Regulation and Productivity Growth

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In recent years, it has become increasingly fashionable to attribute a myriad of our economic and social difficulties to excessive government regulation. If we are to believe the rhetoric, government regulation is partly or largely to blame for soaring inflation, lagging growth in GNP, declining productivity growth, the decline in the value of the dollar, and even general reductions in the animal spirits of entrepreneurs. While many of these claims may eventually be shown to have some validity, the evidence linking regulation to these various national economic maladies is presently very weak.

The reaction against regulation which has developed in the past few years reflects the confluence of two different forces: (i) a growing concern that "economic" (rate-setting, entry-restricting) regulation overly restricts competition and protects regulated firms from new technologies and new competitors; and (ii) the view that newer "social" (health-safety-environmental) regulation directs too many resources to controlling various hazards, excessively reducing privately traded goods and services. These newer forms of regulation are generally the inspiration for the charge that business is over-regulated and thus unable to discharge its function of aggressively exploiting new technologies and bringing new products to the market as it once did. The result is declining productivity, a stagnant economy, and perpetual inflation.

It is not very difficult to see how this connection between stagflation and regulation has developed. Prior to the 1970s, the economy managed to grow at a rather satisfactory rate without bouts of major peacetime inflation. While we are discovering that productivity growth may have been declining throughout the post World War II period,[1] it did not begin its catastrophic decline until 1973.[2] Inflation surged in 1974 after the relaxation of price controls only to decline briefly, but then to surge ahead to double-digit levels by 1979. Given that the Occupational Safety and Health Administration, the Environmental Protection Agency, the National Highway Traffic Safety Administration, the Consumer Product Safety Commission, and the National Environmental Policy Act had their origins between 1969 and 1972 it is not surprising that many observers see a link between pervasive regula-

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[1] See Norsworthy *et al.* (1979)

[2] See Denison (1979) for a detailed analysis of this decline.

tion and stagflation. But this case has not been substantiated by thorough empirical work, and much of it may in fact not withstand careful scrutiny.

Even at a superficial level, it is difficult to place the blame for lagging productivity growth and inflation upon regulation. The 1970s were not tranquil years in other respects. The commodities boom of 1973 preceded the oil embargo and the subsequent surge in world oil prices. Price controls were in place for almost three years, and during part of this period macroeconomic policy was excessively stimulatory. Labor force participation rose at an unexpected rate. And the economy shifted gears from a fairly major war to virtual peacetime production. The confluence of these forces could be expected to have seriously disruptive effects upon the economy, and it would be naive to associate our ills solely with one of them.

In this paper, I can only review the evidence linking productivity growth and a few of the more extensive forms of regulation — environmental and worker-safety programs. I shall argue that whatever the effects of these policies upon recent productivity growth, there is a danger that the future effects may be more pronounced. This conclusion flows from the form which these policies take — a form dictated by political forces. Unfortunately, it will be very difficult to measure these future impacts upon capital formation and productivity growth, and by the time we are able to detect them it may be very difficult to alter course.

I. The New Social Regulation

The number of regulatory programs which affect input choices and production decisions in American business is staggering. A partial listing of the most important of these programs (and the agencies responsible for them) would have to include:[3]

Water pollution (EPA)	Employee safety — mining (MSHA)
Air pollution (EPA)	Employee safety — nonmining (OSHA)
Toxic substances (EPA)	Employee health — nonmining (OSHA)
Hazardous wastes (EPA)	Land use and surface mining (BLM)
Noise (EPA and FAA)	Food and drug safety (FDA and USDA)
Radiation (EPA and NRC)	Consumer product safety (CPSC)
	Automobile safety (NHTSA)

[3] For the noncognoscenti:
EPA = Environmental Protection Agency
FAA = Federal Aviation Administration
NRC = Nuclear Regulatory Commission
MSHA = Mine Safety and Health Administration
OSHA = Occupational Safety and Health Administration
FDA = Food and Drug Administration
BLM = Bureau of Land Management (Department of the Interior)
USDA = Department of Agriculture
CPSC = Consumer Product Safety Commission
NHTSA = National Highway Traffic Safety Administration

This is only a partial list, and it fails to account for the myriad of programs within each category. For instance, toxic substances may be regulated by EPA under FIFRA, RCRA, or TSCA.[4] In each instance, the criteria imposed by legislation are different, and firms must respond accordingly.

In virtually all of these regulatory programs, a standard-setting process is utilized to control the undesired externality. These take the form of "performance standards" — requiring, for instance, that regulated entities discharge no more than x parts per million into the air, water, workplace, or final product — or engineering standards — requiring the installation of specific control equipment or the use of specific production techniques. While economists have often been critical of the standards-setting approach to regulation because of its inefficiency,[5] it is likely to continue to be the predominant mechanism for instituting the newer social regulation. An important reason for this is that it suggests to the public that the particular problem is being addressed to the maximum extent feasible.

An unfortunate part of the standards-setting process is the tendency to saddle new facilities, products, or firms with tighter standards than those facing existing entities or products. This practice exists for a number of reasons. First, there is a popular view that new facilities or products can be designed more economically to limit the generation of undesired externalities than controls upon facilities or products already in existence. Retrofitting old facilities or redesigning existing products is more difficult than designing them *de novo*. Second, this practice conforms with a notion of "forcing technology." Setting ambitious goals for future products or plants will unleash engineers and scientists to create technological solutions heretofore thought impossible. Third, it is often impossible to enforce standards for older facilities or products, but simple to set very stringent standards and enforce them on newer facilities or products. Fourth, the political forces generally operate in favor of lenient treatment for existing products or plants.[6] Obviously, existing assets and products are likely to be more heavily represented in political decision-making than products or plants yet to be built. Finally, a regulatory process biased against new development and growth addresses a commonly expressed concern that market forces overexploit certain common-property resources such as air, water, and land. Slowing growth through regulation is one method — if an imperfect one — for managing these resources.

The pervasiveness of the bias against new facilities or products in federal government regulation cannot be demonstrated with precision. One would have to undertake a thorough review of all major regulatory programs, a task quite beyond the scope of this paper. Nevertheless, a few

[4] Federal Insecticide, Fungicide, and Rodenticide Act of 1972, Resource Conservation and Recovery Act of 1976, and Toxic Substances Control Act of 1976.

[5] The classic statement is in Weitzman and in Spence and Weitzman.

[6] See Crandall (1979) for some evidence.

important examples might provide the reader with sufficient evidence to form an *a priori* case that the bias exists:

- The Congress requires EPA to establish "best available control technology" standards for all *new* stationary sources of air pollution, but existing sources often escape regulation altogether because of inadequate state emissions inventories or insufficient funds for enforcement.
- As the Congress has set increasingly stringent air-pollution standards for new automobiles, it has steadfastly refused to require states to pursue retrofitting policies for older vehicles.
- Although enforcement of standards for conventional water pollutants from existing industrial sources has been incomplete, tighter "best available control technology" standards for new sources have been enforced by EPA.
- In order to protect less developed regions of the country from environmental degradation (and more developed regions from loss of economic activity), Congress has required EPA to set tighter air pollution standards in the less populated regions of the country.
- In regulating chemicals under the Toxic Substances Control Act, EPA requires premarket notification and testing of new chemicals, but it lacks the resources to provide similarly thorough analyses of all chemicals already on the market.
- In determining the efficacy and safety of nonprescription drugs, FDA is moving much more slowly on older drugs which are already on the market than on new introductions.
- Congress has required EPA to mandate flue-gas desulfurization systems on all new power plants using coal, regardless of the coal's sulfur content. This was required to prevent midwestern utilities from substituting low-sulfur coal from new western surface mines for higher sulfur coal from older Appalachian mines.
- The National Highway Traffic Safety Administration's safety standards for automobiles apply only to new automobiles, not to used vehicles.
- HUD has proposed a rule requiring developers to submit "urban-impact statements" demonstrating that new shopping malls will not damage older shopping districts in downtown locations when federal funds are involved.
- The Department of Energy has proposed strict new energy-conservation building codes for new buildings, but is not proposing the retrofitting of older buildings.

This list is not intended to be exhaustive, but it provides some evidence of the new-source bias in environmental, health, safety, and energy regulation. Similar lists could be compiled for traditional entry-restricting, rate-setting regulation. The CAB, ICC, and FCC have required licenses to be obtained for new facilities, and each has found itself confronted with the pressure from existing regulated carriers to resist these applications. Large freight cars, larger commuter airline planes, and satellite business systems have been delayed as regulatory procedures are extended by intervening competitors or other interested parties.

Given the central role of technological progress in improving productivity, these regulatory biases against new products and facilities must have some effect upon productivity growth. This is particularly true if one accepts the view that much of technology is embodied in new assets and cannot be adapted easily to older assets. In some cases, this regulatory bias is damaging even if retrofitting is possible. "New sources" of pollution are generally defined to include older facilities which are temporarily closed for renovation. Thus, one would expect environmental policy to be reducing the rate of technological diffusion in basic pollution-intensive industries. To the extent that other regulatory policies (some of which are enumerated above) share this bias, productivity growth will be further reduced.

Note that the above argument concerning the relationship between regulation and productivity is quite different from that generally addressed by students of productivity growth such as Denison, Kendrick, or Norsworthy. Productivity growth is reduced in their empirical analyses by a diversion of productive resources away from the production of private goods and services towards mandated health, safety, or environmental facilities. These resources are used to *produce* less noise, more safety, or less pollution. New facilities are foregone only because resources are diverted to these compliance requirements. I am arguing that investments are foregone not simply because resources are invested in complying with regulations but because the regulations themselves discourage what would otherwise be productive investments. Savings are thereby diverted to less productive investments in other sectors of the economy, and productivity growth declines.

II. Regulation and Productivity Growth — The Crude Evidence

A useful point of departure for a survey of the effects of regulation on productivity growth is a sectoral breakdown of productivity trends since World War II. If regulation were responsible for much of the recent decline in productivity, one would expect to observe sharper declines in mining, utilities, and manufacturing than in, say, trade or services. In fact, Table 1 drawn from Norsworthy et al. displays some rather puzzling trends.

The rate of growth of labor productivity in the private business sector has clearly been declining since World War II; moreover, the rate of decline has been accelerating. Productivity growth in manufacturing is declining at a more moderate rate than the average for the economy while productivity in mining and construction has been actually *falling* at a precipitous rate. It is interesting, however, that two traditionally regulated sectors — communications and finance — have evidenced rising trends while the labor-intensive sectors, such as trade, services, and construction, have suffered declines in productivity growth. Since none of the latter three sectors has been heavily impacted by environmental, health, and safety regulations, it is clear that the new forms of regulation can hardly be the sole culprits in our postwar productivity slide.

Table 1
Trends in Labor Productivity by Major Sector (1948–1978)

	Average Annual Rate of Growth of Output per Manhour		
	1948–65	1965–73	1973–78
Private Business	3.2	2.3	1.1
Sectors with rising productivity trends:			
Communication	5.5	4.8	7.1
Finance, Insurance and Real Estate	1.0	-0.3	1.4
Sectors with modestly declining productivity trends:			
Agriculture	5.5	5.3	2.9
Manufacturing	3.1	2.4	1.7
Sectors with sharply declining productivity trends:			
Mining	4.2	2.0	-4.0
Trade	2.7	3.0	0.4
Utilities	6.2	4.0	0.1
Construction	2.9	-2.2	-1.8
Services	1.5	1.9	0.5
Transportation	3.3	2.9	0.9

Source: Norsworthy et al.

The only clear indictment of regulation as the source of productivity declines which emerges from Table 1 is in the mining sector. The decline in labor productivity in mining occurred precisely in the year in which much more stringent mine-safety legislation was enacted, 1969.[7] For instance, in the previous 10 years, productivity in coal mining was growing at 5.8 percent per year. Thereafter, it *declined* at a rate of 3.2 percent per year.[8] While other forces may have been at work, it is difficult to avoid the conclusion that a heightened concern for worker safety had much to do with this stunning reversal.

The sharp decline in utilities suggests, however, that two other major influences may be at work — the sharp rise in energy prices in 1973–74 and the deep recession of 1974–75. In fact, the timing of an absolute decline in utilities' labor productivity in 1974 and 1975 provides further evidence of the importance of these forces.

Why has manufacturing held up so well? If we look in detail at manufacturing, we see major differences in productivity growth trends across industries. Moreover, as Table 2 shows, the industries with the sharpest decel-

[7] Federal Coal Mine Health and Safety Act of 1969.

[8] U.S. Department of Labor, Bureau of Labor Statistics, *Productivity Indexes for Selected Industries, 1979 Edition,* Bulletin 2054.

Table 2
Pollution & Worker-Safety Capital Outlays and Productivity Growth—Selected Industries (1959-77)

Industry	SIC *Code*	Pollution Control Capital Expenditures 1973-77 (million $) *BEA*	*Census*	Employee Health and Safety Capital Expenditures 1973-77 *(million $)*	Value-Added 1976 *(million $)*	Average Increase in Output per Employee Hours (% per year) 1959-70	1970-77	1959-73	1973-77
Grain Milling	204	—	158	—	6083	3.9*	3.9	3.3**	5.3
Pulp Mills	261		393		975				
Paper Mills	262	2328	1124	276	4878	4.2	3.3	4.5	1.5
Paperboard Mills	263		640		3128				
Bldg. Paper Mills	266		17		240				
Inorganic Chem.	281		689		6165	3.4	2.5	4.0	-0.2
Plastics Mat.	282		531		6648	3.7	8.1	5.5	4.9
Indus. Org. Chem.	286	3058	1434	854	11348	5.6	3.2	6.4	-1.4
Misc. Chemicals	289		169		3119	0.7	3.9	1.5	3.6
Petroleum Refining	291	5069	2041	1053	11410	5.0	3.7	5.6	0.7
Hydraulic Cement	324	—	318	—	1461	3.8	2.5	4.1	0.4
Steel	331	1791	1987	358	17274	1.3	1.9	2.5	-1.4
Copper, Lead, Zinc	3331,2,3	2369	652***	436	1051	1.5	3.5	2.5	1.4
Aluminum	3334		317		1466	2.6	0.6	2.5	-0.4
Total, Above Industries		14615	10470	2977	75,245	3.5	3.4	4.2	0.8
		(47.0%)	(65%)	(21.9%)	(14.7%)				
Total, All Manufacturing		20106	16108	7000	511,471	2.6	2.8	2.9	1.8
		(64.6%)	(100%)	(51.4%)	(100%)				
Total, All Mfg. less Above Industries		5491	5638	4023	436,226	2.4	2.7	2.7	2.0
		(17.7%)	(35%)	(29.5%)	(85.3%)				
Mining		414	—	563		3.9	-3.4	2.9	-5.9
		(1.3%)		(4.1%)					
Electric and Gas Utilities		8987	—	887		5.9	2.3	5.3	1.3
		(28.9%)		(6.5%)					
Total, Above Industries		24016	—	4427		—	—	—	—
		(77.2%)		(32.5%)					
All Industries		31105	—	13617		2.3	1.7	2.4	0.9
		(100%)		(100%)					

* — 1963-1970
** — 1963-1973
*** — *Excludes spending by SIC 3331 and 3333 in 1977.*
Source: See fns. 8-11. Productivity Data for SIC 28 are unpublished BLS Data.

eration in productivity growth are those which account for most of the pollution-control and worker-safety outlays.

Expenditures for either pollution control or worker safety include capital outlays and current operating expense. Unfortunately, there are no cross-sectional data on the operating costs of mandated occupational safety and health measures. McGraw Hill publishes rough two-digit industry breakdowns of capital outlays on worker health and safety.[9] Similarly, BEA has published estimates of capital spending for pollution control by major industry categories since 1973,[10] and the Census publishes detailed manufacturing-industry data on both capital outlays and operating expenditures for pollution control.[11] To provide rough comparability, I have reproduced in Table 2 only the capital outlays for 1973–77 for pollution control and worker safety in the most affected industries.

A very small number of manufacturing industries, comprising about one-seventh of total manufacturing value-added, account for nearly two-thirds of pollution capital spending in manufacturing and nearly half of all such expenditures by private industry. These same manufacturing industries — mainly paper, chemicals, refining, and primary metals — also account for almost one-half of manufacturing capital outlays for worker safety. Have these outlays affected productivity growth, as measured by the rate of increase in privately traded output per employee hour?

As Table 2 demonstrates, the rate of productivity growth in the regulation-impacted manufacturing industries has slowed considerably since 1970 and drastically since 1973. While the average manufacturing industry showed a slight increase in productivity between the 1959–70 and 1970–77 periods, the average rate of growth slowed somewhat for the regulation-impacted industries. But the difference between 1959–73 and 1973–77 is more dramatic. Average manufacturing productivity growth declined by almost 40 percent between these two periods — from 2.9 percent per year to 1.8 percent. Productivity growth in the heavily regulated industries fell from a level of nearly 50 percent above the manufacturing average in 1959–73 to less than 1 percent per year in 1973–77. Some high productivity growth industries became negative growth industries in the years after 1973. The implication is clear — regulation appears to be associated with sharp declines in productivity growth in certain manufacturing industries, electric utilities, and mining. But is it the causal agent? And, if so how does this causation operate? We turn to these issues after pausing to examine the quality of the available data.

III. The Problem of Measurement

At present, our sole measure of the stringency of regulation is the estimate of compliance costs available through Census, BEA, or McGraw Hill.

[9] Annual McGraw Hill Survey — *Investment in Employee Safety and Health.*

[10] U.S. Department of Commerce, Bureau of Economic Analysis, *Capital Expenditures for Pollution Abatement.* (Published annually in the *Survey of Current Business.*)

[11] U.S. Department of Commerce, Bureau of the Census, *Pollution Abatement Cost and Expenditures,* annual issues.

Companies report compliance costs for pollution control or worker safety, but it is far from clear that these estimates are very accurate or unbiased. Given the form of regulation, a standards-setting process in which administrators are encouraged or instructed to be "reasonable," there is likely to be an upward bias to reported compliance costs.

Equally important is the difficulty in separating compliance costs from other costs of doing business. If pollution control simply means installing a device to capture a residual from the production process which is then buried safely or disposed of by some other firm, the measurement of the costs of compliance might be straightforward. But few pollution or worker-safety problems lend themselves to so neat a solution. Different materials might be used so as to reduce the externalities problem. If utilities switch to low-sulfur coal, how are compliance costs to be measured? The utilities will observe a bidding up of low-sulfur coal prices and a decline in higher sulfur coal prices. How can they know what prices would have been in the absence of regulation?

Another problem derives from the fact that the residuals captured are often fairly valuable. Hydrocarbons or sulfur captured through the treatment of exhaust gases obviously have value, but it is not clear that the sales of these products or the internal use of them is netted out of compliance costs.

Any new investment in a cleaner production facility will produce some efficiency gains. Building a new steel mill which captures more of the energy byproducts and exhaust gases will reduce pollution. But the added investment in pipes and related equipment will also reduce the energy required to make a ton of steel. How much of the exhaust gas system should be credited to pollution control and how much to improved efficiency?

Finally, there are major problems of double counting across regulatory programs. Anything which reduces the discharge of hazardous substances into the environment is also likely to reduce the risk to workers. Are these expenditures reported both to BEA as "pollution" capital expenditures and to McGraw-Hill as worker-safety investments? For example, the refurbishing or reconstruction of a coke oven battery will clearly reduce the discharge of hazardous particulate emissions. But the investment in lower emissions also reduces the risk to workers and is likely to help satisfy OSHA's standard. How can we be sure that the share of the investment in "productive" equipment is separated from "pollution-control" investment and "worker-safety" investment?

To test for the possibility of bias in reported estimates of capital spending for regulation is simply not possible. How do we know what is actually spent in pursuit of regulatory compliance? If we had a more rational regulatory scheme, we would at least have benchmarks against which to assess reported control costs. For instance, if pollution were rationed by price or if discharge rights were tradable, we would have some basis for estimating the incremental costs of control. Or if EPA or OSHA employed civil penalties scaled to the degree to which a firm was generating harmful externalities, we would have a similar measure. Unfortunately, given the enormous array of administratively determined standards and the apparent difficulty in enforcing them, one cannot deduce anything from existing regulatory procedure about costs. Nor do EPA and OSHA have an accurate inventory of dangerous externalities generated before controls were employed; hence, even if we knew the incremental cost of control, we cannot know how much total control each source has employed. It is therefore impossible to make some assumptions about the shape of the incremental cost of control function and to integrate it to obtain a measure of total costs.

In another paper, I have made a mild attempt at estimating potential bias in reported pollution-capital spending data.[12] The Business Roundtable[13] employed Arthur Andersen and Company to carry out a very detailed analysis of regulatory costs for 48 major firms. These data may still be subject to an upward bias, but at least the framework for collecting and tabulating them was developed in advance with the assistance of outside experts. Moreover, the approach should be consistent across all firms — a consistency which may be lacking in other series. Extrapolating from these 48 firms to all industry is obviously hazardous given that the Roundtable firms comprised only 2 to 59 percent of investment outlays and 9 to 30 percent of sales in their two-digit industries. Nevertheless, an extrapolation based upon 1977 sales results in an estimate of pollution-control investment which is 14 percent lower than the corresponding BEA data for the relevant industries. Using the share of total investment accounted for by the reporting firms generates an even lower estimate of pollution capital spending, almost 20 percent below the BEA estimate for 1977. (See Table 3.)

In short, there is reason to believe that we do not have very good estimates of the size of these outlays and that the reported investment may be biased upward. Were this the only problem in measuring the effects of regulation, some thorough cost accounting reviews by government statistical authorities might improve the accuracy of the numbers. Unfortunately, there are other problems.

IV. Reduction of Productivity Growth through the Diversion of Capital

It is clear that the manufacturing industries most heavily impacted by regulation have suffered the steepest declines in productivity growth. Similar conclusions hold for the mining and utilities sectors. But how could regulation cause this effect? The most straightforward explanation — that adopted by Denison and Norsworthy et al. — is that resources devoted to regulatory compliance are resources which cannot be utilized to produce privately traded goods and services. Denison measures the total factor costs of such compliance while Norsworthy et al. simply remove pollution-control capital outlays from the capital stock to estimate the potential effect upon produc-

[12] See Crandall (1979)
[13] Business Roundtable, *Cost of Government Regulation Study*, 1979.

Table 3
Comparison of Business Roundtable and BEA Estimates of Incremental Capital Outlays for Pollution Control (millions of $)

Industry (1)	Industry Shares of Reporting Firms: Sales (2)	Investment (3)	Estimated Environmental Capital Outlay for Reporting Firms (4)	Estimated Industry Totals Using for Divisor Sales (5) = (4) (2)	Investment (6) = (4) (3)	BEA Estimates (7)
26	.09	.16	81	474	267	468
28	.21	.42	565	1418	709	701
29+13	.14	.18	182	685	533	1167
33	.09	.13	222	1300	900	927
35	.13	.32	40	162	66	104
36	.24	.21	40	88	100	111
37*	.30	.59	726	167	85	163
38**	.14	.24	20	75	44	—
49	.05	.02	81	853	2134	2300
TOTAL (Excluding SIC 38)				5147	4794	5941

* Excludes *motor vehicle program costs.*
** BEA data cover wider industry definition.
Source: BEA and The Business Roundtable, *Cost of Governmental Regulation Study,* 1979.

tivity. The latter approach is generally found in popular discussions: capital devoted to regulatory compliance can only come at the expense of "productive" investment (assuming the saving rate is held constant). Therefore, capital deepening is slowed and the embodiment of new technology in plant and equipment is retarded with obviously deleterious effects upon productivity.

The standard explanation of the effects of diverting capital from productive investments to regulatory compliance is obviously correct as far as it goes. The only possible counter-explanation strains credulity for it suggests that businessmen are goaded into more efficient production techniques by all-knowing regulators. According to this argument, the pollution control in a pulp mill may be a free lunch since the EPA mandated standards reveal to engineers in the paper industry a new method of making pulp of which they had been ignorant. This new technology so strongly dominates the old that it allows the management to retrofit old facilities, install pollution control devices, and produce paper at unit costs which are as low as or lower than preregulatory costs.

As I have suggested earlier, however, the simple measurement of resources diverted to regulatory controls may not suffice in estimating the social costs of regulation. But it is likely during the formative years of environmental, health, and safety policy that actual outlays on compliance are likely to be the most important sources of lost output due to regulation. Can this deduction be borne out by the evidence? If regulation leads to a diversion of capital resources from productive investments and if these industries evidence sharply declining rates of productivity growth, one might expect capital formation (net of pollution capital) to have slowed substantially in the 1970s in these heavily impacted industries. In fact, as Table 4 demonstrates, this did not occur during the 1973–76[14] period (when productivity growth declined most rapidly), in the manufacturing industries identified in Table 2.

Using BLS methodology for calculating the gross capital stock, I removed pollution-control investments from the gross and net capital stock data for the heavily impacted industries in our sample. Unfortunately, data do not exist for years prior to 1973; hence, the capital-stock growth estimates for years prior to 1973 include pollution-control capital. While it would have been nice to eliminate worker-safety outlays as well, the data are not disaggregated sufficiently to permit such a calculation.

The pattern of capital-stock growth exhibited by the pollution-control impacted industries is surprising to say the least. As Table 4 shows, these industries showed very little decline in 1973–76 compared to their 1959–73 rates. Since BLS does not report manufacturing capital stock series without pollution-control capital, the 3.7 and 3.5 percent growth rates for all manufacturing for 1973–76 must be adjusted downward. Given the share of investment going to pollution control in 1974–76, this downward adjustment is about 0.8 percentage points. Hence, in 1973–76, the average manufacturing industry showed lower capital-stock growth than those investing heavily in pollution control even after netting out all pollution-control capital!

A few caveats to the above analysis are in order before moving to other topics. First, the average rate of growth of the capital stock for all manufacturing shows little deceleration in the 1970s and none since 1973. This is in sharp contrast to the results of Norsworthy et al. The reason is that Norsworthy et al.'s capital stock data are translog weighted estimates of the capital stock for 1973–78. I have used simpler BLS estimation methods for a shorter period, 1973–76.

Denison argues that one should use a weighted average of the gross and net measures, heavily weighted towards the gross stock. This is not the place to attempt to resolve such a difference of opinion over methodology, but I favor Denison's approach because of the difficulties in interpreting depreciation rates.

Second, any attempt to draw conclusions concerning 1973–76 must be viewed as hazardous at best. Given the sharp commodities boom in 1973, the oil-price rise in 1974, and the deep recession in 1975, it would be difficult to make much of three years' data on capital growth. How, for example, are we to treat the excessive investment by some steel companies in raw materials processing occasioned by the 1973–74 boom? Given the forced closure of aluminum smelting capacity because of energy shortages, what is the meaning of capital stock in this industry? Might the continued growth in capital stock and declining productivity not simply be the reflection of a recession following so closely on the heels of a commodity boom?

[14] Capital-stock data by industry are available only through 1976.

Table 4
Capital Formation in Pollution-Control Impacted Industries (1959-76)
(Excluding Pollution-Control Capital — 1973-76)

Industry	SIC	1959-70	1970-76	1959-73	1973-76
		(Annual Growth Rate in Gross Capital Stock)			
Grain Milling	204	3.3	4.2	3.4	4.5
Pulp Mills	261	-1.3	-1.6	-1.6	-0.4
Paper Mills	262	6.5	0.4	5.4	-0.3
Paperboard Mills	263	5.8	5.6	5.2	7.8
Bldg. Ppr. & Bd. Mills	266	2.8	2.8	2.6	3.5
Inorganic Chem.	281	3.2	1.3	2.6	2.0
Plastic Material	282	7.2	4.6	6.6	5.0
Ind. Organic Ch.	286	6.1	5.0	5.5	6.6
Misc. Chemicals	289	3.8	4.0	3.6	5.0
Petr. Refining	291	1.1	5.0	1.6	6.6
Hydraulic Cement	324	-0.2	1.2	-0.1	1.8
Steel	331	3.3	-0.3	2.4	0.2
Copper	3331	9.2	3.2	9.1	-2.4
Zinc	3333	-1.2	-0.7	-1.5	1.5
Aluminum	3334	3.0	-0.8	2.5	-2.4
Total of Above		4.0	2.4	3.5	3.2
All Manufacturing (*Including* Pollution Control Capital)		3.6	3.3	3.5	3.7
		(Annual Growth Rate in Net Capital Stock)			
Grain Milling	204	3.1	4.3	3.3	4.7
Pulp Mills	261	-3.0	-0.3	-2.7	1.1
Paper Mills	262	6.4	-1.1	5.0	-2.0
Paperboard Mills	263	5.6	5.6	5.0	8.6
Bldg. Ppr. & Bd. Mills	266	2.7	2.7	2.6	3.4
Inorganic Chem.	281	2.8	1.1	2.2	2.0
Plastic Material	282	7.2	4.0	6.4	4.5
Ind. Organic Ch.	286	6.2	4.7	5.5	6.8
Misc. Chemicals	289	3.8	4.0	3.6	5.1
Petr. Refining	291	1.9	5.3	2.3	6.9
Hydraulic Cement	324	-1.9	2.6	-1.1	3.3
Steel	331	3.5	-1.3	2.3	-0.6
Copper	3331	9.7	1.2	9.3	-5.9
Zinc	3333	-1.9	-0.2	-2.0	2.1
Aluminum	3334	1.9	-1.4	2.1	-3.7
Total of Above		4.0	2.0	3.3	3.0
All Manufacturing (*Including* Pollution Control Capital)		3.7	3.1	3.5	3.5

Source: BLS

V. A Review of the Published Estimates of the Effects of Regulatory Expenditures

Most of the recent research on the effects of regulation upon productivity have centered on environmental policy. Denison's study[15] is an exception, but his recent updating of his 1978 study[16] involves only pollution-control spending. Norsworthy et al.[17] have examined only the effects of pollution-capital outlays upon productivity by major sector. Finally, I have attempted to measure the impact of pollution control spending — capital and operating costs — on productivity in a recent paper.

Denison's study of the effects of regulation upon the recent growth in productivity is clearly the most exhaustive and painstaking of the empirical analyses. He attempts to measure the incremental costs of pollution-control and worker safety (as well as protection against crime) for the private business sector. Excluded from his analysis, therefore, are environmental outlays by government (such as municipal sewage expenditures) and by households (on their automobiles, for instance). He provides a clear explanation of how *increases* in the value of resources devoted to these pursuits reduce the rate of increase in productivity. Since these expenditures were rising rapidly in the mid-1970s, their reduction of potential productivity growth peaked in 1975 at 0.35 percentage points. Between 1975 and 1978, Denison finds that the environmental component of these costs was reducing productivity growth by only 0.08 percentage points per year, down sharply from 0.22 points in 1975, because environmental control outlays were rising less rapidly after 1975 than before.

Norsworthy et al. measure the impact of environmental policy on productivity growth solely through its diversion of capital inputs. In the 1973–78 period, pollution control reduced the growth of capital inputs in productive activity from 2.31 to 2.05 percent for the entire private business sector and from 2.16 to 1.47 percent per annum in the manufacturing sector. The net effect of this reduction in capital input was to lower labor productivity growth by 0.1 percent per year in the private business sector and 0.2 percent per year in manufacturing.

The Denison and Norsworthy et al. approaches to measuring the effects of regulation upon productivity growth have been criticized by Smith and Kopp[18] and by Christiansen, Gollop, and Haveman.[19] They contend that such approaches fail to take into account the effects of regulation upon optimal factor proportions. Moreover, Christiansen et al. argue that Denison's approach provides an upper bound estimate to the effect on productivity because (in addition to factor-choice changes) regulation may draw from underemployed resources or it may result in a higher marginal productivity of

[15] Denison (1978)
[16] Denison (1979a)
[17] Norsworthy et al., (1979)
[18] Smith and Kopp (1980)
[19] Christiansen, Gollop, and Haveman (1980)

resources which remain in the private sector for nonregulatory goals. While these effects would seem to be small if not negligible, the criticism of ignoring changes in factor proportions appears well taken. Note, however, that changes in factor proportions may actually lead to an *underestimate* of compliance costs. Bidding up the price of low-sulfur coal or substituting electric furnaces for blast furnaces and oxygen furnaces in steel production may generate improvements in regulatory compliance without measured outlays on pollution control.

There is a more important reason why Denison and Norsworthy et al. may underestimate the effects of regulatory policy upon productivity growth. Recall the argument in Section I, above. Regulatory policy is strongly biased against new sources of the undesirable externality for a large number of reasons. This bias translates into regulatory discouragement of investment in new facilities and particularly in growing areas of the country. The loss in output from foregone opportunities may well become more important than the opportunity cost of resources required to meet regulatory standards. In the extreme case, one could imagine, for example, that EPA would simply refuse to license any new utility plants or manufacturing facilities but fail to enforce standards on existing facilities. Air and water quality might improve even though "compliance costs" were zero! But opportunities to install highly efficient new aluminum pot lines or fluidized bed combustion facilities would be foregone. Productivity growth would be stunted by this repressive policy, industry could be insulated from new thrusts of entry, and the administrator of EPA would boast that the "cost" of regulation had been reduced to zero. Thus, Christiansen et al. are incorrect when they argue that Denison's estimate of the effects of regulatory policies is likely to be an upper limit of the actual effects of regulation on productivity growth.

In Denison's recent book, *Accounting for Slower Economic Growth*,[20] he argues that much of the decline in productivity growth is due to a reduction in the contribution of advances in knowledge and other unexplained sources. This effect is reflected in a decline in the size of the "residual" — which remains after accounting for changes in input quantity and quality — from 1.4 percent per year in 1948–73 to -0.8 percent in 1973–76. According to Denison, very little of this decline in the residual could have occurred because of the slowdown in capital formation after 1973. While some of the improvement in knowledge cannot be utilized until it becomes embedded in new capital facilities, Denison argues that the new investments embodying the greatest improvements will be those most likely to be funded when capital market conditions are unfavorable. As capital formation slows, the projects embodying the smallest advances in knowledge will be those postponed or cancelled.

Denison's argument is sound for those situations in which investment projects are rationed by a market. But when regulators intervene to prevent new facilities from being built, there is no guarantee that they will act so

[20] Denison (1979)

benignly. Discouraging new petrochemical facilities in the Southwest or forbidding new power plants in the West may result in substantial reductions in the embodiment of new knowledge in the capital stock. Certainly, EPA's new source performance standards which discourage steelmakers from adopting the newest technology in existing plants must have such an effect.

There are no other conclusive studies of the effects of regulation per se upon productivity growth. There is, however, a lively debate concerning the impact of a reduced rate of capital formation upon productivity growth and, in turn, the causes of the reduction in capital formation itself. Clark[21] argues that reduced capital formation caused nearly all of the deceleration in productivity in 1965–73, but appears to agree with Denison that other factors must have been responsible in 1973–76. Similarly, Norsworthy et al. find that reduced capital formation may have been a major culprit in 1965–73, but not in 1973–78. On the other hand, Hudson and Jorgenson[22] argue that increased energy prices reduced capital formation in the 1972–76 period, inducing a substitution of labor for capital *cum* energy. Labor productivity was reduced by 2.6 percent between 1972 and 1976 from this energy-induced effect upon the capital-labor ratio, per their analysis. Denison, of course, argues that reduction in the growth of capital inputs accounted for a very small percentage of the reduction in productivity growth.

It is neither possible nor necessary to resolve differences of opinion concerning the effect of capital-stock growth upon the recent productivity slide in this paper. It is sufficient to point out that the size of the effect is uncertain, that the connection between regulation and reduced capital formation is far from conclusively demonstrated, but that capital devoted to controlling various externalities must reduce potential output of traded goods and services. Recent speculation concerning the effect of regulation on uncertainty, lead times for new projects, or the length of time to complete the projects may well turn out to be correct.[23] At present, however, regulation remains indicted in the literature, not convicted.

VI. Some Limited Cross-Sectional Evidence

If outlays on pollution control or worker safety are responsible for slowing productivity growth, we should be able to detect such effects in a cross-sectional analysis of industries which face different compliance requirements. Ideally, we would like to have a large sample of industries from which to draw observations and a considerable period of time over which to observe the effects of regulation. Unfortunately, we have neither. The intersection of the set of manufacturing industries for which published productivity data are available and the set of industries for which capital-stock data exist is only 18. Another 11 industries are available if one wishes to use unpublished produc-

[21] Clark (1979)
[22] Hudson and Jorgenson (1978)
[23] See Malkiel (1979) and Quarles (1979)

tivity series, but the output data on which these latter series are based are unreliable. Moreover, capital-stock data are available from BLS only through 1976 although with some effort these data could be extended forward to 1977 or 1978. Unfortunately, that effort was beyond the scope of this paper.

In previous work,[24] I have attempted crudely to measure the effect of pollution control costs on productivity growth by estimating the effects of changes in capital-labor ratios, energy intensity, and industry output upon the deviation of productivity from its long-term industry trend. The results of this analysis were, at best, inconclusive.

In this section, I attempt to estimate a more conventional form of a productivity growth equation, employing data from the 18- and 29-industry samples alluded to above.[25] In (1), the growth in labor productivity, measured as the percentage change in output per manhour between 1973 and 1976, is related to weighted changes in the growth of capital, labor, and regulation inputs. Specifically, the equation takes the form:

$$\dot{q}/\dot{l} = a_o w_k \dot{l} + a_2 w_k \dot{k} + a_3 w_k \dot{r} \quad (1)$$

where the lower-case letters with dot superscripts represent percentage changes during the 1973–76 period, q is output, l is labor input, k is capital input, and r is regulatory cost.

To estimate (1), I use BLS estimates of the industry's gross capital stock (K_g) or net capital stock (K_n), excluding pollution-control capital. For the labor input, I use total manhours as reported in the *Annual Survey of Manufactures*. For the regulatory input, I use the *operating* costs of pollution control facilities (POL), as reported by the Census Bureau. Finally, capital's share of value added is obtained from the *1976 Annual Survey of Manufactures*. An additional variable for worker-safety capital outlays was included, but the results were inconclusive due the absence of sufficiently disaggregated data in the McGraw-Hill survey.

The results of estimating (1) are reported in Table 5. As expected, the precision of the estimates is greater for the 18-industry sample than for the 29-industries. The coefficients of the weighted labor input and capital stock variables are of the expected (opposite) signs, and they are statistically significant in the 18-industry regression when gross capital stock is employed. Moreover, the percentage change in pollution-control costs reduces productivity growth as expected. Given an average value of w_k of approximately 0.5 in the 18-industry sample, the results suggest that a doubling of pollution-control costs reduces productivity growth by 7 percentage points.

[24] See Crandall (1979)

[25] The industries in the 18-industry sample are: (SIC) 203, 205, 2421, 2434 and 2436, 251, 2611 & 2621 & 2631 & 2661, 2851, 291, 3011, 314, 322, 3241, 325, 331, 332, 3334, 341, 371. The 29-industry sample includes the above plus 204, 264, 265, 281, 2821, 286, 287, 3331, 249, 289, and 329. These industries include most of those in Table 2, which in turn are the most pollution-control impacted industries.

Table 5
Regression Estimates for Percentage Change in Productivity, 1973-76, Selected Manufacturing Industries (t-statistics in parentheses)

		Wghtd. Percentage Change, 1973-76, in:				
		Gross Cap.	Net Cap.	Emp. Hrs.	Pol. Costs	
Sample Size	Constant	K_g	K_n	L	POL	$\bar{R}^2$
18	0.800	0.6286		-0.9199	-0.1399	0.351
		(2.51)		(2.02)	(2.01)	
29	3.065	0.3008		-0.6785	-0.0838	0.180
		(1.50)		(1.74)	(1.61)	
18	1.574		0.4615	-0.8755	-0.1219	0.251
			(1.90)	(1.77)	(1.64)	
29	2.906		0.2779	-0.7724	-0.0807	0.166
			(1.33)	(1.75)	(1.54)	

Neither the worker-safety capital outlay growth variable nor an energy-utilization growth variable added to the explanatory power of equation (1). When a variable representing the deviation of industry output in 1976 from its long-term (1960–73) trend was introduced, however, it reduced the precision of the estimates of the other variables, particularly the pollution-cost variable. This occurs because of an inverse correlation between industry growth in the sample and pollution-cost growth. In short, it appears that rising pollution-control costs increase unit costs and output prices, thereby reducing demand for the industry's product. Of course, to "explain" flagging productivity growth by a variable which captures slower output growth is a bit circular; hence, the result is not reported.

VII. Concluding Comments

It is clear that we have not yet begun to explore the effects of the new "social" regulation upon economic performance. The casual evidence that worker-safety and pollution-control programs reduce productivity growth is abundant, but it is more difficult to demonstrate this effect with precision once one delves into disaggregated data. In part, this may be due to poor data and too short an historical period over which to search for the effect. In addition, if regulation operates by discouraging new projects or products, there is no very good indicator of the severity of regulation across industries. It is very difficult to measure opportunities foregone.

There are continuing criticisms from the proponents of stricter regulation that analyses of the cost of regulation or of its effect upon productivity ignore the benefits of regulation. If all output were counted, they contend, productivity might actually be shown to be increasing. Unfortunately, the evidence on the "benefits" of environmental and worker-safety regulation is even more scarce than data on the costs or privately traded output effects. There is no conclusive evidence, other than the mine-safety example alluded to above, that the standard environmental programs and OSHA policies have cleaned up the air or water or improved worker safety. The full effects upon output of our recently conceived regulatory policies are therefore unknown. The danger exists, however, that by the time we understand these effects we will have so discouraged investment in new facilities in basic industries that revival of these sectors will be difficult. Owners of tired old (overvalued) assets will be as potent a force against regulatory change as taxi medallion owners in New York or small refineries have proven to be in other regulatory arenas.

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Discussion

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Here is another fine paper in the series, each of which deals with one particular aspect of the economic slowdown, except for John Kendrick's paper which was more of an overview. By way of preface I would like to emphasize that this partial approach has its limitations. There is some tendency, heard yesterday and again today, of saying: Well, what I looked at is really not very important. It must be something else. That, of course, raises the question of whether the slowdown has one cause or many causes. If there are many causes, which is at least possible and was also suggested by the work of Kendrick and Denison, then we cannot reject any of them on the ground of being small. The fact that they are small means they are to be supplemented by other explanations.

This is a problem also with Bob Crandall's fine paper. Mostly I gathered two things from his paper. In the first place, he collected some very interesting data; although he has emphasized their limitations, there is something there. Second point, from a more theoretical view is the effect of grandfather clauses, the unwillingness of the legislative and administrative processes to bear down too heavily on existing polluters and the impact this will have on new construction. These are very important points. For the rest, Bob does not make great claims for his analysis and this I think is due in large part to the insufficiency of the data. The kind of regulation he deals with is a rather new phenomenon and the evidence as yet is inadequate for econometric estimation. He tried some cross-sectional analysis but the results are not really very conclusive, nor is this something for which he can be blamed. We just have to wait a few more years before we can do that kind of analysis better than we can now.

I would like to make a few comments on the regulatory issue. In the first place, Bob Crandall has focused on what one might call the new regulation, of which the environmental regulation and work safety are principal examples. The old regulation also has interesting relations with productivity. I myself have played around a lot with data by industry covering the entire economy. As we all know, there is much more documentation on manufacturing in the United States than on other sectors of the economy yet manufacturing accounts for less than one-quarter of GNP. There is a danger of being misled by this one well-documented but basically not very important sector at the expense of much larger sectors about which we know much less.

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I'll come back to that in a moment. Now as it turns out, the regulated sectors have generally had a pretty good productivity performance. The highest productivity growth over the postwar period in the United States is found in two regulated sectors, airlines and communications. This was something of a caution to me because I have always been opposed to the old type of regulation. It turns out I may have been wrong. The question is: is the good performance due to regulation or not? I frankly don't know. One could go at length into the old question of economies of scale which was the purported justification for much of the regulation we have had. This works well in industries like communications where there probably are economies of scale although they may not have been conclusively demonstrated. It does not help you in an industry like trucking which also has good performance by the usual criteria and this is an especially difficult one to live with.

Now, I would like to say something in this connection on utilities. There has been a slowdown in utilities. This I think also points to the importance of economies of scale. What has happened in utilities is that their product became much more expensive as a result of fuel price increases. Previously the industries with economies of scale benefited from growth much of which they had to pass on to their customers in the form of lower prices. That's how the regulatory mechanism worked. When their growth was interrupted by higher fuel prices, their performance deteriorated very severely. As with other aspects of utilities, it also meant their construction programs became severely upset. Another reason was that the electric utilities, in particular, never recognized such a thing as price elasticity, unlike, say, the telephone companies. To the electric utilities it was an article of faith that the demand for their product was independent of price, and they suddenly discovered that wasn't true. I could say more about this but I just wanted to say this because the old regulation also has interesting relations with productivity.

On the new regulation, as Bob Crandall points out in passing, the emphasis on standards has really been very detrimental to the economy as a whole and probably also to pollution control. The environmental movement took the wrong turn, I think, about 1971–1972 when the sulfur tax was rejected by Congress. Since then the whole emphasis has been on standard-setting. Standard-setting, I believe, has been a source of severe distortions including the grandfather clause distortion that Bob has pointed out. It also has probably not had a major effect on the level of pollution in the United States as a whole. If we had given taxes a try, we might by now have something to show for all the effort.

I also wanted to comment briefly on some other points in Bob's paper. At one point, he mentions the apparently improved performance of the financial sector which to be exact is finance, insurance, and real estate. I would like to point out that in this sector there are severe data problems, not so much because of lack of knowledge but rather because of the very peculiar ways this sector is handled by national accountants. The banking sector is largely in the realm of fantasy when it comes to gross product. There is a so-called banking imputation which I have never understood, although I have tried very hard. If you take it literally, the banks in this country hand out $150 in free services per annum to every man, woman, and child, and this sum has been growing rapidly. This doesn't correspond to anything in reality so one cannot infer much from the data for the banking sector.

The real estate sector also is subject to severe limitations because of the convention that owner-occupied dwellings are owned by entrepreneurs who happen to live in the same building. This is also not a very good way of looking at it, especially because the deflator for this owner-occupied sector is assumed to be the same as the deflator for rented dwellings, yet we all know that rented dwellings are generally different in kind from owner-occupied dwellings. Therefore the data for the financial, insurance, real estate sector really should not be taken seriously.

Talking about data, I would like to make a plea while I have the floor for a considerable improvement in data outside the manufacturing sector. There is a great deal to be done in beefing up these data, and especially in explaining what there is. Not only are the data not as accurate as they could be, but we need to know better what we have. B.E.A. and B.L.S. should put a much greater effort in describing the nature of their series. Some years ago the British Central Statistical Office put out a rather thick volume describing in great detail what their series mean. Nothing like this has ever existed for the United States; it should be a matter of high priority to have such a book so that we could also know what it really is we are dealing with, say, in the case of industry data. It is very hard to find out how much of this is based on double deflation. One can get general statements that manufacturing usually is based on it and nonmanufacturing usually isn't, but it is very hard to find out for sure except by talking to the individual who actually does the work.

Now mentioning the British leaves me with one final remark having to do with international comparison. There is a slightly provincial flavor in the kind of analyses we have gone through here on the productivity slowdown. The question has not yet been raised, is this a phenomenon peculiar to the United States or has it happened in other countries as well? As it turns out, it is not exactly peculiar to the United States but neither is it universal. I was at a conference at the American Enterprise Institute on the French economy a couple of weeks ago, in which it appeared that the French productivity performance in recent years has been good not only by our standards but also by French historical standards. There may even have been some improvement in recent years. The same is true for some other European countries, although it is not the case everywhere. That is why it might be very revealing to do more work on international comparison with the view to seeing what exactly the differences are, say, between France and United States; what was it in the French economy that permitted them to maintain and even improve their productivity growth whereas we have had this marked slowdown. This project could be done with relatively modest resources and might be a useful supplement to the papers we have here.