Review of *Productivity in the U.S. Services Sector: New Sources of Economic Growth*
by Jack E. Triplett and Barry P. Bosworth

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1. Introduction

Jack Triplett and Barry Bosworth have written an important book on economic measurement that should be read and digested by every economist who is interested in measuring productivity in general and in the service industries in particular. 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 also find this book invaluable.

The book is the product of fifteen workshops on the measurement of output and productivity in difficult to measure sectors of the economy that were organized by Bosworth and Triplett and held at the Brookings Institution between 1998 and 2003. The Alfred P. Sloan Foundation and the three major U.S. Statistical Agencies, the Bureau of Economic Analysis (BEA), the U.S. Department of Commerce (the Census Bureau) and the Bureau of Labor Statistics (BLS) wisely provided funding for this major initiative. Appendix B in the book lists the participants at the sixteen workshops and most of the major names in the economic measurement area participated in one or more of these workshops.

The book is organized into 11 chapters and two Appendices. Appendix B has been mentioned above and Appendix A is an extensive data appendix that lists the authors' productivity accounts for 54 U.S. industries divided up into 25 goods producing industries and 29 services producing industries within the U.S. private nonfarm business sector for the years 1987-2001. The authors constructed measures of labor and multifactor productivity for each of the 54 industries and various subaggregates, combining information from the BLS and BEA. There are also valuable commentaries on some of the chapters by Kevin Stiroh, Robert Gordon, David Humphrey, Denis Fixler and Brian Ratchford.

- My plan for this review is to give a few representative results from each chapter and each commentary and at times, to insert a few comments of my own on the material presented.

2. Chapter One: Introduction

[1] The author thanks Industry Canada for partially supporting the research in this report but they are not responsible for any opinions expressed by the author.

Naturally, this chapter gives an overview of the results in the book:

"Our broad conclusions about the improved productivity of the services producing industries are developed in chapter 2. 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 percent a year before 1995 and at 1.5 percent a year for the 1995-2001 period) but hardly at all in the goods producing sector." J.E. Triplett and B.P. Bosworth (2004; 3).

The above sentences summarize the main empirical results in the book but the authors point out that the book is also a book on measurement. In the late 1980's and early 1990's, Baily and Gordon (1988) and Griliches (1992) (1994) brought to the attention of the profession the fact that most service sector industries were not very well measured.[2] 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 1930's and 1940's when primary and manufacturing industries played a predominant role in virtually all economies and the statistical system was 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 difficult measurement issues in their book.

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

"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." J.E. Triplett and B.P. Bosworth (2004; 5).

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

3. Chapter Two: Overview: Industry Productivity Trends

The main conclusion that emerges from this chapter is that the U.S. post 1995 MFP (multifactor productivity)[3] growth resurgence was evident in many non IT (Information Technology) industries and that it was particularly evident in a number of service sector

[2] See Diewert, Nakamura and Sharpe (1999) who summarized the special issue on service sector productivity and the productivity paradox in the Canadian Journal of Economics and see also the papers in this issue.

[3] 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).

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 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)." J.E. Triplett and B.P. Bosworth (2004; 9).

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 constructed measures of labor and multifactor productivity for each of the 54 industries in their data base for the years 1987-2001. I will not review their results in detail; instead I will focus on the methodology that they used. They constructed industry MFP estimates using both gross output and value added as the output concept but they emphasized the gross output results as being more preferable. It should be mentioned that they could not find reliable data on industry hours so they were forced to use industry employment as their measure of labor input.[4]

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

We now come to discuss two issues raised by Triplett and Bosworth that are methodologically difficult.

The first difficult issue is how exactly should productivity changes within various industries be aggregated into a measure of aggregate productivity change:

"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

[4] Triplett and Bosworth (2004; 12-13) used the BLS allocation method to work out the share of net operating surplus that the self employed earn. BLS Approach 1 to this allocation problem imputes a wage to the self employed that is equal to the wage of comparable employees in the industry, leaving what is left over as the return to the capital used by the self employed. BLS Approach 2 allocates an industry rate of return to the capital used by the self employed and allocates what is left of net operating surplus as the wages earned by the self employed. The problem is that either or both of these allocation methods can give rise to negative compensation for either labor or capital. The BLS averages the two methods of allocation to ensure a positive compensation for both factors of production.

[5] A rearrangement of their equation (1) on page 10 gives this result.

productivity resurgence story that has been overlooked in some macro productivity studies." J.E. Triplett and B.P. Bosworth (2004; 20-21).

The second difficult issue that Triplett and Bosworth address is the aggregation of industry gross output productivities into economy wide value added productivity:

"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.[6] 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. J.E. Triplett and B.P. Bosworth (2004; 21).

Triplett and Bosworth added the following illuminating footnote 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 form M and t_1 and t_2 represent (different) shift factors." J.E. Triplett and B.P. Bosworth (2004; 21).

In order to aggregate industry (gross) labor productivities into economy wide value added per worker, Triplett and Bosworth (2004; 21) utilize a formula due to Stiroh (2002) and in order to aggregate industry (gross) MFP's into aggregate MFP, Triplett and Bosworth (2004; 23) utilize a generalization of a formula due to Jorgenson, Gollop and Fraumeni (1987).

At this point, the 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.

The first point is that I do not think that the aggregation formulae used by Triplett and Bosworth (based on the work of Stiroh and Jorgenson, Gollop and Fraumeni) 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.

The second point has to do with the fact that productivity tends to rise as we go from a gross output formulation of MFP growth to a value added formulation. I agree with Triplett and Bosworth that it is quite possible that some of the increase in national productivity that they found in the data 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

[6] Triplett and Bosworth have a footnote here that will be reproduced below.

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 but 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 percent 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 percent 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.[7]

My final point for further discussion has to do with whether the value added framework is more restrictive than the gross output framework from the viewpoint of assumptions that have to be made in order to implement either approach. Triplett and Bosworth argue above 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. Their first approach relies on the assumption that the underlying technology can be represented by a translog GDP or value added function[8] where the form of technical change that is allowed is very general. 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.[9] Kohli (1990) independently worked out the first translog approach and has applied it in a number of contributions; see Kohli (1991) (2003) (2004) and Fox and Kohli (1998). Since this translog approach is evidently not well known to most productivity researchers, it seems worthwhile to quote Kohli on its advantages:

"The main purpose of this paper is to draw attention to another superlative index, the implicit Törnqvist quantity index, and to advocate its use as an index of real GDP. This index, which is obtained by deflating nominal GDP by a Törnqvist output price index, was first proposed as an index of real GDP by Diewert and Morrison (1986), but, so far, it has received little or no attention in the literature. Yet, compared to the

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

[8] 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.

[9] Schreyer (2001) noted the approach of Diewert and Morrison in chapter 3 of the OECD Productivity Manual.

Fisher index, the implicit Törnqvist index of real GDP has at least three important advantages. First, it can be shown to be exact for the Translog GDP function. This gives it a strong economic justification. Second, the implicit Törnqvist index of real GDP makes it easy to obtain a multiplicative decomposition of real and nominal GDP growth. Third, it is fully consistent with state of the art measures of total factor productivity, which typically rely on Törnqvist indexes." U. Kohli (2004; 338).

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. Schreyer (2001; chapter 3) gives a good discussion on the pros and cons of choosing between the two frameworks. 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%, I do not know how this contributes to economy wide MFP growth unless someone also tells me what its intermediate input share is whereas I have a much better feel for what the contribution to economy wide MFP growth is of a 1% increase in the industry's value added MFP.

The final comment that I want to make on this chapter is this: are we sure that MFP or labor productivity is the "right" concept to use from the viewpoint of explaining living standards in a country? I would like to 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.[10]

4. Comment by Kevin J. Stiroh

Kevin Stiroh made some interesting comments on the previous chapter by Triplett and Bosworth:

"A final issue that has troubled some productivity analysts recently is the observation that certain industries have shown measured productivity growth that is negative, often for long periods of time." K.J. Stiroh (2004; 44).

Stiroh noted that a potential explanation for the above phenomenon is measurement error but he was a bit troubled by the notion that mismeasurement could be identified by simply looking at low productivity sectors. However, unless it can be shown that the negative productivity industry was in decline, it seems to me that a growing industry that exhibits sustained MFP declines is indeed a candidate for measurement error somewhere in the statistical system.

Stiroh ended his commentary by asking the following questions:

"Why does services sector productivity growth fluctuate so wildly? Put another way, what economic, technological, or policy factors cause productivity growth to be more stable in the goods producing industries than in the services producing industries? With the facts established by this book and others, productivity analysts must now turn to this challenging question." K.J. Stiroh (204; 45).

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

Elsewhere in the book,[11] I think that Triplett and Bosworth provide answers as to why there are so many fluctuations in service sector productivity growth rates:

- At times, there are abrupt changes in the methodology used to measure service sector outputs that lead to very different trend rates of growth;
- The product classification for services has not been as well developed as for goods;
- Surveys to collect information on service sector outputs are scarce and practically nonexistent for collecting information on service sector intermediate input flows;[12]
- Changes in the industrial classification;
- Balancing input output tables often introduces errors into sectors that might have been measured perfectly;
- There are severe problems in allocating enterprise wide statistics into establishment statistics and
- Far fewer statistical agency resources have been put into collecting service sector information as compared to goods sectors.[13]

Thus at the present time, I would be cautious about expending too many resources to explain productivity numbers that may be subject to big revisions in the years ahead.

5. Chapter Three: Output and Productivity in the Transportation Sector

This chapter presents a careful comparison of prices and quantities for several components of the U.S. transportation industry based on multiple sources of data. Unfortunately, the general conclusion seems to be: the different sources give rather different answers.

6. Chapter Four: 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, it is also probably the case that the 1984 court decision that opened up the U.S. long distance telephone market to competition led to productivity improvements in the telecommunications industry:

"The Telecommunications Act of 1996 went further, promoting competition in all telecommunications sectors, including the provision of local telecommunications services. Technological and economic changes have included the introduction of fiber optic cable, the expansion of cable services from 10 million subscribers in 1975 to 68 million in 2000, the surge in cellular phone subscribers form only 5 million in 1990 to 128 million in 2001,and regular access to the Internet for more than half of American households." J.E. Triplett and B.P. Bosworth (2004; 71).

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[11] "The comprehensive structure of the BEA estimates often requires rather heroic assumptions to cover gaps in information." J.E. Triplett and B.P. Bosworth (2004; 51).

[12] Agricultural, primary industry and manufacturing industry surveys have been around for at least half a century but corresponding service sector surveys have been slow to develop.

[13] Statistical agency front line workers face an extremely difficult task in their attempts to keep up with today's dynamic economy with hundreds of thousands of new products and establishments springing up every year. For a list of some of the measurement difficulties statistical agencies face, see Diewert (2001).

The authors compare BLS and BEA data for telecommunications and broadcasting and they find that the BEA measure of gross output grows significantly faster than the comparable BLS concept after 1995. 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:

"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." J.E. Triplett and B.P. Bosworth (2004; 75-76).

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

"We have constructed alternative estimates of purchased inputs from the annual Census Bureau (CB) surveys of the communications industry (an industry for which reasonably good information on purchased inputs does exist) for the years 1990-2001. While the definitions are not identical to those of the BEA accounts, the pattern of change in the relationship between purchased inputs and output should be similar in the industry accounts and the CB surveys. We define purchased inputs from the surveys as operating expenses less wages and salaries, supplemental wage benefits, and depreciation." J.E. Triplett and B.P. Bosworth (2004; 76).

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 big. In any case, the authors then compare their 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." J.E. Triplett and B.P. Bosworth (2004; 76).

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:

"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 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." J.E. Triplett and B.P. Bosworth (2004; 85).

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

7. Comment by Robert J. Gordon

Robert Gordon starts out his commentary on the previous two chapters with some well deserved words of praise for the authors:

"The Triplett-Bosworth chapters on transportation and communications are admirable. The authors do the best job to date of untangling what the BEA and BLS data actually show and why they differ, and they bring together evidence on the reasons for acceleration and deceleration of productivity growth at the sectoral level. Moreover, their book is impressive in recognizing past research and linking their results to this inheritance." R.J. Gordon (2004; 87).

But the above positive tone soon turns negative:

"The main thrust of these comments is to praise the progress that the authors have made in reconciling measurement differences but to criticize them on two quite different grounds. First, they display output and productivity measures for the BEA gross output and value added concepts of output as if these were equally important and equally reliable; I argue that several aspects of the BEA intermediate materials estimates are implausible and that future work on productivity in transportation, communications, and indeed the entire economy should place much greater weight on gross output measures when those measures differ from estimates of value added. Second, the chapters are long on measurement discussion and short on substantive answers to significant questions, such as why productivity growth disappeared in airlines and trucking after 1995 and why MFP growth was significantly negative in broadcasting just when labor productivity and MFP growth in the overall economy experienced a marked revival." R.J. Gordon (2004; 87).

Gordon elaborates on his first criticism later in his commentary:

"The book suffers from the authors' impartial presentation of productivity ad MFP measures based on the BEA measures of gross output versus value added, as though these were equally reliable. In their display of value added results, the authors do not heed their own warnings, which are so well developed in the communications chapter. There they provide a blistering indictment of the BEA's methodology for measuring value added. ... There are multiple sources of errors in calculating real value added that do not apply to real gross output, a much more straightforward concept." R.J. Gordon (2004; 92-93).

I think that Professor Gordon is a wee bit too harsh in his first criticism of Triplett and Bosworth. I had no difficulties in figuring out that the criticisms of the BEA value added estimation procedures made in the communications chapter also applied to telecommunications. I also fail to see why the gross output productivity numbers are of more interest than the value added numbers (but of course, the reader will already realize that I have some biases with respect to these matters). If we are attempting to measure MFP, then both the gross output and the value added measures of MFP will be biased if our estimates for the price and quantity of intermediate inputs are biased so I do not see the point of Gordon's criticism with respect to MFP concepts. If we are only attempting to measure gross output or value added labor productivity, then I would argue that both

measures are not of great interest to me as measures of welfare improvement: a high value added labor productivity number could be explained by a big increase in capital input and a high gross output labor productivity number could be explained by big increases in materials or capital services inputs. However, if I had to choose between the two labor productivity concepts on welfare grounds, I would pick value added labour productivity over gross output labor productivity as the number which on average would be more relevant in explaining increases in living standards. The point is that bad estimates of intermediate input at the sectoral level lead to poor estimates of sector MFP (either concept) and this in turn leads to difficulties in ascertaining the industry sources of aggregate MFP gains (which do not require information on intermediate inputs).

With respect to Gordon's second criticism: given the uncertain nature of the sectoral numbers, I think it is quite appropriate for Triplett and Bosworth to *not* use their estimates to answer the big questions that Gordon asks; i.e., why did productivity growth in the U.S. disappear in airlines and trucking after 1995?

8. Chapter Five: Overview: Productivity and Measurement in the Finance and Insurance Sector

Triplett and Bosworth provide the following introduction to this chapter and the two following chapters:

"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." J.E. Triplett and B.P. Bosworth (2004; 95).

This introductory chapter provides the output and productivity trends that Triplett and Bosworth estimated for the U.S. Finance and Insurance industries over the period 1987-2001. As usual, the authors find some puzzling results for these two industries and their subsectors. Changes in methodology explain some of the puzzles. Triplett and Bosworth make the case that some of the anomalous results can be explained by national income accounting conventions in these sectors but since these arguments will be discussed in the next two chapters, we will not delve into these problems at present.

However, Triplett and Bosworth explain another source of differences between the BEA and BLS industry data bases in this chapter:

"For finance, two input problems need to be discussed—the allocation of income to the self employed and fluctuations in the capital share because of unusual gains and losses. These problems persist throughout the services industry data. They are not unique to the finance and insurance industries, but because they loom large in this section we discuss them here ... The allocation of the reported income of self employed workers between capital and labor income creates considerable difficulty for some services industries. In the BEA industry data base, all self employment income is treated as property income. Yet some of it must be labor income."

Triplett and Bosworth are certainly correct in their assessment of the BEA procedure. They go on to explain how the BLS solves this problem:

"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 as we noted, yields an aggregate that exceeds self employed income. They then reduce both incomes in proportion, to control the total to the actual self employed income. ... We generally used the BLS estimates of capital and labor shares for our productivity estimates and applied them to the BEA value added estimates. ... Note that the BLS capital shares for brokerage are far more stable than the BEA shares ... . J.E. Triplett and B.P. Bosworth (2004; 119).

Thus Triplett and Bosworth use the BLS solution to the problem of allocating the income of the self employed into labor and capital components, as was indicated above.[14]

Triplett and Bosworth also discuss another measurement problem that was flagged above; namely excessive fluctuations in the share of capital in some finance industries due to stock market booms:

"However, 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 (see Table 5-3), 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." J.E. Triplett and B.P. Bosworth (2004; 120-121).

Triplett and Bosworth bring another measurement problem to our attention at the end of the chapter:

"An additional problem should be noted. 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 U.S. where they are generally 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); i.e., 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.[15] This is fine as far as it goes but a problem arises when we aggregate over industries in

[14] However, the above quotation indicates that there may be an inconsistency in the Triplett Bosworth data base in that industry employment is used as the measure of labor input but the share of labor income is based on the BLS hours measure of labor input.

[15] Jorgenson and Griliches 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." D.W. Jorgenson and Z. Griliches (1972; 85).

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?[16]

Note that as we progress through the chapters in the book, the exact nature of the BLS, BEA and Triplett Bosworth data bases become more apparent.

Triplett and Bosworth 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." J.E. Triplett and B.P. Bosworth (2004; 122).

9. Chapter Six: Price, Output and Productivity of Insurance: Conceptual Issues.

The 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:

"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." J.E. Triplett and B.P. Bosworth (2004; 127).

And the risk assuming model of insurance is explained as follows:[17]

"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." J.E. Triplett and B.P. Bosworth (2004; 128).

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[16] For more on this problem, see Diewert (2005a).
[17] Triplett and Bosworth (2004; 129) attribute this view of insurance to Denny (1980).

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!

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:

"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." J.E. Triplett and B.P. Bosworth (2004; 128).

Triplett and Bosworth have a nice explanation for why households purchase insurance:

"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. This problem was the subject of Erwin Diewert's (1995) paper and of George Akerlof's comments at the Brookings workshop." J.E. Triplett and B.P. Bosworth (2004; 132).

Triplett and Bosworth also note that insurance could be treated as a margin industry:

"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." J.E. Triplett and B.P. Bosworth (2004; 144).

There are many other interesting discussions about various aspects of insurance in this chapter but I have collected a sufficient number of quotations from chapter 6 that I can give my own position on the issues raised by Triplett and Bosworth.

First of all, I confess to having been a gross premiums advocate in Diewert (1995), which supports the position taken by Triplett and Bosworth in chapter 6; i.e., in Diewert (1995), I thought that the appropriate (value) measure of insurance industry output was gross premium income. I now believe that I was mistaken; i.e., I have now 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 (2004; 132); i.e., consumers are not indifferent to small certain losses and large losses that have the same expected value.[18]

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 get an increment of utility equal to the gross premium; in this case, the population gets 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![19]

On page 151, Triplett and Bosworth ask whether the investment income of insurance companies should be added to the outputs 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; i.e., investment income should be added as a separate output of the insurance industry.

10. Chapter Seven: Measuring Banking and Finance: Conceptual Issues

The authors introduce their topic as follows:

"This chapter, like the chapter on insurance, builds on the research literature and presentations and discussion from two Brookings economic measurement workshops that covered banking and finance output and productivity together with national accounts experts in the most exhaustive exchange of views on the topic of banking output that has taken place in any forum." J.E. Triplett and B.P. Bosworth (2004; 177).

What are the outputs of banks?

"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 defining loans as bank outputs oversimplifies. Rather, a loan provides a flow of finance to borrowers, which continues for the life of the

[18] Thus I now feel that there is nothing wrong with the nonexpected utility model that is developed in Diewert (1995) until we get to equation (26), where I divided premiums paid by a difference in utility levels. Now, I suggest that we should divide premiums minus expected claims (instead of just premiums) by the utility quantity to get the price of insurance. However, the entire approach needs a new look.

[19] I agree with Triplett and Bosworth that the club model that national income accountants use to justify their treatment of insurance seems flawed; the reduction of large risks by pooling has to play a role in a realistic theory of insurance.

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." J.E. Triplett and B.P. Bosworth (2004; 178).

Thus in the authors' view, banking services consist of a sum of loan interest rates times amounts of loans plus explicitly priced services plus implicitly priced services. Of course, the practical problem is how exactly to price the implicitly price services. Triplett and Bosworth (2004; 179) contrast this "economists banking output definition" with the definition of banking output that can be found in the System of National Accounts 1993, which is loan interest received during the period (say $r_L L$) less interest paid on deposits (say $r_D D$) plus explicit fee income.

Triplett and Bosworth (2004; 182) go on to describe their preferred production model for a bank but in my view, they do not satisfactorily resolve the problem of pricing the implicit banking services mentioned above. 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 participated in one of the Brookings workshops and was a principle author of SNA 1993:

"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." J.E. Triplett and B.P. Bosworth (2004; 194).

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:

"As Hill (1996) explains in his paper for the Brookings November 1998 workshop, 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." J.E. Triplett and B.P. Bosworth (2004; 195).

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

"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." J.E. Triplett and B.P. Bosworth (2004; 197).

"The SNA's resolution of the paradox [that banking absorbs resources, even though lending is defined as nonproductive] is to treat the bank as providing services which are separate from, and additional to, the actual borrowing and lending." P. Hill (1996; 2).

Triplett and Bosworth make the following comment on the above quotation by Hill:

"As this statement suggests, the national accountants' logic points them in the direction of finding nonfinancial services that are equal to the interest rate margin." J.E. Triplett and B.P. Bosworth (2004; 198).

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:

"The reference rate has not been well defined. It has variously been set at the midpoint between borrower and depositor rates or might also be specified as the rate at which banks buy and sell purchased funds. More recently, it has been specified as the government bond rate."

Triplett and Bosworth (2004; 201) go on to reinterpret the SNA's FISIM 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's FISIM approach is that it is not derived from any general principles that I can discern.[20] 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?

11. Comment by David Humphrey

Humphrey makes a number of interesting technical observations, which I will not list here. However, his discussion should serve to remind us that there are two schools of thought on how to measure bank outputs:

[20] Moreover, the FISIM approach is not quite consistent with the user cost approach to banking. Triplett and Bosworth (2004; 209) explicitly point this out but of course, they do not endorse the user cost approach, perhaps because it depends on the choice of a reference rate that is too arbitrary in their view. In my view, the "right" reference rate in the user cost approach is the firm's cost of equity capital but this concept is not particularly well defined!

- A quantitative indicators school that looks at say the number of checks written, the number of electronic payments, the number of time account deposits and withdrawals, the number of new and existing loans and so on (Humphrey falls into this school) and
- The user cost school that focuses on the financial flows of the firm.

Unfortunately, generally speaking, the two schools generate very different productivity estimates.

12. Comment by Dennis Fixler

In the first part of his commentary, Fixler argues for the premiums minus claims viewpoint for the determination of the value of the output of the insurance sector, essentially on the national accounts argument that it is desirable to avoid double counting. I have already indicated above that I find this point of view persuasive.

There is an additional task for national accountants to accomplish associated with insurance claims: it would be desirable to have an explicit "damage" sector in the production accounts that would deduct expected losses due to natural disasters, fire and theft from the economy's outputs or inputs.

Fixler also argues for the user cost approach to banking since it largely "solves" the problem of pricing unpriced services:

"As explained in Fixler, Reinsdorf and Smith (2003), the user cost approach provides a model of bank behavior that treats financial services as the outputs of banks and yields a valuation of the unpriced services provided to both borrowers and depositors. Avoiding negative value added was not the motive for adopting the user cost approach." Dennis Fixler (2004; 225).

However, one problem with the user cost approach that might be of concern to national income accountants is that the approach may lead to a shift of a primary input (the net financial assets of the firm) into value added. Thus adoption of the user cost approach to financial firms may lead to an "artificial" increase in GDP. Of course, whether or not the net financial assets of the firm should be regarded as a primary input is another question that needs to be decided.

13. Chapter Eight: Output and Productivity in Retail Trade

Compared to the previous 3 chapters, this chapter is easy reading! The authors point out that there are two methods to measure value added in the retailing sector:

- Measure the value of sales less the value of goods purchased for resale or
- Measure the margin between the selling price and the purchase price times the amount sold during the period under consideration.

The authors document some of the recent improvements made by BLS and BEA in constructing retail price indexes and they also discuss a list of interesting measurement complications.

14. Comment by Brian T. Ratchford

A few quotations taken from Ratchford's discussion of the previous chapter will nicely summarize many of the retailing issues discussed by Triplett and Bosworth:

"Triplett and Bosworth provide an overview of major issues affecting productivity and its measurement in retail trade and e-commerce, paying special attention to answering the following question: Are the measured productivity gains in these areas real or an artifact of the method used to measure them? The chapter provides an excellent summary of the key issues affecting the measurement of retail productivity; it also provides a survey of what is known about productivity change in specific retail sectors and about the impact of information technology and e-commerce on retail productivity." B.T. Ratchford (2004; 251).

"More work is needed to explore the direct measurement of retail services, to explore how sales and margin measures coincide with direct measures of retail services, and to explore how much retail services change over time." B.T. Ratchford (2004; 253).

"My other question is about scanner data. For the grocery, drug and mass merchandise categories, huge amounts of detailed price and quantity data are available in scanner data. ... My (possibly naive) question: To what extent are these data used in price and output measurement? They would seem like a logical source." B.T. Ratchford (2004; 254).

Indeed, scanner data have been used as a logical source; see Feenstra and Shapiro (2003).

15. Chapter Nine: Output and Productivity in Other Sectors

The three service sector industries that are covered in this chapter are: business services, medical care and educational services.

With respect to business services, the authors make the following observations:

"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." J.E. Triplett and B.P. Bosworth (2004; 258).

The authors point out a further implication of the above imputation procedures: if capital input has been growing more rapidly than labor 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.

"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." J.E. Triplett and B.P. Bosworth (2004; 258).

"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." J.E. Triplett and P.B. Bosworth (2004; 259).

A description of the treatment of medical care and educational services will have to be obtained from the book. Needless to say: there are many measurement difficulties associated with both areas.

16. Chapter Ten: High-Tech Capital Equipment: Inputs to Services Industries

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

"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?" J.E. Triplett and B.P. Bosworth (2004; 275).

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

"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." J.E. Triplett and B.P. Bosworth (2004; 281).

Triplett and Bosworth (2004; 301) show an interesting graph of software price indexes from 1992 to 2000 for 11 OECD countries and they comment as follows:

"The chart resembles a fan: in Sweden, software prices were reported to have risen nearly 30 percent over the five year 1995-2000 interval, in Australia they fell nearly 30 percent, and other countries were arrayed in between." J.E. Triplett and B.P. Bosworth (2004; 300).

17. Chapter Eleven: Data Needs

In the opening paragraph for this chapter, 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 BLS new producer price program with its emphasis on filling in the gaps for service sector outputs.

- The Census Bureau has greatly expanded its coverage of services in recent years.
- The joint efforts of the BEA, BLS and Federal Reserve Board in developing deflators for high-tech capital stock components.
- The BEA revised and extended its measures of the capital stock by industry and asset type and the productivity program of the BLS used 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:

"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. J.E. Triplett and B.P. Bosworth (2004; 331).

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 (2004; 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." J.E. Triplett and B.P. Bosworth (2004; 331).

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.

I conclude this review by congratulating Jack Triplett and Barry Bosworth on a job well done. In addition to providing valuable information on the industrial 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.

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