European regulatory philosophy in recent years. While the Bush administration was resisting some of the advancing rigors of the global environmental movement, the British were erecting new monuments to the European Union's environmental fervor. Way (2002, SS10-SS11) reported the appearance of "fridge mountains" as the roughly 2.5 million annually discarded refrigerators piled up, waiting for special equipment to remove not only the refrigerant gasses from the sealed refrigeration systems, but also from the bubbles in the plastic foam insulation that fills the area between refrigerators' outer bodies and their inner food compartments. In addition to reclassification as "hazardous waste," a January 1, 2002 European Union Directive mandated removal of all CFCs and HFCs, including residues originally used to blow the foam bubbles, before refrigeration equipment could be discarded. While reclaiming refrigerant from sealed refrigeration systems was comparatively easy, its extraction from foam insulation required special equipment not even available in England when the mandate went into effect. The Ozone Depletion Network Online Today (2002) therefore expected refrigerant reclamation to add as much as 86 million dollars per year to the cost of disposing of British refrigerators. The United States did not participate in any such program to capture CFCs or HFCs from the foam insulation when discarding refrigerators. Pope and Rauber (222) lament the Bush administration's resistance to advancement of international treaties attempting further constraint of ozone-depleting chemicals even though chlorofluorocarbon restrictions, as they explain, have apparently already reversed the expanding of the hole in the ozone layer. While Pope and Rauber appear dismayed by the Bush administration standing down from warring all-out against pollution, these advocates of more vigorous environmental protection seem oblivious to the perverse impact this war has apparently had on productivity growth.

The IT Revolution's Differing Effects in Europe and the United States

As can be seen below, the 2007 *Economic Report of the President* (59) shows that the recent increase in the rate of U.S. productivity growth was an experience that many Europeans failed to share.

Bush Administration Exhibit 2



Europeans enjoyed the benefit of the computer and related telecommunications revolutions. Other factors, such as the merger waves Harford (2005) found to have had favorable performance effects, may have been adding positive influences favoring productivity growth in Europe. We have just seen that environmental regulation has recently been an important negative influence on productivity growth in Europe, and we can add a broader survey of other negative influences to illuminate the timing of Europe's productivity growth performance.

Skeptical of the significance of the information technology revolution's alleged post-1995 impact in America, Gordon (Five Puzzles) compares the experience of Europe with America. Gordon does not focus on environmental regulation specifically, but looks at social policy more broadly and emphasizes differences seen in the latter half of the 1990s. Europe, in contrast to America, failed to undergo a productivity growth revival from 1995 onward – Europe suffering, instead, a more than one percentage point slowdown in 1995-2003 (compared with 1990-1995), in divergence from America's 0.9 percentage point acceleration in output per labor hour growth (Gordon, Five Puzzles, 43-44). Moreover, Gordon (Table 4) shows a decline from 1.5 percent a year productivity growth in Europe from 1995 to 2000 to 0.9 percent a year from 2000 to 2003, a period during which American productivity growth did not slow at all. Since information and communication technology investment in Europe is similar to in America over the period (but with Europe exceeding in mobile telephones), the productivity growth dissimilarity, in his reckoning, casts doubt on the widely accepted perception of the importance of the information-communication technology revolution in explaining the productivity growth resurgence in America (Gordon, Five Puzzles, 44). However, Gordon (45) cites recent work that indicates that wholesale, retail and securities trading industries using information-communication technology advances accounted for virtually all of the American productivity growth advantage over Europe in the late 1990s. Gordon (46) says:

> …we can suggest in parallel that Europe has fallen behind because European firms are much less free to develop the "big box" retail formats. Impediments include land use regulations that prevent the carving out of new "Greenfield" sites for "big box" stores in suburban and exurban locations, shop-closing regulations that restrict the revenue potential of new investments, congestion in central-city locations that are near the nodes of Europe's extensive urban public transit systems, and restrictive labor rules that limit flexibility in organizing the workplace and make it expensive to hire and fire workers with the near-total freedom to which U. S. firms are accustomed.

Gordon (46) also cites a 1992 report by McKinsey Global Institute that corroborates these assertions. Yet he leaves the post-2000 greater widening of the productivity growth disparity between Europe and the United States not fully explained by these considerations.

Feldstein (2003) argues that more than technological advancement embodied in new computers and other equipment was behind the acceleration in U. S. productivity growth that began in the mid-1990s. Incentives and institutional structures were vital also and in Europe, where their positive influences were relatively lacking, productivity growth failed to accelerate in spite of the same equipment advances as in the U. S. In contrast to the United States, where computer advances facilitated producing more output with fewer workers and middle managers, European work rules embodied in legislation and union contracts prevented shuffling workers around or reducing their numbers (Feldstein 2003, 5). This greatly diminished the incentives in Europe, moreover, to achieve labor saving technological progress. In a 2001 article in the *Financial Times*, Feldstein had made a similar argument, emphasizing that productivity growth was achieved by increasing output relative to personnel involved in purchasing, sales, marketing, product design, accounting and management in the U.S. while labor market rigidities and fundamental limitations in employment practices and management incentives in Europe stifled productivity growth.

Higgs (2004, 123-131), citing Feldstein, emphasizes that European labor market regulations stifled growth of the labor force and produced a relentless trend of rising unemployment over a period when American unemployment largely cycled up and down and labor force growth was massive. This helps illuminate Maddison's observation that U. S. economic growth outperformed Europe's at the same time that European productivity growth did not, over the 1973 to 1998 period, exhibit anywhere near the unexplained decrease that was seen in U. S. productivity growth. Furthermore, Higgs' explanation leaves room for additional factors to help explain the more recent deficiency of European productivity growth – factors similarly imbedded in the alleged European regulatory imbroglio to which these authors call our attention. Environmental regulation is a neglected additional factor.

Understanding of the jump in U.S. productivity growth in the second half of the 1990s is improving along with an understanding of why Europe did not share this jump. The very rapid output quality change of the IT revolution propelled an explosion in perceived productivity growth in industries producing IT equipment. Europe lagged behind in the 1990s because of a broad variety of regulations and restrictions partly (if not largely) identified by Feldstein, Higgs, and Gordon. Then, after the 1990s, the additional acceleration of American productivity growth suggests that environmental regulation displays particularly strong explanatory power since Europe and the U. S. then diverge in environmental regulatory strictness.

Is using new computer equipment or relaxing overzealous environmental regulation in the U. S. causing the post 2001 jump in productivity growth? A 2004 paper by Stiroh (23-24), based on both a meta-analysis of other papers and an additional statistical study of its own, concludes that IT investment has been important in powering the American productivity growth revival. However, argues Stiroh, another causative omitted variable seems reasonable to suspect based on the nature of findings of many of the studies examined. Stiroh (1) devotes attention to the output elasticity of IT investments and examines results of 20 published econometric studies. The median estimate is 0.046 for these 20 studies, but results range from negative 0.06 to positive 0.24, showing the impact of IT investment to be surprisingly uncertain. Stiroh's findings certainly fail to disprove the hypothesis that relaxing environmental regulations has been playing a large role in causing the productivity growth acceleration during the period of the Bush presidency. Environmental regulation is a very powerful omitted variable that many investigators are apparently neglecting when they look to the computer revolution, supposing it to be the dominant cause. Perhaps they tend to omit a controversial variable if they know it to be offensive to a large proportion of their potential readers, especially if inclusion might undermine political causes that such investigators otherwise favor.

Post-1973 Environmental Regulation Impact Studies

Environmental regulation appears to be quite well known as a major source of the propensity toward stagnation among manufacturing industries that are susceptible to its rigors. Virtually every investigator attempting to look for it identifies at least some degree of negative impact of environmental regulation on productivity growth. A statistical brief issued by the U.S. Bureau of the Census (1993) states that every dollar in pollution abatement costs incurred by the average firm in the Bureau's statistical sample results in $3 to $4 worth of reduction in productivity. At the end of this pamphlet, the Census Bureau lists two contact people, one an administrator of Economic Statistical Briefs and the other, Wayne B. Gray, a leading authority on the subject of pollution abatement and productivity. Subsequently, Gray published a 2002 book in which he summarizes much of the existing empirical literature on the subject and provides copies of 21 previously published journal articles.

Gray's Table 1

Environmental regulation and productivity slowdown, US manufacturing sector: comparison of results (Source: Wayne B. Gray, 2002, Table 1, p. xvii)

	Annual reduction %	Slowdown %	LP/TFP	Method	Data	Time period
Denison (Chapter 1)	0.23	NA	TFP	Growth account	Aggregate	1975
Christainsen and Haveman (Chapter 2)	0.27	21	LP	OLS	Aggregate	1973–77
Gray (Chapter 3)	0.17–0.28	12–19	TFP	OLS	Industries	1973–78
Conrad and Morrison (Chapter 6)	0.23	18	TFP	Index	Aggregate	1973–80
Norsworthy *et al.* (1979)	0.16	11	LP	Growth account	Aggregate	1973–78
Scherer (1982)[1]	0.19–0.27	24–35	LP	OLS	Industries	1973–78

[1] Scherer (1982) includes 81 manufacturing and six non-manufacturing industries.

The earliest studies seemed to find relatively smaller impacts on productivity growth while some of the later studies seemed to identify environmental regulation as a relatively more stagnating influence. In the introduction to his readings book, Gray (xvi-

xvii) began with a synopsis of a study that Denison undertook shortly before his death. Denison found that early pollution abatement efforts reduced the growth of U.S. net national product by nearly a quarter of a percentage point per year from 1973 to 1975 (a result seen on page 14 of Gray's reprint of Denison's article). This initial phase of such regulation seems partly obscured by the "energy crisis" of that period. In addition to Denison's growth accounting results, Gray summarized empirical studies by Christainsen and Haveman, Gray, Conrad and Morrison, Norsworthy, et al, and Scherer – 6 separate studies in total, which are summarized in his Table 1 above. Gray (xvii) asserted that, although the methodologies of the separate studies varied widely, the findings were all similar, showing in the neighborhood of slightly more than a 0.2 percentage point reduction in annual multifactor productivity growth, during the 1970s, attributable to environmental regulation.

Gray (xviii) cited other studies that suggested a larger effect such as the 1986 Barbera and McConnell paper reporting that pollution abatement capital expenditures in the chemicals, primary metals and stone, and clay and glass industries caused a 0.28 to 0.38 percentage point reduction in annual productivity growth. Gollop and Roberts (Gray 2002, xix) compared firms in the electric power industry and found firms constrained by environmental regulations suffered a 0.59 percentage point per year resulting productivity growth slowdown.

Gray (xxi) also cited two general equilibrium studies, one by Jorgenson and Wilcoxen and another by Hazilla and Kopp. Jorgenson and Wilcoxen (Gray 2002, xxi) found that environmental regulation reduced U.S. output growth by 0.19 percent per year over the 1974-85 period. Hazilla and Kopp (Gray 2002, xxii) found that, by 1990, while environmental regulation imposed significant direct costs on only a few industries, the other industries throughout the economy suffered substantial indirect costs as effects on input prices rippled throughout the system. By 1990, the total of all these costs in the Hazilla and Kopp model represented a 977 billion dollar reduction in U.S. GDP (Gray 2002, xxii). Some of the later studies seemed to find a larger impact as if stagnating effects were increasing.

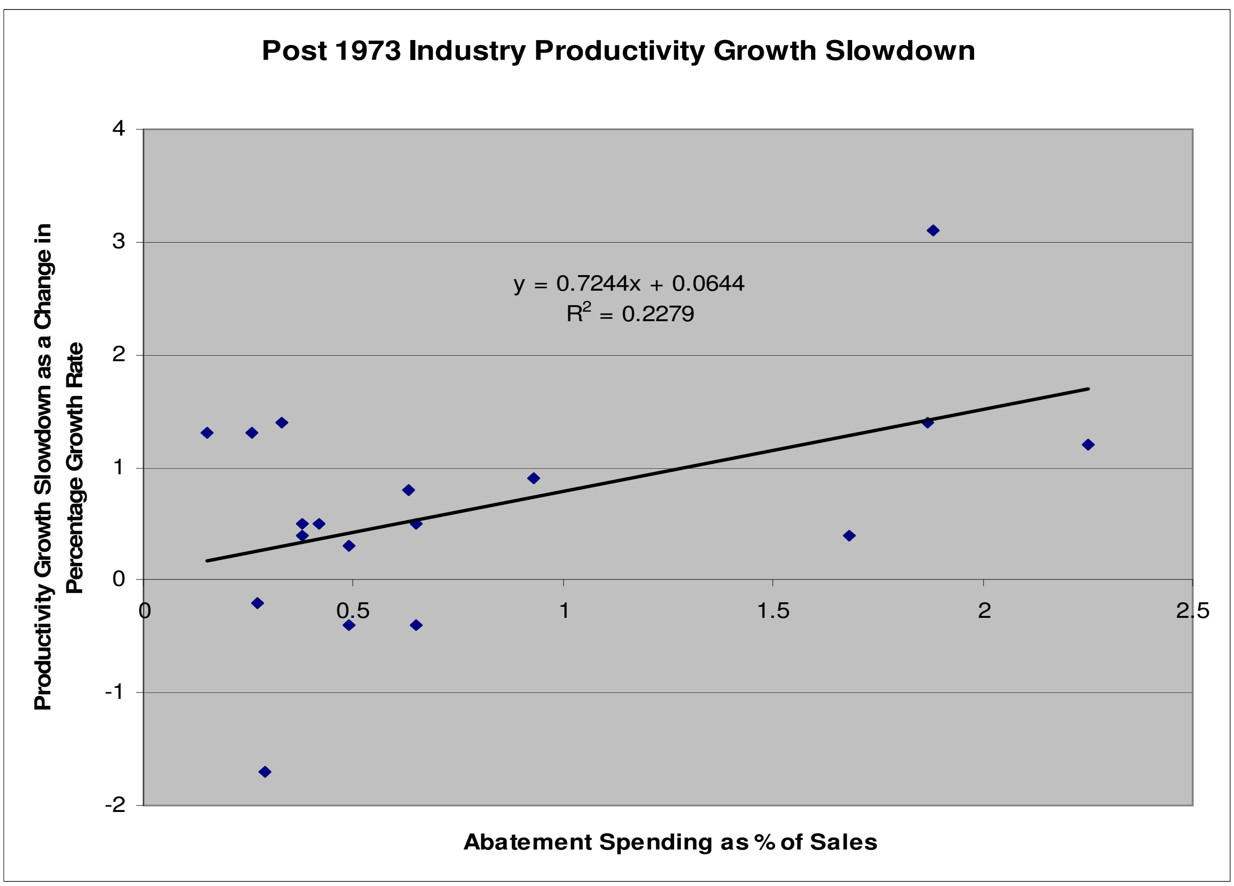
A separate 1995 study that Robinson completed for the U.S. Congress, Office of Technology Assessment, obtained results showing a larger effect than the earlier studies Gray features. Although regulatory compliance costs by 1986 were only about 1.14 percent of total shipments for the entire manufacturing sector (426), Robinson (416) found that resulting productivity reductions were cumulatively an order of magnitude greater. He (387) concluded that, as its dominant effect, environmental regulation ostensibly "diverts economic resources and managerial attention away from productivity enhancing innovation." In Robinson's lengthy analysis, he ultimately found (411 and 414) that environmental regulations apparently slowed multifactor productivity growth between 1974 and 1986, in the manufacturing sector of the U.S., by about a full percentage point per year, making the sector's output about 11.4 percent lower than it might otherwise have been by 1986. By extending this rate over a longer interval, we can infer that, without environmental regulation, manufacturing output might have grown about 22 percent more than it actually did between 1970 and 1990, had the annual rate of slowing Robinson found not occurred over that entire period (Marxsen 2000, 76).

Hazilla and Kopp found that, with all its ripple effects, environmental regulation reduced real GNP by 92.41 percent as much as such regulation reduced manufacturing output over the period of their study (Marxsen 2000, 76). Inferring from this proportion, because Robinson's work implies that manufacturing output might have been over 22 percent higher by 1990, Hazilla and Kopp lead us to suspect that real GDP might have been over 20 percent higher by 1990. Since environmental regulation, in a one independent variable model such as will be illustrated below, seems capable of explaining a large portion of the productivity growth slowdown that began in 1973, one should regard such regulation as a critically important omitted variable in models that ignore it.

Environmental Regulation's Differing Effects Among U. S. Industries

The U. S. Census Bureau has assembled data (and sporadically published it) reflecting pollution abatement expenditures by industry, especially for the manufacturing sector. Comparing such data with the post-1973 decrease in each industry's productivity growth resulted in the summary seen below in Figure 1 (obtained from Table 1 data in the Appendix).

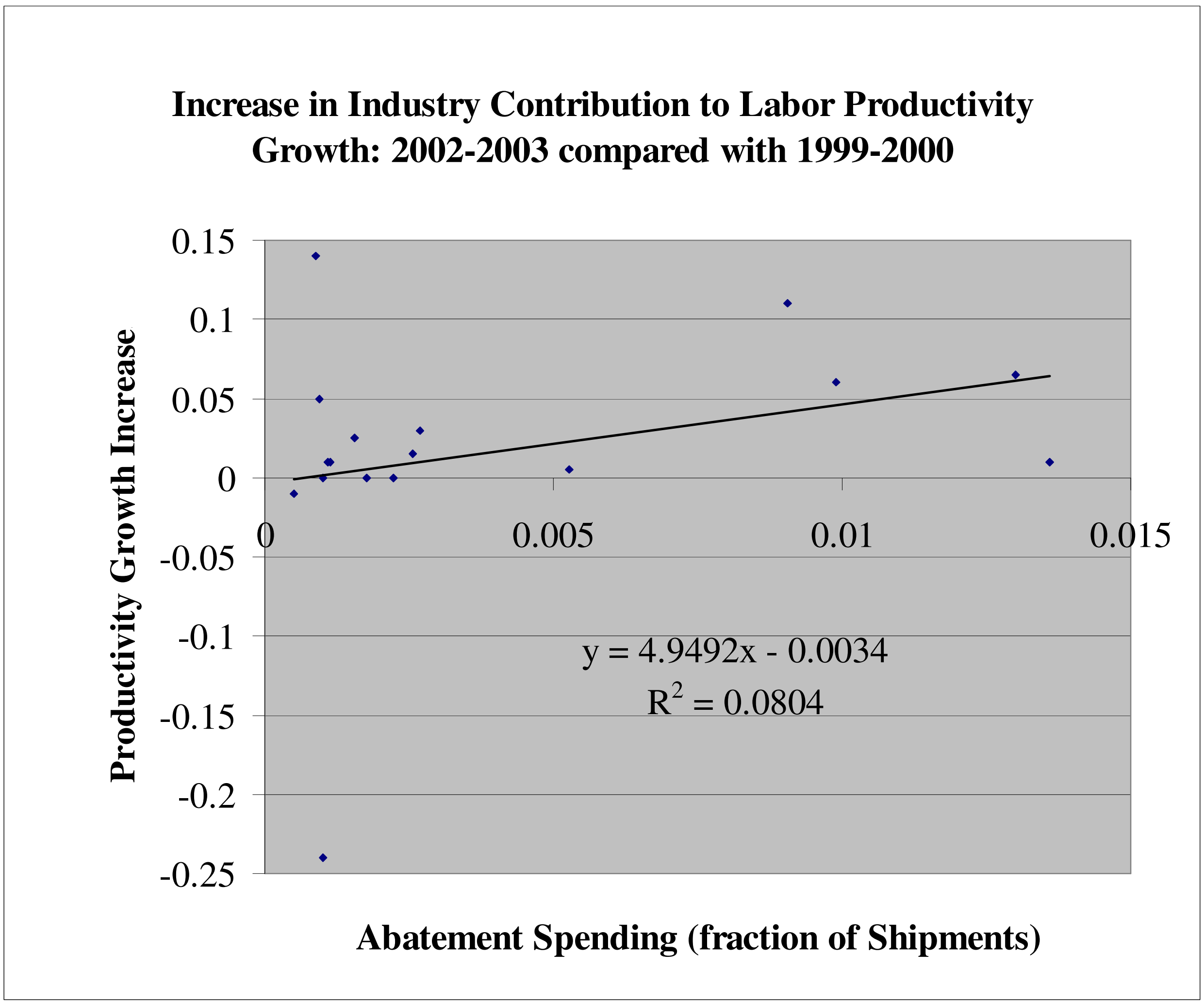
Figure 1



Source: Marxsen, 1997, Graph 1, p. 31.

The pattern seemed quite clear and similar to what Robinson had found by an analogous methodology. Industries that carried greater pollution abatement expenditure, as a fraction of industry sales, also suffered greater declines in average productivity growth (multifactor) in the 1973 to 1992 period compared with their 1949 to 1973 period averages (Marxsen, 1997). Pollution abatement expenditures consisted of U. S. Bureau of the Census compiled capital expenditures plus net operating costs for 1991 alone, as provided by the Office of Technology Assessment. While an average of abatement expenditures over all the years in question might have been preferable, the Office of Technology Assessment did not provide data for other years and neither was comparably published data available from the U. S. Bureau of the Census. As explained in a 1997 article in *Regulation*, the estimated impact, on multifactor productivity, of pollution abatement requirements was large enough to make manufacturing sector output about 17 percent lower by 1992 than it might have been without environmental protection requirements (Marxsen, 31). The cumulative lost output is much larger than the seemingly much more modest annual direct compliance costs. Now compare:

Figure 2



As if illustrating that the Bush administration was removing the previous impediment to productivity growth, a remarkably similar industry pattern of productivity acceleration following the first year in office of the Bush administration appears above in Figure 2 (obtained from Table 2 data in the Appendix).

Here, 1999 pollution abatement expenditures (capital plus operating) in available industries are presented as the independent variable explaining the increases in the various industries' contributions to labor productivity growth in the 2002-2003 period compared with the 1999-2000 period (earlier period two year annual averages being subtracted from the later two year periods' annual averages).

Nordhaus (2005, Table A-2, 30) provides estimates of each industry's contributions to annual labor productivity growth in his effort to see whether the surge in productivity exists outside of computer manufacturing and related industries. Except for transportation equipment manufacturing and computer manufacturing, in Figure 2 (and Appendix Table 2), the pattern of points looks strikingly like the pattern in Figure 1 (and Appendix Table 1). In fact, transportation equipment shows a productivity growth change that is quite large relative to its pollution abatement expenditures also in the earlier data of Appendix Table 1. Because pollution abatement spending in automobile manufacturing is low relative to the very costly abatement equipment embodied in the product itself, one might underestimate the impact of easing the rigors of environmental restrictions by just focusing on abatement in the manufacturing process alone.

In contrast, computer manufacturing is responding to other variables: the bursting of an IT capital market bubble happened in this interval. Eliminating from Figure 2 transportation equipment and computer manufacturing as two outliers dramatically increases the coefficient of determination (R^2) from 0.0804 to 0.2915. The standard error of the regression coefficient for abatement expenditure likewise falls from 4.3223 down to 1.6562, making the coefficient (3.8302) statistically significant at the 95 percent level. The standard error of the abatement expenditure coefficient in Figure 1 was, for comparison, 0.3333, and its estimated value was likewise statistically significant at the 95 percent level.

Conclusion

Rapid productivity growth has already proved to be a redeeming feature of history. It stayed some of the plagues that Malthus once predicted. It has, perhaps, recently moderated the tendency toward the acceleration of inflation that otherwise might have arisen in America since 1995. America faces serious problems in the projected funding of Social Security obligations and in managing its growing national debt. However, if productivity growth continues at rates seen in some of the past several years, it might significantly rescue America from these and many other problems that have befallen her with the slowing of productivity growth that plagued the nation in the last quarter of the 20th Century. Rapid productivity growth sparks new hope that a return to excessively enthusiastic environmental regulation could yet dash. A kinder, gentler administrative philosophy of enforcement of environmental regulations might profoundly benefit future productivity growth – that is the principle policy implication of this paper.

The overall impact of environmental regulation on productivity growth has seemed difficult to measure empirically, and formal cross-sectional and time-series regression models appear to have failed to persuade the public convincingly. This paper has attempted to make its case more like an attorney's argument where circumstantial evidence predominates.

America's acute productivity growth slowdown from 1973 to the mid-1990s was deeper than in Europe and her environmental regulatory zeal was likewise greater than in Europe. Numerous studies linked a significant part of the slowdown to environmental regulation in America, and some studies linked a very large part. The acceleration of productivity growth in America that Europe largely failed to experience was coincident in the U.S., with just the opposite of a rising crescendo of the environmental regulatory strictness in Europe. Regulation in America suffered little or no setback in the latter 1990s, and most sectors of the U.S. economy did not participate in the productivity growth acceleration during the second half of the 1990s. The very rapid productivity growth after 2000 likewise is concurrent with the Bush administration's alleged laxity in maintaining the regulatory rigor inherited from environmental protection initiatives instituted under previous administrations. Other factors are also almost certainly at work, but the post-2000 experience greatly adds to the awareness that environmental regulation has likely been a strong influence in causing the past slowing of productivity growth. Econometricians should not abandon the rigorous effort to detect or demonstrate this connection more persuasively.

Appendix

Table 1

Multifactor Productivity Growth Slowdown and 1991 Pollution Abatement Expenditure as a Percentage of Industry Final Sales

Industry	Productivity 1949-1973 Percent	Productivity 1973-1992 Percent	Slowdown per year Percent	Pollution Spending Percent
Food	1	0.5	0.5	0.42
Textile	2.1	1.6	0.5	0.38
Lumber	1.4	0.6	0.8	0.63
Furniture	0.7	0.3	0.4	0.38
Paper	1.5	0.1	1.4	1.87
Printing	0.5	0.8	1.3	0.15
Chemical	2.8	0.3	3.1	1.88
Petroleum	0.8	0.4	1.2	2.25
Rubber	1.3	1	0.3	0.49
Leather	0	0.4	0.4	0.65
Stone	1	0.1	0.9	0.93
Prim Metal	0.4	0	0.4	1.68
Fab Metal	0.9	0.4	0.5	0.65
Machinery	1	2.7	1.7	0.29
Electric	2.2	2.6	0.4	0.49
Trans Eqp	1.6	0.2	1.4	0.33
Instruments	1.8	2	0.2	0.27
Misc.	1.5	0.2	1.3	0.26

Source: Marxsen, 1997, Table 1, p. 30.

Table 2

Increase in Industry Contribution to Labor Productivity Growth and 1999 Pollution Abatement Expenditure as a Fraction of Industry Shipments

	1999-2000 Average Contribution	2001-2002 Average Contribution	Increase in Productivity Contribution	1999 Abatement Spending
Primary metal mfg	0.02	0.03	0.01	0.0136
Petroleum & coal	-0.035	0.03	0.065	0.0130
Paper mfg	-0.01	0.05	0.06	0.0099
Chemical mfg	0.04	0.15	0.11	0.0091
Nonmetallic mineral	0.005	0.01	0.005	0.0053
Food Bev & tobacco	0	0.015	0.015	0.0026
Fabricated metal	0.035	0.065	0.03	0.0027
Textile mill & products	0.02	0.02	0	0.0018
Wood product mfg	0.005	0.005	0	0.0022
Plastics & rubber	0.025	0.05	0.025	0.0016
Printing & related	0.01	0.02	0.01	0.0011
Electrical equipment	0.03	0.04	0.01	0.0011
Furniture & related	0.005	0.005	0	0.0010
Computer & electronic	0.61	0.37	-0.24	0.0010
Machinery mfg	-0.005	0.045	0.05	0.0009
Transportation equip	0.03	0.17	0.14	0.0009
Miscellaneous mfg	0.04	0.03	-0.01	0.0005

Source: Derived from Nordhaus, 2005, Table A-2, p. 30, and U.S. Census Bureau, 2002, Table 1, p. 1

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