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Federal Reserve Bank of St. Louis
*Review*
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# In This Issue . . .

In the first article in this *Review*, "The Growing Share of Services in the U.S. Economy — Degeneration or Evolution?" Mack Ott examines the growth of the U.S. service sector relative to agriculture and manufacturing employment and output to determine the answers to two key questions: Are recent changes in employment patterns fundamentally different from those undergone in the 19th century transformation of the United States from an agrarian to an industrial economy? And, are either the recent or long-term U.S. developments different from the recent and long-term economic history of other industrial economies? The author shows that the recent growth in services neither differs from that of other industrial economies nor diverges from long-standing trends in U.S. economic history.

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Many analysts of the Tax Reform Act of 1986 fear that repeal of the investment tax credit and the imposition of less generous tax depreciation deductions for capital investment will reduce the U.S. capital stock and, as a result, damage the economy.

In the second article in this *Review*, "Tax Reform and Investment: Blessing or Curse?" Steven M. Fazzari analyzes the effect of recent changes in corporate and personal taxation on the economic efficiency of the U.S. capital stock. Because investment imposes costs on the economy as well as generates benefits, Fazzari shows that investment reductions caused by tax reform are not necessarily bad for the economy. To the extent that tax reform removes special investment subsidies in the old tax law, it could enhance the efficiency of the capital stock. After studying the implementation of recent tax changes and their effect on the cost of capital, Fazzari concludes that some aspects of tax reform removed special investment subsidies and, thus, by themselves, could enhance the efficiency of U.S. capital formation. When all the changes due to tax reform are considered together, however, the author shows that the overall impact may reduce capital spending below the economically efficient level.

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The decline in the price of oil in 1986 sparked a renewed concern over how oil prices affect the economy and whether such an oil price decline has effects on the economy that are equal and opposite to those of previous oil price increases. In this issue's third article, "The Macroeconomic Effects of the Recent Fall in Oil Prices," John A. Tatom reviews the theoretical channels of influence of energy prices and provides some evidence on how previous oil price increases have affected production in seven nations. Although economic theory generally indicates that energy price effects are symmetric — that is, the effects of an oil price decline are equal and opposite to those of an oil price increase — Tatom reviews some recent arguments suggesting that an oil price decline like the one in 1986 could have either adverse, or opposite but smaller, macroeconomic effects than previous experience might suggest.

Tatom emphasizes that oil and energy prices had been falling since early 1981, when measured in dollar prices or, more importantly, when measured relative to the prices of the nations' output. Thus, he argues, there is ample experience to test whether price declines have different effects than increases. Tatom describes various tests that indicate that oil price declines have symmetric effects on U.S. economic activity.

# The Growing Share of Services in the U.S. Economy — Degeneration or Evolution?

*Mack Ott*

*Surely the American people are not willing to become merely a service economy. The American character is as much built around the sinews and muscle of the factory line as the white-collar office.*[1]

— Editorial, *Christian Science Monitor*

Since World War II, the production of services as a share of U.S. real gross national product (GNP) has risen from 58 percent to 68 percent. The concomitant shift in the distribution of the labor force has been much larger: about half of U.S. workers were employed in service industries in 1948; this proportion had increased to nearly three-fourths by 1985. These momentous changes have given rise to fears that the United States is fast becoming a nation of people who are "serving each other hamburgers or taking in each other's laundry."[2]

The irony in this view is that it embodies a profound misinterpretation of U.S. economic history, both recent and long-term. It has been the strength, rather than the weakness, of the manufacturing sector that has precipitated the shifts in employment and output toward services. Put simply, high productivity growth in manufacturing and agriculture and the long-term effects of American investment in education have made the faster growth of the service sector possible. These forces have persisted not just since World War II, but for a century or more. Similar trends in output and labor characterize the last century of economic history in other industrial nations as well.

The purpose of this article is to document these long-run trends and to highlight some of the forces driving them. The conclusion from this overview is that, far from indicating a decline in the U.S. economic outlook, the rising share of services reflects the increasing productivity and well-being of workers, both inside and outside of U.S. factories and mills.

## OUTPUT, LABOR AND CAPITAL EMPLOYMENT IN THE UNITED STATES SINCE 1948: A BRIEF REVIEW

During the postwar era, output of the U.S. economy as measured by real GNP has more than tripled, from $1.1 trillion (in 1982 dollars) in 1948 to $3.7 trillion in 1986. Meanwhile, civilian employment nearly doubled, from 58.3 million to 109.6 million. Since the economy has been growing, analysis is greatly facilitated by considering proportional shares rather than levels of output and labor. Chart 1 shows that, while the services share of output has risen and, consequently, the commodities share has fallen, the share of real GNP in manufacturing output has remained virtu-

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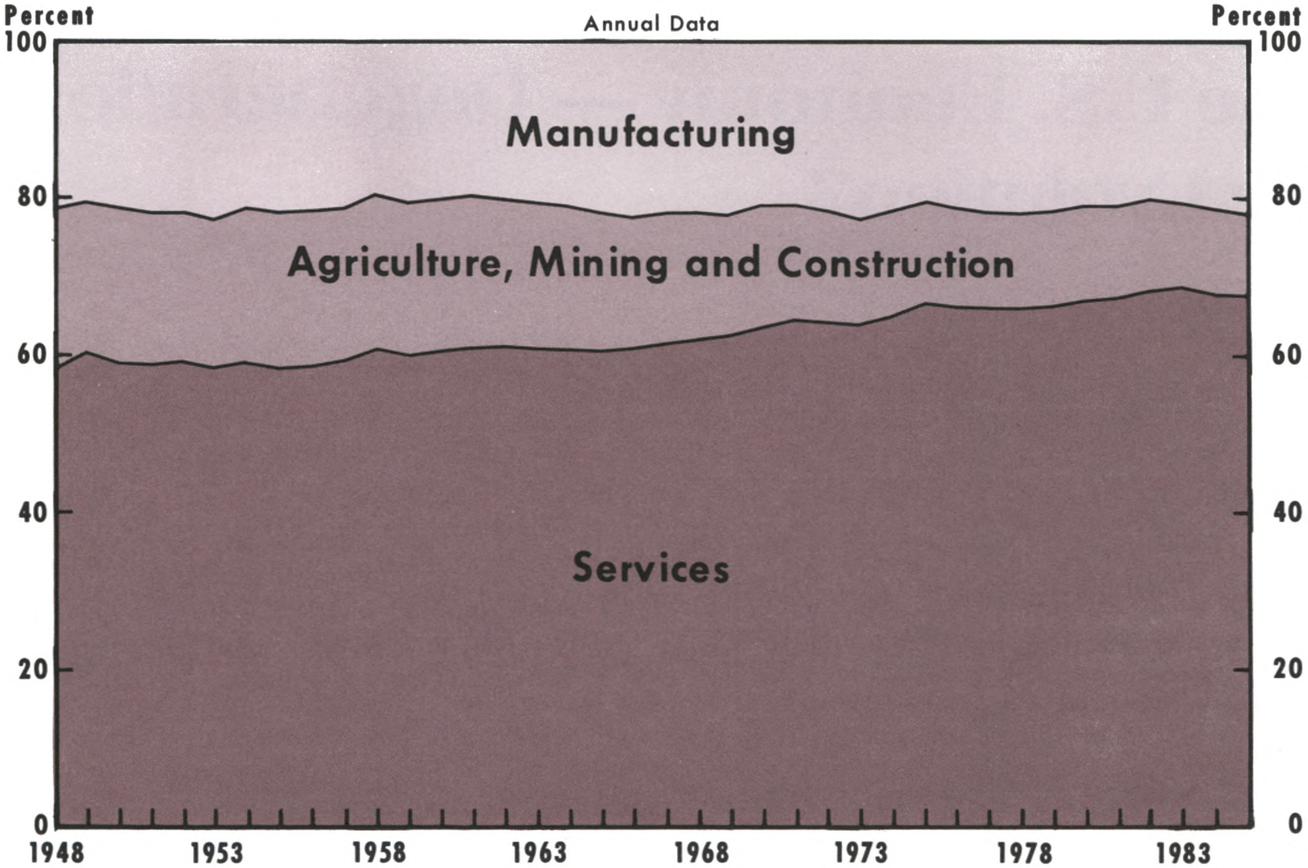
[1]See *Christian Science Monitor* (1987).

[2]Murray (1987). Of course, many economists and commentators have countered this simplistic characterization of rising service employment and output; for example, see Browne (1986), Krugman and Hatsopoulos (1987), McUsic (1987), Shelp and Hart (1986), Tatom (1986, 1987) and Seaberry (1987). The phrase has become so idiomatic that Browne used it as the title of an article debunking its thrust. She points out that the share of employment in the narrow service sector ("other services" in this article) has been rising faster than manufacturing for some time.

Chart 1
## Distribution of Real GNP 1948–1985




ally unchanged at roughly 21 percent.[3] Consequently, the widespread perception of U.S. deindustrialization is puzzling.

In 1948, 31.4 million Americans were gainfully employed in service industries and 26.9 million in commodities production. Service sector employment since then has grown apace with total employment, rising to 83.2 million in 1985. Concurrently, employment in the commodity sector has grown much more slowly. In particular, agricultural employment declined by over half, from 6.6 million workers to 3.0 million, mining fluctuated around 1.1 million, construction varied between 3 million and 5 million, and manufacturing grew from 16 million to a peak of 20.9 million in 1979, then declined to around 19.2 million in 1985.

As a result of its faster growth, the share of employment in the services sector has risen during the four postwar decades, from about 54 percent in 1948 to 72 percent in 1985. As table 1 shows, the postwar rise in the share of labor (L) in services and its fall in commodities has been persistent and general across subsectors. Among the service subsectors, other services rose from a 13.2 to a 23.2 percent employment share; government employment rose from 11.7 to 18.3 percent, then tailed off to 16.3 percent; and finance nearly

[3]The commodities sector includes agriculture, manufacturing, mining and construction industries; agriculture, in turn, includes forestry and fishing. The services sector includes transportation, communications, utilities, wholesale trade, retail trade, finance, and other services industries; finance includes banking, thrift, finance and real estate, and other services includes personal services, business services, auto repair, health services, legal services and miscellaneous professional services. To mitigate the unavoidable confusion between the services sector and its other services subsector, the subsector will be referred to as *other services* unless the context makes this unnecessary.

Table 1

## U.S. Input and Output Shares by Industrial Sectors, 1948–85

| | 1948 | | | 1956 | | | 1964 | | | 1972 | | | 1980 | | | 1985 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | L | K | Y | L | K | Y | L | K | Y | L | K | Y | L | K | Y | L | K | Y |
| **COMMODITIES** | 46.2%* | 41.2% | 41.2% | 41.7% | 42.5% | 41.3% | 37.2% | 40.0% | 39.3% | 33.9% | 38.1% | 35.8% | 31.2% | 38.8% | 32.7% | 28.1% | 35.6% | 32.4% |
| Agriculture | 11.4* | 7.5 | 5.5 | 8.2 | 7.8* | 4.4* | 5.7 | 6.7 | 3.3 | 3.9 | 6.3 | 2.7 | 3.4 | 6.5 | 2.4 | 2.9 | 4.9 | 2.6 |
| Manufacturing | 27.4 | 23.0 | 21.3 | 26.6* | 22.6 | 22.6 | 25.1 | 21.7 | 21.6 | 23.6 | 22.7* | 21.5 | 21.1 | 22.5 | 20.9 | 18.7 | 21.1 | 21.6 |
| Mining | 1.8* | 8.0 | 6.5* | 1.4 | 10.2 | 6.3 | 0.9 | 9.9* | 5.3 | 0.8 | 7.3 | 5.2 | 1.1 | 7.7 | 4.3 | 0.9 | 8.1 | 3.6 |
| Construction | 5.7 | 2.6 | 8.0 | 5.6 | 2.0* | 9.2 | 5.5 | 1.8 | 9.3* | 5.6 | 1.9 | 6.4 | 5.6* | 2.1 | 5.1 | 5.7 | 1.4 | 4.5 |
| **SERVICES** | 53.8% | 59.3% | 58.8% | 58.3% | 57.4% | 58.7% | 62.8% | 59.9% | 60.7% | 66.1% | 61.8% | 64.2% | 68.8% | 61.3% | 67.3% | 71.9%* | 64.4%* | 67.6%* |
| Transportation | 5.2* | 25.8* | 6.8* | 4.6 | 18.3 | 4.9 | 3.8 | 13.3 | 4.1 | 3.5 | 10.1 | 4.2 | 3.2 | 8.9 | 4.1 | 3.1 | 7.6 | 3.5 |
| Communications | 1.3 | 3.5 | 0.8 | 1.3 | 4.4 | 1.0 | 1.2 | 5.6 | 1.2 | 1.4 | 6.5 | 1.8 | 1.3 | 7.8 | 2.5 | 1.2* | 8.4* | 2.6* |
| Utilities | 0.9 | 11.0 | 1.2 | 0.9* | 13.5 | 1.7 | 0.9 | 13.9* | 2.2 | 0.9 | 13.9 | 2.5 | 0.8 | 12.8 | 2.7* | 0.9 | 12.0 | 2.9 |
| Wholesale Trade | 4.9 | 1.5 | 5.0 | 5.1 | 1.6 | 5.1 | 5.2 | 2.1 | 5.6 | 5.3 | 2.7 | 6.7 | 5.6 | 3.2 | 6.7 | 5.6* | 4.2* | 7.4* |
| Retail Trade | 13.5 | 4.4 | 9.5 | 13.7 | 4.2 | 9.2* | 13.7 | 4.7 | 9.0 | 14.1 | 5.2 | 9.2 | 14.6 | 5.5 | 9.0 | 15.5* | 6.1* | 9.5 |
| Finance, Insurance, Real Estate | 3.2 | 9.6 | 9.6 | 3.9 | 11.0 | 10.9 | 4.4 | 14.0 | 12.4 | 5.0 | 15.9 | 13.5 | 5.7 | 15.6 | 14.6 | 6.2* | 17.5* | 14.6* |
| Other Services | 13.2 | 3.5 | 11.5 | 13.5 | 4.5 | 10.4 | 16.1 | 6.2 | 11.6 | 17.8 | 7.5 | 12.3 | 20.4 | 7.5 | 13.9 | 23.2* | 8.5* | 15.0* |
| Government | 11.7 | — | 13.8 | 15.3 | — | 14.6* | 17.5 | — | 13.8 | 18.3* | — | 13.1 | 17.1 | — | 12.0 | 16.3 | — | 11.1 |
| | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

NOTE: *Denotes maximal share attained within the preceding eight years; labor force is total employment, full and part-time; capital stock is real private, net reproducible tangible wealth in 1982 dollars.

SOURCE: *The National Income and Product Accounts of the United States*, 1929–82; for capital stock — *Survey of Current Business*, January 1986; for 1985 — *Survey of Current Business*, July 1986.

doubled, from 3.2 to 6.2 percent. Only transportation declined appreciably as railroads lost their dominance in freight and passenger markets to trucking and airline firms.

In commodities production, the share of labor in agriculture fell from 11.4 percent in 1948 to 2.9 percent in 1985, and mining's share halved, from 1.8 to 0.9 percent. Manufacturing employment, rising in absolute terms until 1979, fell persistently throughout the period in share terms, from 27.4 to 18.7 percent. Only construction had the same employment share, 5.7 percent, in 1985 as in 1948.

Table 1 also delineates the shifting capital (K) and output (Y) shares in the postwar U.S. economy. As was shown in chart 1, the commodities output share declined from 41.2 percent to 32.4 percent, but the decline was virtually all in agriculture, mining and construction. In services, the distribution of rising output shares during 1948–85 was quite diverse: Communications and utilities shares doubled and tripled, respectively, and financial services had the largest share increase — 5 percentage points — while government services and transportation had declining shares.

The decline in the transportation output share from 1948 (6.8 percent) to 1985 (3.5 percent) made the shift in the capital from commodities to services smaller than it otherwise would have been. As the railroad's share of transportation output fell from 1948 to 1985, there was a substitution of public for private capital in the transportation sector. The privately owned railroad capital stock — equipment and rights-of-way — was supplanted not only by privately owned trucks and aircraft but also by the publicly owned highways, airports and air control networks used by trucking companies and airlines.[4] If transportation capital were excluded from table 1, the change in the distribution of the capital stock from 1948 to 1985 would reveal a much greater rise in the service sector's capital share: from 44.5 percent in 1948 to 70.1 percent in 1985.

In sum, the postwar shift of the U.S. economy toward services has been pervasive: all sectors of services other than transportation and government have become proportionally larger and more capital-intensive. Thus, while it may be provocative to speak of the rising share of services as being produced by short-order cooks and laundry workers, it is grossly inaccurate (see opposite page): As illustrated in the postwar breakdown of the other services subsector, the service activities which have grown fastest since 1948 have been those in which capital investment — both in human skills and in physical equipment — have been substantial. More important, the shift toward services, did not commence in the 1970s, but characterizes the entire postwar era, and reflects a substantive shift in the occupational characteristics of the U.S. labor force as well.

## WHY HAS THE SERVICE SECTOR EMPLOYMENT SHARE RISEN SINCE 1948?

There are two fundamentally interrelated reasons for the rise in the service sector's share of employment in the postwar era: slower growth in labor productivity and faster growth in the demand for services.[5]

### *Slower Productivity Growth in Services*

Labor productivity is measured by the ratio of output per hour of labor input (Y/H). As table 2 shows, overall labor productivity in the U.S. economy rose at an average rate of 1.8 percent per year, from $11.23 per hour (in 1982 dollars) in 1948 to $21.66 per hour in 1985.[6] Productivity growth was much slower in the

[4]The rising share of capital in the truck and air carrier sectors has not been commensurate with their rising proportion of transport services. In 1948, the railroads accounted for about one-fifth of the entire U.S. capital stock, but by 1985, this share had shrunk to less than one-thirtieth. In terms of the transportation sector's capital stock, the railroad share fell from 78 percent in 1948 to 37 percent in 1985. Over this same period, the share of transportation output in GNP (1982 $) from railroads fell from 38 percent to just over 17 percent, while the share of truck and air carriers rose from 14.5 to 60 percent. Yet, the share of transportation capital in the truck and air carrier industries rose from about 7 to 36 percent, a much smaller increase than the decrease in the railroad capital stock.

[5]The relatively rapid productivity growth in manufacturing has been widely documented as an explanation for the declining labor input; see for example, Tatom (1986, 1987), McUsic (1986) and Krugman and Hatsopoulos (1986). The OECD's ongoing estimation of Purchasing Power Parity also provides support for optimists about the *level* of U.S. productivity. Real GDP per capita for the United States in 1986 is 41 percent greater than for Japan and 33 percent larger than for Germany. These ratios are essentially unchanged from 1985; see BIS (1987).

[6]When productivity is measured on a per worker basis, the results are even more divergent than the per hour basis shown in table 2 — 1.85 percent annual growth rate overall with 2.32 percent in commodities vs. 1.47 percent in noncommodities; however, the per worker data include self-employed, while the hourly data in table 2 do not. By reporting on a per hour basis, the distortion due to the divergent patterns of hours per week in different sectors are avoided, but at the cost of omitting data on entrepreneurs, proprietors and especially farmers who are the most important class of owner-operators (Indeed, the agriculture sector data underlying table 2 imply half-time employment throughout the 1948–85 period — 929 annual hours in 1948 and 1,068 in 1985.). When agriculture's productivity is measured per worker (including the self-employed owners), its growth rate during 1948–85 is 3.33 percent compared to the table 2 figure of 2.95 percent.

# Is the Growth in Other Services Hamburgers and Laundry?

The most prominent service subsector in the postwar rise is "other services." Its labor share increase, 10 percentage points, is about equal to the employment share decline in manufacturing, and its rise in capital and output shares are exceeded only by those in finance, insurance and real estate (table 1). Clearly, it is this subsector that critics have in mind when they rail about rising service output being equivalent to U.S. industrial decay, and, in particular, declining job content for U.S. workers. A closer look (table below) at the other service sector, however, belies this characterization of both its output and employment trends. Hamburger cooks (actually enumerated in the retail subsector) and laundry attendants are by no means the primary force in the surge in service employment, in particular in other services.[1]

The table below reveals that the share of personal services — where laundry is reported — has actually declined. In fact, the 3.5 percentage-point rise in the other services share of output is more than accounted for by the rise in professional services. During the 1948–85 period, the share of U.S. GNP emanating from business, medicine, legal and miscellaneous professional services rose from 4.9 percent to 10.1 percent of GNP. Moreover, the 10 percentage-point rise in the service employment share is about the rise in employment in these professional services, an increase of 9.6 percentage points, and the rise in capital in business, medical and legal services accounts for 57 percent of the capital share increase.[2]

[1]For example, during 1977–82 (the most recent data available by occupation within industries), employment in eating places (waiters, waitresses and cooks) rose about 900,000; however, health services (non-hospital) rose over 600,000, legal services 150,000 and business services over 800,000, while laundry and dry cleaning establishments' employment fell by 8,000 during the same five years. The longer-term implications of this shift of occupational choice has been articulated by others; for example, see Freeman (1980), U.S. Congress (1984), Shelp and Hart (1986), Browne (1986), Seaberry (1987).

[2]Miscellaneous professional services include the services of architects, decorators, veterinarians and consultants not elsewhere classified. Capital in miscellaneous professional services is not separately measured.

## Output, Labor and Capital Shares in Other Services

| | 1948 | | | 1960 | | | 1972 | | | 1985 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Y | L | K | Y | L | K | Y | L | K | Y | L | K |
| Other Services | 11.6% | 13.2% | 3.6% | 11.4% | 15.1% | 5.3% | 12.3% | 17.8% | 7.5% | 15.0% | 23.2% | 8.5% |
| Personal | 1.3 | 2.1 | 0.3 | 1.1 | 1.9 | 0.4 | 0.9 | 1.6 | 0.5 | 0.6 | 1.5 | 0.4 |
| Business | 1.0 | 0.7 | 0.3 | 1.4 | 1.3 | 0.7 | 2.0 | 2.3 | 1.5 | 3.3 | 4.5 | 2.2 |
| Auto Repair | 0.4 | 0.6 | 0.3 | 0.5 | 0.6 | 0.9 | 0.7 | 0.7 | 1.1 | 0.8 | 1.1 | 1.5 |
| Health | 2.2 | 1.9 | 0.3 | 2.6 | 2.7 | 0.7 | 3.4 | 4.3 | 1.1 | 4.3 | 6.0 | 1.3 |
| Legal | 1.0 | 0.4 | 0.2 | 0.9 | 0.5 | 0.2 | 0.9 | 0.5 | 0.1 | 1.0 | 0.9 | 0.2 |
| Misc. Prof. | 0.7 | 0.4 | N.A. | 0.9 | 0.7 | N.A. | 1.1 | 1.0 | N.A. | 1.5 | 1.6 | N.A. |
| Other | 4.9 | 7.1 | 2.2 | 4.0 | 7.5 | 2.5 | 3.4 | 7.4 | 3.2 | 3.3 | 7.7 | 3.0 |

SOURCE: *The National Income and Product Accounts of the United States, 1929–82*; for capital stock — *Survey of Current Business*, January 1986; for 1985 — *Survey of Current Business*, July 1986.

Table 2

## U.S. Output-Labor Hour and Capital-Labor Hour Ratios by Industrial Subsectors, 1948–85 (thousands of 1982 dollars)

| | Overall | Commodities | | | | | Services[2] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total | AG[1] | MIN | CONS | MFG | Total | TRAN | COM | UTIL | WHO | RET | FIN | SERV |
| Y/H 1948 | $11.23 | $10.74 | $ 9.95 | $ 38.16 | $19.82 | $ 7.84 | $11.57 | $12.50 | $ 6.59 | $ 12.88 | $10.22 | $ 8.03 | $32.84 | $10.29 |
| Y/H 1985 | 21.66 | 22.54 | 29.17 | 67.79 | 17.78 | 20.81 | 20.78 | 22.75 | 38.38 | 60.95 | 24.65 | 12.88 | 49.38 | 14.02 |
| Growth Rate | 1.79% | 2.02% | 2.95% | 1.56% | –0.29% | 2.67% | 1.60% | 1.63% | 4.87% | 4.29% | 2.41% | 1.29% | 1.11% | 0.84% |
| K/H 1948 | $10.99 | $ 8.94 | $11.57 | $ 40.06 | $ 4.29 | $ 7.16 | $13.05 | $39.93 | $ 24.21 | $101.46 | $ 2.56 | $ 3.14 | $27.62 | $ 2.67 |
| K/H 1985 | 24.26 | 24.67 | 55.34 | 150.83 | 5.64 | 20.24 | 24.02 | 49.67 | 123.28 | 248.52 | 14.05 | 8.28 | 58.9 | 7.95 |
| Growth Rate | 2.16% | 2.78% | 4.32% | 3.65% | 0.73% | 2.84% | 1.66% | 0.99% | 4.49% | 2.45% | 4.70% | 2.65% | 2.06% | 2.99% |

[1] Capital is real fixed reproducible nonresidential capital — equipment and structures. Since land is also a form of capital and of key importance in agriculture, the omission of land implies that the capital-labor ratios for agriculture are understated.

[2] Output, labor and capital exclude the government subsector.

SOURCE: *The National Income and Product Accounts of the United States, 1929–82* and *Survey of Current Business*, July 1986 for real GNP and labor hours; for capital stock — *Survey of Current Business*, January and July 1986.

service sector (1.6 percent per year) than in the commodity sector (2.0 percent per year).

The slower productivity growth in services was not at all uniform across its subsectors. Labor productivity growth in communications (COM) was the fastest of all subsectors, and it was nearly as fast in utilities (UTIL). At the same time, wholesale trade (WHO) labor productivity grew faster than the average rate of the commodity industries. Yet, as noted earlier, the employment shares in these service categories did not rise appreciably during the postwar era. The subsectors that accounted for virtually the entire increase in the service employment shares — other services, retail trade and finance — had average annual productivity growth rates of only about 1 percent.

Perhaps some of this slower productivity growth resulted from the shorter average work year in services (measured in hours), implying a large component of part-time employment. In 1985, the average hours per employee in commodities, 1,783 hours, was nearly three weeks longer than the average in noncommodities, 1,672 hours; moreover, in the service sector annual hours varied considerably. For example, communications and utilities workers averaged 1,986 and 1,936 hours in 1985, roughly the same as the average in manufacturing, 1,942 hours; in contrast the other services, finance and retail sectors each had average employee hours of less than 1,670 hours. Conversely, construction (1,575 hours) and agriculture (1,068 hours) also had low annual hours. Both industries are seasonal and susceptible to the vagaries of weather, but construction has had negative productivity growth while agriculture's productivity growth has been very high. Thus, low hours in and of themself do not provide an explanation for slow productivity growth.

Rising labor productivity results from either an increase in the proficiency of workers — an increase in human capital — or an increase in plant and equipment — nonhuman capital.[7] Focusing for the moment on nonhuman capital, table 2 shows that during 1948–85, capital-labor ratios (K/H) have at least doubled in every sector of the U.S. economy except construction and transportation, and that productivity (Y/H) generally has grown faster in those sectors with faster capital growth (K/H).[8] As with productivity, however, these ratios have risen more slowly in services (1.7 percent per year) than in commodities (2.8 percent per year).[9]

While productivity growth has been slower overall in services, it has resulted from neither a dearth of investment nor intrinsically lower capital intensity of services; indeed, as noted earlier, if one omits transportation, capital grew much more rapidly in services than in commodities production. As shown in table 2, capital-labor ratios have been consistently higher in four of the seven service sectors than in manufacturing, and the capital-labor ratios in the communications and wholesale categories were the fastest growing of all sectors. Moreover, in every industrial sector, capital has grown more rapidly than labor since 1948.[10] In particular, the capital-labor ratio in other services grew faster than that in manufacturing — 3.0 percent vs. 2.8 percent — even though the other services share of labor was rising while the manufacturing share of

[7]Theodore W. Shultz is the economist most influential in developing the notion of "human capital" for the reservoir of skills, proficiencies and knowledge, for which he was awarded the 1979 Nobel Prize in Economics; see Shultz (1961). The rise in this productive capacity of workers comes from two sources. Experience, sometimes referred to as the learning curve, enhances the rapidity and accuracy of workers in completing assigned tasks. Formal training, both classroom and on-the-job, increases the understanding and insight of workers, which leads to rising facility and quality through better methods and product innovation.

[8]The rank-order correlation between the 1948–85 sectoral growth rates of Y/H and K/H in table 2 is .46; if transportation is omitted (given the distortion in the capital-labor-output relations entailed in the shift from railway to airline and trucking), the rank order correlation is .53. Both correlation statistics are significant at the 5 percent level.

[9]Evaluating the impact of the increased capital input fully would require a consideration of the quality of capital and technological change. Also, the real price of a machine with given capacity may have declined during the 1948–85 period; if so, the quantity of capital would be understated. More important, technological advances occurred during this period, especially in computer-controlled manufacturing processes. For example, numerical control and multi-axis omnimills have made possible the manufacture of aircraft and rocket engines to tolerances not feasible at the beginning of the period. These applications also have reduced the labor input required in design and engineering processes through the automation of drafting and modeling procedures. Proliferation of these changes can be sampled by a glance at want-ads for CAD/CAM workers — computer-aided design and computer-aided manufacturing. Moreover, the growth of capital-labor ratios is driven both by capital growth and labor growth. As table 1 shows, the share of both capital and labor have risen in services, while labor has fallen and capital has risen in commodities, especially agriculture. Thus, labor shifts may amplify or attenuate the accompanying capital increases in terms of the capital-labor ratios.

[10]Since the employment share fell in manufacturing, it is possible that the increases in capital-labor ratios, were due to falling employment rather than rising capital. Yet, as table 1 shows, the share of private, net U.S. nonresidential capital in manufacturing, like its share of output, has remained relatively constant at about 22 percent during the postwar period. Thus, capital invested in manufacturing industries has grown apace with its output.

Table 3

**Relative Prices of Commodities and Services in U.S. GNP, 1948–86 (1982 = 100)**

| | 1948 | 1952 | 1956 | 1960 | 1964 | 1968 | 1972 | 1976 | 1980 | 1984 | 1986[3] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Implicit GNP Deflator, Prices of Durable Goods as Numeraire[1]** | | | | | | | | | | | |
| Consumption | | | | | | | | | | | |
| Durable Goods | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |
| Nondurable Goods | 76.8 | 76.1 | 74.3 | 74.5 | 187.2 | 77.8 | 82.5 | 91.8 | 100.2 | 102.9 | 101.5 |
| Services | 53.1 | 58.1 | 64.6 | 68.0 | 69.1 | 73.5 | 81.3 | 86.0 | 94.1 | 112.2 | 116.2 |
| **Fixed-Weight GNP Price Index, Prices of Goods as Numeraire[2]** | | | | | | | | | | | |
| Goods | | | | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |
| Services | | | | 70.9 | 73.5 | 78.0 | 85.6 | 90.6 | 94.7 | 100.0 | 113.5 |
| Structures | | | | 59.4 | 57.7 | 60.1 | 68.9 | 80.3 | 98.9 | 100.0 | 98.8 |

[1] Nondurable goods are those with assumed useful lives of three years or less, such as clothing, food and publications.
[2] Not available prior to 1959.
[3] 1986 based on preliminary IV/1986 data.

SOURCE: *Survey of Current Business*, tables 7.4, 7.2.

labor was falling. In summary, capital investment was rapid in each service sector except transportation.[11]

## *Faster Demand Growth in Services*

There is substantive evidence that the postwar rise in the share of U.S. output in services reflects a relative shift in final demand for services and away from commodities. Output of services has risen as a share of total output (table 1); a rise in the relative price of services, then, can only mean that the demand for them also has increased relative to commodities. As shown in table 3, the relative price of consumption services measured in terms of the price of durable goods has more than doubled since 1948.[12] More generally, the lower half of the table indicates that the relative price of all services (producers' as well as consumers') measured in terms of the price of goods has risen by about two-thirds since 1960.

Why has the demand for services risen as a share of output even though their prices relative to commodities have risen? One plausible answer is that the quality of services has risen, and the data, unadjusted for the quality improvement, understate quantity and, therefore, overstate price.[13]

Another answer that has been advanced by development economists and economic historians is that, as economies mature, rising income is progressively directed toward purchases of "higher-order" or luxury goods of which services predominate. Thus, Clark (1951) found that:

[11]As table 1 shows, except for transportation and utilities, the service subsectors' capital shares all attain their maximums (denoted by asterisks) at the most recent observation; in contrast, in the commodities sectors, the maximum capital share in each subsector occurs considerably earlier.

[12]That is, construct a bundle of consumer durable goods (such as televisions, electric mixers and bowling balls) and a bundle of consumer services (such as dentist's visits, movie tickets and automobile servicing) each costing $1,000 in 1982. Thus, by construction, the relative price of the services in terms of the durable goods was 100 percent in 1982 prices. Comparing the same bundles in 1948, table 3 implies that the price of the service bundle was only 53 percent of the durable goods bundle, while in 1985 its relative price was 116 percent.

[13]Service output is primarily measured in terms of inputs; thus, if inputs, especially labor, increase in their productivity — e.g., physicians or accountants and lawyers assisted by computer — their hourly charges will rise and, uncorrected for the quality rise, the unit price will incorrectly be raised by the same amount. Such errors would also lead to understated productivity growth in table 2. Marimont (1969), who provides a detailed description of the methods and shortcomings of the U.S. Commerce Department's accounting procedures for services, eloquently encapsules this measurement problem (p.16):

> The industries that are the subject of this paper do not make a pair of shoes, a refrigerator, or a drill press; all of which are tangible and can be counted, although with varying degrees of ambiguity. Instead, they provide services, that is, they safeguard savings, insure lives, lend money, advertise businesses, audit books, restore health, repair cars, and so on. Conceptual questions that are extremely difficult to answer are raised when one attempts to count such units of output or measure changes in their quality in order to provide a meaningful and consistent measure of their contribution to total GNP.

> . . . in the most advanced countries the demand for manufactured goods tends to settle down finally at about 20–25 percent of the national income. The demand for farm products falls to 10 percent of national income, and will fall lower as income advances further. It follows that in the most advanced countries the demand for services, including building and handicrafts and the products of small-scale manufacture, will rise to 70 percent or more of national income.[14]

## LONG-RUN TRENDS IN THE DISTRIBUTION OF OUTPUT AND INPUT SHARES

The discussion of the U.S. postwar economy, the data in tables 1–3, and the shaded insert on page 9 clearly establish five characteristics about the evolution of output and input shares:

- The share of U.S. output in services has risen steadily over the entire 1948–85 period;
- Labor productivity has grown faster in the commodities sector than in the services sector;
- The shift in output has reflected a relative shift in consumer demand toward services;
- Labor and capital inputs have persistently risen in services production;
- The shift of labor into the services subsector of "other services" production has been primarily into activities requiring specialized skills, not into unskilled activities.

These observations raise questions about the long-run character of U.S. economic development:

- How long has the relative rise in service production and employment been going on?
- What has happened to the distribution of U.S. labor by occupation over longer time periods?
- Are the other major industrial economies experiencing similar or parallel employment and output evolutionary patterns?

### *Output and Labor Shares in the U.S. Economy, 1800–1985*

The main currents driving the evolution of U.S. output and labor distribution since 1800 have been the rising productivity of labor successively in agriculture and manufacturing. Agriculture absorbed nearly three-quarters of the labor force in 1800 (persons aged 10 years and older, free and slave) with the residual being poorly accounted for.[15] By 1840, agricultural employment still occupied between 60 and 70 percent of American labor; however, the share of employment in manufacturing and construction had risen from 3 percent in 1810 to about 14 percent. In 1860, agriculture's share was still about 60 percent of the free labor force compared with more than 18 percent in manufacturing and construction.[16] While pre-Civil War data are not available for an analysis of output by industry in constant dollars, it has been estimated that in 1879 prices, the 1839 and 1859 agricultural shares of total commodity output were 72 percent and 55 percent, respectively, while manufacturing's shares in the same years were 17 percent and 32 percent.[17]

More consistent data are available on the distribution of output and labor for the period from 1870 to 1940. Unfortunately, the output data are for national income in current prices, which distort the distribution of shares among sectors.[18] Nonetheless, with these caveats, the data on national income and employment shares by industry for 1870–1940 are presented in table 4.

The most obvious characteristic of the data in table 4 is the steady rise in the proportion of the labor force in service production over the 70-year period, along with the concomitant decline in the proportion of labor in commodity production. The proportion of the labor force in agriculture fell from one-half in 1870 to about one-sixth in 1940. Although the manufacturing share rose over this period, most of the labor released from agriculture went to services production, whose share roughly doubled. While the distribution of employment gains varies across the various service categories, every category's share rises strongly.

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[14]Clark (1951), p. 366. Clark first advanced the notion of higher-order goods (luxury goods) in the initial, 1940 edition of his book, which argued that the service output share would rise with economic development; he presented international and historic evidence to support his assertions. See Beeson and Bryan (1986) for a discussion of higher-order goods.

[15]Lebergott (1964), table A-1, p. 510.

[16]Lebergott (1964), table A-1 and Fabricant (1949), table 2, p. 42.

[17]Table F-238-249, p. 239, *U.S. Historical Data Colonial Times to 1970*.

[18]Gross National Product (GNP) less capital consumption allowance (estimated depreciation) equals Net National Product (NNP). NNP less indirect business taxes plus subsidies less current surplus from government enterprises equals National Income (NI). NI is convenient for some analyses because it is equal to the sum of all payments to factors of production — wages and salaries plus profits plus rent plus interest. Two distortions are introduced by taking shares of NI in current dollars rather than GNP in constant dollars: First, if productivity in agriculture and manufacturing grew faster than in other sectors, the resulting decline in unit prices over the 70 years in these sectors will overstate their share in real terms in early years and understate it in later years. Also, since national income omits depreciation, indirect taxes and subsidies, the data also may distort the shares relative to total value added on a real GNP basis. For an illustration of how changes in the relative price of manufacturing affects shares of real GNP, see table 3 in Perna (1986), p. 32.

Table 4

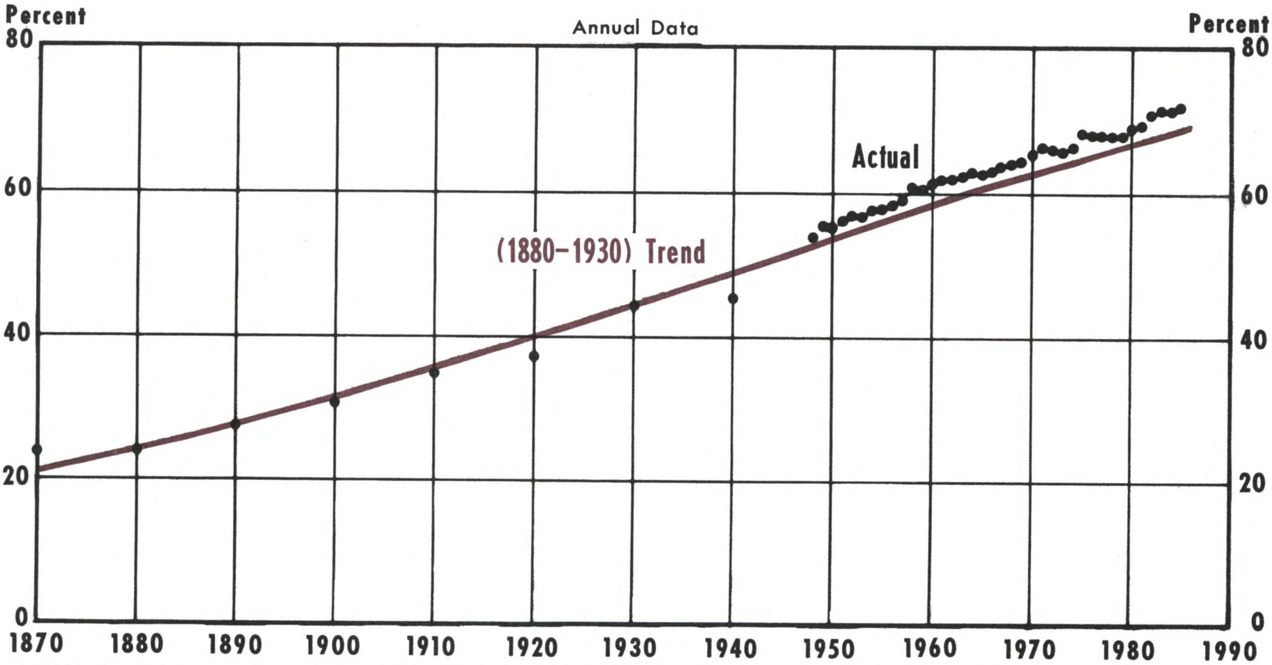
## U.S. Labor and Output Shares by Industrial Sector, 1870–1940

| | 1870 | | 1880 | | 1890 | | 1900 | | 1910 | | 1920 | | 1930 | | 1940 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | L | Y | L | Y | L | Y | L | Y | L | Y | L | Y | L | Y | L | Y |
| Commodity Production | 74.9% | 44.0% | 74.8% | 39.4% | 70.9% | 41.1% | 67.7% | 43.7% | 62.8% | 46.5% | 61.7% | 47.1% | 53.1% | 38.0% | 48.2% | 38.8% |
| Agriculture | 49.7 | 22.2 | 50.0 | 19.0 | 42.8 | 14.2 | 37.5 | 18.8 | 31.5 | 19.8 | 27.4 | 15.4 | 22.1 | 9.3 | 17.2 | 9.7 |
| Mining | 1.5 | 1.5 | 1.8 | 2.1 | 2.0 | 2.1 | 2.6 | 2.8 | 2.9 | 3.4 | 3.0 | 3.8 | 2.4 | 2.6 | 2.1 | 2.5 |
| Construction | 5.8 | 5.7 | 4.8 | 5.0 | 6.1 | 5.0 | 5.7 | 3.9 | 6.2 | 4.0 | 5.2 | 3.2 | 6.2 | 4.0 | 6.6 | 2.6 |
| Manufacturing | 17.4 | 14.6 | 18.2 | 13.3 | 20.0 | 18.9 | 21.8 | 18.2 | 22.3 | 19.3 | 26.1 | 24.6 | 22.5 | 22.0 | 22.4 | 24.0 |
| Services Production | 23.9% | 56.0% | 24.0% | 60.6% | 28.3% | 58.9% | 31.1% | 57.2% | 35.1% | 53.5% | 37.4% | 52.4% | 44.2% | 61.9% | 45.5% | 61.2% |
| Transportation, Communications, and Utilities | 4.8 | 10.9 | 4.7 | 12.9 | 6.2 | 11.2 | 7.0 | 10.5 | 8.2 | 10.7 | 9.6 | 11.7 | 9.3 | 11.8 | 7.2 | 10.4 |
| Retail and Wholesale Trade | 6.1 | 15.2 | 6.6 | 16.1 | 7.7 | 16.8 | 8.5 | 16.8 | 9.1 | 16.0 | 9.8 | 14.7 | 12.4 | 14.7 | 13.5 | 12.1 |
| Finance, Insurance Real Estate | 0.3 | 11.5 | 0.4 | 12.0 | 0.7 | 13.1 | 1.0 | 12.4 | 1.4 | 12.5 | 1.9 | 11.3 | 2.9 | 14.7 | 2.9 | 11.8 |
| Other Services | 10.7 | 14.2 | 10.0 | 15.2 | 11.3 | 12.5 | 11.8 | 11.0 | 12.9 | 9.1 | 11.6 | 7.9 | 14.7 | 10.9 | 16.2 | 10.3 |
| Government | 1.9 | 4.2 | 2.3 | 4.5 | 2.5 | 5.2 | 2.8 | 6.5 | 3.5 | 5.3 | 4.5 | 7.3 | 4.9 | 7.8 | 5.7 | 16.7 |
| Industry Not Specified | 1.2% | — | 1.1% | — | 0.7% | — | 1.2% | — | 2.0% | — | 0.9% | — | 2.7% | — | 6.2% | — |

NOTE: Totals may not add to 100.0 percent due to rounding. For 1870–1930 labor includes persons 10 years and older; 1940 includes 14 years and older. Income is current dollars national income for one year earlier than column heading, except for 1940 which is 1937.

SOURCE: National income, U.S. Department of Commerce, *Long Term Economic Growth, 1860–1970*, Series 141–151; Labor, Carson (1949), table 1.

Chart 2
## Share of Employment in U.S. Service Sector 1870–1985




NOTE: Logistics curve based on service sector share employment; for details, see footnote 19.

Overall, the shift of employment from commodity to services production has been both persistent and relatively steady. An examination of the data from 1880 to 1930 reveals that the share of employment in services grew at an average annual rate of about 1.8 percent.[19] Applying this 1880–1930 trend growth rate to the 1880 labor share and projecting it over the succeeding 105 years, as chart 2 does, fits the rising labor share reasonably well. The predicted 1985 services labor force share is 68.5 percent, while the actual labor share in services production for 1985 (from table 1) is 71.9 percent. Apparently, the shift from commodities to services has been proceeding fairly steadily for more than a century.[20]

## *The Distribution of U.S. Labor By Occupation, 1900–80*

The analysis thus far has categorized output, labor and capital by industrial sector. Yet, industrial firms in commodities employ a wide variety of support staff as

[19]By definition, the employment share in services must lie between 0 and 100 percent; consequently, a simple trend exponential growth rate is not relevant in forecasting the share. A logistic growth curve, $S_t = [1 + \exp\{a + b\,(t\text{-}1880)\}]^{-1}$, meets the boundary constraints and is easily fit to the data in table 4. The parameters (a = 1.1527, b = -.0184) were computed using the observed shares for 1880 and 1930; these years were used to avoid the labor market disruptions following the Civil War and World War I and the distortions of the 1930s.

[20]Less can be said about the pattern of relative production since the national income data are in current prices; however, there was clearly a shift from agriculture to manufacturing within commodities and a moderate shift from commodities to services, both starting around 1920.

well as industrial craftsmen, operatives and labor — including lawyers, nurses, accountants, gardeners, and even cooks and laundry workers. Consequently, any change in the amount of support work accomplished outside of the corporation by subcontracting for services will change the distribution of employment even if the set of tasks being accomplished overall is unchanged.[21]

On the other hand, the set of tasks to be accomplished in any production activity has evolved during this century due to innovation and capital investment, particularly investment in human capital.[22] For example, in the production of machine tools since 1900, the relative labor inputs of engineers, designers, computer operators and the like have risen relative to machinists, other craftsmen and operatives. Thus, a more complete picture of the distribution of the U.S. labor force can be obtained by considering its occupational as well as its industrial distribution. The occupational breakdown of U.S. employment based on the U.S. decennial censuses for 1900–80 is given in table 5.

Several features of the occupational distribution's evolution are clarified by the data in table 5 which shows U.S. census percentage distribution of workers by standard occupational categories.[23] First, as indicated earlier, the share of employees in agricultural occupations has declined precipitously — from 37.6 percent in 1900 to 2.8 percent in 1980 (the sum of farmers and farm labor entries in table 5). More striking, however, is the rise in the share of technical and managerial occupations and the decline of unskilled or unspecialized labor. In 1900, private household workers plus farm plus nonfarm labor accounted for 35.6 percent of employment, while technical and managerial occupations absorbed about 10.1 percent; in 1980, these low-skill labor categories constituted only 6.6 percent of the labor force, while management and technical occupations had increased to a 27.3 percent share.[24] Although skilled manual trades — craftsmen, foremen and operatives — made up a larger share of the labor force in 1980 than they did in 1900, this share had declined markedly from its peak in 1950 — from 34.4 percent to 26.7 percent. Most of this decline was in operatives, especially from 1970 to 1980; some may reflect the upgrading in job skill requirements to professional and technical, a category whose increase occurred primarily during these three decades.

A more informative taxonomy is to divide the occupational types into the following three categories: information provision and decisionmaking, direct production, and non-information services. These groupings, the subheadings in table 5, divide the census categories according to the primary form of output generated by the worker. The first category encompasses the production of information by decisionmakers and all the supporting design, analysis and record-keeping occupations and sales staff. The second comprises labor directly involved in production of goods and public utility services such as transport and electricity. The third consists of services other than information or utilities: private household services, police and fire services, and food and cleaning services. The evolution of labor shares within these more inclusive categories is rendered in chart 3 for the years 1900, 1950 and 1980.[25]

The data from table 5, summarized in chart 3, show that during this century the information and decisionmaking occupations have grown from about one-sixth of all employment to well over half. Direct production

[21]That subcontracting of services is a key impetus in the rise of service employment was emphasized by several experts testifying in the congressional hearings on service industries. See U.S. Congress (1984). For example, Kravis argued:

> The other factor pushing up employment in the service industries is the tendency of commodity-producing industries to contract out services formerly performed in-house. . . . The advantages of employing outside specialists increase as technology becomes more complicated — for example, computerized accounting and — more capital intensive — cleaning office buildings, catering employee meals; the hiring of in-house [sic] lawyers to handle labor negotiations and tax matters.(p. 426)

[22]This implies the increasing importance of human capital in production, which, in turn, has been facilitated by a rise in the schooling of the average American worker. In 1900, the average American worker had completed 7.7 years of schooling; in 1957, schooling per worker was 11.0 years and in 1984, it was 12.1 years. Moreover, the school year, measured in average attendance per pupil, has increased by over 60 percent, from 99 days in 1900 to 159 days in 1957 to 162 days in 1970. See Shultz (1971) and U.S. Department of Commerce (1986), table No. 671, p. 397.

[23]One tacit measure of rising U.S. welfare is the increase in the age at which labor force entry is presumed to take place, from 10 years of age in the 19th century to 14 years in the mid-20th century to 16 years in the late 20th century. In part, this reflects the increasing investment in human capital through formal schooling.

[24]Considering only nonagricultural employment (that is excluding both farm management and farm labor), the share of unskilled labor fell from 28.7 percent of U.S. nonfarm employment in 1900 to 5.2 percent in 1980. During these eight decades, management, technical and other information occupations rose from 28.2 percent to 54.5 percent of persons employed in nonfarm occupations.

[25]The information category of employment was emphasized by several witnesses in the Congressional hearings on Service Industries [U.S. Congress (1984)], especially Levinson and Roach, pp. 261–87. This taxonomy does not quite conform to the commodities/services division used earlier since technical occupations include both medical diagnosis *and* treatment, while operatives include transportation and some other services such as occupations in public utilities.

Table 5
**Occupational Distribution of the U.S. Labor Force**

| | 1900 | 1910 | 1920 | 1930 | 1940 | 1950 | 1960[5] | 1970 | 1980 |
|---|---|---|---|---|---|---|---|---|---|
| **Information Provision/Decisionmaking** | 17.6% | 21.4% | 24.9% | 29.4% | 31.1% | 36.6% | 40.1% | 47.4% | 53.0% |
| Professional and Technical | 4.3 | 4.7 | 5.4 | 6.8 | 7.5 | 8.6 | 10.8 | 14.5 | 18.0 |
| Managers, Officials and Proprietors (nonfarm) | 5.8 | 6.6 | 6.6 | 7.4 | 7.3 | 8.7 | 8.1 | 8.1 | 9.3 |
| Clerical and Administrative Support[1] | 3.0 | 5.3 | 8.0 | 8.9 | 9.6 | 12.3 | 14.1 | 17.8 | 17.3 |
| Sales Workers | 4.5 | 4.7 | 4.9 | 6.3 | 6.7 | 7.0 | 7.1 | 7.0 | 8.4 |
| **Direct Production** | 73.3% | 69.1% | 67.1% | 60.8% | 57.2% | 52.9% | 43.7% | 39.6% | 34.1% |
| Farmers (including managers) | 19.9 | 16.5 | 15.2 | 12.4 | 10.4 | 7.4 | 3.7 | 1.8 | 1.3 |
| Farm Labor | 17.7 | 14.4 | 11.7 | 8.8 | 7.0 | 4.4 | 2.3 | 1.3 | 1.5 |
| Craftsmen and Foremen | 10.5 | 11.6 | 13.0 | 12.8 | 12.0 | 14.2 | 13.6 | 13.9 | 12.9 |
| Operatives | 12.8 | 14.6 | 15.6 | 15.8 | 18.4 | 20.4 | 18.9 | 18.0 | 13.8 |
| Nonfarm Labor[2] | 12.5 | 12.0 | 11.6 | 11.0 | 9.4 | 6.6 | 5.2 | 4.7 | 4.5 |
| **Non-information Services** | 9.0% | 9.6% | 7.8% | 9.8% | 11.7% | 10.5% | 11.2% | 12.8% | 12.9% |
| Private Household Workers | 5.4 | 5.0 | 3.3 | 4.1 | 4.7 | 2.6 | 2.7 | 1.5 | 0.6 |
| Other Service[3] | 3.6 | 4.6 | 4.5 | 5.7 | 7.1 | 7.9 | 8.5 | 11.3 | 12.3 |
| | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |
| Labor Force (millions)[4] | 29,030 | 37,921 | 42,206 | 48,686 | 51,742 | 58,999 | 67,990 | 79,725 | 97,460 |

[1]Includes computer equipment operators, secretaries, stenographers, typists, financial record processing occupations, and mail and message distributing occupations.
[2]Mine labor included from 1970; prior to 1970, mine labor included in operatives.
[3]Includes protection (police, firefighters, private security), food service, and cleaning and building service occupations.
[4]Economically active population, from decennial census; prior to 1940, includes gainfully employed civilians 10 years and older, for 1940 and 1950 14 years and older, from 1960 on 16 years and older.
[5]Labor force includes workers not classified by occupation; occupational percentages computed on total of classified workers.

SOURCE: *Historical Statistics of U.S. Colonial Times to 1970*, Table Series D233-682; and 1980 *Census of Population*, General Social and Population Characteristics, U.S. Summary, Table 104.

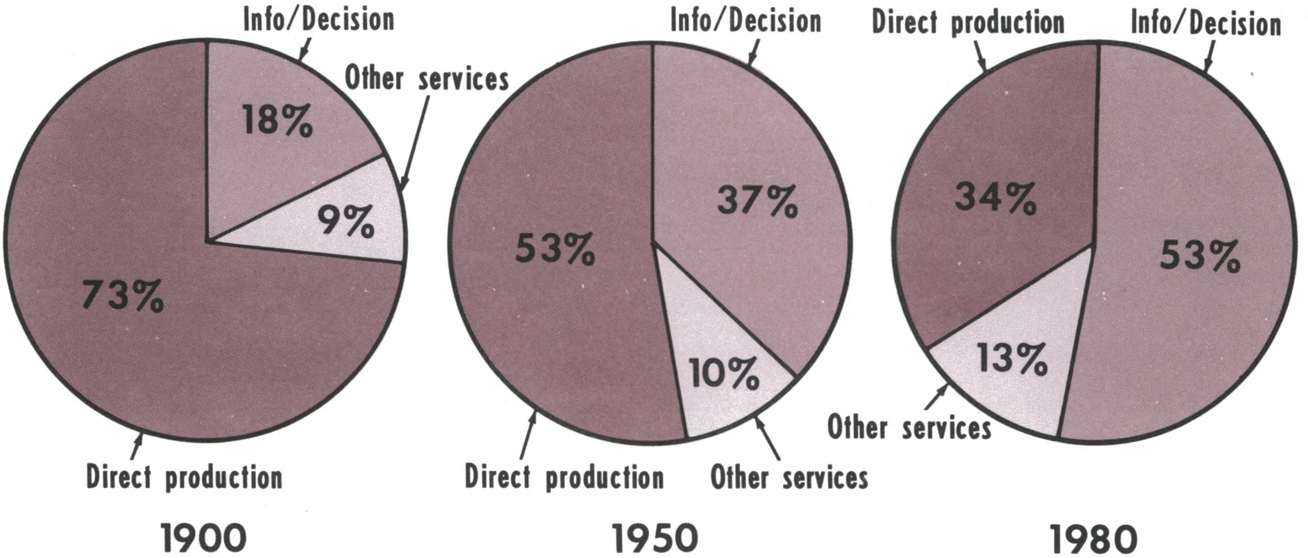
labor, meanwhile, has fallen from about three-fourths of employment to about one-third. The principal source of the decline in production occupations has been agriculture, whose share fell from 37.5 percent in 1900 to less than 3 percent in 1980. Nonagricultural production occupations have a slightly lower share in 1980 than in 1900, but are well down from their maximum share of 41.1 percent attained in 1950. The non-information services share has increased slightly; in fact, since 1940, its share has risen by 1.2 percentage points with the decline in household services being slightly more than offset by the rise in other services (primarily protection — fire, police and security).

The data from table 5 also can be used to illustrate the relatively steady evolution of the U.S. occupational distribution in this century. A growth curve is fit to the labor share in information provision/decisionmaking occupations as it evolved during 1900–30. Projecting the share of employment in this category can then be used to determine if there have been abrupt shifts during the 1930–80 period.[26] As chart 4 shows, the projected share based on 1900–30 data fits the occupational distribution quite well, growing at an annual rate of about 2.2 percent: the predicted 1980 share is 55.9 percent, compared with its actual share of 53.0 percent (table 5). A similar exercise for the direct

[26]Since the employment share in information provision/decisionmaking must lie between 0 and 100 percent, a logistics curve is appropriate to assess the trend; see footnote 19. The fitted logistics curve using the 1900 and 1930 shares ($S_t$) from table 5 is

$$S_t = [1 + \exp(1.544 - 0.022\,(t-1900))\,]^{-1}.$$

Chart 3
## U.S. Employment Distribution by Occupation 1900–1980




production labor share predicts a 1980 share of 37.4 percent compared with the observed 34.1 percent.

Table 5 and charts 3 and 4 show that the functional role of the typical American employee is progressively moving away from the final mechanical step of commodities production — that is, fabrication assembly, or packaging.[27] More than 50 percent of employment is now concentrated in analysis, design, managing and recording processes, and sales, while, by inference, U.S. capital (or foreign labor) is occupied to a larger extent in mechanical production. Some observers decry this as the initial symptom of industrial calamity:

> The result is the evolution of a new kind of company: manufacturers that do little or no manufacturing and are increasingly becoming service-oriented. They may perform a host of profit-making functions — from design to distribution — but lack their own production base. In contrast to traditional manufacturers, they are hollow corporations.[28]

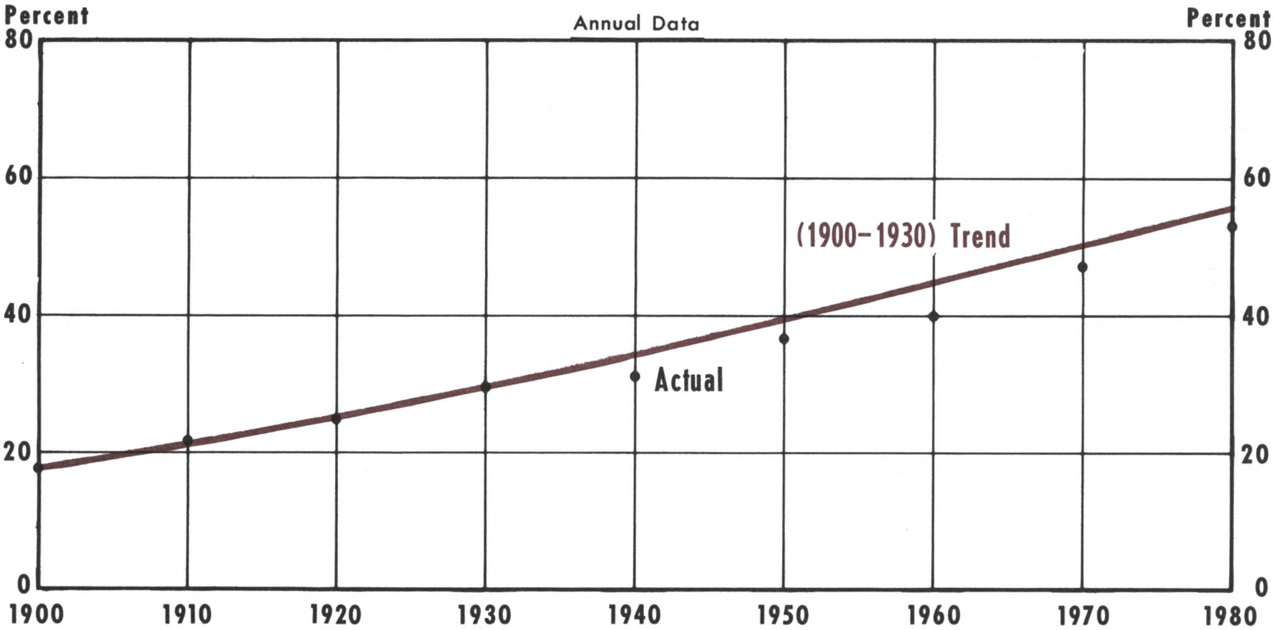
Yet this evolution simply reflects the operation of the law of comparative advantage. As U.S. labor has become more productive — due to increased human and nonhuman capital — the opportunity cost of its use in lower-valued stages of production has risen. Those production processes in which capital cannot sufficiently substitute for (or augment) labor must be ceded to foreign lower-cost labor.[29] This view of labor complements the conclusion of an analysis of the performance and competitiveness of U.S. multinational corporations by Lipsey and Kravis:

[27]This notion — that innovation and investment make the production process more roundabout or lengthen the period of production — is the focus of a long-standing debate in economic theory. It is at the core of the Austrian approach to capital theory; see "The Austrian Theory of Capital and Interest," chapter 12 in Blaug (1985).

[28]*Business Week* (1986), p. 57. Ironically, the same article positively assesses several companies whose primary activities are product research and development distribution with production done in foreign countries due to high domestic labor costs: Nike Shoe (German), Emerson Radio Corp. (U.S.), Pitney Bowes Inc. (U.S.) and IBM (U.S.).

[29]The process works in reverse as well. Feder (1987) quotes Steven Walleck, head of manufacturing consulting for McKinsey & Co. in Cleveland, as claiming "major shifts from labor intensive overseas plants to the United States usually follow the design of new products especially suited for automated manufacturing and the introduction of new manufacturing systems." An interesting example of this is the recent agreement between Inland Steel (U.S.) and Nippon Steel (Japan) for a joint venture, a cold-roll steel mill to be built in South Bend, Indiana; see Kotlowitz (1987). This announcement followed by less than three months the Nippon Steel decision to close 12 of its steel mills in Japan; see Cullison (1987).

Chart 4
## Share of U.S. Workers in U.S. Information Provision/Decision Making 1900–1980




NOTE: Logistics curve based on percentage share of information services occupation employment 1900–1930; for details, see footnote 26.

This record is consistent with the view that American management and technology remained competitive, and is at variance with the argument sometimes made that the fall in the share of the U.S. in world manufactures exports was due to management failures and declines in technology. Perhaps the greater integration of the world economy with respect to transport and communications, and hence to the ease of managerial control over activities in distant locations, facilitated the expansion of affiliate exports in the 1957–77 period, but even so, American management should be credited with taking advantage of these opportunities. And since 1977, American-controlled firms abroad have maintained their shares in a rapidly growing world market, with powerful competition from Japan and some other industrial countries and the advent of new competitors.[30]

[30]Lipsey and Kravis (1986), p. 24.

The Lipsey-Kravis hypothesis is consistent with the persistent downward trend of the postwar share of manufacturing *employment*. Yet, since the share of U.S. *output* in manufacturing has been constant over this period, this trend does not imply the demise of the manufacturing sector. Moreover, if the other industrial economies have experienced similar trends in employment and output shares, these trends can be interpreted as a normal stage of advanced industrialization.

## *International Comparisons of Output and Labor Distribution*

Throughout the 20th century, all advanced economies have undergone parallel transformations in their output and employment distributions. In each of the advanced economies, the shares of labor and output in agriculture have diminished greatly. For example, as table 6 shows, the Japanese share of output in agriculture was more than 54 percent in 1890 and the corresponding employment share was 76 percent. These shares were somewhat smaller for France and the United States, and considerably smaller for Germany and Great Britain. Over the succeeding 60 years, in these countries agricultural activity declined, while their goods production sectors' share rose.

From 1950 to 1984, while the specific patterns of the production and output evolution vary somewhat, the five industrial economies share three key features. First, the proportion of goods production to real gross domestic product (GDP) peaked between 1960 and 1970, and has fallen to less than 40 percent for each, with the decline smallest for Japan.[31] Second, the share of employment in goods production, which also peaked between 1960 and 1970, has declined for each country from 1970 through 1984.[32] Third, by 1984, each nation had similar output and employment shares in services production.[33]

Some semblance of these long-term output and labor shifts can be seen in the three developing economies included in table 6: Greece, Spain and Turkey. Over the 1960–84 span, employment and output shares declined most in agriculture; while these proportions rose for both goods and service production, the largest increases were in the service sectors. This pattern resembles the shifts during 1870–1940 in the U.S. economy (see table 4).

[31]GDP is GNP less net factor income from abroad.

[32]Once again, the Japanese decline is slight, but Japan began the 1960s with by far the largest reservoir of agricultural employment, a reservoir that over the next 24 years declined by 21.3 percentage points. This employment outflow contributed a large low-cost inflow into manufacturing which the other industrial economies had long since absorbed. This pattern is similar to the decline in U.S. agricultural employment during 1870–1940; see discussion above, p. 12 and table 4.

[33]This similarity probably will become even closer as Japan reduces its inefficient share of agricultural labor. Declining Japanese agricultural employment and protectionist inefficiencies were the topic of recent reviews in the *Wall Street Journal* (Darlin (1986) ) and *The Economist* (1987). Also, the Bank of Japan was recently quoted [Bank of International Settlement (1987) ] as describing its economy in terms of duality, with relatively more rapid expansion expected in the service sector: "sluggish mining and industrial production, declining business activity in the manufacturing sector" contrasting with the fixed investment by non-manufacturers: "which have benefitted from the effects of the year's appreciation and low oil prices, are showing unexpected firmness, and they are limiting the deceleration of the economy as a whole... With the sustained increase in the non-manufacturing sector, the total number of employees will grow modestly."

## CONCLUSION

The postwar rise of the U.S. economy's service sector continues trends in output and employment that reach back well over a century in U.S. history. The employment shift has much to do with slower productivity growth in services, the causes of which are not well understood. This evolution is not unique to the economy of the United States, but parallels changes in other industrial nations and, to some extent, developing economies as well.

The rising share of output and employment in the U.S. economy's services sector is even more pronounced when analyzed in terms of occupational categories. Moreover, the capital distribution in the United States also has been shifting toward service production. These are not symptoms of impending disaster for the U.S. economy. Rather, they are evidence of its efficient long-term evolution, propelled by the relatively more rapid growth of labor productivity in commodities than in services. Clearly, this evolution enhances the economy's capacity to provide rising standards of living for consumers and occupational satisfaction for workers.

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Table 6

## International Comparisons of Output (Y) and Employment (E) Percentage Distributions among Agriculture (A), Goods (G) and Services (S), for Some OECD Economies

| | | 1890 | | | 1950 | | | 1960 | | | 1970 | | | 1980 | | | 1984 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A | G | S | A | G | S | A | G | S | A | G | S | A | G | S | A | G | S |
| **Developed Economies**[1] | | | | | | | | | | | | | | | | | | | |
| France | Y | 37.0 | 32.0 | 30.0 | 23.0 | 46.0 | 31.0 | 9.9 | 43.1 | 47.0 | 6.7 | 44.0 | 49.3 | 5.0 | 32.4 | 62.6 | 5.4 | 30.7 | 64.3 |
| | E | 48 | 25 | 27 | 27.0 | 26.2 | 25.9 | 22.4 | 38.1 | 39.5 | 13.5 | 37.2 | 47.2 | 8.7 | 35.9 | 55.5 | 7.9 | 33.0 | 59.1 |
| Germany | Y | 19.6 | 25.0 | 55.4 | 10.4 | 43.7 | 45.9 | 6.5 | 48.7 | 45.8 | 3.8 | 51.7 | 44.5 | 2.0 | 37.8 | 60.1 | 2.2 | 36.0 | 61.9 |
| | E | 36 | 39 | 25 | 16.9 | 46.6 | 36.4 | 10.3 | 57.5 | 32.2 | 8.6 | 48.6 | 42.8 | 5.8 | 43.5 | 52.7 | 5.6 | 41.3 | 53.1 |
| Japan | Y | 54.3 | 16.2 | 29.5 | 24.4 | 31.5 | 44.1 | 13.3 | 37.5 | 49.2 | 6.4 | 41.4 | 52.2 | 3.7 | 36.5 | 59.8 | 3.4 | 38.2 | 58.4 |
| | E | 76 | 10 | 13 | 42.4 | 23.9 | 33.7 | 30.2 | 28.0 | 41.8 | 17.4 | 35.2 | 47.4 | 10.4 | 34.8 | 54.7 | 8.9 | 34.8 | 56.3 |
| U.K. | Y | 9.7 | 36.9 | 53.4 | 5.6 | 46.2 | 48.2 | 3.3 | 36.9 | 59.8 | 3.1 | 36.0 | 60.9 | 1.9 | 31.6 | 66.6 | 1.9 | 31.6 | 66.6 |
| | E | 15 | 54 | 31 | 5.6 | 49.0 | 45.4 | 4.2 | 47.2 | 48.5 | 3.2 | 43.2 | 53.6 | 2.6 | 36.3 | 61.1 | 2.6 | 32.9 | 63.6 |
| U.S. | Y | 17.1 | 25.6 | 57.3 | 7.2 | 37.7 | 55.1 | 3.9 | 32.3 | 63.8 | 3.4 | 30.9 | 65.8 | 2.9 | 28.2 | 68.9 | 2.4 | 29.8 | 67.8 |
| | E | 42 | 28 | 30 | 11.4 | 33.8 | 54.7 | 8.3 | 34.6 | 57.1 | 4.5 | 33.2 | 62.3 | 3.6 | 29.3 | 67.1 | 3.3 | 28.5 | 68.2 |
| **Developing Economies**[2] | | | | | | | | | | | | | | | | | | | |
| Greece | Y | | | | | | | 23.0 | 20.0 | 57.0 | 16.2 | 22.7 | 61.1 | 12.8 | 22.8 | 64.4 | 12.2 | 19.9 | 67.9 |
| | E | | | | | | | 53.9 | 18.6 | 27.5 | 38.9 | 25.5 | 35.6 | 30.7 | 28.1 | 41.2 | 29.4 | 27.8 | 42.8 |
| Spain | Y | | | | | | | 30.7 | 37.6 | 31.7 | 12.4 | 28.5 | 59.2 | 10.0 | 30.8 | 59.2 | N.A. | N.A. | N.A. |
| | E | | | | | | | 42.3 | 31.3 | 26.3 | 29.5 | 36.5 | 34.0 | 18.9 | 35.3 | 45.9 | 18.0 | 32.7 | 49.3 |
| Turkey | Y | | | | | | | 36.9 | 18.7 | 44.4 | 28.0 | 27.1 | 44.8 | 22.9 | 26.7 | 50.4 | 21.0 | 26.5 | 50.5 |
| | E | | | | | | | 78.3 | 10.1 | 11.6 | 67.6 | 14.1 | 18.3 | 60.7 | 15.5 | 23.8 | 57.9 | 17.1 | 24.9 |

[1]The data for 1890 and 1950 vary in time of observation by as much as 5 years before or 1 year after column headings. Also, the output data are centered averages of several years' observations whose mean time of observation is at or slightly earlier than given date. See *Long-Term Economic Growth*, Tables D67-79 and D130-144 for details. For 1960 and later, the OECD data include utilities with manufacturing, mining and construction — the Goods column; prior to 1960, utilities are included in Services.

[2]Not available prior to 1960.

SOURCE: 1890 and 1950: U.S. Department of Commerce, *Long-Term Economic Growth 1860–1970*, Series D-67 to D-81 and D-130 to D-144; for 1960–84: OECD *National Accounts of OECD Countries*, Constant Dollar (1970 Prices) Gross Domestic Product; *Labor Force Statistics*; OECD Economic Surveys 1985/1986 — *Greece, Spain, Turkey*.


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# Tax Reform and Investment: Blessing or Curse?

*Steven M. Fazzari*

A number of recent studies have concluded that the Tax Reform Act of 1986 will reduce capital spending incentives in the United States.[1] Many analysts fear this result.

There is, however, an alternative view. By removing special subsidies for various kinds of investment, tax reform may encourage firms to invest in projects because they have high economic returns, rather than large tax benefits. If economic returns more closely reflect social values than the previous tax subsidies, investments could be better suited under tax reform to produce goods and services that people want and enhance the productivity of the economy. Thus, the recent reform of capital taxation may actually improve economic welfare, even though it reduces the aggregate capital stock and investment. This paper investigates the welfare implications of the new capital tax system.

## THE EFFICIENT ALLOCATION OF CAPITAL RESOURCES

In many popular discussions of taxes and investment lurks an implicit assumption that more investment is always better than less. After all, investment causes the capital stock to expand, increases potential output growth and enhances labor productivity. While these outcomes are undoubtedly desirable, the simple view that investment is always beneficial ignores the costs imposed by greater capital accumulation. By investing resources in more productive capital, people forego the opportunity to consume some goods and services. Thus, investment generates opportunity costs.[2]

To evaluate whatever changing levels of investment improve social welfare, one needs a criterion that incorporates both the costs and benefits of changes in

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[1]See, for example, Prakken (1986), Henderson (1986), Aaron (1987), the *Economic Report of the President* (1987) and Fazzari (1987).

[2]The opportunity costs associated with investment may be best illustrated by an extreme case. Suppose *all* of a society's output were invested in capital goods. Growth would be maximized, but there would be no current consumption at all. This perspective emphasizes the trade-offs between investment and consumption. One could also consider the efficiency of the allocation of total investment among different capital projects; this topic, however, is outside the scope of this article.

the capital stock. The most widely used criterion that meets this objective is economic efficiency.[3] A particular level of investment is efficient if the benefits of all projects undertaken exceed their cost while the benefits of investment projects foregone fall short of their costs. Let us consider this concept in more detail.

The benefit gained from a marginal investment has two dimensions: the amount of new output the investment produces and the length of time it takes for this additional output to become available. Consider an investment project that increases output by Y units at the end of its first year of production. Assume that the project depreciates at a constant annual rate $d < 1$, so that it produces $(1-d)$ Y units of output at the end of the second year, $(1-d)^2Y$ units at the end of the third year, etc. In general, the project will produce $(1-d)^{t-1}Y$ units of additional output at the end of year t.

Let P represent the market price of the output that individuals are willing to pay for additional units of this good. According to the economic efficiency criterion, this price represents the current value of a unit of output.[4] Thus, the social value of an investment project in any year will be the quantity of additional output it produces multiplied by the goods' market price.

The concept of time preference implies that for a variety of reasons (impatience, uncertainty and attitude toward risk, for example), individuals would prefer to have goods and services sooner rather than later. Thus, the value of a given bundle of goods is smaller the further in the future it becomes available.

A simple way of expressing this idea formally is to assume that individuals discount the value of output available in the future, relative to the value of current output, at a constant rate r, where r is a positive fraction. Thus, if a bundle of consumption goods available today has a value of \$10, the *present value* of the same bundle delivered a year from now will be $\$10/(1+r)$. If it is delivered in two years, it will have a lower present value, $\$10/(1+r)^2$. In general, the present value of output that is worth PY at a time t years in the future is $PY/(1+r)^t$.

These concepts allow us to construct an expression for the present value (V) of an investment project that increases output in each future period t by $(1-d)^{t-1}Y$ units. The output has a constant market price of P. The present value is:

$$V = \sum_{t=1}^{\infty} (1-d)^{t-1} PY (1+r)^{-t},$$

which simplifies to:

$$V = PY/(r+d).^5$$

To attain economic efficiency, any project should be undertaken that has a present value exceeding its present cost, the market price of the capital project denoted by $P_c$. Thus, efficiency requires investment up to the point where the least-valued project undertaken has a productivity Y that satisfies:

$$P_c = V = PY/(r+d), \text{ or}$$

$$(1) \quad (r+d)\,P_c = PY.$$

The efficiency condition given by equation 1 has a natural graphical interpretation. Rewrite equation 1 as:

$$(2) \quad PY - dP_c = rP_c.$$

The right side represents the cost of deferring consumption. In figure 1, this cost rises as the capital stock expands because the more resources that are deferred away from consumption into capital, the greater the premium individuals require to compensate them for their time preference. The left side of equation 2 represents the net output created by an investment project after allowing for the depreciation of capital. In figure 1, this net marginal benefit from the least productive investment falls as the capital stock increases.

[3]Although efficiency is the most widely used welfare criterion, it does not address some significant welfare issues. Most important, the efficiency criterion does not deal with the equity of changes in wealth distributions caused by policy changes.

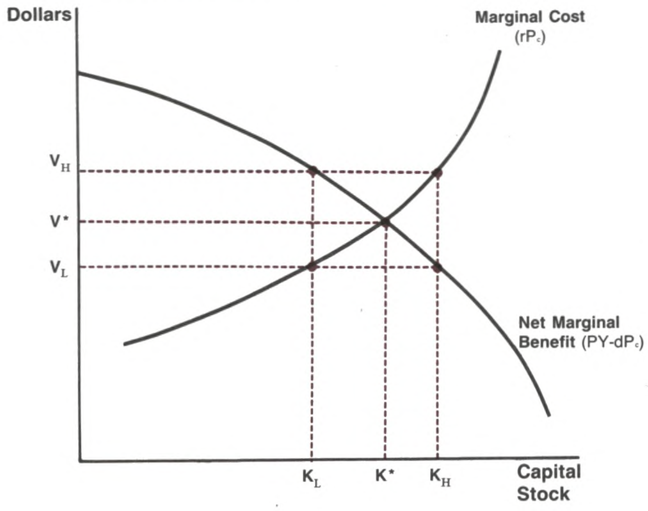
[4]There are important limitations to the view that the market price measures the value of output because this measure does not incorporate any concept of distributional equity. The efficiency criterion remains meaningful for any given distribution of wealth, but it cannot be used to evaluate the implications of changing wealth distributions.

[5]This simplification is based on the fact that the geometric series $\sum_{t=0}^{\infty} \alpha^t$ is $(1-\alpha)^{-1}$. Thus,

$$V = \frac{PY}{1-d}\sum_{t=1}^{\infty}\left(\frac{1-d}{1+r}\right)^t = \frac{PY}{1-d}\left[\sum_{t=0}^{\infty}\left(\frac{1-d}{1+r}\right)^t - 1\right]$$

$$= \frac{PY}{1-d}\left[\left(1-\frac{1-d}{1+r}\right)^{-1} - 1\right] = \frac{PY}{1-d}\frac{1-d}{d+r} = PY/(d+r).$$

Figure 1
**Capital Stock and Economic Efficiency**




Suppose the capital stock is $K_L$ as shown in figure 1. New investment, on net, will produce new output valued at $V_H$ in the market, but individuals are willing to release the current resources necessary to carry out the investment for a payment of only $V_L$. Unexploited gains to new investment exist, therefore, and $K_L$ is not the efficient capital stock. On the other hand, the marginal costs of the least-valued investment project exceed its net benefits at a capital stock of $K_H$. Efficiency then requires a decrease in investment and capital. Only at K*, where equation 2 is satisfied, have all gains from changing the capital stock been exploited. This level gives an economically efficient capital stock.

## *Profits and Firm Investment Decisions*

A market economy has an efficient rate of investment and level of capital stock if firms undertake projects up to the point where the least productive investment satisfies equation 1. Firms, of course, are motivated by profit; they will invest in projects that increase their shareholders' wealth. An investment project will be profitable if its net revenue exceeds its cost to the firm. The revenue gained from investment will be the net output produced by the new capital (Y, initially) multiplied by the price of output (P). The cost to the firm consists of depreciation and real interest earnings foregone by investing funds in fixed capital rather than financial assets.[6]

A firm's capital investment will be profitable if:

$$PY > P_c d + P_c i,$$

where i represents the real rate of interest the firm foregoes by investing in fixed capital. Thus, firms will invest up to the point where

$$PY = P_c\,(d+i).[7] \tag{3}$$

Note that equation 3 looks almost the same as equation 1. They will be the same if the real market rate of interest (i in equation 3) equals individuals' discount rate (r in equation 1). This point will be addressed below.

In spite of their close similarity, it is important to understand the conceptual distinction between equations 1 and 3. Equation 1 defines a welfare standard for investment and the capital stock according to the efficiency criterion. On the other hand, equation 2 describes the level of investment profit-maximizing firms will undertake in the market.

Much economic analysis has been devoted to understanding the conditions under which economic efficiency will be attained by the market. To obtain this result for the market analyzed here, the interest rate must equal individuals' discount rate. The real interest rate represents the opportunity cost to firms of borrowing funds for capital investment. It also is the return to savers who give up the chance to consume today by lending, either directly or through financial intermediaries.

Suppose individuals decide that they want to consume more today. They reduce their saving, decreasing the supply of funds flowing into credit markets, driving up interest rates. This continues until individuals are satisfied with the current level of saving at the prevailing market interest rate. Thus, the interest rate measures individuals' discount rate at the margin, the premium they require to exchange some consumption now for consumption in the future in the absence of personal taxes on interest income. Under these circumstances, the interest rate equals the discount rate (i = r), and equations 1 and 3 determine identical levels of the capital stock. That is, firms will have profit

[6]For a further discussion of the revenues and costs that determine the profitability of investment, see Fazzari (1987).

[7]This condition is equivalent to the maximization of net present value, under the assumptions made here. I have also assumed that the firm is a price-taker, in both input and output markets.

incentives to invest in capital just up to the efficient level.[8]

## EFFICIENCY AND NEUTRAL TAXATION

The main result of the previous section suggests that the market outcome of firms' independent, self-interested investment choices leads to an efficient capital stock. The analysis that led to this result, however, ignores the effect of corporate taxes on investment incentives. This section introduces the influences of corporate taxes; it provides a theoretical basis for evaluating the implications of tax reform for efficient capital investment.

As a general rule, taxes change the economic incentives faced by firms. In the case of the corporate income tax, however, it is possible, at least in theory, to structure the tax so that capital investment decisions do not change. Rewriting equation 3, we see that firms will invest up to the point where the economic profits from a marginal investment project equal zero:

$$(4) \qquad 0 = PY - P_c(i + d).$$

The right side of equation 4 represents the economic profits from a marginal investment. Suppose these profits are taxed at a rate $\tau$. Then firms will invest up to the point where *after-tax* profits from a marginal investment are zero,

$$0 = (1-\tau)[PY - P_c(i + d)], \text{ or}$$

$$(5) \qquad (1-\tau) PY = (1-\tau)[P_c(i + d)]$$

The level of capital investment that satisfies equation 4 will also satisfy 5; the same actions that maximize 100 percent of profits will maximize 80 percent, 60 percent, or any non-zero proportion of profits. In this case, the corporate tax rate affects the portion of a firm's profits that go to the government, but it does not affect the firm's incentives to invest efficiently.[9]

Economists call this kind of tax neutral. A neutral tax does not change the allocation of economic resources. The key to neutral taxation in this context is that all revenues are taxed while all economic expenses are fully deductible.[10] This result is clear in theory, but difficult to implement in practice, as we will now discuss.

## U.S. CORPORATE TAXATION

The U.S. corporate tax system is not nearly as simple as the tax analyzed above. In general, it is not neutral. The next section summarizes the effect of the tax code on the cost of capital. Then, three important non-neutral aspects of U.S. tax law are discussed: tax depreciation schedules, the investment tax credit, and the deductions allowed for the opportunity cost of invested capital. Some non-neutralities arising from personal taxes are considered later.

### *The Cost of Capital in the U.S. Tax System*

The efficient capital stock condition given by equation 5 under neutral taxation assumes that the economic costs of capital are fully deductible from taxable income. For a variety of reasons, however, the U.S. tax code does not allow deductions based strictly on economic costs. This introduces a number of non-neutral aspects into the tax code. To understand the source of these non-neutralities, we must compare the determination of capital investment under the U.S. tax law with the efficiency standard of a neutral tax given by equation 5.

Let k represent the investment tax credit rate, z the present value of a one-dollar tax deduction for depreciation, and L the proportion of a marginal investment financed with debt (the debt leverage ratio). Suppose the expected inflation rate is $\pi_e$. Profit-maximizing firms will invest up to the point where the least-valued

[8]The result that unrestricted market interaction leads to efficient outcomes is often used to argue for the normative position that market results are socially desirable. This conclusion, however, is limited in general. Again, the idea that the willingness of individuals to save at the margin represents the social discount rate takes the distribution of wealth as given. The efficient capital stock level would likely change for different wealth distributions. Also, investment may have external social costs or benefits not recognized by the private firms that make investment decisions. Thus, private market investment incentives might differ from social incentives. Finally, this analysis applies only to general economic equilibrium with full utilization of resources. Existence of involuntary unemployment or idle capacity would change the structure of the analysis. Despite these qualifications, efficiency analysis is widely regarded as relevant to evaluate the long-term impact of the tax system.

[9]This result assumes that the firm is indifferent between internal and external sources of finance. If this is not the case, investment may be affected by reduced cash flow caused by higher corporate taxes, even if the tax is neutral in the sense discussed in the text. See Fazzari (1987) and Fazzari and Athey (1987) for further discussion.

[10]Economic expenses include all the opportunity costs of buying and using capital. They may differ in important respects from accounting costs used by firms in their financial statements. Interest foregone on shareholders' equity, for example, represents an economic opportunity cost but is not deducted from the firm's accounting profit.

unit of capital purchased satisfies,

(6) $(1-\tau)PY = P_c(1-k-\tau z)[i + d - \tau L(i + \pi_e)]$.[11]

The left side of equation 6 is the after-tax benefit gained from investment, as presented earlier. The term $P_c(1-k-\tau z)$ on the right side represents the fact that each dollar spent on investment generates an investment tax credit of k and a depreciation deduction with a present value of z.

The other change in equation 6 relative to the neutral tax case in equation 5 is that only explicit interest costs are deductible from taxable income. Thus, if the firm finances investment with debt, the explicit interest expense can be deducted from taxable income, but the opportunity cost of interest foregone on reinvested internal funds or proceeds from new equity issues cannot be deducted. Furthermore, because nominal interest is deducted, changes in the inflation rate will affect the value of the interest tax deduction, to the extent that markets anticipate inflation in the nominal interest rate.

As equation 6 indicates, the U.S. tax system may introduce non-neutralities. The complicated expression on the right side of equation 6 reduces to the efficient neutral tax given by equation 5 only under special circumstances. We shall now consider this point in greater detail.

## *Depreciation Allowances*

In the neutral tax equation 5, economic depreciation is deducted from taxable income in every period. In equation 6, the present value of depreciation allowances (z) is treated as a lump-sum deduction that reduces the after-tax price of capital goods up front. The two approaches will lead to equivalent results, however, if the depreciation schedule underlying the calculation of z is the same as economic depreciation.

To find the present value of depreciation allowances that leads to neutral taxation, suppose that there is no investment tax credit ($k=0$), the firm finances marginal investment with debt alone ($L=1$) and expected inflation is zero ($\pi_e = 0$). Then equation 6 reduces to:

(7) $(1-\tau)PY = P_c(1-\tau z)[(1-\tau)i + d]$.

To make equation 7 equivalent to the condition describing efficient investment from equation 5, the marginal cost of a new unit of capital must be the same in each case. This implies that the right side of equation 4 equals the right side of equation 6:

$$(1-\tau)P_c\,(i + d) = P_c(1-\tau z)[(1-\tau)i + d].$$

This equation can be solved for the efficient present value of depreciation allowances ($z^*$), that is,

(8) $z^* = d/[(1-\tau)i + d]$.[12]

Intuitively, $z^*$ is the present value of a perpetual depreciation flow d per dollar of investment. The discount rate consists of the after-tax real interest rate plus the depreciation rate. The latter term appears because the amount of depreciation declines as the asset deteriorates.

The present values of depreciation schedules prescribed by the tax code can be compared with the efficient benchmark given by $z^*$. The first column of table 1 gives the efficient present value under the old and new tax laws.[13] The efficient present value changed after tax reform because the corporate tax rate fell from 46 percent to 34 percent.

The present value of actual depreciation allowances prescribed by the tax code are presented in the second, third and fourth columns of table 1, again for the old and new tax laws.[14] Expected inflation plays an important role here. Neither the old nor the new tax law indexes depreciation deductions for inflation. Assuming that higher expected inflation increases nomi-

[11]The original reference for the form of the cost of capital given in equation 6 is Hall and Jorgenson (1967). Further references and a more-detailed explanation of the components of equation 6 can be found in Fazzari (1987).

[12]Equivalently, $z^*$ can be derived by computing the present value of economic depreciation deductions discounted at the after-tax real rate of return $(1-\tau)i$. This analysis is complicated if one explicitly considers the differential tax treatment of dividends and capital gains where corporate income is distributed to shareholders. See Auerbach (1983) for further discussion.

[13]The efficient present value ($z^*$) calculations in table 1 assume a real discount rate of 3 percent, before taxes. The economic depreciation rates for autos and light trucks, office computing and accounting equipment, and communications equipment were estimated by Gravelle (1982) as .33, .27 and .12, respectively. The average economic depreciation rates for equipment and business structures were .14 and .06 from the Washington University Macro Model maintained by Laurence H. Meyer and Associates, Ltd.

[14]See Ott (1984) and Fazzari (1987) for a discussion of how these present values are computed and the details of the tax depreciation schedules. These calculations do not account for the fact that the depreciable base for an asset eligible for the investment tax credit was reduced by one-half of the credit, under the old tax law. This simplification is made to focus on the effect of changing the depreciation schedules alone. It is formally equivalent and conceptually simpler to think of the reduction in the depreciation base due to the investment tax credit as a reduction in the value of the credit rather than in the present value of depreciation deductions.

Table 1
**Present Values of Tax Deductions for Depreciation**

| Asset | Efficient present value | Actual Present Value 0% Inflation | 5% Inflation | 10% Inflation | Efficient inflation rate |
|---|---|---|---|---|---|
| **Old tax law** | | | | | |
| Autos and light trucks | .953 | .982 | .954 | .928 | 5.2% |
| Office, computing and accounting equipment | .943 | .968 | .919 | .874 | 2.5% |
| Communications equipment | .881 | .968 | .919 | .874 | 9.2% |
| Equipment average | .896 | .970 | .925 | .884 | 8.5% |
| Business structures | .787 | .881 | .730 | .619 | 2.9% |
| **New tax law** | | | | | |
| Autos and light trucks | .943 | .967 | .918 | .874 | 2.4% |
| Office, computing and accounting equipment | .932 | .967 | .918 | .874 | 3.5% |
| Communications equipment | .858 | .952 | .882 | .822 | 6.9% |
| Equipment average | .876 | .960 | .899 | .847 | 7.1% |
| Business structures | .752 | .745 | .494 | .357 | −0.1% |

NOTE: The calculations are based on a 3 percent real, before-tax discount rate.

nal interest rates, the present value of a fixed, nominal depreciation flow decreases with rising expected inflation, as shown in table 1.[15]

With no expected inflation and nominal interest rates equal to real rates, the tax depreciation schedules generally lead to more generous present values than the efficient present value. Thus, the rapid write-offs of capital goods allowed by the tax code *subsidize* investment in the absence of inflation. Although the new tax law reduces this subsidy somewhat, the differential still remains.

As expected inflation rises, however, the present values of actual depreciation allowances decline and approach the efficient level. The final column of table 1 gives the expected inflation rate at which the present value of the depreciation deduction allowable for tax purposes equals the efficient level. Under the old tax law, equipment deductions, on average, would have been efficient with an expected inflation rate of 8.5 percent. After tax reform, this declined to 7.1 percent.[16]

The results for business structures are somewhat different. The rapid structure depreciation allowed under the old tax law led to a substantial subsidy at zero expected inflation. Because of its slow depreciation, however, the present value of nominal depreciation allowances for structures is especially sensitive to any changes in nominal interest rates caused by rising expected inflation. Thus, under the old tax law, the accelerated structures deduction was efficient at a moderate 3.1 percent expected inflation rate.

Tax reform sharply reduced the present value of structures depreciation; it increased the tax service life from 19 to 31.5 years and replaced an accelerated depreciation schedule with a straight-line schedule. As table 1 shows, this pushes depreciation allowances for business structures to the efficient level at an expected inflation rate close to zero. Even at moderate levels of expected inflation, however, the slow write-off mandated by the new tax law causes a substantial

[15]For the calculations in table 1, the before-tax nominal discount rate is assumed to rise by one percentage point for each percentage-point increase in the expected inflation rate. A number of economists have argued that nominal interest rates must increase by more than the rise in expected inflation to maintain real returns constant because of personal taxes levied on nominal interest income. See Darby (1975) and Feldstein (1976), for example. If this is the case, the present values of depreciation allowances will decline more than the figures in table 1 indicate when expected inflation rises.

[16]This result is sensitive to the assumption made about the real before-tax discount rate. If this rate increases from 3 percent to 5 percent, the efficient expected inflation rate for the equipment average rises from 7.1 percent to 12.0 percent.

disincentive for structures investment relative to the efficient level.

## The Investment Tax Credit

The depreciation deductions allowed in the tax code correspond to one aspect of the economic cost of using capital. In a neutral tax system, the economic value of these costs should be deducted from taxable income. Inefficiency arises from depreciation deductions only to the extent that the tax depreciation schedules are more or less generous than economic depreciation.

The investment tax credit, on the other hand, represents a direct subsidy to investment. It does not correspond to any aspect of the economic cost of capital. By itself, the investment tax credit provides incentives for firms to purchase more of the eligible assets than the efficiency criterion would dictate. The repeal of the credit in the new tax law moves the tax system closer to neutrality.

The investment tax credit applied to only a subset of capital assets. Thus, the subsidy not only distorted the amount of investment, but also the composition of investment. A detailed analysis of this issue lies outside the scope of this paper, but efficiency gains from the repeal of the credit may result from a more effective allocation of investment among different assets and activities. Furthermore, inefficient investment that took place as a result of the subsidy competed for scarce funds and raised the interest rate. This could have crowded out other efficient projects that may have been undertaken in the absence of the subsidy.[17]

Of course, given other distortions in capital taxation, some kind of subsidy may be appropriate to offset the disincentives to investment arising from other aspects of the tax system. As the previous analysis showed, the equipment assets eligible for the investment tax credit generally benefit from rapid depreciation deduction subsidies at low inflation rates even with the changes due to tax reform. Thus, the investment tax credit is not needed in the current environment to offset the distortions caused by tax depreciation schedules. The credit, however, may offset another distorting aspect of the tax code: firms' inability to deduct the full opportunity cost of funds tied up in capital investment.

[17]The author thanks Milton Friedman for comments on an earlier paper that emphasized these points.

## Debt Financing and Capital Cost Deductions

In the neutral tax system represented by equation 5, the opportunity cost of capital given by the real interest rate (i) is fully deductible from taxable income. It does not matter whether the interest expense involves explicit payments to debt holders or implicit opportunity costs of foregone interest earnings by equity holders.[18] The tax law, however, allows deduction of explicit interest expense, but does not allow deduction of interest foregone when investment is financed through internal cash flow or new equity.

To the extent that new capital spending is not completely debt-financed, the after-tax cost of capital rises and investment falls relative to the efficient level. This effect is reflected in equation 6 by the fact that the deduction for interest expense is multiplied by the marginal proportion of investment financed by debt (L). This introduces an important non-neutrality into the tax system.

At a zero inflation rate, this effect alone gives firms an incentive to employ less than the efficient level of capital. But inflation mitigates this distortion. The economic cost of capital depends on the real interest rate. The tax code, however, allows firms to deduct nominal interest expense. As expected inflation and nominal interest rates rise, therefore, the real value of tax deductions for interest expenses increases.

At a sufficiently high inflation rate, the tax benefit from deductions for nominal interest will offset the increase in the after-tax cost of capital arising because interest foregone on internal financing cannot be deducted from taxable income. One can solve for the expected inflation rate that leads to this efficient result ($\pi^*$) by equating the deductions for interest expense in the neutral tax system from equation 5 with the deduction in the actual tax system from equation 6:

$$\tau i = \tau L(i + \pi^*).$$

This gives

$$\pi^* = i(1-L)/L. \tag{9}$$

With a real interest rate of 3 percent and the debt leverage ratio 30 percent, the efficient inflation rate from equation 9 is 7 percent.[19]

[18]See Fazzari (1987) for a further discussion of debt and equity finance for capital spending.

[19]The average corporate debt leverage ratio in the second quarter of 1986 was 30.6 percent according to data from the Washington University Macro Model.

Tax reform has a subtle effect on this problem. The new tax code, like the old law, does not allow deductions for interest foregone by shareholders. But the new law eliminates preferential personal tax rates for capital gains income. Thus, corporations will have an incentive to pay out a greater proportion of their income as dividends and finance more new investment with debt. This reduces the efficiency distortion caused by the non-deductibility of foregone interest from internal finance at low inflation rates.[20]

## INVESTMENT NON-NEUTRALITIES FROM PERSONAL TAXES

The discussion to this point has focused primarily on the corporate tax system. But, ultimately, corporate profits accrue to shareholders who are liable for personal taxes as well. We shall now consider the effect of personal taxes on the firm's incentive to invest in fixed capital.

If personal taxes on all corporate-source income were uniform, they would not directly affect corporate investment decisions because, again, the same actions that maximize 100 percent of profits will maximize any constant proportion of profits.[21] Personal taxes on corporate income, however, are not uniform. In particular, income from capital gains has been taxed at lower rates than dividend and interest income.

This lower rate provides a rather subtle subsidy for investment. Suppose individual capital gains are taxed at a rate $\tau_{cg}$ while interest income is taxed at the regular personal rate $\tau_p$. If capital markets equate the after-tax rate of return on earnings retained by the corporation with the after-tax interest rate on debt, then:

$$(1-\tau_{cg})(i_{cg} + \pi_e) = (1-\tau_p)(i + \pi_e),$$

where $i_{cg}$ is the implicit real interest rate on corporate retentions.[22] Thus, as long as:

$$\tau_{cg} < \tau_p,$$

$$i_{cg} + \pi_e = (i + \pi_e)(1-\tau_p)/(1-\tau_{cg}) < (i + \pi_e).$$

The favorable treatment of capital gains income leads to a subsidized rate of interest for investment financed with retained earnings.

Let us integrate this effect into the cost of capital formula. As before, assume that the firm finances a fraction L of marginal investments with debt and $1-L$ with retained earnings. The weighted average nominal opportunity cost of funds the firm faces is:

$$(10) \quad c = (1-L)\left(\frac{1-\tau_p}{1-\tau_{cg}}\right)(i+\pi_e) + L(1-\tau)(i+\pi_e).^{23}$$

The firm's cost of capital is then:

$$(11) \quad P_c\,(1-k-\tau z)(c - \pi_e + d).$$

Equation 11 reduces to the right side of equation 6 when the personal tax rate on capital gains equals the personal tax rate on regular income ($\tau_{cg} = \tau_p$).

### *Capital Gains Taxation After Tax Reform*

Tax reform has fundamentally changed the terms of the capital gains subsidy by repealing the 60 percent exclusion for capital gains income. This change, however, does not mean that the personal tax advantages of capital gains income has been removed. Shareholders that receive capital gains income still benefit from the deferral of tax until the time the asset is sold and the capital gain is realized.

The effective tax rate on capital gains income, therefore, depends on the length of time an investor holds an asset. One can compute $\tau_{cg}$ as the present value of the tax paid at realization per dollar of capital gain discounted at the individual's after-tax real interest rate:

$$(12) \quad \tau_{cg} = (1-\mu)\,\tau_p/[1+(1-\tau_p)i]^H,$$

where $\mu$ is the proportion of capital gains income excluded from tax and H is the holding period.[24]

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[20]Debt finance is beneficial in the sense that it pushes the economy closer to efficiency at the microeconomic level. On the other hand, higher debt ratios can make the macroeconomic system as a whole less stable. This issue is outside the scope of this paper. For further discussion, see Caskey and Fazzari (1986).

[21]Even uniform personal taxation could have an indirect effect on investment because the tax on the return from saving will reduce individual incentives to defer current consumption. This tends to raise real interest rates and increase the opportunity cost of capital. This issue is considered later in the article.

[22]This approach follows Henderson (1986), p. 23. It ignores any risk premium required by investors in corporate equity.

[23]Equation 10 is based on two simplifying assumptions. First, no marginal investment is financed with new share issues. According to Henderson (1986), new shares account for only 4.9 percent of the U.S. capital spending finance. Second, and more importantly, equation 8 assumes that the earnings from marginal, internally financed investments are completely retained and will be taxed as capital gains. This analysis is complicated by dividends. See Auerbach (1983) for further discussion.

[24]This equation is a simplification. In general, the accrual-equivalent capital gains tax rate depends on the rate of growth of the asset's value and the holding period in a more complicated way. Further complications arise because capital gains not realized before the asset holder's death may escape taxation. Also, much capital gains income is realized by tax-exempt or tax-deferred funds such as pensions or individual retirement accounts. See Auerbach (1983), pp. 919–20 for further discussion and references.

As we can see from equation 10, the effect of the capital gains personal tax subsidy depends on the ratio $(1-\tau_p)/(1-\tau_{cg})$. If the personal tax rate on interest income equals the tax rate on capital gains income, this ratio will be unity, and equation 10 gives the same opportunity cost of funds that was derived in the absence of personal tax considerations.

This ratio, however, is not equal to unity. Assuming an average marginal personal tax rate on ordinary income of 28 percent, a 60 percent capital gains exclusion, a 3 percent real after-tax discount rate, and a 10-year holding period for long-term capital gains, the ratio $(1-\tau_p)/(1-\tau_{cg})$ was 0.78 for the old tax law. This figure is based on an effective capital gains tax rate of 8.3 percent from equation 12. Removing the 60 percent capital gains exclusion and lowering the personal tax rate to 22 percent gives an effective capital gains tax rate of 16.4 percent and a ratio $(1-\tau_p)/(1-\tau_{cg})$ of 0.93 for the new tax law.[25]

Under a completely neutral tax system, all personal income would be taxed equivalently; so $(1-\tau_p)/(1-\tau_{cg})$ would equal unity. Thus, tax reform moves the system toward neutrality from this perspective alone.

## TAX REFORM AND EFFICIENCY: AN OVERALL ASSESSMENT

The preceding sections of this article analyzed a number of non-neutral features of U.S. capital taxation. The effect of tax reform on each of these non-neutralities was considered separately. This section provides an overall assessment of whether tax reform has brought capital taxation closer to the efficiency standard.

Table 2 provides one perspective on the efficiency of the tax law, before and after tax reform. The figures show the ratio of the actual after-tax cost of capital to the efficient cost of capital under neutral taxation. The calculations are based on the assumption that the real interest rate firms face in the market reflects the social opportunity cost of providing capital.[26] Thus, this ratio provides a measure of the extent to which the capital taxation system alone distorts investment incentives.

Table 2

**Tax Distortion of the Cost of Capital (Real Interest Rate Equals Social Opportunity Cost)**

| | Ratio of Actual to Efficient Cost of Capital | |
|---|---|---|
| **Asset category** | **Old tax law** | **New tax law** |
| Autos and light trucks | 0.90 | 1.01 |
| Office, computing and accounting equipment | 0.85 | 1.00 |
| Communications equipment | 0.79 | 0.98 |
| Equipment average | 0.80 | 0.99 |
| Structures average | 0.94 | 1.11 |

NOTE: Calculations are based on a 3 percent real interest rate, a 4 percent expected inflation rate and a 30 percent debt leverage proportion.

This ratio measures the extent of the *tax distortion* of capital costs. If the ratio is unity, there is no distortion, and the tax system is neutral for that class of asset. A ratio less than one indicates that the tax system encourages investment relative to the efficient rate; a ratio greater than one shows that the tax system discourages investment relative to the efficient rate.

The effects of tax reform on equipment tax distortions are striking. Under the old tax law, the system provided a subsidy to equipment investment: the ratios are less than one. This was due primarily to the investment tax credit. Under the new law, the treatment of equipment approaches remarkably close to tax neutrality. The results presented in table 2 are based on a 3 percent real interest rate, a 4 percent expected inflation rate and a 30 percent marginal debt leverage ratio. Qualitatively similar results for equipment asset classes are obtained for a wide range of assumptions about these parameters.

For business structures, the result appears less favorable. The generous depreciation allowances for structures under the old tax law caused the after-tax cost of capital to fall below the efficient level for structures as well as equipment. By sharply reducing the value of structures' depreciation allowances, however, tax reform pushes the after-tax cost of structures' capital well above the efficient level.

[25]These results were not changed much by increasing the real, after-tax discount rate to 5 percent, or shortening the holding period to 5 years. With the maximum marginal personal tax rates, however, greater subsidies result. The $(1-\tau_p)/(1-\tau_{cg})$ ratio was 0.59 for the old law and 0.89 for the new law.

[26]This ratio is computed as the actual cost of capital from equation 11, $(1-k-\tau z)(c-\pi_e+d)$, where c is defined in equation 10, to the cost of capital under neutral taxation from the right side of equation 5, $(1-\tau)(i+d)$. The investment tax credit rates are adjusted to reflect the fact that the depreciation base for an asset eligible for the credit was reduced by one-half of the credit. Thus, $k = k_g(1 - 0.5\tau z)$, where $k_g$ is the statutory investment tax credit rate.

The excessive taxation of business structures, however, may not be as large as the figures in table 2 suggest. The calculations assume that all investment is financed with the average 30 percent debt leverage ratio. But structure debt leverage ratios are probably higher than the average, because collateral value provided by structures is more easily realized than the values of firm-specific equipment. Higher leverage ratios reduce the cost of capital because interest expense is tax deductible. If the leverage ratio for structures reaches 50 percent to 70 percent (the exact value depends on expected inflation), structures taxation will be neutral, even under the new tax depreciation schedules.[27]

The results presented in table 2 reflect the efficiency of taxes on firms' capital alone because the real market interest rate was assumed to reflect the social opportunity cost of capital. As mentioned earlier, however, individuals pay personal taxes on interest income. Thus, the market interest rate exceeds the return required by savers. Suppose that savers require an after-tax rate of return of r. Because nominal interest is taxed, the nominal market interest rate $(i+\pi_e)$ must satisfy:

$$(13) \quad r = (i+\pi_e)(1-\tau_p) - \pi_e$$

to give savers an after-tax real rate of return equal to r.[28]

This changes the comparison between the actual and efficient cost of capital in a fundamental way. The efficient cost of capital is based on the social discount rate r, while firms must pay a higher real interest rate in the market to compensate savers for the personal taxes they pay on interest income. To reach efficiency according to this perspective, therefore, investment must receive tax subsidies that stimulate capital spending sufficiently to offset the disincentives to saving arising from taxes on personal interest income.

Table 3 presents tax ratios that incorporate this effect. The results are different from those in table 2 for the capital tax system alone. The investment subsidies for equipment in the old tax law led to an effective cost of capital that still fell below the after-tax opportunity cost of savers, although the tax ratios for the old law in table 3 are closer to unity than in table 2. The cost of capital for structures that were ineligible for the investment tax credit, however, was well above the efficient level, even with the old law's generous depreciation allowance. By removing the capital subsidies, tax reform increased the cost of capital above the efficient level in all cases. To the extent that investment subsidies are desirable to offset the disincentive to saving caused by personal taxes on interest, tax reform does not improve efficiency.

Table 3

**Tax Distortion of the Cost of Capital (Real Interest Rate Increased to Offset Personal Interest Tax)**

| | Ratio of Actual to Efficient Cost of Capital | |
|---|---|---|
| **Asset category** | **Old tax law** | **New tax law** |
| Autos and light trucks | 0.96 | 1.06 |
| Office, computing and accounting equipment | 0.93 | 1.07 |
| Communications equipment | 0.93 | 1.11 |
| Equipment average | 0.92 | 1.10 |
| Structures average | 1.25 | 1.35 |

NOTE: Calculations are based on a 3 percent after-tax rate of return to savers, a 4 percent expected inflation rate and a 30 percent debt leverage proportion. The real interest rate is obtained from equation 12.

One also should note that the tax distortions for the new law become worse at higher expected inflation rates. This is because personal taxes are levied on nominal interest income. As expected inflation and nominal interest rates rise, therefore, the premium required to maintain individuals' after-tax real return on saving rises even faster.

## CONCLUDING REMARKS

This article has analyzed the effect of the Tax Reform Act of 1986 on the efficiency of U.S. capital formation. The results leave little doubt that the old tax law subsidized equipment investment. Tax reform removed these subsidies, especially the investment tax credit. Now, the tax system causes the after-tax cost of capital to correspond closely to economic depreciation and market rates of interest. Tax reform apparently moves equipment taxation close to neutrality, in

[27]If the leverage ratio is higher than average for structures, it must be lower than average for equipment. For example, a 50 percent structures leverage ratio would imply about 20 percent equipment leverage to obtain a weighted average of 30 percent because approximately two-thirds of investment consists of equipment. Reducing the leverage ratio to 20 percent for equipment, however, does not substantially change the results presented in this article.

[28]This issue is discussed in detail by Darby (1975) and Feldstein (1976).

the sense that the after-tax cost of capital reflects real economic depreciation and real market interest rates. For structures, however, an apparent subsidy due to generous depreciation allowances under the old tax law was more than offset by tax reform. Now the tax on structures is substantially higher than the level consistent with neutrality.

From a broader perspective, however, some investment subsidies were necessary to attain an efficient allocation of resources between consumption and capital formation. Because personal interest income is subject to tax, many economists have argued that the market interest rate overstates the social opportunity cost of investing in capital. Thus, investment subsidies, like those in the old tax law, can offset the disincentive to saving arising from personal taxes.

One might argue that the distortion caused by personal taxes on interest income should be dealt with directly rather than by subsidizing capital investment. The lower personal tax rates resulting from tax reform accomplish this to some extent, although this effect is offset by higher taxes on capital gains and tighter restrictions on IRA benefits. Thus, tax reform's implications for the efficient allocation of current resources between investment and consumption remain ambiguous.

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# The Macroeconomic Effects of the Recent Fall in Oil Prices

*John A. Tatom*

BETWEEN the end of 1985 and the second quarter of 1986, oil prices fell by about half, the reverse of the near doubling of oil prices in both 1973–74 and in 1979–81.[1] This decline prompted a renewed debate about the effects of oil price changes and whether the effects of oil price declines are simply the reverse of oil price increases, that is, whether the effects are symmetric. This article examines these issues. A theoretical analysis of oil and energy price effects on the economy is presented first, along with some evidence on the actual effects of oil price increases on the United States and other countries. While the theory indicates symmetric effects, several arguments suggest the 1986 oil price decline will not have equal and opposite, or symmetric, effects on the economy.

## THE THEORETICAL CHANNELS OF OIL PRICE EFFECTS

There are several channels through which an oil price "shock," an unanticipated change in the level of oil prices, could affect the economy. The first is through its effect on aggregate supply; this has come to be called a "price shock." In this view, an oil price increase results in an initial upward shift in the aggregate supply curve that will raise prices; output falls along a downward-sloping aggregate demand curve. Subsequent wage adjustments, however, can restore the initial level of output and price. This analysis can be found in many textbooks.[2]

The effect of oil price shocks on aggregate supply is more involved than simply a rise in the cost of output, however. Energy price shocks are changes in relative prices; to make such changes effective, the supply of energy must be altered.[3] To the extent that energy is a factor of production, the production possibilities and aggregate supply conditions of the economy are al-

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[1]This paper pays little attention to the rise in U.S. oil prices from about $13.40 per barrel in the fourth quarter of 1986 to about $17.00 per barrel in March of 1987. The adjustments in early 1987 are not large enough to affect the arguments below.

[2]See, for example, Hall and Taylor (1986, pp. 134–35). Despite the unique fit of past experience with the emerging "real business cycle theory" which emphasizes productivity shocks, such theorists tend to ignore oil price changes as a source of such shocks; for example, Prescott (1986) maintains that oil price shocks do not affect a country's production possibilities.

[3]Alternatively, many transitory price shocks occur from quantity shocks that are transmitted through transitory relative price changes. The characterization of price or quantity shocks is unimportant in theory. Quantity shocks, however, are typically transitory and associated with transitory relative price changes, while permanent macroeconomic shocks of a "cost-push" type tend to be associated with permanent changes in relative prices that also affect potential or natural output.

tered.[4] Energy price shocks alter the incentives for firms to employ energy resources and alter their optimal methods of production. Energy-using capital is rendered obsolete by an energy price increase, optimal usage of the existing stock is altered, labor resources are diverted to economize on energy use and production switches to less energy-intensive technologies.[5] Thus, existing capital and labor resources are *incapable* of producing as much output as before. The reduced capacity output of the economy is usually referred to as a decline in potential or natural output.

A second channel emphasizes an effect on aggregate demand. Analysts use a "tax analysis" in which domestic aggregate demand is affected due to a change in net imports of oil. In this analysis, the direction and extent of effects depend on the country's net oil export status. Countries that are self-sufficient in oil are unaffected by oil price shocks, while net exporting countries experience an increase (decrease) in aggregate demand when oil prices rise (fall). The effect on net oil importing countries is exactly the opposite.[6]

Such a simple characterization, however, ignores the effects of oil price changes on productivity, which tend to work in the same direction regardless of the oil trade status of the country. Thus, a focus on trade status would suggest that Canada, whose net oil exports equaled 0.4 percent of GDP in 1973, would have had a boost to aggregate demand, or output and employment, from the 1973–74 oil price rise, and that the United Kingdom, which became a net oil exporter in 1979, would have had a similar gain from the 1979–81 oil price hike. Neither conclusion is supported by evidence on real output, employment or productivity growth.[7] Similarly, while this argument suggests that output and employment in the United Kingdom would have been adversely affected by the 1986 decline in oil prices, the evidence again does not support the conclusion.

In most models of the economy, price shocks operating through aggregate supply have the dominant effect. Hickman (1984) examines 14 large and small scale econometric models and finds that aggregate prices respond quite similarly to an oil shock and that the models are linear and symmetric so that aggregate price level responses are proportional to the magnitude of the oil price shock.[8] The Hickman (1984) study also indicates that oil price shocks affect aggregate demand only minimally in several models of the U.S. economy because:

> incipient deterioration in the terms of trade from the increase in the price of oil imports is partly offset by the induced rise of export prices, and because the decline of world production does not impinge heavily on U.S. exports (p. 91).

The channels of influence on aggregate supply can be seen in figure 1, which shows the aggregate supply and demand for aggregate real output. Initially, the price level is $P_0$ and output is $y_0$. A higher oil price for an oil-importing country would reduce aggregate net exports and shift the aggregate demand curve, $AD_0$, to the left, according to the aggregate demand channel above. If this were the only effect, both output and the price level would fall. This effect is not included in the figure because of its dubious merit and to focus on the aggregate supply channel. The "price shock" raises the supply price of aggregate output for any level of output, thus, the aggregate supply curve, $AS_0$, shifts upward to $AS_1$. Figure 1 also incorporates the capacity output; thus, the aggregate supply curve, $AS_0$, shifts with a relatively steep slope at the initial level of real output ($y_0$) to reflect the notion that at $y_0$, existing supplies of domestic capital and labor resources are fully employed, and price level variations cannot induce larger use of energy, given the relative price of

[4]This is the emphasis in Rasche and Tatom (1977a, b, c and 1981). Hickman (1984) discusses this channel in a study of 14 macroeconomic models. He indicates that the participants in the study generally agreed there is such an effect, but that formal estimates of it were included in only six of the 14 models. Phelps (1978) and Gordon (1975) implicitly recognize the shift in production possibilities in models that treat a supply shock as a shift in a fixed supply of resources. Related theoretical and empirical analyses are discussed in Tatom (1987).

[5]Baily (1981) and (1982) emphasizes the capital obsolescence arguments. Fischer (1985) incorporates this effect in a model of aggregate supply. Wilcox (1983) successfully tested the interest rate implications of the energy-induced decline in the marginal productivity of capital.

[6]Hickman (1984) breaks this aggregate demand shift for an oil price increase into a domestic "terms of trade" effect that reduces domestic disposable income and a net export effect due to reduced foreign income. His argument for an aggregate demand shift also includes a shift due to a discretionary policy response in the face of an oil price shock.

[7]See Rasche and Tatom (1981) and the evidence below.

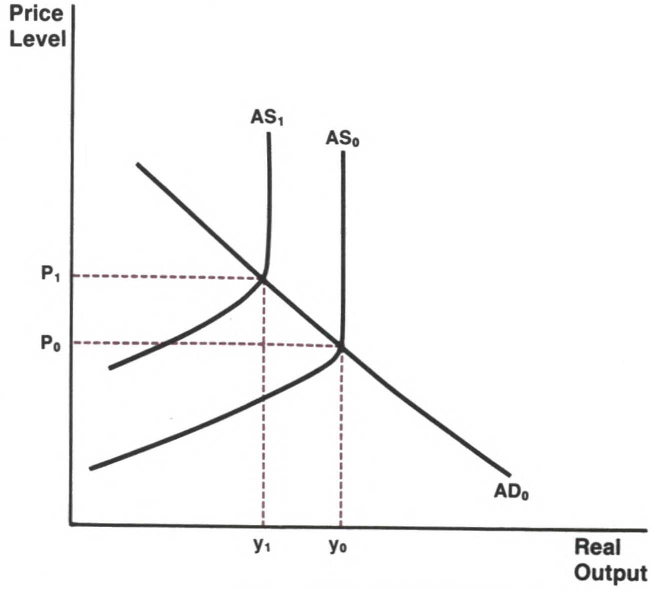
[8]The linear and symmetric issues were addressed by comparing simulation outcomes for a number of energy shocks including a 20 percent increase or decrease in the price of oil and a 50 percent increase in the price. Hickman also notes that most models have unitary price elasticities of aggregate demand so that "the relative magnitude of the output and price responses to an oil shock is similar across models, with big output reductions accompanying large price increases and vice-versa" (p. 93).

energy, or increase supplies of other resources. When energy prices rise, the aggregate supply curve shifts upward, but the level of output corresponding to full utilization of existing labor and capital resources also shifts to the left, $y_1$.[9]

In capital and labor markets, this productivity loss is manifested in lower real wages and, over time, in a smaller capital stock relative to labor. The latter effect reinforces the initial productivity loss and shows up as a reduction in growth of the capital stock and economic capacity during the period of adjustment to a lowered desired capital-labor ratio. Since the theoretical channel is reversible, energy price reductions have equal and opposite effects to those of an energy price increase; in figure 1, an equal-sized energy price reduction shifts aggregate supply from $AS_1$ to $AS_0$.[10] Thus, this approach implies that energy price changes have symmetric influences on the economy.

Figure 1

**The Aggregate Supply Effect of a Rise in Energy Prices**




## *Some International Evidence From Earlier Oil Price Changes*

The theory presented above suggests that energy price shocks should affect the productivity of capital and labor resources similarly across countries. Support for this view is provided by Rasche and Tatom (1981), using production function estimates for Canada, the United Kingdom, Germany, France and Japan. More recent evidence can be found using business sector data for these countries and Italy prepared by Helliwell, et al (1986) for the Organization for Economic Cooperation and Development (OECD).[11] This data can be used to demonstrate the significance of the general predictions of the theoretical analysis for earlier energy price increases.[12]

The top panel of table 1 presents the annual average growth rate of the relative price of energy from the OECD data set.[13] Table 1 also shows the growth rates of output per worker, capital per worker, and energy per worker in the seven countries. Two periods including

[9]Analyses like that in figure 1, but which ignore the shift in capacity, have upward sloping supply curves at ($P_1$, $y_1$) that suggest that the former output level, $y_0$, is achievable if government policy can raise aggregate demand sufficiently; viewed another way, these analyses suggest that the decline in output from $y_0$ to $y_1$, involves a reduction in employment of existing labor and capital resources.

[10]In Rasche and Tatom (1977a, b, c and 1981), aggregate demand shifts play no essential role. Shifts in oil imports or exports are presumably offset by corresponding changes in other imports or exports or by changes in other components of aggregate demand. This analysis also emphasizes that optimal policy responses are effectively limited or absent because economic capacity is changed, and the economy adjusts to energy price shocks relatively quickly. Output cannot be "restored" to its original level through short-run aggregate demand management. Moreover, such policies work slowly relative to the dynamics of adjustment to a supply shock, so that the effects of oil price shocks are largely completed before monetary and fiscal policy effects could have an impact on them.

[11]These data, updated and revised from the original article, were kindly provided by Mr. Peter Jarrett and Mr. G. Salou of the OECD.

[12]The OECD data on the business sector was prepared to develop the supply-side of the OECD's macroeconomic model for seven countries. Two important characteristics of this data are the consistency of measurement across countries and the development of the energy purchases series. Helliwell et al. (1986) do not directly address the symmetry issue or whether variations in energy purchases fully capture the effects of energy price shocks on aggregate supply. Energy price effects work through changes in the relative cost of capital and energy in their model, so the effects are implicitly symmetric.

[13]These data are available from 1963 for all countries but Japan and extend to 1983. The relative price of energy is constructed by deflating the nominal price of business energy purchases by the deflator for business sector gross output. Besides the United States, only Italy, Germany, and Japan show declines for this measure after 1981. The only decline for the latter three countries is in 1983 and ranges from a decline of only 3.1 percent (Japan) to 5.1 percent (Germany). The decline in the relative price of energy in the United States from 1980 to 1985 and rise in most other countries is one of the reasons given in Tatom (1986) for the improvement in productivity growth in the United States compared with other countries and, therefore, the improved U.S. competitiveness and associated rise in the value of the dollar in international exchange.

Table 1
**Annual Growth Rates**

| Relative price of energy | 1965–73 | 1973–79 | 1979–83 |
|---|---|---|---|
| United States | −0.1% | 8.2% | 5.6% |
| Canada | −0.4 | 8.1 | 6.8 |
| Japan | −3.7 | 5.3 | 15.5 |
| United Kingdom | −2.9 | 4.7 | 3.8 |
| France | −1.1 | 5.3 | 9.3 |
| Germany | −2.0 | 6.8 | 5.7 |
| Italy | −2.7 | 9.4 | 9.8 |
| **Output per worker** | | | |
| United States | 1.5% | 0.1% | 0.3% |
| Canada | 3.0 | 0.8 | −0.0 |
| Japan | 9.2 | 3.0 | 2.1 |
| United Kingdom | 3.7 | 0.9 | 1.4 |
| France | 5.5 | 3.5 | 1.5 |
| Germany | 5.0 | 3.3 | 1.3 |
| Italy | 6.9 | 2.2 | −0.1 |
| **Capital per worker** | | | |
| United States | 2.5% | 1.7% | 2.1% |
| Canada | 2.5 | 2.3 | 4.6 |
| Japan | 10.5[1] | 6.5 | 5.1 |
| United Kingdom | 4.6 | 3.3 | 4.8 |
| France | 5.1 | 4.9 | 4.6 |
| Germany | 5.9 | 4.8 | 4.5 |
| Italy | 6.5 | 3.5 | 3.2 |
| **Energy per worker** | | | |
| United States | 1.8% | −0.4% | −4.3% |
| Canada | 3.8 | 0.7 | −1.8 |
| Japan | 10.9 | −0.2 | −6.4 |
| United Kingdom | 2.8 | −1.4 | −3.0 |
| France | 5.0 | 3.0 | −3.3 |
| Germany | 6.8 | 1.8 | −0.5 |
| Italy | 8.0 | −1.9 | −5.4 |

[1]1967 to 1973; 1967 is the earliest available data.
SOURCE: OECD data, except for the United States, where more recent U.S. data on output, employment, and capital are used.

the 1973–74 and 1979–81 oil price shocks and their aftermath are shown, along with the 1965–73 trend in each variable. The second panel shows the slowdown in labor productivity from the 1965–73 trend during each period. Japan and Italy had the sharpest reductions in the 1973–79 period. The slowdown in labor productivity growth is more pronounced in all countries, except the United States and United Kingdom, in the 1979–83 period when compared with 1965–73.

The capital-per-worker growth rates also declined in 1973–79 compared with those in 1965–73. Movements in the capital-labor ratio are not indicators of the desired capital-labor ratio when cyclical movements in employment depart from labor force growth. Nonetheless, over the 1979–83 period, four countries showed a further deceleration; the growth of capital per worker accelerated, however, in the United States, Canada and the United Kingdom.

As the bottom panel of table 1 shows, the growth rate of energy per worker slowed markedly in each country for each period. The largest reductions in 1973–79 were in Japan and Italy, the two countries in which the largest reductions in the growth of output per worker also occurred. All countries showed larger reductions in the growth of energy per worker in the 1979–83 period. The results in table 1 are consistent with the theoretical predictions that a rise in the relative price of energy reduces both energy and capital per worker and, therefore, lowers output.

Over the period 1973–83, output per worker growth slowed substantially in the seven countries when compared to the 1965–73 period; reduced energy use alone accounted for a substantial share of these reductions without taking into account the energy price-induced reductions in capital per worker.[14] Some analysts have suggested that these developments will not be reversed, or at least not reversed in proportional magnitudes, by the recent decline in the relative price of oil and other energy resources. Some of these arguments are examined in the next section.

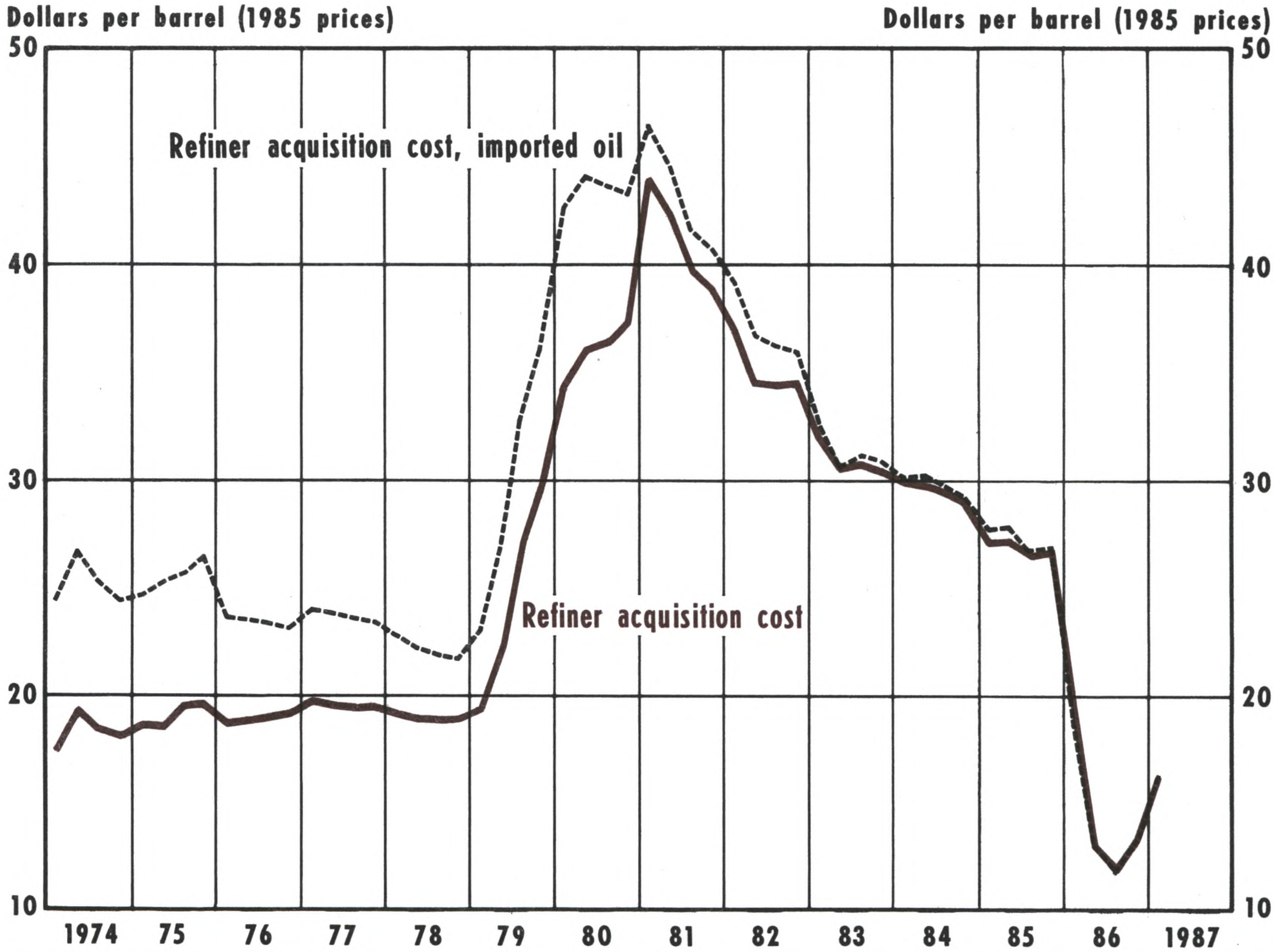
## DO OIL PRICE INCREASES AND DECREASES HAVE EQUAL AND OPPOSITE EFFECTS?

Previous studies of the effects of oil price changes on the economy do not indicate that they are asymmetric. Existing models of oil price effects are not formulated in a manner that would reveal such asymmetric effects, however. Besides, empirical models rely heavily on the experience in the 1970s, when real oil and

[14]The reductions in energy use per worker together with "output elasticities of energy use," the percentage change in output associated with each percentage point change in energy use, can be used to estimate the direct effect of the energy use reductions on output. These elasticities, estimated in Tatom (1987), show that reduced energy use had a substantial negative effect on output and productivity growth in these seven countries.

Chart 1

## The Relative Price of Oil




energy prices did not decline.[15] There are some arguments, however, that suggest the recent oil price decline will not yield equal and opposite effects.

### *The Asymmetric Effects of Transitory vs. Permanent Oil Price Declines*

If the recent decline in oil prices is only temporary, there should be no long-run adjustments of methods of production, prices or employment. At least one perspective on the recent declines, however, suggests that they are not likely to be reversed. According to this view, the decontrol of the U.S. crude oil market in early 1981 lowered OPEC's optimal price of oil. This view also suggests that OPEC2 was due largely to output changes associated with the Iran-Iraq war; if correct, the OPEC2 price increase ultimately will be reversed.[16] Consequently, the 1986 oil price reduction is not a temporary aberration, but the continuation of a downward oil price adjustment that began five years earlier.

[15]Real oil prices and energy prices did decline through most of the post-war period included in the estimation of most models, but on a steady and moderate trend rather than abruptly. Hamilton (1983), however, indicates that there were cyclical movements induced by oil shocks before 1973.

[16]The analysis in Ott and Tatom (1982a and b) and several of the references cited there explain this argument.

Chart 1 shows the relative price of oil from 1974 to the end of 1986. The prices, measured relative to 1985 business sector prices, show the average U.S. refiner acquisition cost for oil and for imported oil. The imported price is included to indicate the world price of oil. The two prices differ until early-1981 because of the entitlement system that held the U.S. price paid for oil, whether domestic or foreign, below that in the world market. Subsequent differences reflect minor variations in the characteristics of domestic and imported oil. Note that the U.S. real price of oil in 1974–78 averaged about $19.50 per barrel (1985 prices) and varied little. OPEC2 sent the world price up from $22 per barrel at the end of 1978 to about $46 per barrel in the first quarter of 1981, when U.S. decontrol of the domestic oil market occurred. Subsequently, the world and domestic price of oil fell to about $27 per barrel by late 1985, a decline of $17 to $19 per barrel, then further declined to an average of about $14 per barrel (1985 prices) in 1986.

An examination of chart 1 reveals three central points: (1) the 1986 oil price decline is not unprecedented — the decline began in 1981; (2) the 1986 decline was exceeded by the larger reductions that occurred from 1981 to the end of 1985; and (3) not until early 1986 had U.S. real oil prices fallen to their 1974–78 levels. Thus, the recent shock makes the 1981–86 change comparable in magnitude to the 1979–81 increase, except for the timing. These results are consistent with the view that the 1986 shock is permanent and point to the fact that the United States has had at least five years of experience with declining real oil prices.[17]

Chart 2 shows the quarterly relative price of energy (measured by deflating the quarterly average producer price index for fuel, power and related products by the business sector price deflator from 1970 to the present); the price has been indexed to 1972. Energy prices show the same pattern as the real price of oil in chart 1, especially the relative magnitudes associated with the OPEC1 and OPEC2 increases and the 1981–86 decline. From the end of 1972 to the third quarter of 1974, the logarithm of the relative price of energy rose 45.8 percent; from the first quarter of 1979 to the first quarter of 1981, it rose 47.9 percent; finally, from the first quarter of 1981 to the second quarter of 1986, it fell 51.8 percent. These changes were largely due to the near doubling in real U.S. oil prices in each of the earlier periods and the decline since early 1981.

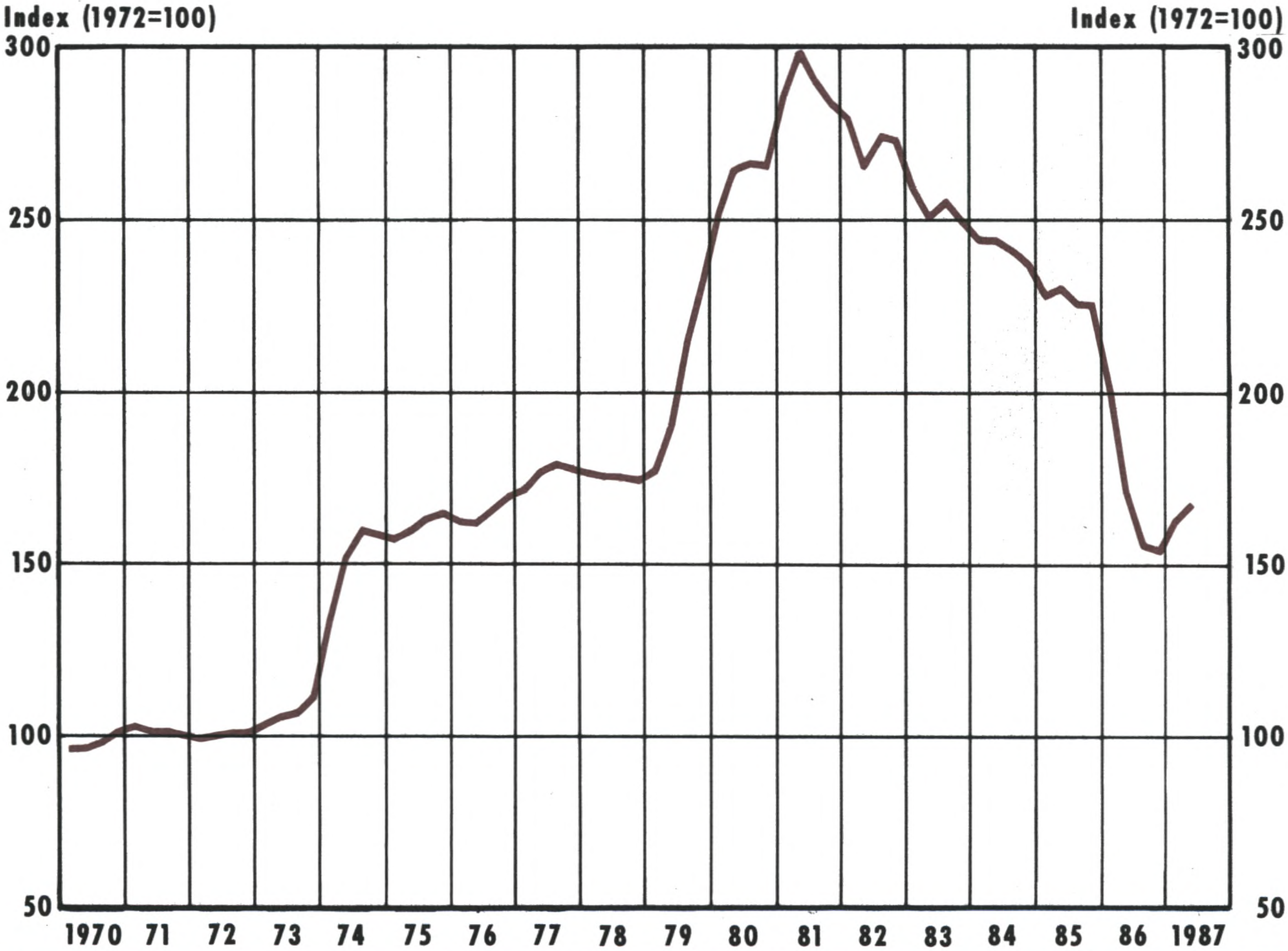
OPEC's incentive to maintain a lower price than prevailed as recently as 1985 can be seen from production and consumption developments since OPEC2. In 1973–79, world oil production (and, roughly, consumption) ranged from about 59.7 million to 62.5 million barrels per day, of which OPEC produced about 30.7 million (in 1973 and 1979, the figures were 31.0 and 30.9, respectively). OPEC output declined to 16.1 million barrels per day in 1985. World production also fell, to about 53 million barrels per day in 1982–83, and only recovered to about 54 million barrels per day in 1985. Thus, OPEC's market share plummeted from about 50 percent during 1973–79 to about 30 percent of a smaller market in 1985.

Comparing 1979 and 1985, world consumption fell about nine million barrels per day or about 14.5 percent, while non-OPEC production rose about six million barrels per day, or about 20 percent. The decline in the OPEC share arose from both a relatively large increase in rest-of-the-world production and a decrease in world consumption. OPEC, by late 1985, had not adjusted fully to its lowered optimal price. In 1985–86, Iran and Iraq's joint production level of about 3.6 million barrels per day, while 50 percent larger than in 1981, was well below their 1973–78 joint production level of 8 million barrels per day.

Since 1980, oil market developments have lowered OPEC's optimal price of oil. The actual price was reduced gradually in an attempt to increase the quantity of oil demanded and reduce competitors' supplies. By the end of 1985, such efforts had not been successful; moreover, even if the price reductions since then become somewhat successful, the rest of OPEC will face a future problem — a decline in market share and stronger incentive to lower prices — to the extent that Iran-Iraq production eventually rises further back toward pre-war levels. Thus, the recent decline in world oil prices is not likely to be temporary and its effects should not be asymmetric, at least not on this account.

[17]Since the initiating factor in OPEC2 has not totally disappeared, further downward movement can be expected. In 1978, Iran and Iraq produced 7.8 million barrels per day. This dropped to a low of 2.4 million barrels per day in 1981 and recovered to only about 4 million barrels per day at the end of 1985. Trehan (1986) presents an "alternative" view of nominal oil prices, arguing that they are driven by movements in the exchange value of the dollar. But Trehan's model only explains nominal price movements, given the relative price of oil, it does not account for the sharp nominal price changes associated with relative price disturbances.

Chart 2
## U.S. Relative Price of Energy




### *Do Oil Price Changes Have Asymmetric Effects on Capital Obsolescence?*

When oil prices rise, energy-using capital is rendered obsolete, unless (1) product prices adjust sufficiently, (2) product demand is unaffected, *and* (3) other lower-cost methods of production are unavailable. In the absence of these conditions, increased scrapping and/or alterations in the optimal employment of capital resources occurs. One approach to obsolescence emphasizes "putty-clay" technology, where the capital stock embodies a technology that is premised on expected factor and product prices and "fixed" relative factor proportions, for example, labor and energy employment per unit of capital. When factor prices change, the existing capital stock is no longer optimal; *any* relative factor price change can make the existing capital stock obsolete. Oil price shocks (or other factor price shocks) reduce productivity by effectively destroying capital resources regardless of the direction of change.

The concept of putty-clay capital suggests that short-run relative factor proportions are insensitive to factor price changes; it appears that output and employment can be altered only after sufficient time has passed so that capital can be changed. But inelastic factor proportions increase the short-run output loss associated with a rise in energy prices. Firm and industry output adjustments and industry product prices are larger when factor substitution cannot occur in the short run because of a change in the price of one resource.[18] The asymmetric result from a putty-clay perspective rests on the assumed relative ease of shutting down the use of existing plant and equipment compared with the adjustment cost of installing new capital or reemploying obsolete and idle capital. But this difference, if it actually exists, is one of the relative timing of effects. Thus, the putty-clay assumption does not yield differences in the response of the desired capital-labor or capital-energy ratios when the relative price of energy changes. These determinants of output and productivity respond similarly whether capital is putty-clay or not.

## *Are Firms' Responses to Cost Reductions and Cost Increases Asymmetric?*

Another argument is that firms respond differently to factor price reductions than to increases. A factor price increase forces adjustments because profitability and survival are threatened. A factor price decline gives rise to less pressure to change production methods; profits rise for energy-using firms even if they don't alter their behavior. A related argument is that adjustments to energy price shocks depend on the state of the economy, especially the state of the business cycle. Capacity utilization was relatively high and unemployment rates were relatively low when OPEC1 and OPEC2 occurred. These conditions have not been observed since 1981. Thus, current incentives to expand production due to factor price reductions or even to reduce product prices could be viewed as weaker. Incentives to expand the employment of energy-using plant and equipment, especially through new purchases, could be more limited in light of supposed weak demand for output.

These views ignore maximizing behavior or even minimal interest in achieving efficiency in the pursuit of firms' goals. Moreover, they ignore the effects of competition from other firms. Again, this argument suggests, at best, a difference in the timing of adjustments to a lower energy price shock, not an asymmetry in the direction or magnitude of the effects of lower energy prices.

## *Do Inter-Industry Effects Result in Asymmetric Macroeconomic Effects of Oil Price Changes?*

Another suggestion is that adverse effects on domestic oil-related industries dominate the positive developments for other industries when oil prices fall, despite a recognition that the reverse effects do not occur, or are not dominant, when oil prices rise. The importance of reductions in oil exploration and development activity and oil-related loan losses for the macroeconomy have been overstated, however. The effects are symmetric in that the domestic oil market boomed following both OPEC1 and OPEC2, while the dominant effects were on other producers.[19] More importantly, however, reductions in such activity in 1986 reflected short-run responses that reverse when factor prices in exploration adjust to the permanently lower oil price.

Part of the confusion over the dominance of domestic oil effects could arise from the apparent relatively slow growth of employment following the 1986 oil shock, especially early in the year. Yet this result is consistent with the earlier experience with oil price increases. In the initial period of a shock, the dominant effect is on productivity and supply, given product prices; with little price level adjustment, aggregate demand changes little. Thus, when oil prices rise sharply and unexpectedly, desired output falls more than sales, resulting in undesired inventory reductions that create upward pressure on prices and, initially, downward cyclical pressure on the unemployment rate.[20] Proponents of an asymmetric response in 1986 may be relying on an inaccurate comparison of the adverse cyclical experience that followed past oil price increases after a few quarters and the immediate cyclical developments that followed the 1986 oil price reduction.

[18] It is curious that some analysts appear to ignore the short-run pressure that the putty-clay assumption puts on reducing capacity utilization through shutting down, arguing instead that the effects of oil shocks work relatively slowly over extended periods of time as the capital stock is adjusted. How individual product prices or the price level can adjust relatively rapidly, as considerable evidence shows, in the face of the changes in "fixed" costs in the putty-clay case, is not typically addressed.

[19] Some analysts contend that the U.S. experience in 1973–74 was not comparable because of price controls on domestic crude oil. See Trehan (1987), for example. This ignores the 75.3 percent rise in domestic crude oil prices that occurred from III/1973 to III/1974, despite the existence of controls, or the 196 percent increase from January 1979 to January 1981, a period of similar controls.

[20] See the unemployment rate discussion in Tatom (1981, 1983b) and more recent evidence in Ott and Tatom (1986).

## DO OIL PRICE REDUCTIONS HAVE ASYMMETRIC EFFECTS? THE EVIDENCE

Empirical macroeconomic models can provide evidence on the symmetry issue because real oil and energy prices have been falling for nearly six years. A simple reduced-form model is used [see Tatom (1981, 1983b), (1987)] to analyze the short-run effects of oil price shocks. In addition, evidence from production function estimates that have been used to assess the productivity effects of adverse oil shocks is examined. The evidence from these models on GNP, price and output effects of energy price changes is presented below. Finally, some evidence on symmetric temporary surges in inflation in seven countries is discussed.

### *The Model*

The Andersen-Jordan GNP equation (1968) expressed in growth rates and augmented to account for effects of the energy price changes is used in the model. While such effects could be either permanent or transitory, estimates reveal that the statistically significant effects are only transitory. The price equation for the GNP deflator in this model is a reduced-form equation in which the principal determinant of inflation is the rate of growth of the money stock (M1); price controls and energy price changes, however, also influence the level of prices and, temporarily, the inflation rate. Since real GNP is the ratio of nominal GNP to the price deflator, the growth rate of real GNP is the difference between the growth rates of nominal GNP and the GNP deflator.

The GNP equation includes a strike measure (the change in the quarterly average of days lost due to strikes deflated by the civilian labor force), current and four lagged values of money (M1) and federal expenditure growth, and six previous quarter's changes in the relative price of energy, (the quarterly average producer price index for fuels, related products and power, deflated by the business sector price deflator). The price equation includes the current and 20 lagged growth rates of the money stock, dummy variables for wage-price control (for II/1971 to I/1973) and decontrol periods (I/1973 to I/1975), and changes in the relative price of energy for the past four quarters.

The model was estimated over the periods I/1955 to III/1980 and to III/1986, respectively, in Tatom (1987).[21] The model and energy price effects are stable and two tests rejected the hypothesis that energy price reductions since 1981 have had different effects, either in sign or size, on GNP, price, or indirectly, output growth. The two tests involved allowing post-1980 declines to have different effects on GNP or price growth and, second, allowing energy price declines throughout the sample to have different effects from increases in energy prices.[22]

### *Oil Price Shocks and Real GNP*

The effect of an oil price shock on output is determined from those on nominal GNP and prices. Since the effect of an energy price shock on the growth rate and level of GNP is zero after six quarters, its effect on output after that time is the inverse of its effect on the price level. The model described above yields estimates that indicate the responsiveness of the price level to energy price changes has not changed since 1980; thus, the permanent responsiveness of output to such changes, has not changed. In addition, the timing and magnitude of the short-run output effect has remained unchanged as well. The elasticity of the price level with respect to an energy price change (that is, the percentage rise (fall) in the GNP deflator associated with each percentage point rise (fall) in the relative price of energy) is estimated to be 0.050 to 0.058.[23] Thus, a doubling in oil prices led to about a 40 percent energy price rise during OPEC1, OPEC2, that, in turn, resulted in a permanent increase in the price level and decrease in output of about 2 percent to 2.3 percent [(40)(.05) to (40)(.058)] in each instance; the same size

[21]Over the longer period, adjustments were made for systematic overpredictions of GNP and price growth. These overpredictions are uncorrelated with the right-hand-side variables or other factors that various analysts claim explain a fall in velocity since 1981; see Tatom (1983a). The intercept shift in each equation was chosen by finding the shift that minimized the standard error of each equation where the shift was allowed to occur in any quarter since 1978. Christiano (1986) has shown that a trend velocity shift of this type is supported by the stability of difference-stationary models. The shifts used here begin in II/1981 for the GNP equation and in III/1982 for the price equation.

[22]A third test involves testing an asymmetry hypothesis suggested by Neumann and von Hagen (1987). They argue that, given wages and prices, relative price uncertainty reduces aggregate supply. Thus, an energy price change can reduce output and raise the price level regardless of whether energy prices rise or fall if it also raises relative price uncertainty. For energy price increases, the direct effect on aggregate supply and the uncertainty effect would reinforce each other, but for energy price reductions, they work in opposite directions. This hypothesis was tested by introducing the standard deviation of the relative price of energy and its lags in the equation estimates; these measures are *not* significant in either equation.

[23]This elasticity is the sum of the coefficients on the rate of change in the relative price of energy in the inflation equation.

decline in oil prices from IV/1985 to III/1986 is estimated to result in the same size reduction in prices and rise in output as in these earlier instances.

## *Oil Price Shocks and Productivity*

The effect of energy price changes on productivity can be evaluated by estimating an annual business sector production function in which business sector output, X, is regressed on business sector hours, $h_t$, the product of the lagged net capital stock (constant dollars) and Federal Reserve capacity utilization rate, $k_t$, the relative price of energy, $p^e_t$, a constant, a trend, t, and trend breaks in 1967, t67, and in 1977, t77.[24] The production function is "Cobb-Douglas," or linear in logarithms and estimated with a "constant returns to scale" restriction.

The estimate for the period 1948–80 is (t-statistics are given in parentheses):

$$(1)\quad \ln X_t = \underset{(0.80)}{0.299} + \underset{(13.18)}{0.690} \ln h_t + \underset{(5.90)}{0.310} \ln k_t - \underset{(-2.49)}{0.053} p^e_t + \underset{(10.97)}{0.019}\, t - \underset{(-3.41)}{0.006}\, t67 - \underset{(-1.96)}{0.008}\, t77$$

$$\bar{R}^2 = 0.97 \qquad SE = 0.90\% \qquad DW = 1.88 \qquad \hat{\rho} = 0.25$$

The production function, estimated for the period 1948 to 1985, is:

$$(2)\quad \ln X_t = \underset{(1.15)}{0.377} + \underset{(15.01)}{0.701} \ln h_t + \underset{(6.41)}{0.299} \ln k_t - \underset{(-3.40)}{0.055} p^e_t + \underset{(11.57)}{0.019}\, t - \underset{(-3.87)}{0.006}\, t67 - \underset{(-3.09)}{0.006}\, t77$$

$$\bar{R}^2 = 0.97 \qquad SE = 0.86\% \qquad DW = 1.84 \qquad \hat{\rho} = 0.28$$

There are no statistically significant differences between the estimates in equations 1 and 2. Hence, adding five additional years of data during which energy prices declined sharply produces no changes in the estimates. Such evidence is only suggestive, however. A more direct test is to allow the coefficient on the energy price to be different after 1980. When equation 2 is estimated permitting energy prices from 1981 to 1985 to have a different effect on output, the difference is 0.0016 (t = 0.94); while the change in the coefficient is positive, indicating a smaller impact on output, the difference is tiny and statistically insignificant. When equation 2 is used to predict business sector output in 1986, the error is 0.05 percent; that is, business sector output grew 3.31 percent from 1985 to 1986, nearly the same as the 3.36 percent predicted by equation 2.

The output elasticity of the energy price in equation 2 is −5.5 percent, smaller than earlier estimates where trend shifts were not statistically significant and, thus, were omitted. Without the trend shifts in first-difference estimates of equation 1 and 2, the short-run output elasticity of the energy price is 8 percent.[25] Over short periods, such as the past ten years, it is not possible to determine whether trend shifts represent truly permanent changes or whether they are simply capturing residual effects due to energy price shocks or other transitory effects on productivity trends. In either case, the estimated output elasticity is in line with the estimate from the reduced-form model above.[26]

## *Oil Price Shocks and The Rate of Price Increase*

Price developments across the seven countries referred to earlier provide more casual evidence of a symmetric response to the recent decline in oil prices. The top panel of table 2 shows that, during the period of the previous two oil price increases, inflation rates temporarily surged upward from levels in the preceding year and subsequently fell back. Since the timing of the peak rate of increase for a four-quarter period varied among the countries, inflation measures for

[24]Rasche and Tatom (1977b, c and 1981) test a popular hypothesis that the trend growth of productivity declined in 1967. The hypothesis is rejected but, the results indicate a smaller size for the output elasticity of energy prices when the insignificant trend-shift is included. When recently revised NIPA data are used, however, the 1967 trend break cannot be rejected.

[25]Tatom (1987) reports the results of both of the tests used in the GNP and price equation above for the first-differenced production function. First, the energy price declines from 1981 to 1985 were allowed to have differential effects on business sector output growth. Second, energy price increases and decreases in the period 1948 to 1985 were treated as two separate variables. A test of whether the coefficients of these variables are equal and opposite in sign is a test of symmetry. Both of these tests fail to reject symmetry. Finally, the standard deviation of real energy price changes (measured over the current and previous two years) was added to the level equation 2 and its first-difference was added to the first-difference equation. It is not significant in either case and does not alter the other coefficients.

[26]The emphasis above is on the output elasticity of the relative price of energy, given capital and labor employment. Rasche and Tatom (1981, p. 13, and elsewhere) explain that the desired capital-labor ratio falls (rises) due to an energy price rise (decline), and that, given potential employment, the long-run response is larger by a percentage equal to $s_k/s_l$, where $s_k$ and $s_l$ are the shares of capital and labor in value added. In equations (1) and (2) this increment to the output elasticity is 44.9 percent and 42.6 percent, respectively.

Table 2

**Oil Shocks and Rates of Increase of Consumer Prices**

| | Pre-OPEC1 III/1972–III/1973 | OPEC1* III/1973–III/1975 | Post-OPEC1 III/1975–III/1976 | Pre-OPEC2 IV/1977–IV/1978 | OPEC2* IV/1978–IV/1981 | Post-OPEC2 IV/1981–IV/1982 |
|---|---|---|---|---|---|---|
| Canada | 8.1% | 10.9% (12.0) | 6.5% | 8.7% | 11.0% (12.7) | 9.7% |
| France | 7.6 | 12.7 (14.9) | 9.5 | 9.5 | 13.0 (14.1) | 9.5 |
| Germany | 6.9 | 6.6 (7.4) | 3.9 | 2.4 | 5.9 (7.1) | 4.7 |
| Italy | 10.8 | 18.3 (25.7) | 16.5 | 12.0 | 19.4 (21.5) | 16.8 |
| Japan | 16.9%** | 16.8 (23.8) | 9.1 | 4.4 | 5.2 (7.7) | 2.8 |
| United Kingdom | 9.1 | 21.7 (26.6) | 13.7 | 8.1 | 14.8 (21.6) | 6.2 |
| United States | 6.8 | 10.1 (12.1) | 5.5 | 8.9 | 11.6 (14.4) | 4.5 |

| | December/1984–85 | December/1985–86 | December–June 1987 |
|---|---|---|---|
| United States | 3.8% | 1.2% | 5.4% |
| France | 4.7 | 2.1 | 5.4 |
| Germany | 1.8 | −1.1 | 2.3 |
| Italy | 8.6 | 4.3 | 5.1 |
| Japan | 1.8 | 0.1 | 3.0 |
| United Kingdom | 5.6 | 3.8 | 6.8 |
| Canada | 4.4 | 4.2 | 5.0 |

*Peak four-quarter rate given in parentheses.
**I/1973–III/1973.

two- and three-year periods are given along with the peak increase over four quarters (in parentheses).

The bottom of table 2 illustrates the symmetric response associated with the 1986 oil price decline. Consumer price increases slowed sharply in each country, except Canada where the slowing was slight. During the first six months of 1987, however, the rate of price increase rose sharply in all seven countries. In all the countries except Italy, inflation was higher in early 1987 than it had been in 1985, the year prior to the oil shock.

## CONCLUSION

The decline in oil prices in 1986 raised the question of whether oil price shocks have symmetric effects on macroeconomic variables. The analysis presented here indicates that energy price shocks matter because they affect economic capacity and hence productivity of labor and capital resources, or aggregate supply. Their specific effects on other macroeconomic variables follow from the effects presented here. This view suggests that oil price increases or decreases have symmetric effects on the economy.

The United States had experienced a relatively large decline in the relative prices of oil and energy from 1981 to 1985, a decline that exceeded the recent one in 1986. Thus, evidence on the adjustments of spending, prices, output and productivity is available and described here that bears on the symmetry question. The evidence suggests that energy price shocks have symmetric effects. Formal tests of changing energy price coefficients in reduced form equations and an aggregate production function reject the asymmetry hypothesis. Finally, consumer prices for the United States and six other countries exhibit symmetric temporary movements surrounding the 1986 oil price decline.

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