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THE MISMEASUREMENT OF ECONOMIC GROWTH

Martin J. Bailey

INTERNATIONAL CENTER FOR ECONOMIC GROWTH

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PREFACE

The International Center for Economic Growth is pleased to publish *The Mismeasurement of Economic Growth*, by Martin J. Bailey, as the twenty-third in our series of Occasional Papers, which features reflections on broad policy issues by noted scholars and policy makers.

In this paper, Dr. Bailey discusses how current economic methods understate the gains an economy makes from policy liberalization. Much of the mismeasurement is due to the technique of distinguishing between changes in pricing and actual increases in national product or national income. Other discrepancies can occur in the choice between measuring production or measuring consumption and investment.

Dr. Bailey is a distinguished scholar who has made theoretical contributions in public finance and macroeconomics and provided useful insights about the practical implications of the uses of economic policy tools. We are confident that his contribution will be of interest to policy makers and researchers in all countries, developing or developed, that are engaged in deregulation of an economy. This topic is particularly relevant to developing and centralized economies undergoing a policy liberalization. If the measured gains from liberalization are small, there may be little incentive to continue the program in the face of any opposition. It is important to know if the measure is inaccurate and the actual gains are greater than those measured.

Nicolás Ardito-Barletta
General Director
International Center for Economic Growth

Panama City, Panama
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ABOUT THE AUTHOR

Martin J. Bailey is professor of economics at Emory University and has previously held this position at the University of Maryland, the University of Rochester (where he was also associate dean of management), and the University of Chicago. He has also held senior posts in the U.S. Departments of Defense, Treasury, and State. Dr. Bailey is the coeditor of *The Taxation of Income from Capital* with Arnold C. Harberger and is the author of *National Income and the Price Level, Reducing Risks to Life: Measurement of the Benefits,* and numerous articles.

MARTIN J. BAILEY

The Mismeasurement of Economic Growth

During the 1980s we have seen or heard many accounts of how badly socialist and heavily regulated economies have performed, of how well the free economies have performed, and of dramatic gains for economies that have moved toward liberalization. These accounts have come not only from economists and scholars, but also from political leaders and journalists, among whom it has become fashionable in recent years to talk about "the magic of the market." To those of us familiar with the themes presented in Adam Smith's *Wealth of Nations* and with their more recent technical elaborations, the new revelations may be greeted either with wry satisfaction or with concern that the new fashion is neither profound nor likely to be long lasting.

If we also look at the data on real growth rates, it is surprising to find that there doesn't seem to be much difference. The differences in reported growth rates between the free economies, as a group, and the socialist economies on which we have reasonably good data, as a group, are surprisingly unimpressive, especially compared with the variability within each group. The numbers are doubly surprising because both basic economic reasoning and the striking anecdotal accounts lead us to expect much more. Should we conclude that unsound, oppressive economic policies have little measurable effect on real

growth and that the enthusiasm behind much of the anecdotal information is overblown?

In fact there is a potentially measurable effect on real growth, but the conventional measures fail to show much of it. They understate it for two main reasons. First, because the usual measure is real gross national product (GNP), not real national income or income per capita, it omits some of the gains from more efficient resource allocation and all the gains from trade in consumer goods. Second, customary procedures for obtaining index numbers systematically understate real change and overstate inflation; this bias is stronger for free, fast-growing economies than for tightly controlled, slower-growing economies and is stronger still for newly liberalized economies. Data have not generally been collected that would provide accurate estimates of these biases, but there is reason to believe that they are substantial.

These measurement problems are distinct facets of the general problem of determining how much of the growth of national income or product, in nominal terms, is real growth and how much is merely an increase in the general level of prices. As we know from the literature on index numbers, different techniques for making the separation can give different results. Apart from the effects of foreign trade, it also makes a difference, in a distorted, inefficient economy, whether we make the separation with production or with consumption and investment—that is, whether we use prices paid by end users or prices received by producers.

Impressions and Indications

Stories are now commonplace about the rapid growth of the most successful Asian economies—Japan, Korea, Taiwan, Singapore, and Hong Kong. In the cases of Hong Kong and Singapore—island economies with few natural resources other than their resourceful people—internal and external trade are almost completely free. The other three are notable for having shifted policy, sometime after World War II, toward encouragement of exports and relatively unrestricted internal trade; all three, however, restrict imports severely. Recently there have also been enthusiastic news stories about the effects on other low-income economies of new policies liberalizing trade and reducing in-

ternal regulation. Ghana and Mauritius are notable examples. There are also anecdotes about economies that have remained heavily statist and have stagnated; and there is extensive scholarly research, as well as ample news coverage, of the waste and disruption associated with price supports and trade manipulation of the agricultural policies of the developed industrial countries.

These impressions, not widely shared in earlier years, have gained much wider currency because of the striking experience of the 1980s. The relatively free developing economies, especially those in Asia, seem to be enjoying rampant prosperity and growth, whereas the more interventionist, socialist economies of the third world are suffering stagnation, continuing poverty, and debt. In Europe the high-price agricultural programs have shifted their economies from net importers of most farm commodities to net exporters of several major ones; whereas the disastrous low-price agricultural policies of Egypt and most of the rest of Africa have shifted several of those countries from net exporters to net importers of food. The shift to heavy intervention in labor markets in western Europe was followed by heavy unemployment throughout the region in the 1980s, compared with the low and falling rate of unemployment in the United States.

All these developments have been reported widely and have been appreciated as examples of bad policy in a much broader audience in the United States than had previously been the case.

Growth Rates of Real Output

The general impression given by this information, mostly anecdotal, is that a dramatic increase in living standards and growth is a result of a shift from economic statism to relatively liberal policies, and that the opposite shift is costly for living standards and growth. One might think, therefore, that the regularly published data on growth rates would show striking differences between the countries that intervene heavily in their economies and those that intervene less or intervene very little. In fact, there are differences in the expected direction, but in many cases they are surprisingly modest and hard to separate from the variations in growth rates due to other influences.

Consider, for example, the following data from the leading industrial countries, shown in Table 1. The data are shown for two periods, 1950 to 1970 and 1970 to 1988, to highlight the general drop in growth rates around 1970. There was also a political change. West German economic policy had been noninterventionist and noninflationary before 1970. In the 1970s a Socialist election victory was followed by a major expansion of social legislation, especially important in the labor market, where it became costly and difficult to dismiss workers. Similar legislation was also passed in other European countries that had been highly interventionist in the earlier period.

The relatively high growth rates of the earlier period mainly reflected the rebound from the devastation of World War II. Note the high growth rates in that period for West Germany and Japan, whose economies suffered especially severe war damage. This large rebound effect makes it hard to identify any effect of economic policy in comparing the growth rates of the various countries in this period.

Nevertheless, the later period gives us two comparisons relevant to the issue at hand. First, we can compare the two relatively free economies in that period, Japan and the United States, with the others. Second, we can compare the change in West Germany's performance from the first period to the second with the corresponding change for the other European countries; this comparison can tell us something because West Germany shifted from a relatively free market policy to a heavily interventionist policy, of the type the others had in both periods.

Looking at the first of these two comparisons, we find that in the period after 1970 the average of U.S. and Japanese growth rates was higher than the average of growth rates for the four European coun-

TABLE 1 Comparative Growth Rates in Industrial Countries, 1950–1988 (percentage)

	West Germany	Japan	United States	Average of France, Italy, and United Kingdom
1950–70	6.64	10.20	3.54	4.71
1970–88	2.29	4.38	2.76	2.58

SOURCE: Japan, 1950–1955, from G. C. Allen, *Japan's Economic Expansion* (Oxford: Oxford University Press, 1965). All other data from International Monetary Fund, *International Financial Statistics* (Washington, D.C.: IMF, various years).

tries. It is hard to be much impressed by this small difference, especially when one considers the variability from one country to another and from one time to another in these rates.

The second comparison seems to be a little more telling. Before 1970 West Germany's growth rate was higher than the rates in the other three European countries (though not as high as Japan's), whereas after 1970 West Germany's growth rate fell below the three-country average. This comparison reinforces the impression, drawn from the first comparison, that there was a growth effect connected with state intervention. However, a third comparison fails to reinforce this impression—the drop in West Germany's growth rate after 1970 was smaller than the drop in Japan's. Thus, it is possible that we are seeing nothing more than random differences in the slowdown from the rebound after World War II.

By contrast, the data from the newly industrializing countries of Asia show a more clear-cut advantage for their relatively open economies. Table 2 shows that their growth rates since 1960 compare favorably with both the rates for developing countries in general and the rates for the developed countries shown in Table 1. From 1960 to 1980 the four Asian "tigers" had average growth rates between 8.8 and 9.8 percent, compared with 5.45 percent for all developing countries as a group. Among the developed countries, only Japan is comparable, with its heavy rebound element in the earlier 1950–70 period. In the more recent period after 1980, when recession lowered growth rates almost

TABLE 2 Comparative Growth Rates in Developing Countries (percentage)

	Singapore	Taiwan	South Korea	Hong Kong	Developing countries
1960–1980	9.19	9.29	8.85	9.75	5.45
1980–1987	8.03	—	8.66	7.01[a]	1.80

a. 1980–84.

SOURCE: South Korea and Singapore from IMF, *International Financial Statistics*, various years. Taiwan from Samuel P. S. Ho, *Economic Development of Taiwan* (New Haven: Yale University Press, 1978), 123–25, and Shirley W. Y. Kuo, *The Taiwan Economy in Transition* (Boulder, Colo.: Westview Press, 1983), 201. Hong Kong from Gavin Peebles, *Hong Kong's Economy* (Oxford: Oxford University Press, 1988), 4, 45. Developing countries from International Monetary Fund, *World Economic Outlook* (Washington, D.C.: IMF, various years).

worldwide, the four Asian countries outgrew all others. Although the growth rates in these four countries did slow down, it is striking how little they slowed compared with other countries.

A puzzle here is why these Asian countries did so much better than the United States and Japan in recent years, when the policy environments were broadly similar in all six countries (Hong Kong and Singapore have had the nearest thing to free trade, whereas South Korea and Taiwan, like Japan and other developed countries, protect their agriculture and depart substantially from free trade in other ways). Although the policy environment may be a major influence on comparative growth rates, it is evidently not the only one.

Another related comparison that tells a similar story comes from the data for the small number of countries that have opened their economies and have shifted sharply in the direction of freer internal and external trade within the past fifteen years. In Table 3 and hereafter we refer to this shift as liberalization. The liberalizations occurred between 1975 and 1983, and the comparative base periods vary according to the availability of the data. The gains following liberalization range from 1.2 to 2.9 percent in the annual growth rate, but we should note that this improvement occurred when the world was in recession and ran counter to the poor experience of developing countries as a group. There is also a problem in the comparisons because of the specific base dates. For example, both Ghana and Turkey began their liberalizations in 1983, when the world economy was in reces-

TABLE 3 Effect of Liberalization on Growth Rates in Less-Developed Countries (percentage)

	Chile	Ghana	Mauritius	Turkey
Preliberalization	2.61	1.52	3.1	5.2
Postliberalization	3.85	4.43	5.4	6.6
Dates:				
Preliberalization	1950–75	1960–83	1960–80	1960–83
Postliberalization	1975–87	1983–87	1980–87	1983–87

SOURCE: IMF, *International Financial Statistics*, various years.

sion; consequently, the earlier period shows a lower growth rate and the later period a higher rate than would have been the case if world economic activity had been higher in 1983.

Taken together, these data suggest that liberalization pays, but that it is hard to predict how large the benefit will be. If we had to forecast the improvement in growth a country would enjoy as a result of liberalization, it would seem safe to forecast an improvement of 1 to 3 percent, compared with how well it would do otherwise. However, one could not have high confidence that the result would fall in even this relatively wide range. Clearly, the result varies with circumstances, and the effects of special circumstances usually cannot be foreseen. Why was Chile's improvement so small compared with other countries? Why are the differences so small among the developed countries? Of even more interest to our present inquiry is the question, why are these gains so modest in comparison with the anecdotal stories of dramatic gains from liberalization?

The Measurement Problem

When a country liberalizes, a flood of imports enters the country, giving consumers the opportunity to buy modern foreign products that had previously been unavailable. Marketplaces that were previously rather colorless come alive with a diversity of goods. In many cases long waiting lines for necessities disappear. None of these changes are reflected in the data in Tables 1, 2, or 3.

The omission is serious but not surprising. Trying to capture all these changes with systematic data is extraordinarily difficult, would strain the resources of national statistical agencies, and would overstretch their technical capabilities. In fact, the types of changes involved are not dealt with properly in the developed countries; the statistical agencies in the United States have begun only a partial, cautious effort to deal with them. The natural conservatism of statistical agencies in most countries leads to an understatement of growth and to a particularly severe understatement of the impact of new products. Convention has also settled on a standard measure of growth that overlooks the effects of trade on the standard of living.

In spite of this, various past special studies of U.S. data provide us with valuable insights into the scope of the problem, particularly in connection with durable goods such as automobiles, household durables, and factory equipment. The problems of measurement affecting the standard growth data, on which these studies shed some light, are the following: (a) the introduction of new, improved models of previously existing products, (b) the introduction of entirely new products, and (c) the gains from trade.

New, improved models. Data for the United States are relatively plentiful on the problem of accounting for quality change in durable goods, because of a long series of studies and an active controversy about it. The main focus of this type of work has been on the proper measurement of price change in the major price indexes, such as the consumer price index. To the extent that measured price changes contain an element of quality change, the corresponding index of real output will be understated. The experience of the United States with this issue is therefore directly relevant to the measurement of growth in other countries where the measurement problem has scarcely been investigated.

With household durable goods (and other durable goods throughout the economy) a conventional index of price change has to cope with a continuing series of improvements and modifications of successive models. The typical pattern is that last year's standard model becomes this year's economy model, soon to be reduced for clearance and termination of production. Last year's premium model becomes this year's standard model, last year's deluxe model becomes this year's premium model, and a new, more elaborate deluxe model enters the line this year. Table 4 illustrates this progression with a hypothetical case, which could be a line of refrigerators or television sets.

The traditional procedure in decades past at the Bureau of Labor Statistics, and at other price-gathering agencies, was to use the price change for the top of the line, the standard item, and the economy item each year, comparing nonidentical items. In the table, the price changes obtained by this traditional procedure appear in the column headed "price change by rank order." It shows the price difference between the new deluxe model of 1990 with Model A, which was the top of the line in 1989, is a 23 percent increase. Similarly, the price

TABLE 4 Price and Quality Change in New Models

	Price ($)		Price change by rank order (%)	Price change by item (%)
	1989	1990		
New deluxe	—	430	23	
Model A	350	360	31	3
Model B	275	240	37	-13
Model C	175	—		

difference between Model A in 1990 (the standard model in that year) and Model B in 1989 (that year's standard model) is a 31 percent increase, and the corresponding change for the economy model is a 37 percent increase.

On the other hand, Model A was available both years, and its price increased by only 3 percent, and the price of Model B fell by 13 percent. Thus, in this example, the traditional procedure had a strong and consistent inflationary bias in its measure of price change. It confused a quality change with a price change. Meyer Burstein, in an early study of the demand for refrigerators, constructed his own price index, using catalog prices of identical models in adjacent years, which showed a substantially lower rate of price increase than that for refrigerators in the consumer price index. A whole series of subsequent studies using various methods measured the same type of bias for several other durable goods.[1]

Taking these studies together, and extrapolating them to other consumer durables, suggests that until 1960 the effect of this type of bias on the consumer price index was to add almost 2 percentage points a year to its estimate of inflation. In response to the studies, including some studies within the statistical agencies of the U.S. government, this bias problem is said to have been largely corrected (the remaining bias in the CPI

1. M. L. Burstein, "The Demand for Household Refrigeration in the United States," in Arnold C. Harberger, ed., *The Demand for Durable Goods* (Chicago: University of Chicago Press, 1960); Zvi Griliches, "Notes on the Measurement of Price and Quality Changes," *Studies in Income and Wealth* 28 (Wahington, D.C.: National Bureau of Economic Research, 1964); and Jack E. Triplett,"Price Index Research and Its Influence on Data: A Historical Review," presented to the 50th Anniversary Conference, Conference on Research in Income and Wealth, May 12–14, 1988.

due to all other quality changes, such as that in older rental housing and that in medical care, is uncertain and controversial).[2]

New products. The top of the line each year, in the above example, presents a special problem that can be dealt with using the "hedonic" method, that is by comparing its characteristics with those of the older models and estimating a value for each characteristic from market data.[3] Occasionally, however, an "improved new model" of an item of durable equipment may be so superior that it immediately replaces the old items in new sales. In a more extreme case, a new durable good is unlike anything that preceded it. In these types of cases, the methods that use identical or similar models in successive years will fail to separate price change from quality change successfully. Traditionally, statistical agencies simply ignore new products until they take a significant share of sales. This is understandable, because many new products fail the market test and disappear. Our failure to make retrospective corrections for products that become important in consumer lifestyles or that take a significant share of a market for producer durable equipment imparts an additional inflationary bias of unknown size to price statistics. It could be comparable to the new models bias just discussed, but without the pertinent data one can only speculate about the importance of this new products effect.

An example that sheds some light on this problem is the appearance of television sets in the U.S. market from 1948 onward. In late 1948 small TV sets were offered in a few department stores as luxury items, and few people felt they could afford them. For the next two years the available sets became progressively bigger and cheaper, until by the end of 1950 they sold to a mass market through a wide variety of retail outlets. The Bureau of Labor Statistics introduced them into the consumer price index in December 1950. One can find price quotations in advertisements in the newspapers of that period, although at

2. See Triplett, *Price Index Research*, and Phillip Cagan and Geoffrey H. Moore, *The Consumer Price Index* (Washington, D.C.: American Enterprise Institute, 1981).

3. See Griliches, "Notes on Measurement," and Triplett, *Price Index Research*, on the hedonic method.

this distance it is impossible to find strictly comparable models or make the appropriate quality adjustments.

Nevertheless, a selection of representative price quotations from that period is illuminating. Table 5 has newspaper quotations for table models only, picked as nearly as possible for the middle of the price range and similar in features and appearance to the previously quoted model of the same size or next smaller size. Linking together the price changes of same-sized models and using the apparent relationship between price and screen size on given dates, I imputed the price of a seventeen-inch model for each quoted date, as shown in the right-hand column. The resultant estimated price index fell by a factor of five—that is, to less than 20 percent of its initial value, over this two-year period. In the forty years since 1950, the prices of television sets have been comparatively stable while the CPI rose severalfold, so that the relative price of the former has again fallen by roughly a factor of five. That is, the relative price of TV sets fell as much in the two years before they entered the CPI as it fell in the subsequent forty years, if the estimated price index in Table 5 is approximately correct.

If one could estimate the demand curve for TV sets during the period when they were just coming onto the market, one could then estimate a Divisia index of price and quantity change. (A conventional "Laspeyres" price index uses the same set of quantities of goods, kept constant for several years, as fixed weights in a weighted average of price levels or price changes. By contrast, a Divisia index

TABLE 5 Prices of Table Model Television Sets, 1948–1950 (dollars)

	10 inch	12 inch	14 inch	17 inch	Imputed 17 inch
December 1948	349.95	—	—	—	735.00
June 1949	269.95	—	—	—	565.00
December 1949	189.95	249.95	—	—	390.00
June 1950	—	108.95	148.95	—	190.00
December 1950	—	—	—	139.95	140.00

SOURCE: *New York Times* and *Washington Post*, on or about the fifteenth of the reported month.

changes those weights smoothly and continuously when product sales respond to price changes.) When quantity is changing rapidly, frequent adjustment of the quantity base, as is done (continuously) in the Divisia price index, provides a reasonably good approximation of price change and real output change from the standpoint of consumer welfare. The approach used in Table 5, however, was a repetition of the overlapping models method, with some interpolation—a rough and ready approximation to the hedonic method of adjusting for quality change. In some cases there is too little overlap for this approach to be usable, and some other way must be found to correct for quality change. Such cases arise mainly in producers' durable equipment rather than consumer goods, however, and are less relevant to our present inquiry. The treatment of such problems is of interest in some cases, though, and it raises issues that we need to consider.

A significant and startling example of the new models problem is the experience over the past thirty-five years with computers—always a producers' durable good but now also a consumer good. During the three decades before 1985 a rapid sequence of new computer technologies entered the market so rapidly that a steady equilibrium was never reached. Although in most pairs of adjacent years some models were common to both years, new models were constantly crowding out the oldest one still being produced. Prices fell for the old models, but delays in the dissemination of user knowledge of new machines and other adjustment delays, meant that the prices of old models fell somewhat more slowly than they would have had to to stay fully competitive with the new models. Under these conditions, better estimates of price changes are obtained by estimating implicit prices of the characteristics of the products, such as speed and memory size, by hedonic methods.

Table 6 shows some results from the underlying work that led to the official computer price index introduced in the 1985 revision of the GNP accounts, retroactively to 1969. For the matched models method discussed above in connection with Table 4, Table 6 shows average price declines for the years 1972–1984 of 8.5 percent for processors, 6.9 percent for disk drives, 3.5 percent for printers, and 1.3 percent for displays. For three alternative hedonic approaches (the first of which includes the matched models price changes on a weighted basis, whereas the other two simply include all models in the data set for the

TABLE 6 Average Annual Price Declines for Computer Equipment, 1972–1984 (%)

Calculation method	Processors	Disk drives	Printers	Monitors
Matched models	8.5	6.9	3.5	1.3
Hedonic				
Composite	17.8	12.6	13.7	7.3
Characteristics	17.6	12.6	10.4	7.7
Regression	19.2	16.9	15.5	7.3

SOURCE: Rosanne Cole et al., "Quality-Adjusted Price Indexes for Computer Processors and Selected Peripheral Equipment," *Survey of Current Business* 66 (January 1986): 49.

overall methodology), the price declines run from twice as large to several times larger. Consequently, in times of rapid change, the effect of new models is greater than the matched models method indicates. In the case of computers, the long delay before the problem was addressed in the United States has resulted in an appreciable understatement of U.S. economic growth. In other cases of new goods, hidden growth also remains outside the available indexes.

Furthermore, the above calculations may have failed to account for all the improvements in computer design that are not easily represented by such simple measures as speed and memory size. Some studies that seem to account for these improvements more completely have shown average annual rates of decline of computer prices as great as 50 percent or more.[4] However, the more extreme results must in part be discounted for failing to allow for software development costs that are associated with new equipment. The hedonic approach may be supposed to allow, implicitly, for these costs because such costs reduce what users are willing to pay for improved new equipment.

In the case of producer goods, conventional index-number construction sometimes leads to even greater overstatement of price increase, and consequent understatement of growth, from the standpoint of the eventual value of the producer goods to consumers. The tradition in index-number construction for producer goods has been to base

4. See Jack E. Triplett, "Price and Technological Change in a Capital Good: A Survey of Research on Computers," in Dale W. Jorgenson and Ralph Landau, eds., *Technology and Capital Formation* (Cambridge: MIT Press, 1989), esp. Figure 2, from a study by Victor L. Peterson, Ames Research Center, NASA.

the change in "quantity" involved, in the substitution of a new machine for the one previously sold, on the difference in cost of production of the two machines, regardless of their comparative productivities. This procedure is controversial because the sudden replacement of one machine by another in the list of machines sold to users means that the new machine is markedly superior, out of proportion to its relative cost. For some applications in production analysis, the traditional comparative cost approach may have some merit. But for applications to consumer goods, that cannot be the case. What is relevant to our present inquiry is the value of new products as perceived by consumers, regardless of their comparative costs. Similarly, for our present inquiry, the potential productive power of producer goods to provide goods to consumers is the appropriate concept for measurement.

The distinction between these two approaches is illustrated in Table 7. A new machine, whose output is 200 units, comes on the market in place of an old machine with an output of 100 units. Suppose that the ratio of net marginal products is also two to one. Because the new machine has a production cost of only 130, compared with the old machine's 100, production of the old machine stops immediately. Suppose that the new machine sells for 130 in the new period, and that the old machine previously sold for 100. Under the relative cost approach, a new machine would be considered to be 1.3 times as much machinery as one of the old machines, and accordingly the price index for this type of machine would be held unchanged. From the viewpoint of the user, however, the new machine is as much machinery as two old ones, and the user pays only 130 for a new machine rather than 200 for

TABLE 7 Quality Change Adjustment: Relative Cost versus User Value

	Old	New
Output per machine	100	200
Unit cost of production	100	130
Quality change based on relative cost	1.0	1.3
Price change using relative costs		0
Quality change based on user value	1.0	2.0
Price change using user value		-35%

two old ones. The user would see the relative price for the new period as 1.3/2 = 0.65, or a price decline of 35 percent.

Summary of the U.S. measurement problem. The fragmentary information that we now have does not permit reliable estimation of the biases in the data on U.S. real economic growth. It does suggest, however, that substantial problems remain. The Bureau of Labor Statistics relies primarily on the matched models method to correct for the quality change of those durable goods included in the consumer price index, which is a big improvement on the previous traditional method. For economists who are not intimately familiar with the details of how particular goods are dealt with, it is impossible to estimate the remaining biases (not all of which work in the same direction). For our present purposes, it is enough to note that at one time the bias in the CPI appears to have been as high as 2 percent per year, and may have been higher due to delays in introducing new goods into the index. Research on problems in the producer price index seems to indicate an even greater bias in that index, because it covers only durable goods and because new equipment and new technology pervade the goods covered.

As a result of this work, it is fair to suppose that real growth in the United States was underestimated by several percent per year in the years before 1960, and by a lesser but still appreciable amount since then. It is therefore also fair to suppose that errors of measurement in other countries, especially the less developed ones, are even more serious and understate real growth to an even greater extent in those cases where new products come into the market as freely as they do in the United States. By contrast, highly regulated, statist economies that do not have comparable flows of new products and that manipulate their price indexes to understate endemic inflation, will have less of this type of bias and may overstate their real growth rates.

Gains from trade. A final measurement problem of particular concern is that we customarily measure the growth of real GNP or gross domestic product (GDP) rather than the growth of real gross national expenditures. GNP and GDP include exports but not imports, whereas expenditures do just the opposite. Therefore, the growth rate as conventionally measured omits much of the growth in the gains from trade. For

the United States this difference is unlikely to be important, both because imported goods are a comparatively small part of total expenditures and because the new products are no more significant in our imports than in our exports. For a developing country that liberalizes a highly restrictive trade regime, however, the difference is crucial. By restricting trade it has restricted the gains from trade; by liberalizing, it quickly increases these gains. The conventional growth measure entirely excludes the part of this effect that goes with increased imports of consumer goods.

The effect of the gains from increased trade on the measurement of welfare gains can be illustrated by a hypothetical, highly stylized case of a country, "Cumulanis," that exports raw materials before liberalization and a wider range of products afterward. Table 8 shows the country's pre- and postliberalization internal price structure, production, and trade for cotton, vegetables, and refrigerators. Before liberalization the country exports only cotton and imports only vegetables, while producing cotton, vegetables, and refrigerators for the domestic market. The agricultural products are priced domestically at prices equal to those on the world market, whereas domestic refrigerators are priced at five times the world price at the going, highly overvalued exchange rate. Output, in physical units, is 100 units of cotton, 50 units of vegetables, and 10 units of refrigerators; the consequent nominal GNP in units of local currency is 20,000, and exports and imports are each valued at 5,000.

TABLE 8 Pre- and Postliberalization Prices and Outputs in Cumulanis

	Cotton	Vegetables	Refrigerators	GNP accounts
Preliberalization				
Prices	100	100	500	100
Output (real)	100	50	10	(20,000)[a]
Exports-imports	50	-50	0	(5,000)[a]
Postliberalization (third year)				
Prices	200	200	200	200
Output (real)	120	110	0	(46,000)[a]
Exports-imports	70	10	-80	(16,000)[a]

a. Nominal GNP in local currency and current prices.

At liberalization the local currency is devalued to half its previous international price, and the world price is passed through to all products. Agricultural prices double, and the price of imported refrigerators is now two fifths of the old domestic price. Agricultural output increases in response to these prices, and domestic refrigerator production disappears. Cotton exports rise to 70, and the more than doubled vegetable crop can now satisfy the domestic market and be partially exported. Foreign trade rises from 25 percent to 35 percent of GNP. Because of the devaluation, and because refrigerators have disappeared from output, GNP prices double. However, measured nominal GNP more than doubles. Efficiency gains from the liberalization of agricultural prices and of all trade bring a total increase of 15 percent in real GNP over the three years. Real income increases even more, however, because domestic consumption of cotton and vegetables are unchanged, while purchases of new refrigerators (now of higher quality) have risen from 10 to 80.

Table 9 presents the gain in apparent real income (with no quality adjustment for the refrigerators) and that in real GNP for comparison. The GNP deflator has doubled to 2.0, and real GNP has risen by 15 percent to 23,000. By contrast, a conventional Laspeyres price index has risen to just 1.6 because it includes refrigerators. Deflating nominal expenditures (GNP) by this figure gives real expenditures of 28,750, a rise of almost 44 percent. For comparison, one can also deflate with a Paasche price index, which measures price change retrospectively using current quantities as weights. This index gives more weight to refrigerators and has risen only to 1.44. Using it as deflator gives a

TABLE 9 Gains in Real Output and Real Income

	Base year	Postliberalization
Nominal GNP	20,000	46,000
GNP deflator	1.0	2.0
Real GNP	20,000	23,000
Laspeyres price index	1.0	1.6
Real income (Paasche)	20,000	28,750
Paasche price index	1.0	1.44
Real income (Laspeyres)	20,000	31,900

measured real income of 31,900, a rise of almost 60 percent. The true measure of consumer gain of welfare (but not counting the higher quality of refrigerators) would be approximately 50 percent of base year income, that is, an amount intermediate between measures obtained by using the Paasche and Laspeyres price indexes. The understatement in the real GNP figure—the difference between the conventionally measured 15 percent and the almost true measure of about 50 percent (without quality adjustment)—is striking.

This example illustrates the point that measured growth, which shows the effects of resource shifts and improved resource utilization, could be a modest, unimpressive figure, while welfare is improving substantially. The greater the rise in the ratio of imports to GNP, the greater the understatement of actual growth in terms of consumer welfare. Moreover, in addition to the effect of the gains from trade just illustrated, the new product biases discussed earlier apply with full force to a rapidly changing bill of goods, most of which are entirely left out of the calculation because of the exclusion of the gains from trade.

Two clarifying comments are required. First, the effect of excluding the gains from trade, for increased trade, applies principally to consumer goods, not imported inputs to production. Second, although this effect and the new products effect reinforce each other and so are more than additive, they are separate and distinct.

Regarding the first comment, the gains from increased imports of those imported goods that are inputs to domestic production are mostly reflected in the conventional growth measure. Where imports had previously been so tightly restricted as to interfere with the manufacturing output that depends on those inputs, idle plants and workers are waiting to respond to increased imports. In this case, the measured increase of domestic output will properly reflect the increased gains from trade after liberalization. Similarly, the gain from imports that replace more expensive domestically produced inputs will wholly or largely be reflected in the conventional measure of growth. In both cases, the conventional measure may leave out part of the gain of consumers' surplus, but that is an ordinary, widespread index-number problem. The major distinctive exclusion is the gain from increased imports of consumer goods.[5]

Second, we should note that the new product effects apply even if trade grows only as fast as measured output, to the extent that the mix of products imported is liberalized. Conversely, the extra rise in standards of living, above the rise in measured output, due to increased gains from trade when trade increases sharply, is appreciable and needs to be accounted for even if no new products are involved.

We must also note that the consumer price indexes in such countries cover so few goods and are constructed so poorly that it is useless to try to estimate these effects by using their CPIs as deflators.

The Liberalizing Developing Country

The typical developing country has slow measured growth, and often has stagnant per capita real incomes. Imports of consumer durables are tightly limited or prohibited, and the few consumers who can afford them typically buy local consumer durables of poor quality and reliability, which are produced behind the protection of the import restrictions. New products are few and unimportant in the budget of the representative consumer.

When such a country liberalizes its economy and its external trade, its measured growth rate increases by 1 to 3 percent per year, as earlier noted, and exceeds the growth rates of the major developed countries. Affordable new products of all types, but especially consumer durables, come into the country's economy and the consumer bill of goods much faster than they do in a major developed country—because the country is catching up, the goods come in a rush. Often the fraction of the country's goods entering into international trade also jumps sharply.

The data for the four developing countries discussed earlier, which liberalized within the past fifteen years, are instructive in this regard.

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5. For an analysis of these effects in the context of a change in the terms of trade, see W. E. Diewert and C. J. Morrison, "Adjusting Output and Productivity Indexes for Changes in the Terms of Trade," *Economic Journal* 96 (1986): 659–79, and K. Hamada and K. Iwata, "National Income, Terms of Trade, and Economic Welfare," *Economic Journal* 94 (1984): 752–71.

Table 10 shows the ratios of imports to GNP before and after liberalization. The ratios have all risen since liberalization, although in the case of Mauritius it is only a small rise. Ghana, with the sharpest rise, is rebounding from a shrinkage of trade, relative to GNP, during the years 1960 to 1983; around 1960 it had been above 30 percent of GNP. By contrast, Mauritius was a one-crop economy before liberalization, producing sugar for export. Consequently, its trade ratio was always exceptionally high, and liberalization led mainly to a diversification of production rather than an increase in trade. The understatement of the gains from liberalization in Mauritius would involve the new products effects, but would involve relatively little additional effect of the gains from trade.

Although data on the past performance of East European economies is so unreliable that it may never be possible to determine their gains from liberalization, it will be instructive to study the effects of liberalization on their economies.

Conclusion

Lest we forget the importance of small differences in rates of growth, consider some simple compound growth rate calculations presented in Table 11. We assume a particularly poor developing country whose real economic growth rate is reported, more or less correctly, at 2 percent, just matching its population growth; future generations can be expected, with no policy change, to have the same desperately low living standard as that of the present generation. Liberalization of all economic policy, including trade, is followed by a rise of the reported

TABLE 10 Pre- and Postliberalization Import to GNP Ratios

	Chile	Ghana	Mauritius	Turkey
Five years preliberalization average	0.16	0.07	0.64	0.13
Latest year[a]	0.29	0.24	0.67	0.17

a. 1984 for Chile, 1988 for Ghana and Mauritius, 1987 for Turkey.
SOURCE: IMF, *International Financial Statistics*, various years.

TABLE 11 Compound Growth Differentials (percentage)

	Growth rate	Per capita growth rate	Per capita improvement in 15 years	Per capita improvement in 35 years
Stagnated GNP	2.0	0.0	0.0	0.0
Liberalized GNP	4.0	2.0	34.6	100.0
Correct measure	7.0	5.0	108.0	356.0[a]

a. Correctly measured growth rate drops to 6.0 percent after the first fifteen years.

growth rate to 4 percent per year, or 2 percent per capita. If true, this improvement means that the present generation will enjoy about 35 percent improvement in its living standard after fifteen years, and the next generation, in thirty-five years, will have double the goods that are available now per capita. That's not bad, but not as exciting as it might be. Suppose instead that correct growth measurement, including the introduction of new goods and the increased gains from trade, adds 3 percentage points to the real growth rate for the first fifteen years, dropping to 2 percentage points thereafter. Then the true effect on living standards is that they will more than double in fifteen years and almost quintuple after thirty-five years.

This is a striking difference that may help us to understand and justify some of the enthusiasm in the reports about specific cases where liberalization has brought visibly dramatic results.

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Measurement of Economic Growth. Study Notes. Save.Â Economic growth is measured by the percentage change in Real GDP. Real GDP adjusts the Nominal GDP figure for the impact of price changes (inflation or deflation). Example: If the Money GDP is $1155 billion and the GDP deflator is 110, what is the Real GDP? Real GDP is $1050 billion. If Real GDP was $1000 billion the previous year, what is the rate of economic growth? While the rate of economic growth goes up and down in cycles, a trend rate of economic growth can be calculated for an extended period of time. While Real GDP is the preferred measure of economic growth, it does have its limitati Economic Growth Measures: The Way Forward. Measuring economic growth is an intricate and subtle exercise. It has a scope that can be large and unmanageable.Â TFP, previously a measurement residual to be minimized, has since been reinterpreted, and has emerged as the key driver for economic growth. Ideas â€“ scientific and engineering knowledge, R&D, expertise â€“ constitute the prime candidates for explaining TFP, but the supporting empirical evidence remains weak. View chapter Purchase book. Economic Growth: Measurement. D. Quah, in International Encyclopedia of the Social & Behavioral Sciences, 2001. 9 Where Next? measures the relative economic growth of the economic system Xâ€™ in relation to the economic growth Yâ€™. In fact, if both Y and X increase in the long run according to some S-shaped pattern of growth (Lewis, 1955; Jarne. et al., 2005), one way to represent such a pattern formally is in terms of the differential equation of the well-. known logistic function.Â is the rate-of-growth parameter. 5 | P a g e. Coccia M. (2017) Measurement of Economic Growth and Convergence: a New Approach. CocciaLab Working Paper 2017 â€“ No. 3. ïƒ· ï€ï€½ 2.