SEPTEMBER/OCTOBER 1989

ECONOMIC PERSPECTIVES

A review from the
Federal Reserve Bank
of Chicago

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The geography of value added

***25th Conference on
Bank Structure and Competition:***
Controlling risk in financial services

**Public investment and productivity
growth in the Group of Seven**

FEDERAL RESERVE BANK
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ECONOMIC PERSPECTIVES SEPTEMBER/OCTOBER 1989 Volume XIII, Issue 5

ECONOMIC PERSPECTIVES is published by the Research Department of the Federal Reserve Bank of Chicago. The views expressed are the authors' and do not necessarily reflect the views of the management of the Federal Reserve Bank.

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ISSN 0164-0682

The geography of value added

Marketing, R&D, even accounting and legal departments, add value to a manufacturer's product, but that value is attributed solely to the production site, a practice that distorts our understanding of regional manufacturing activity

Philip R. Israilevich and William A. Testa

Amoco Corporation, a diversified manufacturer of chemical and petroleum products, refines crude petroleum into gasoline and other products at such locations as Texas City, Texas, and Whiting, Indiana.[1] However, many of the support services which contribute to the value of these refined products are performed at Amoco's corporate headquarters in Chicago, Illinois, and at its research center in Naperville, Illinois.

The sprawling geography of these activities presents a considerable problem in tracking the location of manufacturing across U.S. states and regions. In the case of Amoco, how much manufacturing activity should be attributed to its Chicago area headquarters and R&D center and how much to its refineries in Texas and Indiana?

The U.S. Census Bureau currently attributes all of a company's manufacturing output to the locations of the production plants, i.e., the refineries in the Amoco example. While there may be no one correct method of apportioning output to states and regions, the Census method is clearly inadequate. Consequently, much of what we think we know concerning the changing geography of manufacturing across the U.S. may need to be re-examined.

In this article, the regional biases inherent in the Census measure of manufacturing output, which is called value added (VA), are explained and illustrated. Two potential methods of correcting the problem are evaluated. We conclude by discussing the importance of correctly measured value added in understanding regional economic behavior.

Taking stock of manufacturing

It may come as a surprise to some, but we do not measure manufacturing output by the final sales value of goods such as automobiles, tractors, or refined petroleum. Rather, we count only the value that is added by manufacturing companies to raw materials, such as crude petroleum for gasoline, and intermediate components, such as steel and rubber for autos, in producing these final manufactured products. Companies engaged in the processes of assembling and transforming these intermediate products into finished goods are designated as manufacturers. Their contribution of labor and capital and entrepreneurship to the nation's GNP accordingly becomes the nation's "value added in manufacturing" or manufacturing output.

Formally, value added is the value of products shipped by manufacturers less the value of intermediate goods (which is embedded in the value of the final manufacturing product):

1) Value Added = Value of Shipments – Materials and Intermediate Goods.

Value added is, then, a residual, representing the incremental value contributed to the product by the manufacturing company (see Figure 1). Quite correctly, the value of raw

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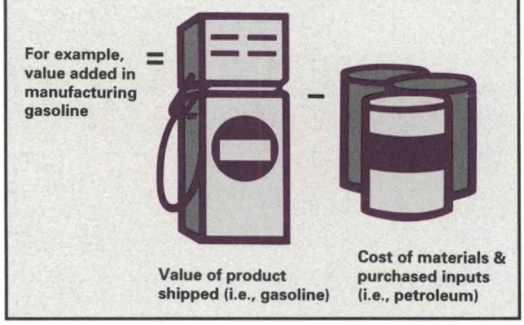
The assistance of Tirza Haviv is gratefully acknowledged.

FIGURE 1

Measuring value added as a residual



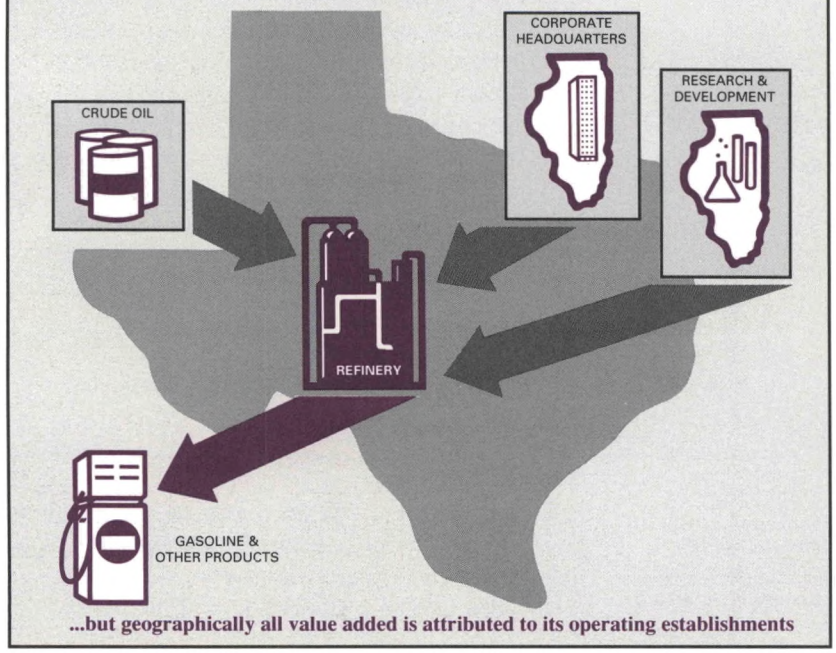
materials and intermediate products is attributed to the industrial sectors in which they originate, such as mining, construction, services, or agriculture.

The current Census method inappropriately apportions a large part of manufacturing value added to states and regions. This inappropriately apportioned part is the activity of "auxiliary" establishments of manufacturing firms, i.e., corporate headquarters, research and development labs, data processing centers, and warehouses (see Figure 2). The activities of auxiliary establishments *are* counted (quite correctly) in the national summation of value added.[2] The national totals of value added are not at issue. However, auxiliary activities are wrongly apportioned to states and regions on the basis of operating establishment site while neglecting the location of the auxiliary establishments. The problem is, therefore, one of geography and not of summation to national industry totals.[3] The total VA of each manufacturing company is allocated to states and regions solely on the basis of where the company's operating or production establishments are located.

However, the geography of the overall company can be quite different from the operating establishments where VA is reported. A manufacturing product's design and engineering may originate at the company's R&D center and not at the operating establishment location.[4] Similarly, the product's advertising and image may be fashioned at an out-of-state sales office or corporate headquarters of the manufacturing company. All these activities, which provide services to the operating establishments, *do* legitimately contribute to a product's value. We believe that this contribution to manufacturing output should be counted at the site of the auxiliary activity. In practice, no VA at all is reported and recorded by auxiliary establishments.

FIGURE 2

Value added to a company's product takes place throughout the nation...



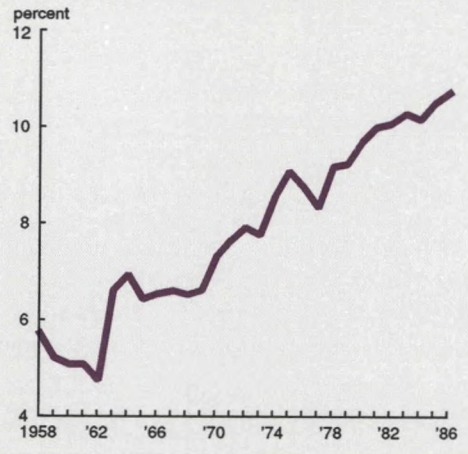
...but geographically all value added is attributed to its operating establishments

The auxiliary economy

It is apparent from the payrolls of auxiliary establishments that the share of VA originating at auxiliary establishments is significant. Auxiliary payroll amounted to almost 11 percent of the nation's total manufacturing payroll in 1986 (see Figure 3 and Table 1). In individual regions, auxiliary payroll ranged from negligible amounts in several states and

FIGURE 3

Share of manufacturing payroll at auxiliary establishments



Standard Metropolitan Statistical Areas (SMSAs) to as high as 49 percent for the State of Delaware and 54 percent in the Stamford, Connecticut, SMSA in 1982.

Among the various types of auxiliary activities, administrative and managerial activities were most prominent in 1982, followed by general office and clerical, and third by research, development, and testing (see Figure 4). For individual industries, the evidence on the significance of auxiliary activities is also striking (see Figure 5). Disaggregating total manufacturing into its 19 major components at the 2-digit SIC (Standard Industrial Classification) code level, the wide-ranging importance of auxiliary payroll is revealed. For example, some industries that fall under the "chemicals industry" banner report over one-fourth of total payroll at auxiliary establishments; some industries in "petroleum and coal products" report over one-third of payroll outside of operating establishments.

TABLE 1

Auxiliary establishments for manufacturing firms—1982

	Number	Share
Total manufacturing	9,676	100.0
Administrative and managerial	7,792	80.5
Office and clerical	6,157	63.6
Research, development, and testing	1,967	20.3
Warehousing	2,087	21.6
Electronic data processing	2,357	24.4
Other activities	4,353	44.9

NOTE: Detailed establishment data exceed totals and sum to more than 100 percent because some establishments participate in more than one activity.

SOURCE: U.S. Department of Commerce, Bureau of the Census, *1982 Census of Manufacturing Subject Series,* Vol. 1, p. 1-100.

Auxiliaries and regions

In studying the corporate organization of the manufacturers, some regional analysts have recognized that diverse activities are undertaken within companies and industries in producing a single product. Moreover, these activities are often located at sites away from each other—even across state borders and regional divisions.

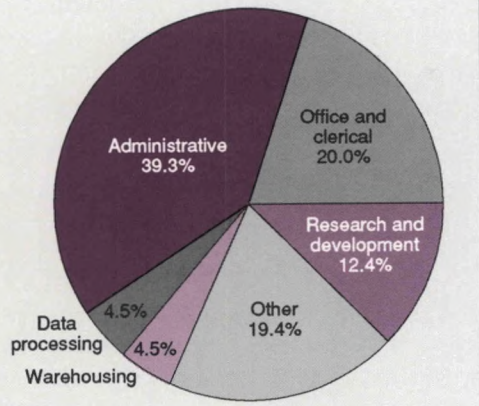
Industry studies by economic geographers have documented the spatial separation of activities within single corporate entities. For example, the R&D functions of pharmaceutical companies in Great Britain have been studied. One study reports that basic research—that of a generally applicable nature—is frequently undertaken at large centralized R&D facilities of large pharmaceutical companies. At the same time, specific and applied R&D is overwhelmingly conducted at the production plant site (Howells 1984).

Studies of manufacturing establishments have also reflected the cumulative importance of such establishment specialization to regions. Jusenius and Ledebur (1976) were among the first to document specialization in the U.S. South by branch production plants of U.S. manufacturing companies. More recently, Malecki (1985) has examined regional specialization in corporate headquarters versus branch plants across U.S. regions for four high-tech industries: computers, semiconductors, medical instruments, and computer software. But despite this wide recognition of regional specialization in diverse manufacturing activities, data covering VA in manufacturing has continued to be allocated to U.S. regions according to the location of production activity alone.

The observed geographic distribution of auxiliary activity varies quite widely across states and across metropolitan areas.[5] Moreover, a cursory view of the distribution of

FIGURE 4

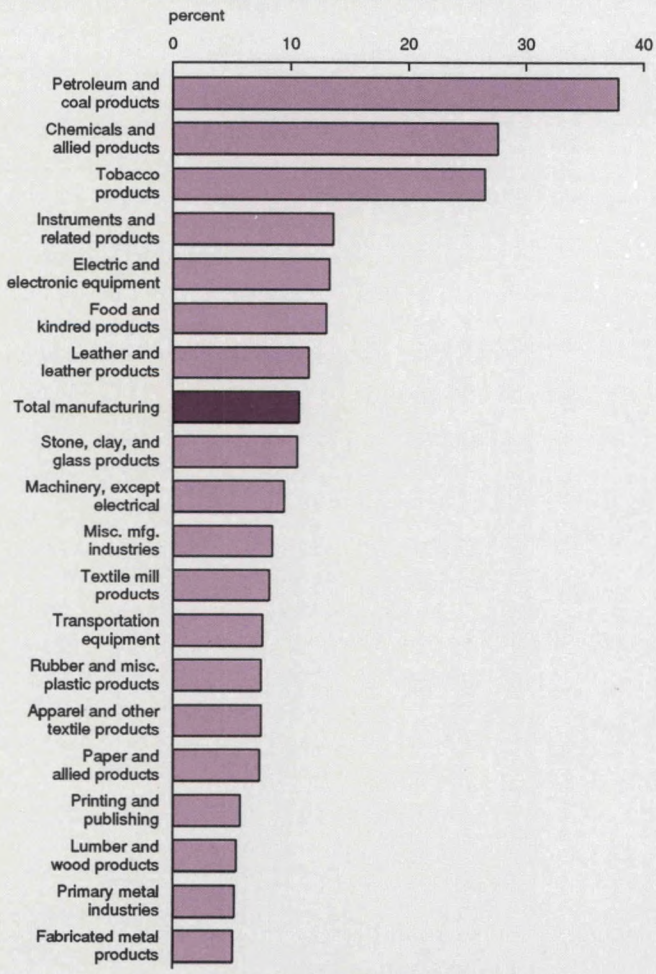
Activities at auxiliary establishments
(percent of employees)



auxiliary payroll suggests a systematic bias across the U.S. (see Figure 6). States in the New England and Middle Atlantic regions are home to very large numbers of auxiliary establishments. Similarly, individual Northern states including Illinois, New Jersey, Michigan, Ohio, and Pennsylvania display manufacturing sectors which are highly intensive in auxiliaries. Meanwhile, states in the South and especially those of the East South Central Region have a dearth of auxiliary locations, tending instead to specialize in operating establishments. Accordingly, we would expect that, in measuring manufacturing output, *the North and Midwest actually have greater levels than currently reported while manufacturing activity in the South is overstated.*

FIGURE 5

Auxiliary payroll share by industry



SOURCE: U.S. Department of Commerce, Bureau of the Census.

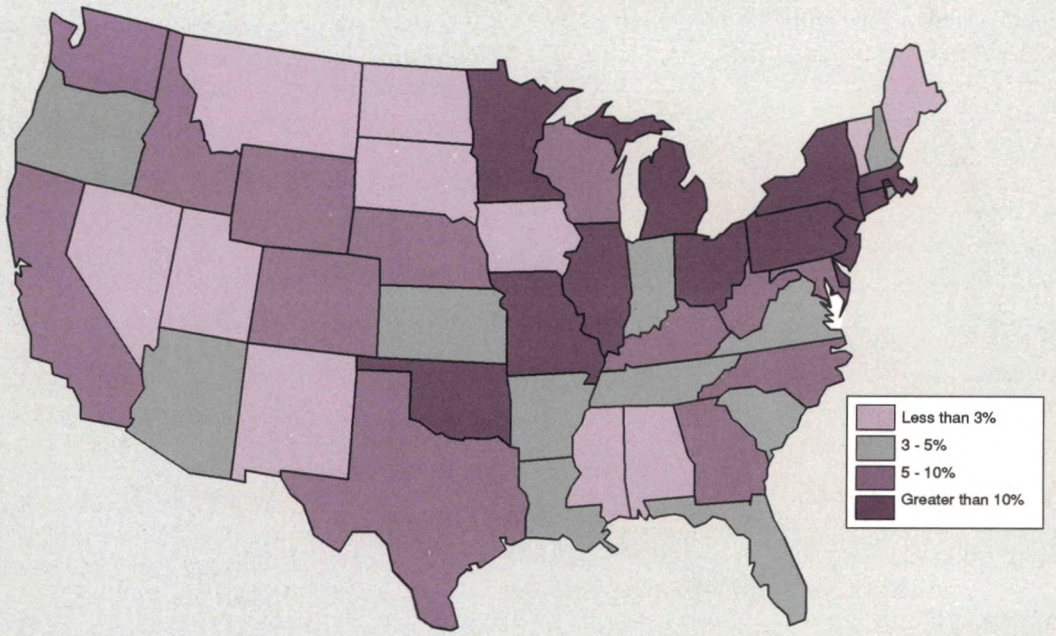
A formal test

It is reasonable to expect that the Census VA is underestimated in states which specialize in auxiliary establishments and overestimated in states with high concentrations of operating establishments. However, the problem may be insignificant if the proportion or split of activity between auxiliaries and operating units is largely the same in each state and SMSA. If such is the case, the difference between the Census and true VA will be insignificant; i.e., operating establishment activity serves as a good allocator of total manufacturing output of companies to SMSAs and states.

To test whether the Census method has a strong bias in overlooking the site locations of auxiliary establishments, a formal hypothesis can be constructed. The current Census method of estimating VA as the residual between value of shipments and materials at operating establishments is equivalent to assuming that either:

FIGURE 6

Ratio of auxiliary payroll



1. the auxiliaries make no contribution to VA; or

2. the auxiliaries locate in close proportion to operating establishments with respect to their effect on VA.

The first assumption can be rejected since we have seen that the auxiliaries' payroll comprises a sizable part of total VA (see Figure 3).

The second assumption can be tested if we assume that region-to-region variations in VA of both types of units, operating and auxiliary establishments, can be approximated by the variations in their respective payrolls. Based on assumption 2, we then can formulate the following null hypothesis:

H_o: the Census-determined VA and true VA are the same.

If true, this hypothesis implies that the elasticities of VA with respect to auxiliary unit and operating unit payrolls are the same. A dollar of either auxiliary payroll or operating payroll will contribute equally to a region's manufacturing VA.

The null hypothesis can then be formally tested using the following ordinary least squares (OLS) regression equation:

2) $V = c + b_a A + b_o O$

where:

V = VA in logarithmic form.

A = payroll for auxiliaries in logarithmic form.

O = payroll for operating units in logarithmic form.

Equation 2 was estimated for both SMSAs and states. There were 172 SMSAs and 46 states which disclosed auxiliary payroll. The estimated results are:

SMSAs: $c = 1.149$ $b_a = 0.031$ $b_o = 0.941$
(12..3) (2.4) (49.3)
adj. $R^2 = 0.97$ n=172

States: $c = 1.197$ $b_a = 0.006$ $b_o = 0.961$
(9.5) (0.3) (39.3)
adj. $R^2 = 0.99$ n=46

NOTE: Numbers in parentheses are t-statistics.

For SMSAs, coefficients for auxiliary and operating units payrolls are both significant and strongly different (b_a is 30 times smaller than b_o). This means that estimated elasticities of VA (b_a and b_o) with respect to payroll in auxiliaries and operating units are very different. This leads to the rejection of the H_o hy-

pothesis.[6] For states the rejection of the H_o hypothesis is even more obvious, since b_o is positive and significant while b_a is insignificantly different from zero. Therefore the hypothesis that b_o is infinitely larger than b_a cannot be rejected.

To test the H_o hypothesis, we had to assume that the payrolls of operating and auxiliary establishments parallel their respective VA for each state and metro area. However, if this assumption is relaxed, it is still evident that the H_o would be rejected. It is inconceivable that differences in the payroll/value-added ratio could offset the large differences between the elasticities of auxiliary unit and operating unit payrolls that were uncovered in the regression estimation.

Secular and cyclical bias

There are reasons to believe that manufacturing value added, as currently measured, distorts our view of both long-term regional manufacturing growth and also of the nature of manufacturing activity over the course of the business cycle. Over the long term, the payroll of employees at auxiliaries has been growing steadily for the past 25 years, now accounting for almost 11 percent of the total industry payroll in comparison to 6 percent around 1960 (see Figure 3). To the extent that growth in auxiliary activity is skewed toward particular regions, long-run growth in manufacturing across regions will be biased there. For example, in a region experiencing greater growth in auxiliary activities than in other manufacturing activities, output growth reported by the Census is likely to be biased downwards over time. As a case in point, the Great Lakes Region, i.e., Minnesota, Wisconsin, Illinois, Michigan, Indiana, and Ohio, has maintained its national share of payroll at manufacturing auxiliary establishments from 1963 to 1986 even while its share of national share of total payroll and output declined.

Distortion of output changes over the course of the business cycle can also be demonstrated. Analysts have long puzzled over the severity of the business cycle in manufacturing regions (Borts 1960; Bolton 1978). In general, they have found that, due to the sensitivity of durable goods sales during business downturns, manufacturing regions undergo wide fluctuations in economic activity over the course of the business cycle.

In measuring the volatility of *any region* with the Census VA, cyclical volatility will be overstated. VA is based on fluctuations in activity at operating establishments over time. But operating or production activities will likely be more cyclical than the manufacturing sector overall, thereby overstating cyclical swings. This further implies that a greater intensity of auxiliary activities in a region will magnify the cyclical bias.

One hypothesized reason for heightened volatility of operating establishments in comparison to auxiliary establishments concerns the differing firm behavior affecting semi-skilled versus highly-skilled workers over the course of the business cycle. With downturns in sales, production workers are more likely to be laid off in comparison to more highly skilled or white collar workers at auxiliary facilities (Williamson, et. al. 1975). If employees at auxiliary establishments acquire "firm-specific" skills to a greater extent than production workers at operating establishments, it will be advantageous for the firm to retain auxiliary workers even when their presence is not required by current production levels. If skills are firm-specific and not transferrable by the employee to other firms, the firm must partly pay for training. Accordingly, firms will be reluctant to lay off these workers during downturns for fear that they will need to train new workers once economic conditions begin to improve.

For the problem at hand, this means that manufacturing activity appears to be more volatile than it actually is because manufacturing shipments gyrate with the business cycle. However, the presence of auxiliary workers (who tend to be retained during downturns) suggests that actual manufacturing activity (including R&D, strategic planning, etc.) continues even while production activities are curtailed. From a geographical perspective, this cyclical reporting bias would tend to be greater at locations of higher auxiliary concentrations where a higher percentage of auxiliary activity fails to be recorded.

Evidence to the effect that auxiliary activity undergoes milder cyclical swings than overall manufacturing activities can be seen by regressing the share of the nation's employment at auxiliary establishments on the business cycle and other variables:

3) $AUX = c + b_t T + b_g G + b_y Y$
where :

AUX = current year share of auxiliary employment in total manufacturing employment.

T = annual time trend 1958 to 1986.

G = year-over-year percentage growth in U.S. gross domestic product in constant dollars (1982=100).

Y = a binary variable; one for census year, zero otherwise.

RHO = autoregressive parameter.[7]

Results of the maximum likelihood estimation procedure are:

$c = -2.48 \quad b_t = 0.0013 \quad b_g = -0.42 \quad b_y = -0.0006$
$\quad (-17.7) \qquad (18.1) \qquad (-2.3) \qquad (-0.06)$

$RHO = 0.34$
$\quad (1.72)$

$n = 29 \quad adj.\ R^2 = 0.97 \quad D\text{-}W = 1.83.$

We included the binary variable *Y* for two reasons. During census years, questionnaires are addressed to each establishment while, during non-census years, *Annual Survey of Manufactures* (ASM) questionnaires are addressed to company headquarters. Second, during census years the entire population is observed, while in an ASM year observations are sampled. For these reasons one could argue that these two types of observations would have different results.

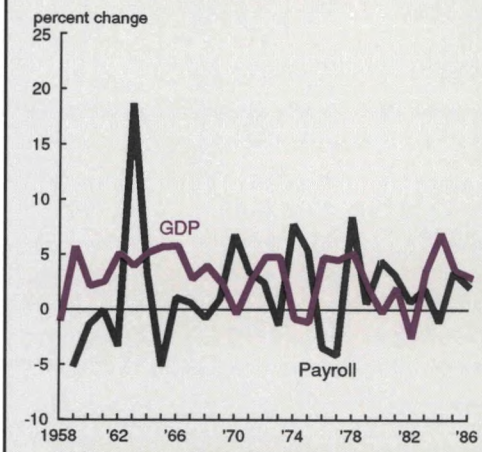
The regression does not confirm this argument. The regression does confirm that there is a significant positive linear relationship between the share of auxiliary employment and time which means that the demand for auxiliary services increases in the long run for total manufacturing.

In addition, a significant negative sign for the variable *G*, a proxy for the business cycle (i.e.,the short run effect), lends support to the hypothesis that *business downturns tend to raise* the share of manufacturing employment at auxiliaries (see also Figure 7). Apparently, the employees of operating establishments are more likely to be laid off than the employees of the auxiliaries.

Thus, in both the long run and the short run, the Census VA may exert a strong regional bias relative to the true but unknown manufacturing output.

FIGURE 7

Change in auxiliary payroll and GDP growth rate



NOTE: Year-to-year difference in share of auxiliary jobs is expressed as a multiple of 1,000. GDP growth rate is expressed as a percent.

Correcting the problem

Since the strong statistical difference between the Census and true VA is evident and important, the next question is whether the true VA can be estimated with greater accuracy. Two approaches can be identified. We argue that one of them, already being used, is deficient while the other holds great promise.

The Bureau of Economic Analysis, U.S. Dept. of Commerce, attempts to rectify the misapportionment of VA by manipulating aggregate regional data with national ratios (BEA 1985). However, their methodology to do so can only be correct under some highly stringent assumptions.

As their first step, BEA multiplies each state's VA (for a given industry) by a national factor which nets out the VA contribution made by auxiliary establishments. This adjustment can only be correct if the proportion of total VA contributed by auxiliaries is identical for each state.

In a second stage of estimation, the BEA method re-allocates the nation's VA of auxiliaries to states, adding it back into the estimated VA of operating establishments. For each industry, the method assumes that each state or region has the same relation between auxiliary VA and auxiliary payroll as the nation. Then the re-allocation of VA to states and regions is

performed according to the reported payrolls of auxiliaries of each industry in the state.

The key assumption of this second stage, that VA can be spatially allocated in proportion to payroll for broad industry categories, is not necessarily erroneous. But it is an assumption that remains untested. Only an analysis using the micro data can validate or reject the second BEA assumption.

The deficiencies of using aggregate data strongly suggest the use of Census data at the establishment level to re-compile VA for states and regions. One obvious but unworkable method would be to sum the factor payments at each establishment—both operating and auxiliary establishments alike. (VA is equivalent to the sum of factor payments including wages, rental, capital costs, and profits.) Unfortunately, this approach must be discarded because several individual data items on factor payments are not gathered by the Census.

However, using existing data from the Census, the analysis can be conducted at the company level. The Census collects payroll and other data on each establishment. The Enterprise Statistics Division subsequently combines these data to portray company structure. Each company can be viewed as a unit of observation composed of both operating and auxiliary facilities. The true VA for the overall company (and each product) is known from existing data (using the residual method). The remaining problem is to apportion each company's VA according to the contribution of each of its establishments.

For the companies with an intricate and integrated structure, the flow of services from auxiliary to operating units may be difficult to determine. This problem is compounded because many operating establishments are defined by a single industry code, yet produce products outside that industry as well. Therefore, an auxiliary service provided to an operating unit will have to be subdivided into as many components as there are products produced by the operating unit. No data series of such detail exists to determine service correspondence between operating and auxiliary units. However, by combining companies into an industry sample set, one can estimate the relationship between auxiliary and operating units in creating VA using econometric techniques. Finally, stepping back once again and viewing each establishment separately, data can be recombined to arrive at better estimates of VA for SMSAs and states according to the locations of their auxiliary and their operating establishments.

Implications for regional research

A correct accounting of manufacturing output will significantly affect the outcome of current regional research on the existing distribution of manufacturing in the U.S.; on the importance of manufacturing to regional economic bases; on the movement of manufacturing activity across regions over time; on regional productivity differences; and finally, on the determination of the linkages between auxiliary services and operating units located in different regions.

To illustrate, a heated debate focuses on whether the nation's manufacturing sector has been diminishing in recent years. The question has been raised, in particular, for the nation's manufacturing intensive regions—especially the Midwest (Hill and Negrey 1987; Schnorbus and Giese 1987). As evidenced by declining shares of employment and income, the Midwest has lost a significant share of the nation's manufacturing activity. However, revised VA may indicate that the losses have been overstated. If, as several studies have suggested, the older industrial belt has retained auxiliary activities even while production operations have decentralized (Jusenius and Ledebur 1976; Giese and Testa 1988), the method by which VA is currently reported would have failed to notice it.

Generally speaking, regions which have witnessed a relative decline (or rise) in the share of manufacturing *vis à vis* other industry sectors probably are understating (or overstating) the extent that manufacturing fortunes influence the regional economy.

The revised VA may also contribute to a better understanding of the growth process among regions. Some analysts believe that the spread of manufacturing from the Northeast–Midwest manufacturing belt to outlying U.S. regions has taken place within a "product cycle" process (Norton and Rees 1979).[8] Historically, the Northeast–Midwest served as the nation's innovative center, creating new technologically-advanced industries. Over time, in order to economize on costs, these industries have decentralized their routine production operations to the peripheral regions of the South

and West. Initially, growth in peripheral regions was composed of branch plant openings—usually production plants of companies headquartered in the Northeast and Midwest Regions. A recent acceleration in manufacturing growth in peripheral regions may reflect a reversal in regional roles; the Southwest and West finally having reached a critical mass of technology and infrastructure so as to spawn their own high-growth industries. The division between VA attributable to auxiliaries versus operating establishments for each region could be used to test for the changing specializations of regions over time.

A more precise measure of output may also change conclusions of papers devoted to measuring regional productivity (Hulten and Schwab 1984; Beeson 1987). While several different measures of productivity have been examined, they all focus on a region's manufacturing output in relation to inputs such as labor and capital. To the extent that the observed output trends are not reliable, conclusions regarding regional performance and competitiveness will not be reliable. Our data, for instance, suggests that productivity in a number of Northeast and Midwestern states is understated, i.e., the numerator, VA, is underestimated, in these studies.

One of the more intractable problems in modeling regional economies has been the observation of the economic linkages and trade flows between regions in services. The interregional flow of goods can be observed from *Census of Transportation* data while the flow of services cannot. The corporate linkages between operating establishments and auxiliaries of manufacturing companies would fill in part of this puzzle. Accordingly, interregional input–output models, which attempt to examine the economic linkages across regions, could be specified more fully. Estimated relationships can be expressed in the form of exports flowing from regions with auxiliary services to regions with operating units. This information can be incorporated into the multiregional input–output model, which would allow analysts to estimate the effect of the change in the output of the operating units for one region on the auxiliary employment for another region.

In a broader context, observing whether these operating–auxiliary linkages are increasing in distance over time would reflect on the question of whether, because of enhanced transportation and communication ability, the service sector can be thought of as an "export base" for regions. Over time, are regions with specialized service sectors serving customers that are farther and farther apart?

FOOTNOTES

[1]Amoco's activities are also large in energy exploration and development. These activities constitute value added in the mining, services, and other sectors.

[2]Another problem, which we will not address in this essay, concerns the fact that this Census Bureau definition of VA also includes the value of services purchased by the manufacturing company from either outside service companies or other manufacturers. Also, the Census does not subtract the materials costs of auxiliary establishments. Both of these practices lend an upward bias to the Census concept of VA.

[3]Others have taken up the possible biases in the national measures of manufacturing output (Mishel 1988). Mishel argues that manufacturing growth has been overstated at the national level by the BEA. This results from a failure to properly deflate the value of intermediate components in manufacturing over time. Foreign-source components are routinely deflated by a domestic price deflator—a procedure that Mishel believes has understated the foreign content of domestically manufactured goods and concurrently overstated the value of domestic manufacturing activity.

[4]With existing data collection procedures, distinguishing auxiliaries from similar activities that take place at operating establishments is somewhat capricious. Often, by the choice of the survey respondents, auxiliary activities that take place at the same site as the operating establishment can be combined and reported as one. In this paper, we single out auxiliary establishments because they are most likely to be located at different sites from operating establishments; the nature of the problem is most easily communicated by making the auxiliary versus non-auxiliary distinction. However, a skewed distribution of support activities versus operating establishments of multi-plant manufacturing companies across the U.S. would result in the same problem. Support services are often located at the same site as production activities.

[5]Here are the summary statistics for states and SMSAs in 1982:

Auxiliary payroll / total payroll

	Mean	Std. deviation	High	Low	n
States	0.083	0.080	0.498	0	46
SMSAs	0.099	0.088	0.534	0.005	172

[6]For formal testing of the equality between b_a and b_o coefficients, we proceed as follows. Equation 2 can be rewritten as:

$$V = c + b_a(A + O) + y_oO = c + b_aA + (b_a + y_o)O.$$

It is obvious that the equality between two coefficients cannot be rejected if y_o is insignificantly different from zero. [See Pindyck and Rubinfeld (1981)]. In both SMSAs and states y_o had t-statistics of 30 and 23 respectively, which strongly rejects the hypothesis of equality between two coefficients in both cases.

[7]OLS estimation resulted in a D-W statistic of 1.33, falling within the uncertain region. After first-order correction for serial correlation, the D-W statistic was 1.83.

[8]Some analysts have long maintained that regional economies can be understood by focusing on "export base", the key industries for which the region produces and trades with the rest of the nation or world. Typically, the export base has comprised manufacturing, mining, and agriculture although many service sectors are now also receiving such recognition. For seminal discussions see Andrews (1953), North (1955), and Tiebout (1956).

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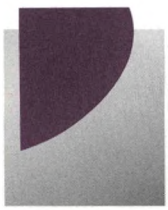
25th Conference on Bank Structure and Competition: Controlling risk in financial services

Mary J. Williamson



Risk management has always been a major challenge for the financial services industry. Today, however, the increasing number of failures of distressed depository institutions seems to indicate that managing risk has become more difficult. At the 25th annual Conference on Bank Structure and Competition, sponsored by the Federal Reserve Bank of Chicago, several industry leaders discussed their recommendations for controlling risk in today's environment. These participants shared several points of emphasis and presented some personal concerns about regulation, supervisory intervention, and deposit insurance.

Different perspectives

The panelists were in practical agreement about the fundamental issues affecting the industry, and all agreed that regulation has been used excessively to control risk. Each, however, had a different perspective on risk and, therefore, advocated different approaches for managing it.

"Banking by definition is the management of risk," began Federal Reserve Board governor John LaWare. This ex-banker-turned-regulator said that he resents the underlying assumption inherent in the regulatory structure that bankers do not know as much as legislators or regulators about how to run a bank. This false assumption has fostered excessive regulation and has created an anti-competitive atmosphere, said LaWare. He added, "it is increasingly creating a disadvantage for the American banking system in world markets, to say nothing about domestic markets." According to LaWare, "supervision, rather than regulation, ought to be the focus" for controlling bank risk.

Continental Bank Corporation chairman Thomas Theobald agreed with LaWare that regulation has gone too far. Taking a broad perspective on the future of the financial services industry, Theobald said that the business of banking will likely undergo "colossal restructuring," but it is not appropriate for "central planners," i.e., legislators and regulators, to decide "the finer points" of the restructuring. "I don't think . . . a sincerely motivated, highly intelligent, nationally interested bunch of people in Washington . . . are going to be able to design the proper response to these changes." Rather, according to Theobald, those decisions belong with the market participants—the consumers and the producers of financial services.

Early in the Conference, Carter H. Golembe, chairman and managing director of The Secura Group, asked, "Why is the market so distrusted as an efficient regulator of banking?" He conjectured that the reasons are that first, history has painted American banking during the first century and a half as "a chaotic black hole that was cured only by the establishment of the Federal Reserve System . . . and federal deposit insurance;" and second, "the market can be a brutal regulator."

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Federal Home Loan Bank Board member Lawrence J. White said that "depositories are special." According to White, their liabilities are special, and that is why they are insured and why controlling the risk of depository institutions is so important. But, like the other panelists, White did not advocate regulation as a primary tool to control risk. Rather, White preferred risk-based capital requirements and risk-based deposit insurance premiums as well as better and earlier supervisory intervention.

Regulation and re-regulation

Regulation is one approach to controlling risk, and according to the panelists, it is the approach most often used—and overused—in the banking and thrift industries. Said White, we regulate "with a vengeance." Many regulations, originally designed to protect the safety and soundness of the financial system, now are considered by some to be outmoded, anticompetitive, and too stringent.

Furthermore, Theobald pointed out that regulations do not always work as planned. He noted that the thrift industry has "just managed to lose $100 to $200 billion in a beautifully regulated business." He added that this loss is greater than the cost of all the land acquisitions throughout the history of the American republic.

LaWare said that regulations can create inefficiencies and used the interstate banking formula as an example. He asked why banks operating in a multi-state environment should be burdened with the operating restrictions of each state in which they operate. LaWare contemplated the possibility of interstate bank holding companies operating under one set of federal rules. This, he said, could stimulate managerial and operating efficiencies rather than replicate the whole regulatory structure in each state.

While all panelists agreed that regulation is not the best way to control risk, LaWare expressed serious concern that the thrift crisis, bank failures, and scandals in the investment banking industry "have created a counterbalance to what was beginning to be a very healthy tendency on the part of Congress to deregulate the financial industry. . . .What we do not need now is a re-regulation binge." Paul Horvitz, professor of banking and finance at the University of Houston, observed at the Conference that both the regulated and regulators have learned from their mistakes and that, given the proper incentive, these human errors will not be repeated. Nevertheless, Horvitz emphasized that the regulatory system does need some reforming, although not extensive restructuring.

Supervision and intervention

Rather than regulation, said LaWare, "we need intelligent supervision doing an in-depth job of monitoring what is going on in all these institutions and the authority to move quickly and peremptorily when something goes wrong." Supervisory attention should concentrate on institutions that threaten the insurance system. LaWare emphasized aggressive monitoring and authority to intervene quickly to change the course of action. Fellow Federal Reserve Board governor, Manuel Johnson, earlier had said "to prevent problem banks from becoming threats to the safety net and the financial system, it is necessary to give examiners stronger tools."

Rather than legislate against risky behavior, which would constitute credit rationing and asset allocation, LaWare recommended improvement in the supervision of banks. For example, LaWare suggested that examiners of financial institutions that are involved in highly leveraged finances need to determine that the proper credit policies are in place and that limits on the proportion of the portfolio that can be dedicated to this kind of lending have been established. As Joseph A. Manganello, Jr., an executive vice president at Bankers Trust Company, said, "Don't make the same bet in your whole portfolio."

In addition, directors should be informed and approve what is going on so that there is some feeling that there is control over the risk. This method is more effective than legislation, which is inflexible and hard to manage, concluded LaWare.

Information systems

White agreed that there is a need to strengthen the ability of regulators to intervene before an institution becomes insolvent. Insurance losses would decrease if supervisory authorities could force recapitalization before insolvency and subsequent loss to the deposit insurance corporations occurred.

Accurate information, however, is crucial to early intervention. Current information

systems make it difficult to detect risk exposure. In fact, financial reporting is based on accounting methods that do not necessarily provide an adequate assessment of present conditions or the value of assets. White, a strong advocate of market value accounting, said that relying on generally accepted accounting principles (GAAP) for banks may indicate financial soundness when market value measures would indicate otherwise. For example, book value measures of capital can be a very misleading measure of an institution's ability to absorb losses.

George Benston, professor of finance, accounting, and economics at Emory University, said that "the accounting system was not and is not designed to present economic values that regulators, economists, and investors might use. . . . It's to control the use of resources, particularly cash." Yet, a crucial piece of information for controlling risk and learning about risk is market information. According to Benston, market value accounting is generally difficult to do, "but not for banks" because of the nature of banks' assets and liabilities. "There really is no substitute for market value accounting," said White. Although initially "it won't be perfect," it would be "a whole lot better than GAAP accounting." GAAP is inadequate and will become increasingly divorced from economic reality, said White. Insurers and regulators need to have a better idea, even if approximate, of the market value of the assets and liabilities of financial institutions.

James Annable, chief economist at First National Bank of Chicago, said, however, that information between the regulator and the regulated is so unbalanced that "a cost-effective regulatory process may not be possible to design." Therefore, deregulation may be the best alternative.

Risk-based capital and insurance premiums

In the sense that capital is akin to an insurance deductible, risk-based capital requirements and deposit insurance premiums go hand-in-hand. As White pointed out, "every auto insurance company in the land will charge a lower premium . . . if you take out a larger deductible. And the same principle ought to apply to deposit insurance premiums." These two means of controlling risk were discussed by the panelists and strongly advocated by White.

"Capital is going to be the focus of managing risk in the financial industries," pointed out LaWare. Capital adequacy has played a central role in controlling the risk of individual institutions because capital protects the deposit insurance funds by reducing any incentives to take risks.

The definitions of capital and acceptable capital requirements are frequently modified and studied by the regulators, and the need to reform and substantially tighten capital requirements has been acknowledged throughout the industry. Recent risk-based capital guidelines, which incorporate off-balance-sheet items into the capital requirements, are certainly a step in the right direction.

Theobald observed, however, that the financial services industry is overcapitalized, while some individual institutions are undercapitalized. The banking industry has never earned more than 10 percent on equity capital, while the rest of American industry is earning 15 to 18 percent. "This is an unsustainable situation," said Theobald. "Now I understand that the regulators want to see more capital, but I think what they really want to see is more capital per enterprise. . . .You can't say you want more capital in the industry when it's already earning a nonmarket clearing return."

While more capital would lead to a lower premium under a typical insurance scheme, deposit insurance is not typical in that all institutions are charged a flat rate. Therefore, the current system overprotects some depositors, while it encourages other institutions to take on higher risks. White commented that he finds it "absurd that the [deposit] insurers do not and cannot charge premiums that are also risk-based."

White also said that practicing co-insurance, i.e., cutting back on coverage, is fine if bank runs are not a problem. He said, however, that he believes in 100-percent deposit coverage and employing other tools to control risk. Theobald disagreed: "What started off as a life vest is now a luxury yacht. We need to limit the deposit insurance . . . I submit that there is no logic that will get you away from the fact that if we don't limit deposit insurance we're going to forever be fighting futile central planning of the financial business."

Competitiveness

Theoretically, restrictions on financial activity prevent financial institutions from taking excessive risk. In practice, however, these restrictions increase risk when they prevent institutions from adapting to the changing needs of their customers. One type of restriction is the "firewall," which legally and operationally separates banking activities of a holding company from nonbanking activities.

"Firewalls that are too high can indeed create risks and inefficiencies, rather than minimize them," said Dennis Weatherstone, president of J.P. Morgan & Company, during the Conference. Referring to investment and commercial banking, he said "the business we do today weaves the two together so tightly that we really have to rip the fabric to separate the threads." Nevertheless, firewalls require that an investment banking subsidiary and a commercial banking affiliate maintain "separate capital, different people, and duplicate support functions." Manuel Johnson conceded that "firewalls will lead to some sacrifice of synergies," but he said that firewalls are necessary to protect the safety net.

LaWare addressed the issue of expanded powers in light of one aspect of the safety net, deposit insurance. He said that he supports the idea of a financial services holding company. If insured banks are isolated from nonbank affiliates, LaWare noted, there should be no limit to other businesses those affiliates could get into. In particular, LaWare said, as many others have, that such financial activities as insurance, real estate, and securities are appropriate for financial services holding companies. But LaWare added, "an industrial corporation cannot own a bank and a bank cannot own an industrial corporation."

This separation of commerce and banking needs to be reexamined. There may be better and cheaper access to capital markets by combining the two. The outcome of the current debate over controlling risk will significantly affect the strength of financial organizations in the years to come. Fundamental reform is needed for insuring deposits and regulating financial institutions. The ongoing appraisal of all risks facing the management of bank funds regardless of size and status is an important priority. The panelists agreed that the financial industry must adapt information, regulation, and supervisory controls to avoid unreasonable and excessive risk.

Public investment and productivity growth in the Group of Seven

A general shift in government spending priorities—from capital investment to consumption—has negatively affected productivity in the G-7 industrial countries

David A. Aschauer

Public policies to promote economic growth and international competitiveness have traditionally been focused on savings and private investment in plant and equipment. And with good reason. In the words of Martin Feldstein, "an increase in the saving rate is the key to a higher rate of economic growth and a faster rise in the nation's standard of living. . . . [T]he evidence is overwhelming that countries with high rates of saving and investment are the ones in which productivity, income and the standard of living rise most rapidly."[1]

Such a focus leads to specific policy initiatives to boost the national savings rate as well as to stimulate private capital accumulation. Among these initiatives are consumption-based tax systems, individual retirement accounts, preferential tax treatment of long-term capital gains, accelerated depreciation of physical capital assets, and investment tax credits. While economists quibble about the quantitative importance of these savings and investment incentives, they are in near unanimous agreement on their qualitative significance for economic growth.

However, there is another potential "supply-side" avenue by which public policy may be able to exert significant influence on the process of sustained economic expansion. What the above policies have in common is that they work through the tax system to affect either the supply of loan funds—savings—or the demand for those funds—private investment in capital goods. Instead, we might look to the opposite side of the government's budget, at the composition of public expenditure and the possible effects various budget policies may have on private sector productivity and economic growth.

In this paper, I distinguish between the public *consumption* and public *investment* and argue that this distinction is as important for economic growth calculations as the analogous calculation on the private side of the economy. Public nonmilitary investment—which I take as a proxy for a public infrastructure of roads, highways, mass transit, airports, port facilities, and the like—is argued to have positive direct and indirect effects on private sector output and productivity growth.

The direct effect on private sector output growth arises from the availability of public capital to support private sector production; roads, highways, and airports allow the distribution of goods and services throughout national and international markets. The indirect effect evolves from the complementarity between private and public capital in private-sector productive activity; an increase in the stock of public capital raises the return to private capital which, in turn, serves to spur the rate of expansion of the private-sector capital stock.[2] Supporting these arguments, I offer empirical evidence of a positive effect of public investment on private investment and private output growth.

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Trends in public expenditure

In all the Group of Seven (G-7) industrialized countries, the growth in gross domestic product (GDP) per employed person—labor productivity growth—has fallen over the last twenty years. Productivity growth for these countries taken together averaged 4.0 percent per year during 1960–68, 3.2 percent during 1968–73, 1.4 percent during 1973–79, and 1.5 percent during 1979–86. In each of the G-7 countries, productivity growth during the 1970s and 1980s was some 50 percent less than that attained during the 1960s. At the same time, there was wide dispersion in average productivity growth across these countries. For instance, between 1960 and 1986, Japan achieved a productivity growth rate of 5.5 percent per year, West Germany one of 3.2 percent per year, and the United States one of only 1.2 percent per year.

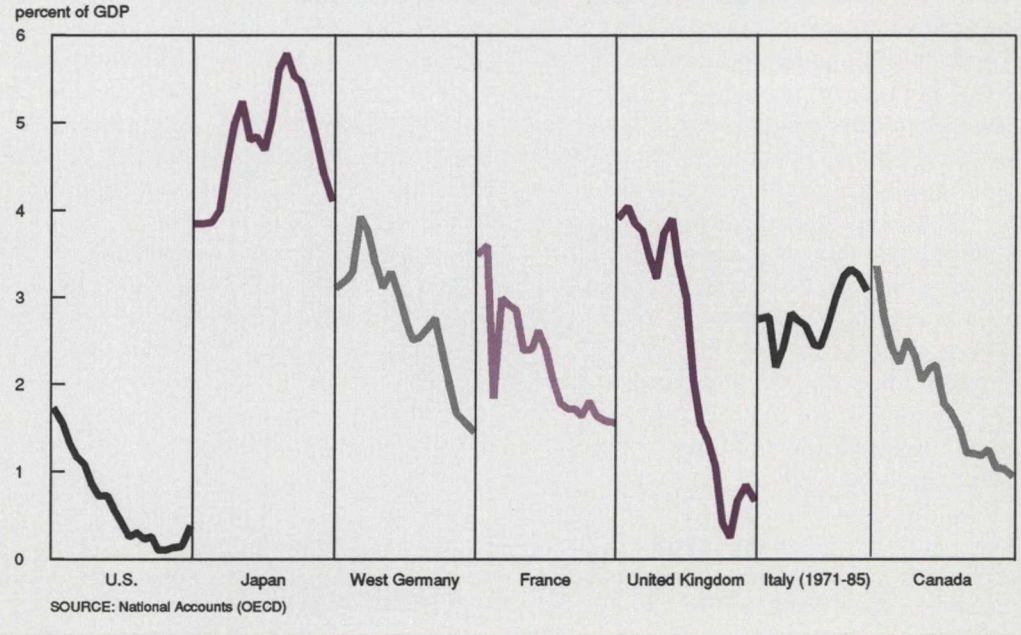
Figure 1 depicts trends in public net (of depreciation) investment during the years 1967 to 1985 for the major industrialized economies.[3] Three broad features stand out. First, in five of the seven countries, the ratio of public investment spending to gross domestic product trended downward; in the United States (from 1.7 percent of GDP in 1967 to 0.3 percent by 1985), in West Germany (from 3.1 percent to 1.5 percent), in France (from 3.5 percent to 1.6 percent), in the United Kingdom (from 3.9 percent to 0.7 percent), and in Canada (from 3.1 percent to 1.0 percent). In Japan, public investment as a share of GDP rose from 3.8 percent in 1967 to 4.1 percent in 1985, peaking at 5.8 percent in 1979. In Italy, public investment climbed from 2.8 percent in 1971 to 3.3 percent in 1983 and then declined slightly to 3.1 percent in 1985.

Second, there exists fairly wide differences in some of the public investment ratios across countries. While public investment absorbed some 5.1 percent of gross output in Japan over this time period, the United States devoted a much smaller output share to upgrading its public capital stock, less than 1.0 percent. In between are to be found the European countries of France, Italy, the United Kingdom, and West Germany along with Canada. Finally, there seems to be no pursuit of countercyclical public works policies; for example, in the United States the public investment ratio was 0.7 percent in 1973 and 1974, 0.6 percent in 1975 and 0.4 percent in 1976 while it was 0.3 percent in 1980, falling to 0.1 percent in 1981 and 1982.

On the other hand, no downward shift in government consumption spending—inclusive

FIGURE 1

Public investment as a share of gross domestic investment: 1967–1985



SOURCE: National Accounts (OECD)

of military spending—is apparent in the data for these countries. As can be seen in Figure 2, the ratios of public consumption to gross domestic product rose in all countries, with the exception of the United States, and in most cases by 2 or 3 percentage points. In the United States, no clear trend is readily discernible, although public consumption was close to one percentage point lower in 1985 than it had been in 1967.

These statistics paint an interesting picture of government spending priorities in the G-7 countries over the roughly twenty-year period from 1967 to 1985. Generally speaking, while public investment slid downward, public consumption climbed. What, if any, effect might this alteration in government budget shares have had on output and productivity growth across these countries? I argue that public capital—particularly infrastructure capital investments such as roads, highways, dams, water and sewer systems, mass transit, airport facilities, and the like—is a vital input to the private production process. If this is the case, then the general shift in budget priorities away from capital accumulation toward consumption may offer a partial explanation for the productivity decline experienced by the G-7 industrial economies.

Methodology

I assume a neoclassical production technology whereby private sector output is obtained by application of labor services to private and public capital stocks. As shown in the box, this framework leads to the following regression equation

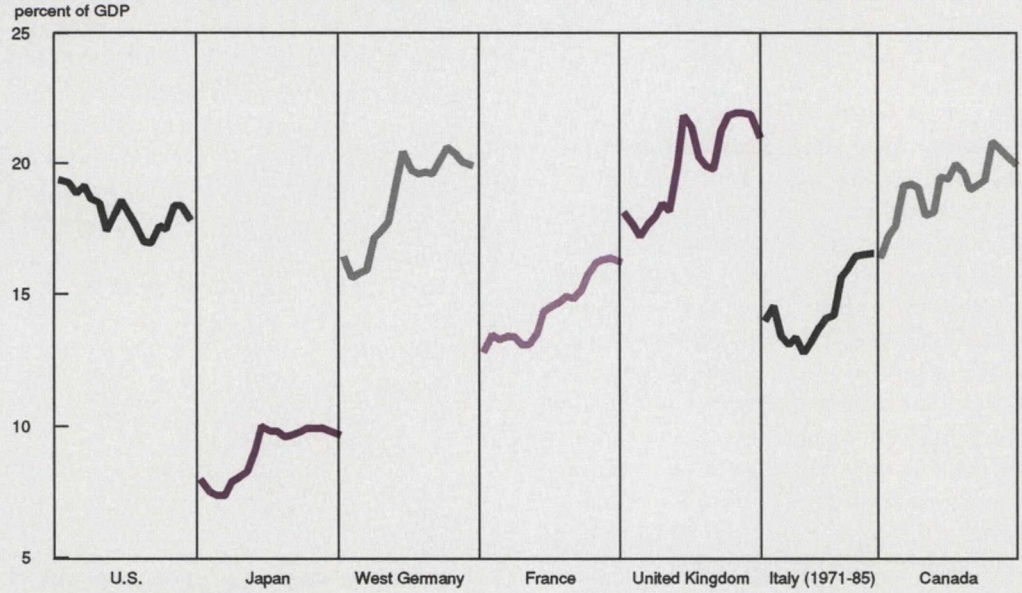
$$Dp_t = b_0 + b_1 * Dn_t + b_2 * ir_{t-1} + b_3 * gir_{t-1} + b_4 * Dcu_t$$

where:

Dp_t = labor productivity growth; Dn_t = employment growth; ir_{t-1} = ratio of private net investment to gross domestic product (lagged one year); gir_{t-1} = ratio of public nonmilitary net investment (also lagged); and Dcu_t = rate of change in capacity utilization. According to standard restrictions on the production function, we expect b_1 to be estimated negatively. Simply stated, the application of more laborers to given quantities of private and public capital stocks lowers the productivity of labor. On the other hand, given the number of workers, raising the amounts of private or public capital should, on average, make each worker more productive, so we also expect b_2 and b_3 to be estimated positively. As labor productivity growth is highly procyclical—rising in booms and falling in recessions—it is likely we will

FIGURE 2

Public consumption as a share of gross domestic product: 1967–1985



SOURCE: National Accounts (OECD)

Estimating productivity growth

In algebraic form, we have the production technology

$y_t = f(n_t, k_{t-1}, kg_{t-1}, cu_t)$
where:

y_t = private sector output during year *t;* n_t = employment during the same year; k_{t-1} = the private capital stock at the beginning of year *t*; kg_{t-1} = the public nonmilitary capital stock also as of the start of year *t*; and cu_t = the rate of utilization of capacity in production. This last variable is entered to capture shocks to the production technology as well as to convert capital *stocks* into *flows* of capital services.

Unfortunately separate estimates of private and public capital stocks are currently unavailable for the Group of Seven industrial nations; however, we can finesse this data deficiency by shifting the emphasis from the level of production to the growth in production. First, by assuming a logarithmic form for the production technology we may derive the expression

$Dy_t = a_0 + a_1*Dn_t + a_2*Dk_{t-1} + a_3*Dkg_{t-1} + a_4*Dcu_t$
where:

Dx_t denotes the percentage growth rate of variable *x* during period *t*. In this form, we can employ a proxy for growth in capital stocks, i.e., the ratio of investment, private and public, to gross output. The relationship between the two variables is given by

$ir = (k/y)*Dk$

where ir = ratio of (private) investment to gross output. As long as the capital-to-output ratio, *k/y*, is fairly stable the ratio of investment spending to output, *ir*, will be a good proxy for growth in the capital stock. The obvious extension of the public side is left undiscussed.

We finally write the equation to be estimated empirically as

$Dp_t = b_0 + b_1*Dn_t + b_2*ir_{t-1} + b_3*gir_{t-1} + b_4*Dcu_t$
where:

$Dp_t = Dy_t - Dn_t$ = labor productivity growth and so $b_1 = (a_1 - 1)$. Under the standard assumptions of a positive but diminishing marginal product of labor, we expect to find b_1 to be negative. We also assume a complementarity between labor and the services of private and public capital stocks. Thus, by raising the stocks of either private or public capital—given labor input—the productivity of labor should be boosted, so we expect b_2 and b_3 to be positive. Further, it is likely that the capacity utilization rate—proxying for technological shocks as well as converting capital stocks into flows of capital services—will enter the final expression positively.

find b_4 is positive. We now confront the data with the above equation to see if they perform according to our theoretical expectations.

Empirical results

I estimated the equation on data gathered for the Group of Seven countries over the period 1966 to 1985. Detail on these data are given in the Appendix. In general, the data provide strong support for the idea that public investment is a critical determinant of labor productivity growth. An increase in the level of public nonmilitary investment by one percent of gross output yields a gain in productive growth of about 0.4 percent per year. The strong positive relationship between public investment and productivity growth is robust to changes in the set of countries included in the data sample and after consideration of the effects of oil shocks in the 1970s.

Table 1 contains the basic set of estimated relationships between the level of public investment and productivity growth. The public investment variable is exclusive of military capital expenditures; is expressed relative to the level of gross domestic product; and is lagged one period. I believe this variable to be a good proxy for the percentage growth in the nonmilitary public capital stock during the previous period. The productivity growth variable measures labor productivity growth as the percentage growth rate of gross domestic output per employed person in each of the Group of Seven industrialized economies.

Column 1 of Table 1 illustrates the strength of the independent effect of public investment on the growth rate of labor productivity. A one-percentage-point increase in the share of GDP devoted to public capital accumulation is associated with a 0.73-percentage-

TABLE 1

Public investment and productivity growth in the Group of Seven
(dependent variable—Dp)

	1	2	3	4	5	6
c	0.68	– 0.21	0.02	–0.33	– 0.21	3.02
	(0.41)	(0.41)	(0.66)	(– 0.46)	(0.39)	(1.63)
gir	0.73	0.44	0.59	0.51	0.41	0.34
	(0.14)	(0.13)	(0.18)	(0.21)	(0.13)	(0.14)
ir		0.22	0.13	0.20	0.24	0.12
		(0.06)	(0.07)	(0.08)	(0.05)	(0.07)
Dn		– 0.35	– 0.29	– 0.64	– 0.32	– 0.35
		(0.08)	(0.09)	(0.17)	(0.08)	(0.08)
Dcu		1.61	1.28	1.67	1.58	1.51
		(0.15)	(0.16)	(0.21)	(0.14)	(0.15)
d74					–1.83	
					(0.60)	
d79					–1.26	
					(0.60)	
gcr						– 0.13
						(0.06)
$\bar{R}^2$	0.17	0.58	0.46	0.48	0.61	0.59
SER	2.21	1.57	1.46	1.47	1.51	1.55
NOB	129	129	91	72	129	129

Column 1 displays the basic relationship between public investment and productivity growth.
Column 2 is the basic equation in the text.
Column 3 excludes Japan and the United States from the sample.
Column 4 excludes Japan, the United States, and Canada from the sample.
Column 5 allows dummy variables to capture the effects of oil shocks.
Column 6 allows a separate effect of government consumption spending.

NOTE: Figures in parentheses represent the standard error.

point rise in the labor productivity growth rate. The standard error of 0.14 yields a ninety-five percent confidence interval which lies well above zero, namely (0.45, 1.01). The public investment variable alone is capable of explaining 17 percent of the variation in productivity growth across time and countries.

Column 2 expands the list of variables allowed to influence productivity growth to include private investment, growth in total employment, and capacity utilization. As with the public investment variable, private investment is expressed relative to GDP and is lagged one year to proxy for previous growth in the private capital stock. The capacity utilization variable is entered in the attempt to convert growth in the stocks of public and private capital (captured by *gir* and *ir*, respectively) into service flows from these stocks. While the estimated coefficient on public investment is markedly reduced—from 0.73 to 0.44—it still is statistically significant at better than a ninety-nine percent level. The private investment variable enters positively, suggesting that a one-percentage-point increase in the ratio of private capital accumulation to gross domestic product will raise productivity growth by an amount equal to nearly one-quarter of a percentage point. Consistent with the expectation of a diminishing marginal productivity of labor, a one-percentage-point increase in the rate of growth of total employment lowers the rate of growth of labor productivity by somewhat more than one-third of a percentage point. Within the organizing context of a Cobb-Douglas production technol-

ogy, the coefficient on total employment should equal unity minus labor's share in gross domestic product; the estimated coefficient therefore suggests that labor's output share was some 65 percent—a reasonable estimate.[4] Finally, as expected, the capacity utilization variable bears a positive relationship with productivity growth.

Columns 3 and 4 of Table 1 exhibit the robustness of the estimated relationship by limiting the samples to exclude the United States and Japan (Column 3) and to include only the four major European economies (Column 4). Excluding the United States and Japan—the countries with the lowest and highest public investment ratios during this period—does not erode the relationship between public investment and productivity; indeed, the estimated coefficient on public investment is increased from 0.44 in the full sample to 0.59 in the limited sample. There is a sizable reduction in the coefficient associated with private investment, however, and the adjusted coefficient of determination is reduced from 58 percent to 46 percent. Focusing on the European countries of France, Italy, the United Kingdom, and West Germany, the relationship between public investment and productivity growth remains significantly positive, although the estimated standard error of the coefficient rises by a non-trivial amount.

The period of analysis, 1966 to 1985, includes years in which there were significant "supply-side" disruptions to production in the highly industrialized economies. Most obvious are the oil price shocks of late 1973 and 1979. Column 5 allows for the separate effects of these oil price shocks by including dummy variables for 1974 (the first year in which the effect of the first major oil price shock would be apparent) and 1979. As expected, the dummy variables are significantly negative, indicating that productivity growth fell by more in those years than can be explained by the private capital and public investment variables and employment growth. The estimated coefficients on these latter variables, however, are not altered in an important way from those in Column 2 and the adjusted coefficient of determination rises only a small amount, from 58 percent to 61 percent.

Column 6 illustrates that the ratio of government consumption—measured residually by subtracting public investment from total government spending on goods and services—bears a marginally significant *negative* relationship with productivity growth. A one-percentage-point increase in the share of gross domestic product devoted to government consumption is estimated to reduce labor productivity growth by somewhat more than one-tenth of a percentage point. Note that this result, in conjunction with the positive association between productivity growth and public investment, indicates that countries should be able to achieve substantial productivity gains by holding fixed their tax revenues and altering the composition of government spending away from public consumption and toward public nonmilitary capital accumulation.

Thus, the results of Table 1 are fully compatible with the idea that public investment is a necessary input to the private production process. Without sufficient investment in a public infrastructure of roads, local transportation, airports, and port facilities, the task of private-sector production becomes much more exacting in terms of sacrifice of either current consumption or leisure activities.

Of course, this is not the only possible explanation for the positive association of public investment and labor productivity. One could argue, for example, that the statistical correlation is the reverse—that public investment slumps in periods of low productivity and (presumed) reductions in tax revenues and is stepped up in times of prosperity and more generous growth in revenues. In economists' language, public investment would be considered a "normal" good. This argument, however, has a number of hurdles that it must clear.

First, the public (and private) investment variable is lagged one year. Statistically, it is therefore a predetermined variable; this reduces the force of the reverse causation argument to some degree. Second, as Column 6 indicates, while there is a positive association between public investment and productivity, there is a negative association between public consumption and productivity. The counterargument thus must explain why public consumption, unlike public investment, appears to be an inferior good. Third, the estimated coefficients in Column 2 are all of the right sign and of a reasonable economic magnitude from

a technological standpoint; it seems unlikely that this is a mere happenstance.

Finally, the results in Table 2 provide more concrete evidence against the reverse causation hypothesis. In these equations, the public investment variable has been purged of its direct relationship with the level of economic activity by prior regression on the rate of growth of gross domestic product. The residuals from this estimated equation are then used in place of the "raw" public investment variable in the regressions reported in Table 2. Column 1 shows the simple relationship between productivity growth and public investment, purged of its income growth component, to be statistically strong and positive. Column 2 allows for the additional effects of private investment, employment, and capacity utilization. As in Table 1, the relationship between public investment and labor productivity growth is attenuated but still of quantitative and statistical importance. Column 3 allows for dummy variables for 1974 and 1979 with only a minor change from the results of Column 2. In Column 4, private investment is also purged of its direct association with output growth, with the result a significantly lower estimated relationship between private investment and growth in output per employed person. Finally, Column 5 adds in the ratio of public consumption to GDP. As with the results in Table 1, the estimated relationship between productivity growth and the share of government consumption in gross output is negative, but now at a considerably diminished level of statistical significance.

TABLE 2

Cyclically adjusted investment and productivity growth in the Group of Seven
(dependent variable—Dp)

	1	2	3	4	5
c	2.34	0.62	0.54	2.51	2.88
	(0.20)	(0.44)	(0.43)	(0.17)	(1.62)
gir	0.72	0.42	0.38	0.53	0.37
	(0.13)	(0.11)	(0.11)	(0.12)	(0.11)
ir		0.23	0.25	0.14	0.15
		(0.05)	(0.05)	(0.06)	(0.01)
Dn		−0.29	−0.27	−0.21	−0.30
		(0.08)	(0.08)	(0.09)	(0.08)
Dcu		1.54	1.51	1.46	1.48
		(0.15)	(0.15)	(0.16)	(0.15)
d74			−1.65		
			(0.60)		
d79			−1.11		
			(0.59)		
gcr					−0.09
					(0.07)
$\bar{R}^2$	0.21	0.59	0.61	0.53	0.59
SER	2.14	1.55	1.49	1.64	1.54
NOB	121	121	121	121	121

Column 1 displays the basic relationship between cyclically adjusted public investment and productivity growth.

Column 2 is the basic equation in the text with cyclically adusted public investment.

Column 3 allows dummy variables to capture the effects of oil shocks.

Column 4 is the basic equation with cyclically adjusted private and public investment.

Column 5 allows a separate effect of government consumption spending.

NOTE: Figures in parentheses represent the standard error.

Table 3 contains reduced form estimates of the relationship between private investment, public investment, and public consumption over the same sample. Column 1 shows a rise in public investment of 1 percent of gross domestic product is associated with an increase in total investment (public plus private) of 2.5 percentage points, or an increase in private investment of 1.5 percent of output. Column 2 calculates that a rise in government consumption of one percent of gross output depresses national investment by 0.59 of a percentage point. The effect of public investment on national investment is reduced substantially, from 2.5 to 1.4 percentage points. This last result is due, no doubt, to the strong negative relationship between public investment and consumption and associated omitted variable bias in Column 1. Columns 3 and 4 repeat the previous regressions but with public and total invest-

TABLE 3

Public and private investment
(dependent variable—ir)

	1	2	3	4
c	5.04	17.46	– 0.06	6.20
	(0.46)	(1.34)	(0.21)	(0.98)
gir	2.50	1.40	2.27	1.66
	(0.16)	(0.17)	(0.15)	(0.16)
gcr		–0.59		–0.38
		(0.06)		(0.06)
$\bar{R}^2$	0.65	0.79	0.65	0.74
SER	2.58	1.98	2.28	1.97
NOB	129	129	129	129

Column 1 shows the basic relationship between public and private investment.
Column 2 displays a separate effect of goverment consumption.
Columns 3 and 4 duplicate Columns 1 and 2, but with cyclically adjusted investment.

NOTE: Figures in parentheses represent the standard error.

ment ratios which are purged of their correlation with the growth rate of gross domestic product. As can be seen, the positive association of national investment with public investment and the negative relationship with public consumption is maintained.

Conclusion

There exists a strong, positive correlation between various productivity measures and public nonmilitary capital expenditure. Aschauer (1988) has established this correlation for annual United States data over the period 1949–1985 and Barro (1989) has attained similar cross-sectional results for a sample of 72 countries.[5] Further, Garcia-Mila and McGuire (1987) have found a statistically significant positive association between gross state product and public capital—highways and educational structures—for the 48 contiguous states.

The contribution of this paper is to expand this list of results and to offer evidence against the "reverse causation" hypothesis that low productivity growth tows in its wake low public capital expenditures. Table 2 contains results which establish a positive correlation between labor productivity growth and public investment even after the latter variable has been purged of its economic growth component by previous regression on the growth rate of gross domestic product. On this basis, I submit that public capital is a vital ingredient in the recipe for economic growth and rising standards of living.

FOOTNOTES

[1]See Martin Feldstein, "A National Savings President," *Wall Street Journal*, November 21, 1988, p. A14.

[2]See David A. Aschauer, "Government Spending and the 'Falling Rate of Profit'," Federal Reserve Bank of Chicago, *Economic Perspectives*, May/June 1988 for elaboration and supporting evidence for the United States.

[3]For Italy, data on public consumption and public investment is available only after 1970.

[4]In the United States, the ratio of employee compensation to gross domestic output equalled 58 percent in 1966 and 60 percent in 1985.

[5]However, Barro suggested that this relationship is due to the reverse causation discussed above. He also estimates a public-capital-stock-to-output ratio and, upon regressing the growth in output (per person) on this estimated variable, finds that while the relationship is still positive, it is not statistically significant at conventional levels. By his own admission, however, his public capital stock measures are subject to large errors in measurement. Indeed, for the United States (for which there are direct estimates of public capital) his measure deviates by 50 percent from its actual value.

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DATA APPENDIX

Dp = growth in real gross domestic product per person employed (OECD Historical Statistics).

Dn = growth in total employment (OECD Historical Statistics).

gir = public gross fixed capital accumulation minus consumption of fixed capital expressed relative to gross domestic product (OECD National Accounts). This variable is lagged one year.

ir = private gross fixed capital accumulation minus consumption of fixed capital expressed relative to gross domestic product (OECD National Accounts). This variable is lagged one year.

gcr = government final consumption expenditure relative to gross domestic product (OECD National Accounts).

Dcu = rate of change of capacity utilization. Raw data are as follows: for the United States, Canada, France, West Germany, and Italy, rate of capacity utilization; for Japan, judgment on capacity utilization; for the United Kingdom, percent of firms operating at full capacity (OECD Main Economic Indicators). The raw data have been normalized to account for differences in mean values and volatility across countries.

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