

Macroeconometric Models and Changes in Measurement Concepts: An Overview*

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This paper introduces the latest report of the Seminar on Model Comparisons, being a set of articles that describe subsequent effects on representative US macroeconometric models of the most recent benchmark revisions in the US National Income and Product Accounts. These accounts state the definitional relationships between measured macroeconomic variables. They also provide an evolving view of the characteristics of the US economy, this evolution occurring as the result of occasional changes in the accounting constructs. In some cases, the changes simply reflect the effect of differences in the availability of the underlying primary measurements. However, in other cases, they are made in order to bring the accounting concepts into better conformity with economic concepts, or for the sake of harmonizing the US accounts with those of other countries. In all cases, such changes may nevertheless affect the particular use of these accounts, implying the need for users to make a careful evaluation of the implications. This paper provides a perspective on the most recent of these changes.

1. Introduction

The immediate stimulus for this special issue of the *Journal of Economic and Social Measurement* is the recent mid-decade benchmark revisions in the US National Income and Product Accounts (NIPA), which among other things instituted a change in the way in which implicit price deflators are computed and used [66, 76, 77, 96, 101]. It can be argued, as does Lasky [67] that the result is a set of accounts more in conformity with economic concepts and with the potential to permit the development of better performing macroeconometric models. The other papers in this issue do not exhibit the same degree of enthusiasm, for an effect of this change has also been to force model builders to reconsider certain structural elements of their models, including the level of aggregation of expenditure items, as for instance in the case of Witte and Green [100], and the treatment of identities, as discussed by Bachman et al [4]. A further effect has been to require annual and quarterly data to be treated differently, affecting the use of models, as particularly discussed by Varvares et al [98]. All such modifications, whether ultimately beneficial or not, can be initially disruptive and potentially time-consuming to implement. Thus it is natural in the face of change to consider the question whether benefits outweigh costs.

However, it is also important to view such issues and questions in a broader context. It is characteristic of macroeconomic measurements that the producer and user are normally different people. Although notable exceptions to this rule certainly exist, as is attested by the Wharton indices of capacity utilization (which were developed in the context of the creation of the Wharton model [58, 61, 62]) and the Penn World Tables [93, 94], it is uncommon for an economist during his or her career to perform the role of both producer and user of data either simultaneously *or serially*.

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This separation can result in economic statisticians, as specialized data producers, who are expert in the practical methods of measurement, but who can be ignorant of how the data may be used and may not appreciate the perspective of any user, as Triplett has discussed in an earlier issue of this journal [95]. Similarly, those who use the data for research can be ignorant of all or nearly all aspects of data production, yet nevertheless believe themselves to be expert in the implications of that use. Such ignorance may lead to false inferences: as Wilcox [99, p. 922] has noted, “when researchers test and reject an implication of a theoretical model, they usually assume that the model is in error and that subsequent investigation should be directed toward the development of alternative models that might better account for the observed characteristics of the data. They usually spend little effort investigating the characteristics of the data themselves or the suitability of the data for use in the application at hand.” It can be read as a commentary on economists’ research methods that six years later Slesnick [91] has found, other than Wilcox, only Blinder and Deaton [8] to have recently looked beyond the face value of the data on US consumption expenditures. On the other hand, inasmuch as these are all relatively current contributions and are not in fact unique [*see*, for instance: 17, 45, 90, 97], it is alternatively possible to view these studies as newly indicative of the increased awareness of economists of the inevitable imperfections of the measurement process.

But there is yet another aspect of these developments that deserves notice at the outset, which is the public nature of the accounts. Today, it is not just economists who are able to monitor the economy’s performance. The general public is also part of the audience, in part because of the media attention now given to business and economic news, even if there is some evidence that what is heard by economists and the public, and the inferences drawn, can be dramatically different, both as regards specifics, such as the proportion of government spending on foreign aid, and the general characteristics of the economy’s performance [7, 37]. The public’s perception of the state of the economy in 1992, or possibly the candidates’ presentation of themselves as less or more “economically” aware, appears to have determined the outcome of the presidential election, with the debate shaped by then current economic soundings [78]. The recent report of the Boskin Commission and its aftermath [10, 11] demonstrates again, if nothing else, that economic measurement procedures once instituted become public policy, particularly to the degree that subsequent changes are perceived to create camps of potential winners and losers. Measurement may be arcane, even to many economists, but it can become topical from time to time, especially when inflation or unemployment rates increase or policies such as Revenue Sharing are enacted. Thus it is important to evaluate methodological changes, as they occur, in order to insure that both producers and users of the data can live with the results.

This journal issue is produced as a research report of the Seminar on Model Comparisons and should be seen in the context of the series of studies that the Seminar has produced over the years, the last being a comparison of the strategic properties of US macroeconometric models [60]. The current contribution specifically provides the response of representatives of four of the major US macroeconometric models to the abovementioned methodological changes in the national accounts. This response should also be seen broadly as being part of the wider dialogue between data producers and users that it is a purpose of this journal to foster. One of the inferences that can be drawn from the Triplett contribution cited earlier is that an important stimulus to the

development of data resources by statistical agencies can be the demands made by knowledgeable data users. It is incumbent upon users of economic data to demonstrate both their needs and the way in which the ongoing development of the data base affects their work. As Charles Schultz has argued, “With some clear exceptions, bodies of statistical information will be useful not so much because they directly suggest answers to policy problems, but mainly indirectly as the research based on such information helps us better understand how society and the economy work.” [95, p. 138].

2. Historical Perspective

It is appropriate that changes in the National Income and Product Accounts be considered from the perspective of developers of macroeconomic models of the type that are represented in this special issue, for the historical development of these models can be viewed as an attempt to breathe life into these accounts. This statement can be faulted in particulars: for one thing, the data upon which these models rest are not exclusively from the NIPA; nor are they all produced by a single statistical agency. Nevertheless, it forcefully indicates the importance of the NIPA data, as a system of accounts, to these (and other) empirical models of the United States. In turn, these models are important for their focus on the *explanation* of interactive economic processes in the context of a well articulated accounting framework as a means of examining the implications of economic policies. During the present decade, it has once again become clear that, *as a practical matter*, economies do respond to economic policies, both when those policies are well-conceived and when they are not. In North America, South America, Europe, and even Asia, the past twenty to thirty years has witnessed the active and often successful management of economic processes, even if the actors in this process have in some cases proclaimed themselves proponents of *laissez faire*; what is said and what is done are not always the same.¹ But what has been most important to this management has not been the fine detail of particular forecast results, which can be misleading when considered narrowly, but rather, much more fundamentally, the ongoing process of learning through doing how a set of economic variables relate over time in characterizing and explaining the patterns of an economy’s behavior.

The inspiration and stimulus for setting up NIPA accounts worldwide can be traced to Keynes’ *General Theory* [55] and *How to Pay for the War* [56], as described by Hicks [46] and Kurabayashi [65] among others, but the edifice represents the work of a large number of economists and economic statisticians, among the most prominent being Morris Copeland, Irving Fisher, Ragnar Frisch, John Hicks, Irving Kravis, Simon Kuznets, James Meade, Richard Stone, and Jan Tinbergen [53]. The existence of these accounts, combined with the other data collected, produced, and distributed by other government agencies, in collaboration with academic specialists and private sector organizations, has generally enabled and shaped the development of applied econometrics. Although today often unsung, this collaborative development continues,

¹ It is also important to recognize that what is ultimately relevant is the net effect of policies, not necessarily those of one actor in the process. In the US, the Administration’s stated policies may or may not be those of the Federal Reserve or the Congress. However, even if Washington is unified in its actions, the fiscal position of the states, as an aggregate, may in some cases modify the effect.

with the results published in both articles and books, including the ongoing NBER series, *Studies in Income and Wealth*, which began in 1937. There are also continuing attempts, as recently recounted by Keuning [63], to provide the basis for more fruitful study of the interactions between economic development and social change by the provision of integrated economic and social accounts that provide a framework in the form of a mutually consistent body of data.

For the United States, the NIPA accounts have been published regularly since 1947, and during this time there has been evolution and change in presentation and specific content. Ruggles [88] provides a readable and reasonably comprehensive telling of the first 30 years of this story; Carson [14] describes the process of setting up the accounts as a system--but see also Kenessey [54]. The present and future are surveyed in a recent collective work [52] that includes a pertinent contribution by Eisner [36], which addresses aspects of the role of model builders and other users. Eisner's earlier AEA Presidential Address [35] forcefully raised important questions concerning the correspondence between economic concepts and measurements, and to a certain degree this torch has been taken up by others [45, 91, 99].

Such perspective is important and it is important also to consider context. Econometricians are prone to give primacy of place in histories of the development of the discipline to the seminal pre-World War II work of Frisch, Haavelmo, Koopmans, Slutsky and others who together established the foundations of the theory, and to those who have extensively elaborated that theory since [32, 47, 73]. But as Hendry has pointed out [46, p. 314], it is the operational application of theory that invests it with meaning. This is seconded, from the perspective of the statistician, by Keuning, who notes that whereas "virtually all economic research focuses on the analytical tools" it can be questioned "whether a further refinement of analytic tools will have sufficient impact when the availability of data is not simultaneously improved." [63, p. 1].

On the basis of the early attempts to construct national accounts, the modern development of US macroeconomic models also began in the late 1940s. Klein's model I was published in 1950, but the work on this and companion models started earlier and incorporated the income-expenditure identity [57]. The Klein-Goldberger model essentially represents the first joint application of the NIPA and macroeconomic models, but it was with the 1965 comprehensive revision of what were then called the "GNP accounts" that the modern era began [38, p. 1]. It has now been more than 30 years since the first efforts of Klein, Adams, Evans, and others at the Wharton School of the University of Pennsylvania to establish regular economic forecasts. Set against the human lifespan, this is a considerable length of time, but against that of complex technological systems, relatively short: the airplane, the automobile, and the computer, as arbitrary examples, have all taken much longer to reach their present degree of maturity. It is important to recognize both this existential element of the process and, as context, that the construction and use of econometric models and theory has not occurred in isolation. Since the 1960s, their development has been enabled and complemented by three other innovations: the digital electronic computer, which has evolved into the now ubiquitous and increasingly capable and powerful microcomputer; the development of econometric software, including both data base management systems and algorithmic computational techniques [9, 31, 33,

34, 46, 59, 71, 72, 82, 83, 84, 85, 87]; and the ongoing elaboration of the aforementioned National Income and Product Accounts, broadly defined to include pertinent extensions [68, 80, 92]. These complementary developments are obviously as fundamentally enabling and operationally important as are the theoretical insights that populate the econometrics literature. It is clearly not too much to say that the construction of large econometric models has crucially depended upon the existence of computational capabilities, yet the impact is actually much wider, for even what are now regarded as simple parameter estimation tasks, achievable in microseconds, were within living memory substantial computational undertakings literally taking hours [9, 42, p. 48]. Much the same could be said about the availability of data today, compared to the 1940s and before.

In considering the state of the art, it is necessary to recognize explicitly that this collaboration has played an essential part, if only to bring out clearly the likelihood that future progress will depend upon a continued combination of skills, and possibly a much greater degree of attention paid to the underpinnings [45]. To build an econometric model or to conduct any other empirical research in this area effectively requires a number of ingredients: data, software, one or more computers, and economic theory and econometric techniques, plus the specific skills to transform these inputs into a result that can be judged valid according to some objective criteria. Arguably, these skills generally should include historical knowledge of both the institutional characteristics of the economic process considered and any past attempts to represent that process. Moreover, it is beneficial to have not only the ability to mix these ingredients appropriately, but also sufficient expertise to deal with the various problems that may arise. For instance, whereas data bases can now be acquired from a variety of sources in machine-readable form, characteristically, even in the case of the NIPA, the data are not all provided in good order, ready to be used as is [86]. The argument is easily made that attention to the more uniform development of the underlying apparatus of research will pay dividends out of proportion to the effort involved. To date, both model builders and economic statisticians have made use of the computer and related technologies, but only somewhat passively as these have evolved, as a consequence of the work of others. So far, there have been too few attempts on the part of economists to define actively the data base management and other technical software requirements [87]; one of the results has been to limit the advance of economic knowledge due to the need for economists collectively to spend too much time preparing to do research.

3. Index Numbers: Fixed Versus Chain Weighted

Turning attention to the specific focus of this issue, it might be suggested that one of the empirical problems that bedevils economists is the proper perspective against which to view conundrums. For example, as Albert Ando once asked,² should the welfare loss from the absence of a Pareto optimal organization of production and exchange be regarded as likely to be on the same order of significance as that associated with a mild recession, or less or more? Other examples variously come to mind: when choosing a parameter estimator, in assessing the impact of estimator inconsistency in the presence of known endogenous variables as regressors, how

² during a lecture to graduate students in a Public Finance course.

should the potential gain from using a simultaneous equation estimator be viewed in the context of the belief that the observed instrument variable values may involve serious errors of measurement, not to mention the possibility of serious functional form misspecification? Or, in the case of index number construction, as Balk and Kersten [5] ask, when the underlying price and quantity data are subject to errors of measurement, what is the statistical significance of the difference between the Laspeyres and Paasche price indexes for a certain pair of years: that is, should effort be put into making better underlying price and quantity measurements or reducing the “substitution bias?” Sometimes, of course, it is possible to establish a context: Franklin Fisher [40] has argued that for the individual consumer, the economic theory of index numbers is well defined, even if there are formidable problems in the aggregation to many consumers. But, other times it is not: in the context of the measurement of real output and input, he goes on to argue, “there is relatively little agreement on the analytical basis for index numbers. Indeed the notion that what one *means* by aggregate real output is a Laspeyres output index is fairly widespread” (p. 88, original author’s emphasis; *see also* [41]). The inference to be drawn is that chain indexes will take some getting used to, whatever the arguments made.

Speaking metaphorically, the need for index numbers generally occurs in those instances in which it is necessary to measure apples and oranges collectively. Apples or oranges on their own can be counted easily and, at least if there are no qualitative issues to be faced, pricing is similarly quite straightforward. It is when the topic turns to the quantity or price of *fruit* that the fun begins. The reason of course is that at this point a unique solution is no longer possible. Even if all agree that quantities should be measured in value terms, with prices in some sense held constant, there is immediately a question of which prices at which point in time. The issue is that of choice of *base period*, and once this is agreed, the next question inevitably is that of the properties of the resulting index. Obvious choices are to establish some fixed historical point in time as the base period or to choose the current period as the base, the results being the well known formulations of Laspeyres and Paasche respectively. Properties of these and other forms of index numbers can be considered by focusing on their formulae in isolation. Alternatively, recognizing that goods (and services) can be regarded as endowed with utility, or as produced with some associated cost, it is possible to consider the properties of index numbers in the context of economic theory. Thus, normatively, the principal evaluative bases for index numbers are the *test approach* and the *economic approach*,³ and each of these have been considered in some detail by a number of authors; Diewert [25, pp. 237-238], for instance, provides a relatively comprehensive bibliography.

3.1 The Test Approach

In order to precisely define the relevant concepts, let p_1, p_2, \dots, p_T be a set of T prices and q_1, q_2, \dots, q_T a set of T corresponding quantities. Then, if 0 is the base period and 1 another period, the formula for the Laspeyres index is:

³ Other approaches to the determination of particular functional forms for indexes can be identified. See, for instance, Diewert [28], who in addition describes the Fixed Basket and Stochastic approaches.

$$Q^L = \frac{\sum p_0 q_1}{\sum p_0 q_0}$$

That for the Paasche is:

$$Q^P = \frac{\sum p_1 q_1}{\sum p_1 q_0}$$

where 1 is the base period and 0 another period. A composite is the Fisher “ideal” index:

$$Q^F = \sqrt{\frac{\sum p_0 q_1}{\sum p_0 q_0} \cdot \frac{\sum p_1 q_1}{\sum p_1 q_0}}$$

developed by Irving Fisher essentially from a consideration of the inherent properties of the Laspeyres and Paasche forms. If P_{01} denotes an index number expressing the ratio between a base period 0 and a period 1, then the standard tests include [44]:

Identity Test: $P_{00} = 1$

Reversal Test: $P_{01}P_{10} = 1$

Circular Test: $P_{01}P_{12} = P_{02}$

Commensurability Test: invariance of P_{01} to changes in the unit of measurement for individual items (goods or services)

Determinateness Test: P_{01} does not become infinite, zero, or indeterminate if an individual price or quantity becomes zero

Proportionality Test: If all individual prices change in the same proportion from 0 to 1, P_{01} should be equal to the common factor of proportionality.

Evidently, the Laspeyres and Paasche indexes fail, specifically, the Reversal and Circular tests. The Fisher ideal passes the Reversal test, but not the Circular.

There are additional tests [23] and of course additional index formulae, but what should be noted, in particular, is that the test approach does not in fact lead to the establishment of a unique, optimal formula. Among other things, various authors, including Frisch [43], have demonstrated that even the limited set of tests listed above cannot be simultaneously satisfied. Thus, under the test approach, the argument for or against a specific formula finally turns on the question of which set of tests is most appropriate [64].

Another composite formula, originally introduced by Alfred Marshall [70], is the chain index. It is created using more elementary index formulae, such as the Laspeyres, Paasche, or Fisher Ideal, and takes the general form:

$$P_{st}^* = \frac{P_{01}P_{12}\dots P_{t-1,t}}{P_{01}P_{12}\dots P_{s-1,s}}$$

where the P_{ij} are any index formulae directly comparing two distinct points in time. Note that if $s < t$, then the chain index formula simplifies to:

$$P_{st}^* = P_{s,s+1}P_{s+1,s+2}\dots P_{t-1,t}$$

Note also that in the case of the chain index the time points are ordered in a unique sequence; it is thus essentially a time series oriented formula. Interestingly, the chain index passes the reversal and the circular tests no matter the type of more elementary formula (the P_{ij}) used.

A further relevant point is that the chain index satisfies the Divisia criteria [44, p. 7]. Consider the factorization:

$$PQ = \sum pq$$

that is, the problem of factoring a sum of products into the product of two factors, P and Q. The first, suggestively, might be regarded as representing the general price level and the second a quantity, or as Frisch puts it, the “total physical volume.”

The Fisher Ideal index itself has the property that:

$$P_{01}^F Q_{01}^F = \sum p_1 q_1 / \sum p_0 q_0$$

where P^F and Q^F are respectively the Fisher Ideal price index and the Fisher Ideal quantity index between two periods 0 and 1. It is this property and the fact that the quantity form and the price form are the same for this index, except that the prices and quantities are reversed between the two, that lead Fisher to call the index “ideal” [39].

3.2 *The Economic Approach*

In his 1992 presentation of the then forthcoming BEA alternative price and quantity indexes, Triplett [96] founded his analysis on the concept of the cost-of-living and upon Diewert’s [19] concept of the “superlative index number,” as an approximation to the “exact” (that is, conceptual) cost-of-living index. A member of this class of index numbers is the Fisher Ideal Index, which as shown earlier is the geometric mean of the Laspeyres and Paasche indexes. Among the properties of Superlative indexes in general and the Fisher index in particular is their justification as theoretically better measures of the cost of living. But, in saying this, it must be emphasized that the theory is best articulated in the case of the theory of the individual consumer. It is not so well developed for the theory of the firm, as the Franklin Fisher citation earlier

indicates.⁴ Moreover, it is becoming increasingly important to recognize that spatial applications are becoming more common: in the context of a progressively more interdependent world economy, bilateral and multilateral comparisons become more interesting. Similarly, in the context of a unified European Community, inter-regional comparisons become more relevant. And, of course, the United States is composed of 50 distinct political entities for which regional measurements to some degree exist; less obviously, the country can be divided into counties and other sub-divisions.

The perspective of the contributors to this special issue is that of users of quantity and price indexes for economic applications. There are three characteristics of the traditional (Laspeyres) output quantity measures that are now and have been attractive to US econometric model builders. Without attempting to assess qualitative precedence, the first is the property of additivity, the fact that they permit both nominal and real quantities to be expressed as simple aggregates. The well known GDP identity, in current value terms, is:

$$\mathbf{GDP\$ = C\$ + I\$ + G\$ + (X\$ - M\$)}$$

In constant values, it correspondingly is:

$$\mathbf{GDP = C + I + G + (X - M)}$$

Moreover, it is possible to write, essentially without constraint:

$$\mathbf{GDP\$ = PDGDP \cdot GDP}$$

$$\mathbf{C\$ = PDC \cdot C}$$

and so on, where **PDGDP** and **PDC** should be understood to be implicit price deflators, implicitly derived from the current and real dollar estimates. Note that:

$$\mathbf{PDGDP = PDC \cdot C/GDP + PDI \cdot I/GDP + PDG \cdot G/GDP + PDX \cdot X/GDP - PDM \cdot M/GDP}$$

The second attractive characteristic is simple time aggregation. In general, measurements that are annual in frequency can be computed simply by summing quarterly or monthly frequency measurements or if, which is more common, the higher frequency measurements are stated at annual rate, the annual measures can be obtained simply as averages of these. Rates of growth introduce a small complexity, inasmuch as annual compound rates are not simply the average of the quarterly or monthly rates, but must be computed in the same way as the conversion of monthly interest rates to or from annual rates.

Finally, the base weighted fixed index readily permits comparisons between any two periods on a consistent basis.

⁴ which is not at all to say that there has been nothing written on the subject; see, for example, Archibald [3], Caves et al [15, 16], Diewert [19, 21, 22], Diewert and Morrison [30], Samuelson and Swamy [89].

The principal defect of the traditional method of price deflation is that it is thought to introduce distortions⁵ as the underlying compositions change over time [12, 75]. The current “weight” of a particular type of good or service within the aggregate economy is its total aggregate value, measured simply as a proportion of GDP. As a pertinent case, consider goods, such as computers, that represent high technology, with the familiar characteristic of a fairly rapidly declining price over time, reflecting both the decreasing cost of production per unit of qualitative output, such as millions of instructions per second, in the case of a computer Central Processing Unit (CPU) chip, and rapidly expanding demand. *A priori*, given expanding demand and a falling cost of production, at least under competitive conditions, it can be expected that additional resources will be allocated towards the production of such goods. In contrast, note that an implication of the above formulae is that:

$$\mathbf{GDP}_t / \mathbf{GDP}_{t-1} = \sum \mathbf{b}_i (X_t / X_{t-1})$$

where:

$$\sum \mathbf{b}_i = 1$$

the \mathbf{b}_i representing the previous period share weights of the components of GDP; the components can be imagine either as representing expenditure categories or industry output originating. The lack of a dollar sign should be understood to imply that these are constant dollar amounts.

The fact that the base weighted Laspeyres quantity index inevitably embodies the fixed shares of the base period has meant that periodic rebasing has had to be done. An implication is that, unless the rebasing is carried backwards, simple additivity is thereby lost. Backward rebasing has historically been a feature of the US accounts, but this procedure is relatively rare outside the US [101, p. 35-36]. Of course, backward rebasing does not remove the problem of fixed base weights; it only shifts the problem away from the present to the past. The heuristic argument for chaining, instead of using a fixed weight deflator, is that it avoids the “substitution bias” of the fixed weight indexes: the presumption that quantity demanded of a good or service increases as its price falls, or decreases as its price rises, implies that the actual weighting shifts in favor of the one and against the other; a fixed weight index does not of course mirror these changes, but rather fixes the composition at the base point(s) in time.⁶ As Triplett points out [96, p. 50], to determine the practical implications of these presumptions is inherently difficult, notwithstanding the various attempts that have been made,

⁵ It is common to use the term “bias” to describe these distortions, but strictly speaking, as Diewert notes, “bias” as a property presupposes the existence of a “true” value, or sequence of values, relative to which the bias can be shown to exist. As Diewert points out [25, p. 268-270], there are at least five sources of bias identified in the literature, including “elementary price index bias,” the use of an inappropriate index number formula; “commodity substitution bias,” the distortion described in the text; “outlet substitution bias,” pricing identical goods from different outlets at different prices; “overlapping price quotes bias,” reflecting quality changes, and “new goods bias.”

⁶ Extended discussion of the associated issues can be found in Diewert [20, 24] and Hill [49].

including those by Aizcorbe and Jackman [1], Braithwait [12], and Manser and McDonald [69].

Demonstrably, one of the effects of the periodic rebasing undertaken by BEA in the past has been the effective rewriting of recent economic history. In particular, a result has been seemingly to lessen in retrospect the severity of past U.S. recessions. One of the primary reasons for BEA's adoption of the chain index in lieu of fixed weight is to avoid this effect. As Young [101, p. 35] asserts, "for most purposes, a fixed-weighted quantity index can only be considered appropriate for comparisons in which both of the years being compared have relative price structures that are approximately the same as that of the base year. Thus, real GDP in 1987 prices may only be appropriate for assessing the performance of the economy in the years around 1987, when the relative price structure resembled that in 1987."

3.3 Broader Issues

Commodity substitution bias is the keynote of this journal issue, for it is the *raison d'être* for the NIPA change to chained deflators. However, it is important not to lose sight of the fact that the particular choice of deflators, among alternative constructions, is only one aspect [18, 29, 74, 79]. As Diewert notes [25, p. 269], among possible "biases," commodity substitution is only one of a group that includes Elementary Price Index Bias, Outlet Substitution Bias, and New Goods Bias.⁷ Of these, the new goods bias may be most important. Indeed, he cogently argues that a characteristic of the modern economy, particularly during the past fifteen to twenty years, is the introduction of new goods and services. This dimensional expansion in the commodity space tends to be ignored in the development of economic analyses, and is difficult for economic statisticians to incorporate. Yet it also plays a role in the context of another major measurement issue: the assessment of productivity. As Diewert points out, "...improvements are no longer taking place only by production units achieving economies of scale but also by the application of science and technology through the creation of new products and new processes. It seems likely that statistical agencies have simply missed the improvements in our standard of living that are due to the increased number of commodities that consumers now have in their choice sets." [p. 270].

It is also pertinent that whereas the present focus is upon national macroeconomic models, that in fact the choice of price and quantity indexes is not just a domestic issue, particularly when viewed in a broader perspective. In the context of the development of accounts that will, or could be, used for international (or inter-regional) comparisons, particularly multi-lateral comparisons, there are several

⁷ Elementary Price Index Bias refers to the use of inappropriate index number formulae at the lowest level of disaggregation in the process of the construction of aggregate indexes; Outlet Substitution Bias occurs whenever the same goods or services found at different prices (generally at respectively high and low cost vendors) are treated as being *ipso facto* different; New goods bias results from the introduction of new goods not previously purchased. A good general discussion of many of the issues can be found in Deaton [18], Nordhaus [74] and Pollak [79]. A further distortion can exist in the case of seasonal goods; see Anderson [2], Diewert [26] and Hill [51] for a discussion of this.

important considerations, as outlined by Diewert [25, p. 249] in the context of his summary of an analysis by Peter Hill [50]:⁸

- “There can be large differences in the size of countries being compared. This makes it more difficult to apply the economic approach to index number theory, which relies on assumptions about the homogeneity of tastes or technology.
- “Countries are modifiable units. They can be partitioned into smaller countries or they can be merged into larger blocks. This raises issues of weighting. For example, comparing Canadian output with Mexican output in a North American multilateral framework should (perhaps) be invariant to whether the United States is treated as a single country or fifty states.
- “Price and quantity movements tend to be gradual in the inter-temporal context (and this makes the application of the chain method attractive). This is not the case in the international context. Therefore, the choice of index number formula will matter more in the multilateral context. Hill [50, p. 393] also pointed out that there is no natural counterpart to the chain principle in the multilateral context.
- “Hill [50, p. 394] noted that it is more difficult to collect price information in the multilateral context. In the inter-temporal context, the price of commodity n in period t , p_n^t , can be in any unit of measurement, as long as that unit is not changed over time. In the multilateral context, the international prices for commodity n , p_n^t , must be measured in exactly the same physical units across countries i . This harmonization of units of measurements may be very difficult to do across country statistical agencies. Moreover, the list of commodities to be sampled at the elementary level should be exactly the same across countries. The requirement for a standard list of representative commodities to be priced by all statistical agencies in the block of countries under consideration is impossible to meet if the countries are diverse.
- “Finally, Hill [50, p. 395] noted that price or volume indexes in the multilateral context typically are required to be transitive--that is, if we compare countries i and j directly, this comparison should be the same as if we were to compare i with k and then k with j . Put another way, no single country should play an asymmetric role in forming the system of multilateral indexes. Hill [50, p. 395] explained the difference between the inter-temporal and multilateral situations as follows: ‘Transitivity is not important in a time series context because time periods form an ordered sequence. For this reason there is little interest in direct comparison between all possible pair of time periods. Direct comparisons tend to be confined either to comparisons with a selected base period, typically the first period in the sequence (leading to fixed base Laspeyres or Paasche indexes) or to comparisons between consecutive time periods (leading to chain indexes). Comparisons between other possible pairs of periods are not usually needed or undertaken.’”

⁸ Additional discussion of some of these issues can be found in Diewert [25, 27].

4. Other NIPA Changes

The reaction of users of the US national accounts to the 1995 mid-decade benchmark revisions has principally been focused upon the adoption of chain-weighted indexes and the individual contributions to this special issue reflect this emphasis. However, other significant changes in the methodology of the accounts include [76]:

- a new treatment of government expenditures by subdividing it into consumption and investment. An effect is to include in Investment both private and public sector expenditures and thus to provide greater symmetry in accounting for each of these sectors.
- a new methodology for calculating depreciation. Straight line depreciation patterns have been replaced by estimates based upon the prices of used equipment and structures. Essentially, for equipment cohorts, the change represents depreciation occurring annually by an equal percentage instead of by an equal amount.⁹

The measurement of investment and the capital stock is important in its own right and rests upon the question of composition. Traditionally, equipment and structures have constituted “capital” in the economic accounts. However, considering capital in the sense of wealth raises the question, recently addressed by Eisner [36], whether this measure should not also include natural resources, as well as a variety of intangible assets that might include both computer software and human capital. In addition, there is also the issue of who is making the investment: in particular, government expenditure on infrastructure and other capital “public” goods is arguably important both in itself and as a potential stimulus to economic growth [81]. BEA has estimated that the inclusion of mineral resources in the capital stock would add between \$480 and \$910 billion to the stock of fixed capital (5 to 9 percent of that total), research and development capital between \$1050 and \$1380 billion (10 to 13 percent), and government capital \$2863 billion (28 percent).¹⁰

Underlying these changes is the intention of the Bureau of Economic Analysis to progressively harmonize the US accounts with the UN’s System of National Accounts (SNA). This process will also involve greater integration of the Income and Product Accounts with the Federal Reserves Flow-of-Funds accounts and the Input-Output accounts, involving, among other things, a more integrated framework for analyzing the real and financial sectors of the economy. Such changes are beyond the scope of this special issue, but it is important to recognize the context in which the particular methodological changes being made are being made.

⁹ As noted in Parker and Seskin [76, pp. 25-26], “In particular, studies of used equipment prices have almost always found that the dollar amount lost in the first year is greater than that in the second year, which is, in turn greater than that in the third year, and so on. Thus...each year, prices of used equipment tend to decrease by an equal percentage rather than by an equal dollar amount.”

¹⁰ These estimates are taken from the background paper *Mid-Decade Strategic Review of BEA’s Economic Accounts, Paper II: Economic Change and Economic Accounts* [13], pp. II-20 ff.

5. Conclusion

As indicated at the outset, the reaction of this special issue's contributors to the change from fixed weighted to chained indexes ranges from enthusiasm to some degree of discomfort at the loss of attractive properties, such as additivity. However, it is obvious that in the context of an economy, such as that of the US, that is experiencing rather rapid technological change, compositional changes are occurring. With the example of computers so readily to hand, it is difficult to argue otherwise. Thus developers of macroeconomic models have tended, albeit in some cases grudgingly, to accept the need to make the changes necessary to incorporate chain indexes into their models. In fact, the relative equanimity displayed by the contributors in the face of change implicitly reflects the general recognition that the National Income and Product Accounts, as they exist today, are evolving in a logical fashion, even if they are not yet ideally suited to the economist's purposes. There is evident recognition that the construction of the models must conform with and reflect the structure of the accounts, rather than to represent an attempt to impose an alternative, possibly more elegant specification by brute force.

This process of adaptation should be seen, as indicated earlier, as a stage in the collaborative evolution of both economic accounts and macroeconomic models. Richard Stone, in his Noble Memorial Lecture [92], has characterized this process as beginning with a statement of measurements, organized as a coherent set of accounts, to which are added behavioral theories to form a model, the model presumably defined so as to be able to express the effect or effects of particular policies, which lead to plans. The plans, confronted by events, will often be frustrated, leading to revision and rethinking. This process will involve the collaboration of the economic statistician, economists, politicians, and administrators, a diverse group with a variety of motivations and concerns. A critical issue is improving the communication between them, especially inasmuch as restatements and revisions will need to be made at any and all stages of the process. Moreover, at the measurement stage, differences in treatment, such as the valuation of commercial transactions at market price, government services at cost, and unpaid household services at zero, often reflect practical requirements rather than matters of principle. Anomalies abound, ranging from the famous, the man who marries his housekeeper, to the prosaic, an automobile as a investment if purchased by a firm or "consumption" if by an individual.

A particular difficulty is the increasing disciplinary complexity, which makes the separation of specialties a progressively greater barrier to communication. There was a time in the not too distant past that a single bookshelf could hold the pertinent works on national income accounting, econometrics, and economic theory, including public finance, monetary theory, and the principles of economics. Each of these topics now requires at least a bookcase, with another bookcase devoted to computation. One effect, for example, is that macroeconomics textbooks no longer, as a matter of course, contain a chapter on economic accounting; this can be seen as presaging a future in which economists become progressively more scholastic, divorced from even recognition that there are measurement problems. But there is also welcome evidence of growing appreciation of the need for the careful, integrated reporting of results: for instance, writing in the *Journal of Economic Theory* on the role of computation in economic theory, Bona and Santos [6] have recently argued for more complete

reporting in economic journals concerning the data used and the calculations made, noting with respect to journal articles that deleting this information “and substituting a reference to the author(s) [or a separate supplementary archive] for further details does not lead to a satisfactory state of affairs. If the relevant details are not in the permanent record, it is nearly certain that they will be lost in due course, and perhaps before the article’s useful lifetime is exceeded” [p. 267].

The limited aim of this special issue is to bring together statements by representative model builders of the effects on their work of a particular change in the data base that underlies that work. In many respects these are preliminary assessments of the effects, and should be so judged. This tentativeness reflects both the time it takes for data users to evaluate and adjust to constructional changes and the likelihood of future changes. During the next ten years, the prospect is that a number of changes will occur in the structure and presentation of the U.S. National Accounts. These changes will be stimulated by the increasing integration of the world’s economies, which will increase the importance of the accounts as a means of assessing economic performance in that context, as well as by the ongoing need to define the state of the domestic economy on its own. Inasmuch as there is a symbiotic relationship between these accounts and economic concepts, it is important that both data producers and users actively collaborate in their ongoing development.

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