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Growth and Inflation: Analysis by Industry

THE BELIEF that prices are determined primarily by demand factors (at least in the short run) continues to dominate the thinking on inflation, even by those who reject most of neo-Keynesian macroeconomics. The widespread conviction that only a slowdown in economic activity will mitigate price increases implicitly accepts the concept of a Phillips curve despite its failing econometric support. While some supply shifts, particularly in energy, have been generally recognized, they are usually awarded no more than incidental importance.

The aim of this paper is to assess the relative importance of demand factors and supply factors on a disaggregated level, specifically the two-digit industry level for the entire U.S. economy.

The essence of the Phillips relation is a positive association between changes in real output and changes in price.[1] If true, it would mean that,

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1. Admittedly this is not the customary interpretation, which is formulated in terms of some indicator of capacity utilization. Although the usual interpretation has (or rather had) some application to the labor market, where the unemployment rate can be used as an indicator, its usefulness in price equations appears to be small, confined to the short run, and highly dependent on the specification. See William D. Nordhaus, "Recent Developments in Price Dynamics," in Otto Eckstein, ed., *The Econometrics of Price Determination,* conference sponsored by the Board of Governors of the Federal Reserve System and Social Science Research Council (Board of Governors, 1972), pp. 16–49; George de Menil, "Aggregate Price Dynamics," *Review of Economics and Statistics,* vol. 56 (May 1974), pp. 129–40, and the literature quoted there; and Hendrik S. Houthakker, "The Statistical Foundation of an In-

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on balance, shifts in demand outweigh shifts in supply.[2] Conceivably a positive association could be found in the aggregate without being present in most industries, but that would raise serious questions about the microeconomic foundations of the Phillips curve.

It will be shown that, on the industry level, changes in output are indeed associated with changes in price, but that the correlation is overwhelmingly negative, both within and across industries. Supply shifts, therefore, appear to be dominant. As a by-product, some insights into the performance of different industries will emerge.

The Data

The analysis is based entirely on the U.S. national income and product accounts, part 6 of which gives data by industry. Most of the data used here are unpublished, though they are available from the U.S. Bureau of Economic Analysis on request.[3]

The principal series analyzed are those for gross product originating (GPO) in current and 1972 prices, for wages and for hours worked. Certain other series were needed to derive gross value added (GVA), defined equivalently as GPO less indirect business taxes less business transfer payments plus subsidies, or as the sum of factor payments and capital consumption allowances (without capital consumption adjustment).

The GPO series are subject to the same conceptual and statistical qualifications as the national accounts themselves. The concept of gross product

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comes Policy," in American Statistical Association, *Proceedings of the Business and Economic Statistics Section* (Washington, D.C.: ASA, 1968), pp. 130–35. In any case, capacity has a clear meaning only in industries with fairly homogeneous inputs or outputs. Most previous research has considered only manufacturing industries for which time series on capacity utilization are available.

2. A less plausible interpretation is that shifts in demand trace out a backward-bending supply curve.

3. Data Resources, Inc., provided much of the data. Some data may be found in Bureau of Economic Analysis, *The National Income and Product Accounts of the United States, 1929–74: Statistical Tables* (Government Printing Office, 1977), but only when unaffected by the change from the 1967 to the 1972 Standard Industrial Classification (SIC). The industry names and SIC numbers are published in U.S. Office of Management and Budget, *The Standard Industrial Classification Manual, 1972* (GPO, 1972). Data for 1974–77 for certain industries (on the 1972 SIC) are in the *Survey of Current Business,* vol. 58 (July 1978). Only the 1972 SIC has been used in this paper.

originating, especially when measured in constant prices, is open to question on theoretical grounds. In addition, there are well-known problems with the national accounts' treatment of the government, banks, and real estate. The decision by the Bureau of Economic Analysis not to publish some data may reflect its judgment that they are less reliable than those published.[4]

THE RELATIONSHIP BETWEEN OUTPUT CHANGES AND PRICE CHANGES

Table 1 provides an overview of the results for the period from 1947 to 1977. Columns 1 through 3 show the average annual percentage change in output and in price for each industry. Two measures are used for output, GPO in 1972 prices and "deflated gross value added." In the latter case, the deflator is the same as for GPO given in column 3.[5]

From columns 1 and 2 it appears that the growth rates of real GPO and deflated GVA are virtually the same in most industries. Several noteworthy discrepancies arise in industries whose output is subject to sales taxes (retail trade) or excise taxes (tobacco, petroleum refining, motion pictures). Whether real GPO or deflated GVA is chosen as a measure of volume is consequently not a matter of great importance, and they are used more or less interchangeably here.

The cross-industry pattern of price and output changes can be seen most conveniently in figure 1. Each industry is identified by the same number as in table 1.[6] The output measure is deflated GVA; it can be verified from the table that the pattern would have been much the same if real GPO had been used. Both price changes and output changes are relative—that is, the overall change in price and output has been subtracted.

4. For the most part, the series were nevertheless taken as they come, but two small industries whose GPO is sometimes negative (due to the unsatisfactory treatment of interest in the national accounts) were combined with closely related industries. Specifically, the industry category "credit agencies other than banks" was merged into "banking," and "holding and other investment offices" was combined with "security, commodity brokers, and services."

5. The choice of the GPO deflator for deflating GVA is questionable. Initially the all-industry GNP deflator was used for the tax-subsidy component, but this led to a negative real GVA in some cases. The method adopted in table 1 operates under the assumption that the components of GPO excluded from GVA constitute an ad valorem excise tax on GVA at a possibly negative rate that may vary by year and by industry.

6. These numbers correspond to the SIC numbers in most cases.

Table 1. Average Annual Rates of Change in the Gross Product Deflator, Real Gross Product, and Deflated Gross Value Added, and Price-Quantity Correlations, by Industry, 1947–77

		Rate of growth (percent)			*Correlation*[a]		
	Industry and number	*Real gross product* (*1*)	*Deflated gross value added* (*2*)	*Gross product deflator* (*3*)	*Absolute deflator and real gross product* (*4*)	*Absolute deflator and deflated gross value added* (*5*)	*Relative deflator and relative real gross product*[b] (*6*)
01	Farms	1.2	1.2	1.9	−0.15	−0.20	−0.33
02	Other agriculture	1.9	1.9	5.9	0.09	0.13	−0.15
10	Metal mining	1.4	1.1	2.9	0.39	0.50	0.38
11	Coal mining	−0.4	−0.5	4.8	0.16	0.19	0.27
13	Oil and gas extraction	2.7	2.6	5.5	−0.03	0.03	0.23
14	Nonmetallic minerals, except fuels	3.2	3.1	3.3	−0.47	−0.44	−0.42
15	Contract construction	3.1	3.0	4.5	−0.41	−0.40	−0.59
20	Food and kindred products	2.8	3.3	2.2	−0.45	−0.23	−0.19
21	Tobacco manufactures	2.5	5.7	1.6	−0.70	−0.40	−0.62
22	Textile mill products	3.2	3.1	0.3	−0.07	−0.07	−0.28
23	Apparel and other textile products	3.1	3.1	1.6	−0.57	−0.57	−0.72
24	Lumber and wood products	2.7	2.6	3.3	−0.13	−0.11	−0.31
25	Furniture and fixtures	3.1	3.1	3.2	−0.63	−0.63	−0.76
26	Paper and allied products	3.5	3.4	3.3	−0.54	−0.54	−0.65
27	Printing and publishing	3.0	3.0	3.6	−0.61	−0.61	−0.43
28	Chemicals and allied products	6.5	6.5	1.4	−0.47	−0.46	−0.59
29	Petroleum and coal products	3.8	3.3	2.6	0.13	0.79	−0.12
30	Rubber and miscellaneous plastics products	4.8	4.9	3.0	−0.26	−0.24	−0.33
31	Leather and leather products	0.1	0.0	3.1	−0.50	−0.49	−0.63
32	Stone, clay, and glass products	2.8	2.8	3.8	−0.30	−0.29	−0.17
33	Primary metal industries	0.5	0.5	5.6	−0.24	−0.23	−0.21

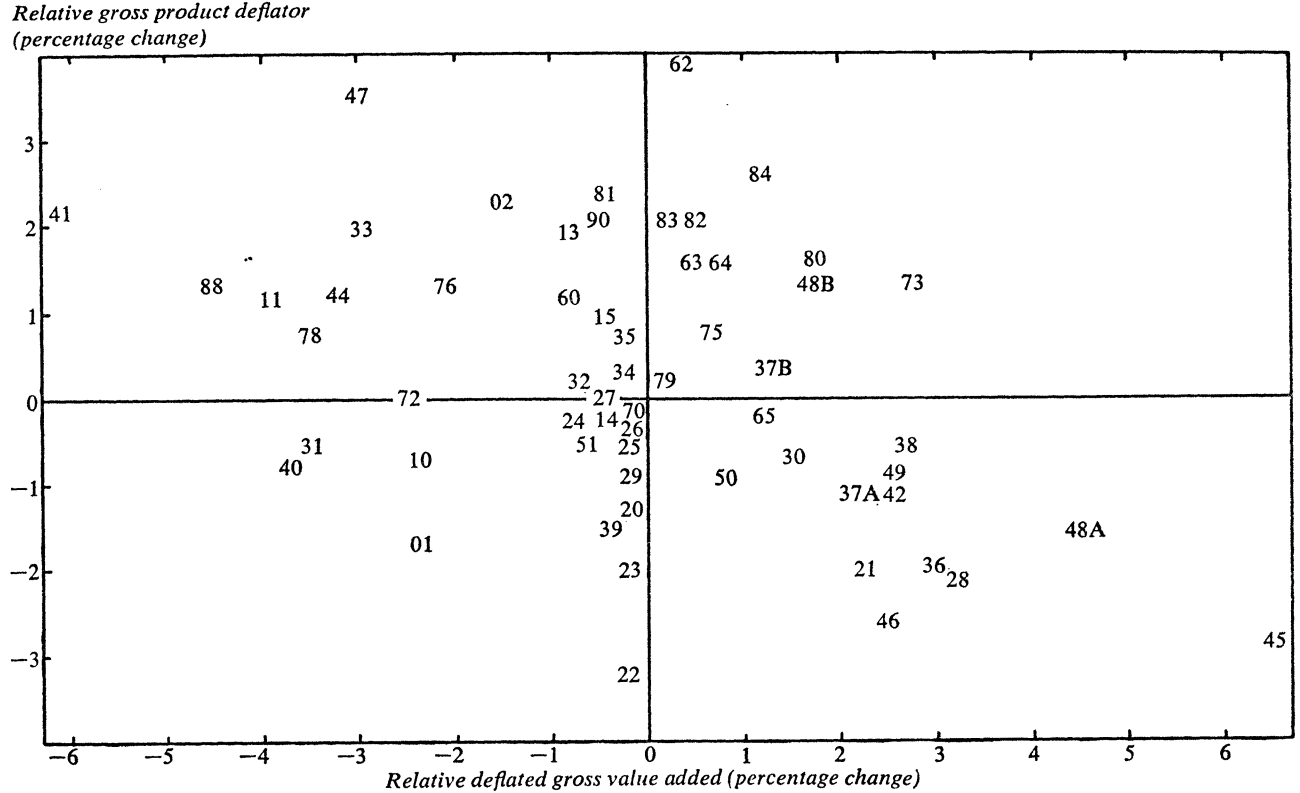
34	Fabricated metal products	3.2	3.1	3.9	−0.33	−0.32	−0.41
35	Machinery, except electrical	3.2	3.2	4.2	−0.08	−0.07	−0.30
36	Electric and electronic equipment	6.2	6.4	1.6	−0.47	−0.48	−0.46
37A	Motor vehicles and equipment	5.4	5.7	2.3	−0.15	−0.17	−0.06
37B	Miscellaneous transport equipment	4.6	4.7	3.9	−0.19	−0.18	−0.15
38	Instruments and related products	5.9	6.1	3.0	−0.02	−0.01	−0.01
39	Miscellaneous manufacturing industries	3.1	3.1	2.0	−0.46	−0.46	−0.53
40	Railroad transportation	−0.6	−0.2	2.8	−0.52	−0.52	−0.67
41	Local and interurban passenger transit	−2.3	−2.7	5.7	−0.83	−0.80	−0.85
42	Trucking and warehousing	6.0	5.9	2.5	−0.67	−0.67	−0.67
44	Water transportation	−0.1	0.2	4.9	−0.68	−0.69	−0.78
45	Transportation by air	9.9	10.0	0.7	−0.72	−0.74	−0.77
46	Pipelines, except natural gas	5.7	5.9	1.0	−0.35	−0.31	−0.37
47	Transportation services	0.4	0.4	7.1	−0.50	−0.47	−0.43
48A	Telephone communication	7.5	7.9	1.9	−0.12	−0.26	−0.47
48B	Radio and television broadcasting	5.2	5.1	4.8	−0.57	−0.55	−0.69
49	Electric, gas, and sanitary services	6.0	5.9	2.6	−0.55	−0.49	−0.23
50	Wholesale trade	4.5	4.3	2.8	−0.26	−0.05	−0.36
51	Retail trade	3.3	2.8	3.2	−0.55	−0.52	−0.29
60	Banking and other credit agencies	3.0	2.7	4.7	−0.52	−0.49	−0.54
62	Brokers, investment companies, and so on	3.6	3.8	7.5	−0.70	−0.61	−0.68
63	Insurance carriers	4.0	3.9	5.0	−0.74	−0.42	−0.46
64	Insurance agents, brokers, and services	4.3	4.3	5.0	−0.55	−0.54	−0.49
65	Real estate	4.8	4.7	3.4	−0.55	−0.37	−0.05
70	Hotels and other lodging places	3.5	3.4	3.3	−0.62	−0.60	−0.56
72	Personal services	1.0	0.9	3.6	−0.59	−0.58	0.15
73	Business services	6.2	6.2	4.9	−0.52	−0.51	−0.53
75	Auto repair, services, and garages	4.1	4.1	4.2	−0.82	−0.82	−0.85
76	Miscellaneous repair services	1.5	1.4	4.9	−0.06	−0.04	−0.49
78	Motion pictures	−0.6	−0.1	4.2	0.19	0.32	−0.01
79	Amusements and recreation services	3.3	3.5	3.9	0.07	−0.01	0.05

Table 1 (continued)

	Industry and number	Rate of growth (percent)			Correlation[a]		
		Real gross product (*1*)	*Deflated gross value added* (*2*)	*Gross product deflator* (*3*)	*Absolute deflator and real gross product* (*4*)	*Absolute deflator and deflated gross value added* (*5*)	*Relative deflator and relative real gross product*[b] (*6*)
80	Health services	5.2	5.2	5.1	−0.18	−0.12	−0.05
81	Legal services	3.0	3.0	5.9	−0.68	−0.67	−0.64
82	Educational services	3.9	3.8	5.5	−0.41	−0.40	−0.20
83	Social services and nonprofit institutions	3.6	3.6	5.5	−0.44	−0.42	0.11
84	Miscellaneous services[c]	4.5	4.5	6.0	−0.25	−0.25	−0.40
88	Private households	−1.1	−1.1	4.9	−0.55	−0.55	−0.32
90	Government	3.1	3.0	5.5	0.15	0.15	0.21

Source: Calculated from U.S. Bureau of Economic Analysis, national income and product accounts, tables 6.1 and 6.2 and unpublished data.
a. Calculated using annual percentage rates of change of the variables.
b. Relative rates of change are obtained by subtracting the overall rate of change from the industry rate.
c. Includes museums, art galleries, botanical and zoological gardens, and miscellaneous services.

Figure 1. Average Annual Rates of Change in Relative Deflator for Gross Product and Relative Deflated Gross Value Added, by Industry, 1947–77



Source: Derived from data in table 1 by subtracting the overall rate of change from the industry rate.

The negative correlation evident in figure 1 means that *inflation has been most rapid in industries that grow slowly*. A striking example among the larger industries is primary metals, which combined 2 percent more inflation a year than the average with 3 percent less growth. Other examples are the airlines, which had 6 percent more growth and 3 percent less inflation, and the telephone industry, which had 4 percent more growth and 1.5 percent less inflation.

Because the correlation is not very close, many exceptions occur.[7] Perhaps the most important of these is health services, which had 1.5 percent growth and 1.5 percent inflation a year in excess of the average. This is probably an industry in which demand pressure has been dominant in determining price-output behavior, and one in which precise measurement of output is subject to conceptual and statistical difficulties. Other notable exceptions are farms, textiles, and apparel, all of which are below average in both growth and inflation. Several manufacturing industries are clustered close to the origin, which corresponds to the average of growth and inflation.

Although the two-digit classification used here is usually too broad for structural analysis, students of industrial organization may also find figure 1 enlightening. A possible interpretation is that performance can be rated according to an industry's position in the figure: the closer an industry is to the lower right the better is its performance, though the weight given to price relative to quantity is arbitrary. Proponents of deregulation (and I include myself) must ponder the impressive showing of regulated industries, such as trucking and electricity and gas, in addition to telephones and airlines mentioned above. Among manufacturing industries, electrical machinery and automobiles, which are not usually considered models of competition, score high.

For the purpose of this paper, the main issue is what figure 1 means for aggregate price-output performance. In the first place, a purely statistical question can be raised: suppose nominal GVA and the GPO deflator are independently distributed random variables and the former is divided by the latter; then the quotient (deflated GVA) obviously has a negative correlation with the deflator. This negative correlation could emerge even when nominal GVA and the deflator are positively correlated. Can this be

7. The simple correlation coefficient is −0.384, significant at the 99 percent level. When real GPO is used instead of deflated GVA, the correlation is somewhat less close but still significant at the 95 percent level. More meaningful weighted figures are given below.

Table 2. Weighted Simple Correlations between Average Annual Rates of Change in Deflated GVA or GPO and the GPO Deflator, 1947–77

Correlation or average annual rate of change	*1947–57*	*1957–67*	*1967–77*	*1947–77*
Correlation				
GVA	−0.019	−0.348	−0.635	−0.343
GPO	0.010	−0.334	−0.593	−0.324
Average annual rate of change (percent)				
Real GPO	3.8	4.0	2.8	3.5
Deflator for GPO	2.0	2.0	6.0	3.6

Source: Same as table 1. Industry values are weighted by their relative importance (measured by 1972 gross product originating). Government, households, and social services and nonprofit organizations are excluded.

all there is to the pattern in figure 1? Although an entirely conclusive answer cannot be given, my own tentative judgment is that measurement error is not the main source of the negative correlation.[8]

A second possibility is that the negative correlation results from the way nominal and real GPO are estimated by the Bureau of Economic Analysis. As is true for much of the national income and product accounts, the industry data are not well documented, but it appears that double deflation is not used for all industries.

Despite these qualifications, it is of interest to look at the cross-industry correlation between deflated GVA and the deflator more closely by distinguishing three subperiods. Furthermore, some advantage exists in weighting the industries by their relative importance (as measured by their GPO in 1972) to make sure that the apparent pattern is not attributable to a few small industries. Moreover, three "industries" (government, households, and "social services and nonprofit organizations") are excluded because they do not belong to business as properly defined. The results are shown in table 2.

8. As a test, a regression of deflated GVA on the GPO deflator was estimated, using deflated GVA per person-hour (defined below) as an instrumental variable. The estimated regression coefficient was negative with a t-statistic of −3.6, more than enough to reject the null hypothesis of independence (and a fortiori of a positive relation). The validity of such a test depends on the appropriateness of the instrumental variable. In this case, the choice was made on the basis of the well-established relationship between price and productivity, but this does not necessarily mean that standard assumptions concerning instrumental variables are satisfied.

The weighted cross-industry correlation has become steadily more negative over time, beginning in 1947–57, when it was virtually zero. It was significantly negative in 1957–67, even though globally that period was quite similar to the preceding one. It is also evident that weighting by industry size does not change the pattern appreciably. A tentative interpretation is that shifts in supply have become gradually more dominant, but that interpretation cannot be tested directly.[9]

CORRELATIONS WITHIN INDUSTRIES

Columns 4 through 6 of table 1 show simple correlations between annual changes in real output and price for individual industries. Again, it makes little difference whether deflated GVA or real GPO is used as the output measure, except for a few industries, notably petroleum refining, in which excise taxes are important. In the remainder of this report I focus on column 6, in which the annual percentage changes in each industry are standardized by deducting the annual percentage change in the corresponding concept for the economy as a whole; the output measure there is real GPO. Thus this column gives the correlation between *relative* output changes and *relative* price changes within each industry.

On the whole, the within-industry correlations of annual changes are even more negative than the cross-industry correlations of changes over longer periods.[10] There are only five positive correlations, and the negative correlations are often quite large. Further insight into this is provided by table 3, which shows tabulations of the within-industry correlations by size and subperiod, omitting the three nonbusiness industries as was done above. Here, too, there is a hint that the correlations have become more negative over time, but it is not nearly as obvious as it was in table 2. In fact, the pattern did not change much between 1957–67 and 1967–77. Column 4 shows that there is some averaging of extreme

9. The problem is that demand shifts can be quantified more easily than can supply shifts.

10. The negative correlation within industries was earlier noted in Walter F. Crowder, "The Concentration of Production in Manufacturing," in Temporary National Economic Committee, *Investigation of Concentration of Economic Power,* monograph 27: *The Structure of Industry,* 76 Cong. 3 sess. (GPO, 1941), pp. 346–406; and in John W. Kendrick, *Postwar Productivity Trends in the United States, 1948–1969,* General Series, 98 (National Bureau of Economic Research, 1961), pp. 203–06.

Table 3. Frequency Distribution of Simple Correlations between Relative Annual Rates of Change in Real GPO and the GPO Deflator, within Industries, 1947–77

Range of correlation, r	*1947–57 (1)*	*1957–67 (2)*	*1967–77 (3)*	*1947–77 (4)*
$0.5 \leqq r \leqq 1.0$	1	0	1	0
$0 \leqq r < 0.5$	13	9	8	5
$-0.5 \leqq r < 0$	22	18	22	31
$-1.0 \leqq r < -0.5$	20	29	25	20

Source: Same as table 1. Relative rates of change are obtained by subtracting the overall rate of change from the industry rate. Government, households, and social services and nonprofit organizations are excluded.

cases, leading to a distinct mode between zero and −0.5; however, there is considerable persistence in the correlations for each industry by subperiod. Needless to say, the statistical qualifications mentioned above are also relevant here.[11]

On the aggregate level, evidence can also be seen of an increasingly negative correlation between changes in output and in prices. The simple correlation between annual percentage changes in constant dollar GPO and in the GPO deflator was 0.425 in 1948–57, 0.150 in 1958–67, and −0.738 in 1968–77. This pattern resembles table 2 rather than table 3, but in any case it reflects progressively greater consistency between aggregate and industry-level price-output behavior.

GENERAL CHARACTERISTICS OF INDUSTRIES

A considerable number of interesting statistics can be calculated from the national accounts data for industries, but only those most relevant to the price-output performance are given here. Table 4 provides, first, nominal gross and net value added (NVA) in columns 1 and 2. Net value added equals GVA, defined previously, less capital consumption allowances. The industry data do not include the capital consumption adjustment needed to bring book depreciation closer to economic depreciation—which is unfortunate.

Nevertheless, a comparison of net and gross value added sheds some light on changes in capital intensity. If the two value-added figures have

11. Instrumental variable regressions were also fitted here. The results, while broadly supportive of a negative correlation, were not significant by the usual criteria—possibly because it was difficult to find suitable instrumental variables on the industry level.

Table 4. Average Annual Rates of Change in Gross and Net Value Added, Hours Worked, and Selected Ratios, by Industry, 1947–77

		Value added		Hours		Ratio		
	Industry and number	*Gross value added* (1)	*Net value added* (2)	*Person-hours*[a] (3)	*Employee-hours* (4)	*Compensation per employee-hour* (5)	*Real gross product per person-hour* (6)	*Deflated gross value added per person-hour* (7)
01	Farms	3.1	2.6	−3.5	−2.7	6.2	4.6	4.7
02	Other agriculture	7.9	7.6	1.7	2.9	5.4	0.1	0.0
10	Metal mining	4.0	3.8	−0.6	−0.6	6.8	1.9	1.6
11	Coal mining	4.3	3.7	−2.3	−2.3	6.2	2.1	2.1
13	Oil and gas extraction	8.3	8.2	1.4	1.6	5.6	1.0	0.9
14	Nonmetallic minerals, except fuels	6.6	6.0	0.5	0.6	6.1	2.5	2.5
15	Contract construction	7.6	7.5	1.2	1.7	5.7	1.4	1.4
20	Food and kindred products	5.6	5.4	−0.5	−0.4	5.9	3.2	3.5
21	Tobacco manufactures	7.4	7.1	−1.4	−1.4	7.4	3.8	6.7
22	Textile mill products	3.4	3.3	−1.3	−1.3	4.9	4.2	4.1
23	Apparel and other textile products	4.7	4.6	0.2	0.3	4.4	2.7	2.7
24	Lumber and wood products	6.0	5.7	−0.5	−0.6	6.1	3.1	3.1
25	Furniture and fixtures	6.4	6.4	0.8	0.9	5.1	1.9	1.9
26	Paper and allied products	6.8	6.5	1.2	1.2	6.1	2.7	2.7
27	Printing and publishing	6.8	6.6	1.4	1.4	5.0	1.5	1.5
28	Chemicals and allied products	8.0	7.6	1.8	1.8	6.1	4.0	4.0
29	Petroleum and coal products	6.0	6.0	−0.2	−0.2	5.7	3.8	3.1
30	Rubber and miscellaneous plastics products	8.0	7.9	2.8	2.8	5.3	2.3	2.4
31	Leather and leather products	3.1	3.2	−1.7	−1.7	4.7	1.6	1.5
32	Stone, clay, and glass products	6.7	6.6	0.4	0.6	6.0	2.2	2.2
33	Primary metal industries	6.1	5.8	−0.2	−0.2	6.5	0.8	0.8
34	Fabricated metal products	7.2	7.1	1.1	1.2	5.7	2.0	2.0
35	Machinery, except electrical	7.5	7.4	1.4	1.5	5.8	1.7	1.7
36	Electric and electronic equipment	8.1	7.8	2.1	2.1	5.7	4.1	4.3
37A	Motor vehicles and equipment	8.1	8.0	0.9	0.9	7.0	4.3	4.7

37B	Miscellaneous transport equipment	8.8	8.8	2.3	2.3	5.9	1.7	1.7
38	Instruments and related products	9.3	9.2	2.7	2.8	5.8	3.0	3.1
39	Miscellaneous manufacturing industries	5.2	5.1	−0.1	0.0	5.2	3.0	3.0
40	Railroad transportation	2.6	2.3	−3.8	−3.8	6.6	3.4	3.9
41	Local and interurban passenger transit	2.9	2.9	−1.6	−1.6	4.8	−0.7	−1.1
42	Trucking and warehousing	8.6	8.6	2.1	2.4	6.4	3.7	3.7
44	Water transportation	5.1	4.7	1.4	−1.4	6.4	2.2	2.4
45	Transportation by air	12.8	13.1	4.9	5.0	6.6	5.0	5.1
46	Pipelines, except natural gas	7.0	7.1	−1.4	−1.9	6.0	7.5	7.7
47	Transportation services	7.5	7.2	2.4	2.2	5.6	−1.8	−1.8
48A	Telephone communication	10.0	9.4	1.4	1.4	7.1	5.8	6.2
48B	Radio and television broadcasting	10.2	10.0	4.2	4.2	4.8	1.0	1.0
49	Electric, gas, and sanitary services	8.7	8.2	1.1	1.1	6.4	4.7	4.6
50	Wholesale trade	7.2	7.1	1.9	1.7	5.6	2.6	2.5
51	Retail trade	6.1	6.1	1.0	1.8	5.2	2.7	1.8
60	Banking and other credit agencies	7.5	6.8	4.3	4.3	5.1	−1.0	−1.3
62	Brokers, investment companies, and so on	11.6	11.7	4.1	4.5	5.8	−0.5	−0.4
63	Insurance carriers	9.1	9.0	2.4	2.4	5.8	1.6	1.5
64	Insurance agents, brokers, and services	9.5	9.5	3.9	3.8	5.8	0.5	0.5
65	Real estate	8.2	8.1	1.3	1.7	5.6	3.4	3.3
70	Hotels and other lodging places	6.8	6.6	1.4	1.8	5.2	2.2	2.2
72	Personal services	4.6	4.5	−0.6	−0.4	5.1	1.5	1.4
73	Business services	11.4	11.2	6.3	6.6	4.5	−0.1	0.0
75	Auto repair, services, and garages	8.4	7.6	2.0	2.4	5.5	2.2	2.2
76	Miscellaneous repair services	6.4	6.4	1.4	2.1	5.2	0.2	0.2
78	Motion pictures	4.1	3.5	0.8	−0.5	5.0	0.4	1.0
79	Amusements and recreation services	7.5	7.3	2.0	2.3	5.4	1.4	1.6
80	Health services	10.5	10.6	4.1	5.5	7.2	0.9	0.9
81	Legal services	9.1	9.1	3.2	4.2	7.3	−0.3	−0.3
82	Educational services	9.5	9.5	3.3	3.4	5.9	0.4	0.4
84	Miscellaneous services[b]	10.8	10.7	4.7	5.5	5.6	0.1	0.1

Source: Same as table 1.
a. Persons engaged in production.
b. Includes museums, art galleries, botanical and zoological gardens, and miscellaneous services).

the same growth rate, the capital-output ratio is unchanged over time, although this inference is clouded by the use of book depreciation. As table 4 shows, NVA generally has a slightly lower growth rate than GVA, suggesting some increase in capital intensity. In fact, in only one industry, air transportation, did NVA grow significantly more than GVA, possibly because of the longer service life or better utilization of aircraft. Industries in which NVA had a markedly lower growth rate than GVA include farms, coal and nonmetal mining, telephone and telegraph, electricity and gas, auto repairs, and motion pictures.

Next columns 3 and 4 present hours worked. Column 3, labeled "person-hours," represents total labor input (including the self-employed).[12] Column 4 is limited to hours worked by employees. For most industries, person-hours rose less than employee hours, reflecting the relative decline of unincorporated enterprises. The difference in growth rates is especially marked in agriculture, construction, retail trade, health services, legal services, and "miscellaneous services."[13] These columns are also worth studying for what they say about the growth of employment, which is especially high in finance and in some service industries.

Column 5 presents the growth of compensation per employee-hour. Contrary to what is often thought, considerable variation occurs among industries; however, the national accounts data have no information on how much of this variation may be due to changes in the composition of each industry's labor force by age, sex, and level of skill. The lowest increases in hourly compensation are found not only in industries with

12. "Person" is used as an abbreviation of "person engaged in production"—either an employee or a proprietor (unpaid family workers not covered). "Persons engaged in production" should not be confused with "production workers," a concept from labor statistics not used in this paper.

Because "person-hours" are not available from the Bureau of Economic Analysis on a complete two-digit basis they had to be estimated for some industry groups, particularly manufacturing and services. This was done by allocating the known total of proprietors' hours in a group in proportion to noncorporate income, which is available in detail. The method is far from ideal because it assumes that the average hourly income of proprietors is the same for all industries in a group. The problem is minor in manufacturing, in which few unincorporated firms exist, but more serious in services. The method was not needed for agriculture and trade, where there are also many proprietors.

13. The apparent rise of proprietors' hours in wholesale trade results from an error in the underlying national accounts data, soon to be corrected.

declining or stagnant employment such as textiles, apparel, leather, and local transit, but also in two rapidly growing industries—radio and television and business services—perhaps because these industries began with relatively high wages in 1947. A similar pattern is found for industries in which compensation per employee-hour rose particularly fast; this group includes health services and legal services, in which employment rose rapidly, and tobacco, in which employment fell but wages were initially much below the average.

Columns 6 and 7 of table 4 are probably the most revealing because they present real output per person-hour, which appears to be at least an intermediate explanation for the patterns described so far. As elsewhere, two measures of output are used, with any marked difference between them appearing only in a few industries. The growth of labor productivity during the period varied widely among industries, ranging from negative growth in five or six cases to over 7 percent a year in pipelines. Besides this small, capital-intensive industry, the higher rates of productivity growth occur in telephones, air transportation, electricity and gas, and farms—none of which are in manufacturing. Productivity performance in the manufacturing sector was best in automobiles, textiles, and electric machinery, and even better in tobacco if deflated GVA is used as the output measure. Primary metals is conspicuous with the lowest growth of productivity among manufacturing industries. In the service sector, where the measurement of real output is notoriously difficult, productivity gains ranged from negative growth (in legal services, which also had one of the highest growth rates of compensation per employee-hour) to moderate growth (in hotels and auto repairs).

The growth rates of productivity help explain the price-output pattern depicted in figure 1. Most industries below the horizontal axis had high productivity growth; those above generally had low or negative growth.[14] The placement of industries from left to right appears to depend mainly on income elasticities, with varying contributions from price trends. It also appears that the recent slowdown in productivity is quite widespread; between 1967 and 1977 only twenty-one industries (out of fifty-nine) had more growth of productivity than they had between 1957 and 1967.

14. A simple regression across industries suggests that a 1 percent increase in real GPO per person-hour leads to a relative price decrease of 0.76 percent and also to a small increase in relative wages in the industry concerned.

Concluding Remarks

This paper is intended to be descriptive rather than analytical. For greater insight, a model of industrial price-output performance should be estimated, but the national accounts do not provide all the information needed for that purpose and are especially weak on capital. Much work has been done on an annual model with four equations for each industry: demand for labor as a function of real output and the relative price of labor, supply of labor as a function of the industry's wage rate compared to the overall wage rate, demand for real output as a function of real GNP and the relative price of output, and price as a function of the wage rate and labor productivity.

When the results of this effort are ready for presentation, they might provide insight into the principal findings of this paper—particularly the negative price-quantity correlation both within and across industries—by distinguishing between explanatory factors peculiar to each industry ("technical change") and more general macroeconomic influences.

Discussion

TWO POSSIBLE EXPLANATIONS were seen by William Nordhaus for the negative correlation between price changes and output changes by industry. One was exogenous differences in productivity growth, which shift supply curves outward by varying amounts; the other was economies of scale that could be realized because of outward shifts in demand curves. He emphasized that it was difficult to distinguish between the two, and yet important to disentangle them. For example, economies of scale could, in principle, explain the marked slowdown in labor productivity in all major industrial countries since 1973. According to that view, the slow growth of demand would have more than a purely cyclical adverse effect on productivity. He mentioned that Japanese engineers and economists point to the slow growth in their export demand as a cause of less robust investment, raising the average age of equipment and retarding the growth in productivity.