Progress in Service Sector Productivity Measurement: Review Article on *Productivity in the U.S. Services Sector: New Sources of Economic Growth*

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MEASUREMENT OF PRODUCTIVITY in the service sector has always represented a challenge for economists. Jack Triplett and Barry Bosworth, both from the Brookings Institution, have taken up this challenge and produced an important book *Productivity in the U.S. Services Sector: New Sources of Economic Growth*[2] that should be read and digested by every economist interested in measuring productivity in general and in service industries in particular.

The book is the product of fifteen workshops on the measurement of output and productivity in difficult-to-measure sectors of the economy organized by the authors and held at the Brookings Institution between 1998 and 2003. The book is organized into chapters on industry productivity trends; productivity trends in transportation, communications, finance and insurance, retail trade, and other service industries; high-tech capital equipment; and data needs. Many chapters also contain commentary by leading economists. An appendix provides productivity estimates for 54 U.S. industries divided into 25 goods producing industries and 29 services producing industries within the U.S. private nonfarm business sector for the years 1987-2001. My plan for this review is to give a few representative results from the chapters and the commentary and at times, to insert a few comments of my own on the material presented.

The authors summarize the main empirical results in the book (page 3) as follows:

> "We find that the bulk of the post-1995 acceleration of productivity growth was within the services producing industries. In the period after 1995, labor productivity in the goods producing industries improved, but not nearly so much as it did in the services producing industries. Multifactor productivity, moreover, accelerated strongly in services producing industries (we measured it at 0.3 per cent a year before 1995 and at 1.5 per cent a year for the 1995-2001 period) but hardly at all in the goods producing sector."

But the focus of the book is largely on measurement issues. In the late 1980s and early 1990s, Baily and Gordon (1988) and Griliches

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(1992, 1994) brought to the attention of the profession the fact that real output in most service sector industries was not very well measured.[3] This was (and still is for most countries) due to the fact that the system of industrial statistics was set up in most countries in the 1930s and 1940s when primary and manufacturing industries played a predominant role in virtually all economies. The statistical system has been slow to respond to the changing nature of production as economies matured and the role of services became much more important. Another important factor hindering measurement in services industries is the fact that many service sector outputs are extremely difficult to measure. Triplett and Bosworth address many of these measurement issues in their book.

Triplett and Bosworth conclude this introductory chapter (page 5) with an important footnote that helps to explain why productivity growth fell so dramatically in U.S. service sector industries in the 1970s and 1980s:

> "Marimont (1969) indicates that there were 'old, old' days when nearly the only information on services concerned employment; at that time BEA estimated services industry output in part by labor extrapolation with a labor productivity adjustment based on manufacturing productivity. When direct information on services output became available for some industries, the methodology changed to combining the direct measures with labor extrapolation in the other industries, but without any productivity adjustment. It is significant that implied productivity in services from the 'old, old' BEA data, before the 1970's, exceeded the implied productivity for the following period."

In other words, the observed U.S. services sector productivity slowdown during the 1960s and 1970s was not based on any hard evidence!

Overview: Industry Productivity Trends

The main conclusion that emerges from this chapter is that the U.S. post-1995 MFP (multifactor productivity)[4] growth resurgence was evident in many non-IT (Information Technology) industries and that it was particularly evident in a number of service sector industries. Triplett and Bosworth do not deny that the strong aggregate MFP growth was also due to the contributions of the IT producing industries, but they make the following observation (page 9) on the relative contributions of the IT and service sector industries:

> "However, as we show later, there is no inconsistency in finding strong MFP contributions from both IT production and from service industries, because the total contributions of industries that have growing productivity are greater than the *net productivity growth* in the aggregate or sector (because of the offsets from industries that make negative contributions and because of reallocations across industries)."

The above quotation highlights the importance of having a solid theory for exactly how industry MFP contributions feed into the aggregate MFP growth.

The authors construct measures of labor and multifactor productivity for each of the 54 industries in their data base for the years 1987-2001. They construct industry MFP estimates using both gross output and value added as the output concept but they emphasize the gross output results as being preferable. As reliable data on industry hours could not be found, the authors use industry employment as their measure of labor input.

3 See Diewert, Nakamura and Sharpe (1999) which summarizes a special issue of the *Canadian Journal of Economics* on service sector productivity measurement issues.

4 Since I am essentially a student of Dale Jorgenson and a former colleague of Zvi Griliches, I will sometimes refer to MFP growth as TFP (Total Factor Productivity) growth following the terminology used by Jorgenson and Griliches (1967, 1972).

Their method for constructing industry MFP growth follows in the Solow (1957) tradition as amended by Jorgenson and Griliches (1967, 1972).[5]

One difficult methodological issue raised by Triplett and Bosworth is exactly how productivity changes within various industries should be aggregated into a measure of aggregate productivity change (page 20-21):

> "First, aggregate productivity is not just the aggregation of productivity changes within the individual industries. Aggregate productivity can also change because of reallocations across industries. As we (and others, including Stiroh (2002) and Jorgenson, Ho and Stiroh (2005)) show, aggregated industry productivity estimates generally exceed direct aggregate level productivity change because of reallocation of resources across industries. These reallocation effects are an important and interesting part of the productivity resurgence story that has been overlooked in some macro productivity studies."

A second difficult issue that Triplett and Bosworth address is the aggregation of industry gross output productivities into economy wide value added productivity (page 21):

> "A second issue concerns combining gross output productivity at the industry level with value added productivity at the aggregate level. Gross output is preferred for production analysis at the industry level because it requires the fewest restrictions on the relationship between intermediate inputs and output. The construction of a production relationship based on value added requires that the components of value added be separable from those purchased inputs. The value added construct at the industry level also implies a specific way that productivity or technical change affects economies in the use of capital and labor on one hand and of savings in intermediate inputs on the other.

Triplett and Bosworth add the following illuminating footnote (page 21) that further illustrates the separability point that they made in the above quotation:

> "Gross output at the industry level can be represented as $Q = f[K,L,M,t]$ where Q is output and K, L and M are capital, labor and purchased inputs, respectively. Excluding purchased inputs and focusing on value added is equivalent to assuming $q = f[g(K,L,t_1),M,t_2]$, where g is separable from M and t_1 and t_2 represent (different) shift factors."

To aggregate industry (gross) labor productivities into economy wide value added per worker, Triplett and Bosworth use a formula developed by Stiroh (2002) and to aggregate industry (gross) MFPs into aggregate MFP, they use a generalization of a formula developed by Jorgenson, Gollop and Fraumeni (1987).

At this point, this previously unbiased reviewer takes off his reporter's hat and moves into the role of a discussant, who may well have serious biases! I would like to make four points about the above material.

First, I do not think that the aggregation formulae used by Triplett and Bosworth are completely definitive. I believe that there is a much better approach that is rooted in economic theory and is based on the work of Diewert and Morrison (1986) and Kohli (1990). However, since this review is already rather long, these results on aggregation theory will have to be deferred to another occasion.

Second, productivity growth tends to rise as one moves from a gross output formulation of MFP to a value added formulation. I agree with Triplett and Bosworth that it is quite possible that

5 The logarithm of the change in MFP is defined as the log of industry output growth minus a share weighted average of the logs of intermediate materials growth plus labor growth plus capital services growth, where the weights are the average of the present period and the previous period share of the input in cost. This formula for MFP growth can be manipulated to give an expression for the growth in labor productivity for the industry over the previous period.

some of the increase in aggregate productivity that they found as they went from gross industry productivities to the familiar C + G + I + X –M value added framework at the national level (here imports play the role of a purchased intermediate input) could be due to reallocation effects.

But I suspect a far more important source of the increase is due to a well known phenomenon: as we shift from a gross output productivity measurement framework to a value added framework, the measured productivity of the production unit will fall. The reason for this is simple to explain. Basically, MFP growth is approximately (or exactly) equal to a quantity index of outputs (in the gross output framework) or a quantity index of net outputs (in the value added framework, where intermediate inputs enter the index number formula with negative quantity weights), divided by a quantity index of inputs (K, L and M inputs in the case of the gross concept and just K and L in the value added framework). The absolute amounts of the gains in outputs or the savings in inputs going from the base period to the current period do not change in either formulation.

However, in the gross framework, the MFP growth is interpreted as the percentage increase in extra net output that the productivity improvements have made possible as a per cent of gross inputs used by the production unit in the base period. On the other hand, in the value added framework, the MFP growth is interpreted as the percentage increase in extra net output that the productivity improvements have made possible as a per cent of labor and capital inputs used by the production unit in the base period. Thus in the second case, the input base is smaller than in the gross case and so the same amount of absolute productivity gains are expressed as a larger percentage increase.[6]

Third, Triplett and Bosworth argue that in order to implement the value added approach, it is necessary to make restrictive separability assumptions on the underlying technology. I do not believe that this is the case. Diewert and Morrison (1986) worked out two separate approaches to measuring technical change or MFP growth in the value added context that make no separability assumptions whatsoever.[7]

Thus I see no good reason to argue that gross MFP measures are superior to net or value added MFP measures. This means that we can choose between these two alternatives on the basis of other considerations.[8] I confess to a preference for the value added measure. When someone tells me that the gross MFP productivity of industry X has increased by 1 per cent, I do not know how this contributes to economy wide MFP growth unless I am also told what its intermediate input share. I have a much better feel for what the contribution to economy wide MFP growth is of a 1 per cent increase in the industry's value added MFP.

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6 This point is fully explained in chapter 3 of Schreyer (2001) but Michael Denny made the above argument to me many years ago.

7 The first approach of Diewert and Morrison relies on the assumption that the underlying technology can be represented by a translog GDP or value added function where the form of technical change that is allowed is very general. This functional form was first suggested by Diewert (1974: 139) as a generalization of the translog functional form introduced by Christensen, Jorgenson and Lau (1971). Diewert (1974: 139) indicated that this functional form was flexible. Their second approach relies on taking an average of two empirically implemental first order approximations to various theoretical economic indexes and thus is very general in that it is completely nonparametric. Furthermore, Diewert and Morrison showed that the two approaches approximated each other to the second order in a certain well defined framework. Kohli (1990) independently worked out the first translog approach and has applied it in a number of contributions (Kohli (1991, 2003, 2004) and Fox and Kohli, 1998). This translog approach is evidently not well known to most productivity researchers.

8 Schreyer (2001: chapter 3) gives a good discussion on the pros and cons of choosing between the two frameworks.

Finally, are we sure that MFP or labor productivity is the "right" concept to use from the viewpoint of explaining trends in living standards in a country? I would argue that *real income* is a better target concept to focus on, where real income is defined as net national product deflated by the consumer price index.[9]

Output and Productivity Growth in the Communications Industry

Just as deregulation of the transportation industry in the U.S. probably led to productivity improvements in this industry, the 1984 court decision that opened up the U.S. long distance telephone market to competition likely led to productivity improvements in the telecommunications industry. Triplett and Bosworth find that after 1995 the Bureau of Economic Analysis (BEA) measure of gross output for telecommunications and broadcasting grew significantly faster than the comparable Bureau of Labor Statistics (BLS) estimate. This result is repeated throughout the book: different sources for more or less the same concept frequently give different results. What is particularly interesting in this chapter however, is that the authors give some interesting explanations as to why the results from different sources might differ (pages 75-76):

> "BEA calculates intermediate materials as the residual difference between the estimates of gross output and value added, in contrast with the input-output accounts, which provide direct estimates of both gross outputs and purchased inputs, with value added being the residual. The estimates of gross output are increasingly drawn from census surveys of individual industries, with benchmark adjustments in order to align with the input-output (I-O) accounts at five year intervals. The data sources for the construction of the value added measures are similar to those used on the income side of the national accounts. Particularly for capital type income, the data are reported to the IRS on a company basis. Therefore the assignment of incomes to specific industries requires conversion to an establishment basis. There are no good ways to make the conversion, and BEA apportions the income by using a cross classification of employment by enterprise and establishment and assuming that capital income per employee for an establishment based industry does not vary by industry of ownership."

In view of the above difficulties with the BEA data, the authors make an attempt at constructing their own estimates using Census Bureau data.

One problem with the above method is that it is likely that the depreciation estimates are based on historical cost accounting and hence may be less than economic depreciation. If this is the case, then the Triplett-Bosworth estimates for purchased inputs may be too large. In any case, the authors (page 76) then compare their Census Bureau (CB) based estimates with the corresponding BEA estimates:

> "Further efforts to compare the CB and BEA data indicate similar estimates of labor costs but very different patterns of change in the estimates of capital income (defined in the Census Bureau data as revenues less operating income plus depreciation). This result is very much in accord with the argument of Yuskavage (2000), which states that it is increasingly difficult to apportion the income of large corporate firms to the specific industries in which they operate."

In addition to the above problems associated with measuring value flows in telecommunications industries, there are problems associated with measuring the output prices in this sector (page 85):

> "With respect to the measurement of prices, the new PPI measures for telecom services provide reliable measures of price change since 1995, but there is some evidence that the price

9 For a justification for this choice of target welfare index, see Diewert (2005b).

indexes missed a significant portion of the decline in long distance charge prior to 1995. Furthermore, the adequacy of the measures of telecommunications equipment is an area of considerable uncertainty."

In view of the above measurement difficulties, the authors conclude the chapter with a warning that the estimates of MFP growth in communications are very tentative.

Productivity Measurement in the Finance and Insurance Sector

Measurement problems in finance and insurance are particularly severe. Triplett and Bosworth (page 95) note that:

"In some services industries, the concept of real output is unclear. When it is difficult to measure the output of an industry, it is also difficult to measure its price change and productivity. The finance and insurance sector is filled with those difficult to measure industries."

One measurement issue is the allocation of income to the self-employed. Triplett and Bosworth point out that BEA treats all self-employment income as property income even though some of it must be labour income. In contrast, the BLS productivity group resolves the problem with a parallel calculation of a normal rate of return on capital for unincorporated enterprises within the sector. They estimate the implied returns to both labor and capital within the industry—which yields an aggregate that exceeds self-employed income. Triplett and Bosworth use the BLS estimates of capital and labor shares for their productivity estimates and applied them to BEA value added estimates.

A second measurement issue is excessive fluctuations in the share of capital in some finance industries due to stock market booms. Triplett and Bosworth (page 120-1) note that:

"…when property income fluctuates in a way that is not related to the contribution of capital equipment and structures to output, as it does with the brokerage industry, these fluctuations in the capital share affect our estimates of the contribution of capital, including IT capital, to labor productivity growth. The true contribution of IT in an industry ... undoubtedly does not fluctuate as much in the short run. ... When fluctuating capital shares misstate the contributions of IT (or of any other factor), that misstatement produces a corresponding misstatement of industry MFP growth."

A third measurement problem is the treatment of indirect taxes:

"The BEA industry database includes indirect business taxes (IBT) in output. For our work, we removed all IBT, so output is measured in what is sometimes referred to in the national accounts literature as 'at factor cost'. In its productivity estimates, BLS removes sales and excise taxes on property (including motor vehicle taxes) in the total—it adds them to the cost of inputs. Either treatment is problematic, to an extent, but for most industries the difference between the two treatments is small."

Although the treatment of commodity taxes may be a minor matter empirically, particularly in the United States where such taxes are small, the theoretical treatment of commodity taxes in a productivity framework is not so straightforward. I favor the BLS treatment of indirect taxes, which is based on the production theory framework developed by Jorgenson and Griliches (1967, 1972). From the sectoral point of view, we should use the prices that producers actually face. This means that commodity taxes that are added to the outputs of an industry should be omitted from the price but commodity taxes that fall on inputs used by the industry should be added to the corresponding price.[10]

10 Jorgenson and Griliches (1972:85) advocated this treatment of indirect taxes: "In our original estimates, we used gross product at market prices; we now employ gross product from the producers' point of view, which includes indirect taxes levied on factor outlay, but excludes indirect taxes levied on output."

This is fine as far as it goes but a problem arises when we aggregate over industries in order to obtain aggregate market sector output: commodity tax wedges that fall on intermediate inputs (e.g. gasoline taxes) do not net out of the aggregation. The question is: how are we to interpret these commodity tax wedges that fall within the market oriented production sector?[11]

Triplett and Bosworth (page 122) summarize their empirical results as follows:

> "The insurance productivity numbers look less plausible than those in the finance industries because they show negative productivity growth."

The conceptual issues surrounding the measurement of insurance sector outputs and inputs are probably the most complicated of all the difficult measurement issues presented in the book. I will not be able to do justice to all of the views that are presented in this chapter so the reader is encouraged to read the original!

Triplett and Bosworth consider at some length two models of (property) insurance:

- The *risk pooling model of insurance* that is associated with the premiums minus (expected) claims view of the output of the insurance industry and
- The *risk assuming model* of insurance that is associated with premiums paid as the measure of insurance industry output.

The authors explain the risk pooling model of insurance as follows (page 127):

> "In the risk pooling view of insurance, the policy holders create or pay into a pool for sharing risk. The insurance company is a facilitator and an administrator: it administers the pooling scheme, and it collects the premiums and pays the claims of the policy holders. The insurance company is essentially a cooperative, in which the members of the cooperative pay a service fee to the insurance company for performing the cooperative's business functions. As Dohm and Eggleston (1998) nicely put it: 'Pooling of risk defines the insurer as an intermediary between the various policy holders, where the insurer's function is to collect premiums and disperse them to claimants. The policy holders retain the risk in this model'. ... The price of insurance is the service fee charged for administering the pool on behalf of the policy holders."

And the risk assuming model of insurance is explained as follows (page 128):

> "In the alternative model of insurance, the insurance company assumes the risk. In this risk assuming or risk absorbing view of insurance, the policy holders buy a service—having their assets or income protected against loss. ... In this view of insurance, the service provided by the insurance company to policy holders is the reduction of risk. Without insurance, an automobile accident implies the loss of the car; with insurance, household wealth is unaffected by the accident."

Of course, it should be noted that although household wealth is not affected by the accident, the purchase of the insurance policy will reduce household wealth by the amount of the premium whether the accident occurs or not. If no accident occurs, then household wealth is reduced by the premium and if an accident occurs, wealth is still reduced by the premium and there is an additional loss due to the accident, which is compensated by the payment of the claim. However, in expected value terms, the expected net loss of purchasing the policy is equal to the premium cost less the expected value of the loss and this expected loss will generally be positive due to the transactions costs of the insurance company in administering the policies it issues. Thus if risk is not a factor in the consumer's decision to purchase a policy, it is difficult to justify the cooperative point of view: in expected value terms, the purchase of a policy is just pouring money (the excess of the premium over expected claims) down the drain!

11 For more on this problem, see Diewert (2005a).

The above considerations would seem to kill the cooperative risk pooling model of insurance. But national income accountants countered that the premiums minus claims model of insurance output prevents double counting in the national accounts that would occur if we regarded the premium as the net benefit to consumers of a purchase of an insurance policy (page 128):

> "For example, it was asserted in the workshop that the premiums minus claims rule for property insurance reduces the possibility of double counting in national accounts the output of auto repair shops paid for by insurance companies. But such pragmatic arguments are ancillary to the main conceptual issue."

Triplett and Bosworth have a nice explanation for why households purchase insurance (page 132):

> "Insurance increases utility because individuals are not indifferent to the choice between losing a small amount with certainty (the premium) and losing a large amount with a probability *that results in an equal expected value*. This is one of the oldest results in utility theory. The nature of the gain from insurance therefore depends on the nature or form of insurance and on the consumer's utility function defined over risky states."

Triplett and Bosworth also note that insurance could be treated as a margin industry (page 144):

> "The outputs of certain industries, notably wholesale and retail trade, are defined in national accounts as their gross margins—sales minus cost of goods sold. Cost of goods sold is a generally accepted accounting terms, so the data are normally recorded in retail and wholesale records. One might invoke this parallel to justify the net premiums treatment of insurance."

In terms of my view on the insurance issue, I confess to having been a gross premiums advocate (Diewert, 1995), which supports the position taken by Triplett and Bosworth. I now believe that I was mistaken; I have fallen into the net premiums camp! Why did I change my position? I now feel that when a consumer buys a policy, he or she purchases a joint product. The first product is the premium cost. The second product offsets this cost and is the expected value of the loss in property. Due to transactions costs within the insurance company, the net cost of the purchase of the policy is generally positive and so the question is why would the consumer throw money away? The answer is given by Triplett and Bosworth – consumers are not indifferent to small certain losses and large losses that have the same expected value.[12]

Triplett and Bosworth ask whether the investment income of insurance companies should be added to the output of the insurance industry or should it be somehow incorporated into the price of insurance as is now the practice in the System of National Accounts? On this issue, I agree entirely with the authors – investment income should be added as a separate output of the insurance industry.

Economists have long struggled with the issue of what constitutes the outputs of banks. Triplett and Bosworth's position on this issue is given below (page 178).

> "Economic researchers on banking have specified a banking model in which bank output is identified with balance sheet components that earn revenue for the bank, primarily loans. A loan is not something that is sold, comparable or analogous to the sale of a computer or a car, so

12 Another way to justify the net premiums approach is to think of a situation where the loss will occur with certainty. In this case, the insurance company will collect a premium from an insurable population at the beginning of the period and pay back a smaller amount at the end of the period. It is obvious that in this situation, the insurable population does not obtain an increment of utility equal to the gross premium; in this case, the population receives a utility *reduction* equal to the transactions costs of the insurance company. In other words, if the gross premium approach were true, insurance would be a utility pump that would artificially inflate the utility of the insured population. The reality appears to be different: in equilibrium, the value of insurance is only equal to the value of the primary and noninsurance intermediate inputs that are utilized by the insurance industry, just as the national accountants have been insisting all along!

defining loans as bank outputs oversimplifies. Rather, a loan provides a flow of finance to borrowers, which continues for the life of the loan. ... Banking output, in this view, is the provision of finance to borrowers (equals revenue from lending) and the provision of finance is a flow of services. ... Additional components of banking output are bank services for which explicit fees are charged. The banking output measure should include as well any unpriced depositor services that are produced by the bank and provided to depositors in a barter arrangement in lieu of higher interest on deposits, though the banks' outputs of transactions services are often omitted from banking research."

The authors contrast their "economists banking output definition" with the definition of banking output found in the 1993 System of National Accounts (SNA), which is loan interest received during the period less interest paid on deposits plus explicit fee income. Triplett and Bosworth, in my view, do not satisfactorily resolve the problem of pricing the implicit banking services. They do however, present some very effective criticisms of the national accounting view on measuring banking outputs; in particular, they attribute the following remarks to Peter Hill who was a principle author of SNA 1993 (page 194):

"He emphasized that interest, in the SNA, is not deemed a payment for performing a service, which means that lending is not in itself the production of a service and that interest received in the accounts of nonfinancial enterprises is not treated as if it were a secondary activity that increases the output of nonfinancial enterprises. When a nonfinancial enterprise finances its activities by debt, rather than equity capital, the value added of this firm in the SNA is invariant to its debt-equity position. Hill pointed out that the treatment of interest in financial firms is exactly parallel to its treatment in nonfinancial firms."

Obviously, when the SNA does not recognize interest as a service, various anomalies will emerge from time to time. The treatment of banking in the SNA was one of these anomalies (page 195):

"As Hill (1998) explains .., the national accounts approach to banking is really a consequence of the national accountants' view of interest. Interest, in national accounts, is primarily a transfer, or a receipt of property income, involving owners of financial claims and others. Interest is not regarded as a payment for a productive service. If interest is not a payment for a productive service, it cannot be payment for an output of banks."

The above position on the unproductiveness of interest means that the value added of banks turns out to be negative. Something had to be done to make the value added of banks positive (page 197):

"To avoid portraying the bank as a leech on the income stream (VA < 0), banks are assumed to provide services equal to the entire net proceeds from banks' lending operations."

In order to assign the interest rate margin (the gap between the lending rate and the lower rate that depositors receive) to borrowers and lenders, the SNA suggests a reference rate (equal to a risk free rate for the period under consideration) that is used to split the margin into benefit portions that are attributed to lenders and borrowers. The authors note that it is not easy to define this reference rate and go on to reinterpret the SNA's approach to banking as an approximation to an interest rate margin; i.e. they suggest that we can treat banking as another national accounts margin industry, like wholesaling or retailing.

Indeed, I think that this is a reasonable analogy: as the banking industry becomes more efficient at allocating financial capital to users, its margins should decline. My main problem with the SNA approach is that it is not derived from

any general principles that I can discern. However, I am not completely convinced that the Triplett-Bosworth approach to banking is the right one either, due to the difficulties involved in measuring unpriced services in their approach. Thus I tend to favor the user cost approaches to banking services pioneered by Hancock (1985, 1991) and Fixler and Zieschang (1991, 1999).

There are some additional problems to be resolved in this banking literature:

- Which deflator should we use to convert monetary flows into real flows?
- Should the net monetary assets of the firm be included in the list of primary inputs for that firm?

Output and Productivity in Business Services

With respect to business services, the authors observe (page 258):

> "In the absence of deflators or direct quantity measures of business services, the two most common methods for estimating output are to project the output on the basis of employment changes or to use wage rates as a proxy for changes in the output price deflator. In both cases, the implied labor productivity growth is zero."

The authors point out a further implication of the above imputation procedures: if capital input has been growing more rapidly than labour input, then the implied MFP growth will be negative. It seems to me that this is a logical explanation for at least some of the recorded negative MFP growth rates for U.S. service sector industries.

The authors made two additional comments relayed to business services that merit notice (page 258-9):

> "With the expansion of the industry accounts to include measures of gross output for business services in 2000, BEA moved away from relying solely on input price indexes. Some components of business gross output, such as advertising, computer software and equipment rental are deflated with price indexes from a variety of sources ... instead of with wage rates."
>
> "In some cases, such as professional services, the BLS asks respondents to reprice at periodic intervals a particular bundle of services. This is an application of what is known internationally as 'model' pricing, a methodology that was first developed by Statistics Canada, Canada's national statistics agency, for pricing construction. ... There are insufficient observations at present to evaluate the resulting price indexes fully, but the rates of change have been less than those implied by the previous reliance on wage rates."

High-Tech Capital Equipment: Inputs to Services Industries

In this chapter, the authors address several issues concerning the measurement of information technology (IT) and other high tech capital inputs. The main methodological issues addressed are as follows (page 275):

> "Many U.S. high-tech deflators are constructed with hedonic indexes, but not all of them are. How much difference does price index methodology make, and if it does make a difference, why? Do hedonic indexes fall too fast, as sometimes alleged? Are there defects to the methodology that justify restricting further expansion of their use, as has also been proposed?"

Triplett and Bosworth show that nothing very definite can be said in answer to the above questions: sometimes hedonic indexes grow faster than matched model results, but more frequently they give faster rates of price decline. However, they summarize their empirical investigations as follows (page 281):

> "But the introduction of hedonic indexes for high-tech products marks effective measurement of their price change, which would not have been done adequately with older methods.

> No real evidence exists that hedonic indexes for IT products have overstated their price decline. The debate on 'whether hedonic indexes?' is over. The debate now concerns how to improve them."

Triplett and Bosworth recognize that the introduction of hedonic indexes in some, but not all countries, has lead to international incomparability in price changes for high tech inputs. They note, for example, that in Sweden, software prices were reported to have risen nearly 30 per cent over the five year 1995-2000 interval, while in Australia they fell nearly 30 per cent.

Data Needs

Triplett and Bosworth note that the U.S. statistical system has made vast improvements in the data that are available for the analysis of productivity by industry and for the service sector industries in particular. They single out 5 developments for particular praise;

- improvements in the BEA GDP by industry accounts;
- the new BLS producer price program with its emphasis on filling in the gaps for service sector outputs;
- the great expansion by the Census Bureau of its coverage of services;
- the joint efforts of the BEA, BLS and Federal Reserve Board in developing deflators for high-tech capital stock components; and
- the revision and extension of BEA capital stock measures by industry and asset type and the use by the BLS productivity program of these updated measures to construct new estimates of capital services by industry.

What are some of the problem areas that remain?

There are inconsistent data sources that are being used to construct inconsistent estimates of gross outputs, intermediate inputs and primary inputs. In particular, in the long run, Triplett and Bosworth suggest that the estimates of GDP by industry should be fully integrated with the I-O accounts. There is also a lack of integration between the BLS and BEA industry programs (page 331):

> "We have been surprised by the degree of overlap between the industry programs of BEA and BLS; yet it appears that there has been very little effort to compare and contrast their sources and methods. It seems evident that there would be substantial benefits to tracing down the sources of difference in the alternative output measures. It is confusing for the statistical agencies to publish such contradictory measures, particularly when the sources of variation are not documented. They clearly incorporate different source data or methods. While we are unlikely to see movement toward an integrated U.S. statistical system (where such redundancies would be eliminated by consolidating these statistical programs and thereby melding resources to improve the data), this is one area where there would be significant gains from greater coordination of research efforts between the two agencies.

It seems to me that the significant measurement components of BEA, BLS and the Census Bureau should be combined into one super economic measurement agency called *Statistics USA*!

Triplett and Bosworth (page 331) also address the issue about whether sustained negative rates of industry MFP growth should be allowed to stand or whether it would be more reasonable to set these negative rates equal to zero:

> "Instead of mechanical 'lopping off the tail' exercises, we believe that the statistical agencies should take negative productivity growth as an indicator of the areas in which they need to allocate resources to improve measurement. An exercise to trace down the source of the negative changes in productivity could offer considerable insight into sources of some of the measurement errors. Because the sources can

include errors in price deflators, in current price output measures, in inputs—both capital and intermediate inputs—and also in labor hours, identifying the sources inevitably is a multiagency task, and we believe it should be undertaken as such."

I agree with all of the above except that I would perhaps lop off the tail in cases of industries that are growing but still exhibit negative MFP growth for 5 or more years.

Conclusion

I congratulate the authors on a job well done. In addition to providing valuable information on the industry sources of recent U.S. economic growth, they have given us a textbook on the different types of measurement error that will cause us to take their empirical estimates with a suitable dose of caution. I believe that this book has lessons for all countries: those economists who advise policy makers should be aware that the industry data that they regard as being reliable are almost surely subject to measurement errors that can be substantial. Economists and statisticians working in national and international statistical agencies and government economists who have responsibilities for interpreting productivity developments for their political masters will find this book invaluable.

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