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"Problems of Price Measurement"

Remarks by

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For most of the past twenty years, the challenges confronting monetary policymakers centered on addressing the question of how inflation could be brought down with as little economic disruption as possible Given the progress that has been made in reducing inflation, and the very solid economic performance that this low-inflation environment has helped to promote, a new set of issues is now emerging on the policy agenda Of mounting importance is a deeper understanding of the economic characteristics of sustained price stability We central bankers need also to better judge how to assess our performance in achieving and maintaining that objective in light of the uncertainties surrounding the accuracy of our measured price indexes

In today's advanced economies, allocative decisions are primarily made by markets Prices of goods and services set in those markets are central guides to the efficient allocation of resources in a market economy, along with interest rates and equity values Prices are the signals through which tastes and technology affect the decisions of consumers and producers, directing resources toward their highest valued use Of course, this signaling process, which involves individual prices, would work with or without government statistical agencies that measure aggregate price levels, and in this sense, price *measurement* probably is not fundamental for the overall efficiency of the market economy Indeed, vibrant market economies existed long before government agencies were established to measure prices

Nonetheless, in a modern monetary economy, accurate measurement of aggregate price levels is of considerable importance, increasingly so for central banks whose mandate is to maintain financial stability Accurate price measures are necessary for understanding economic developments, not only involving inflation, but also involving real output and productivity If the general price level is estimated to be rising more rapidly than is in fact the case, then we are simultaneously understating growth in real GDP and productivity, and real incomes and living standards are rising faster than our published data suggest

Under these circumstances, policymakers must be cognizant of the shortcomings of our published price indexes to avoid actions based on inaccurate premises that will provoke undesired consequences Clearly, central bankers need to be conscious of the problems of price measurement as we gauge policies designed to promote price stability and maximum sustainable economic growth Moreover, many economic transactions, both private and public, are explicitly tied to movements in some published price index, most commonly a consumer price index, and some transactions that are not explicitly tied to a published price index may, nevertheless, take such an index into account less formally If the price index is not accurately measuring what the participants in such transactions believe it is measuring, then economic transactions will lead to suboptimal outcomes

The remarkable progress that has been made by virtually all of the major industrial countries in achieving low rates of inflation in recent years has brought the issue of price measurement into especially sharp focus For most purposes, biases of a few tenths in annual inflation rates do not matter when inflation is high They do matter when, as now, inflation has become so low that policymakers need to consider at what point effective price stability has been reached Indeed, some observers have begun to question whether deflation is now a possibility, and to assess the potential difficulties such a development might pose for the economy

Even if deflation is not considered a significant near-term risk for the economy, the increasing discussion of it could be clearer in defining the circumstance Regrettably, the term deflation is being used to describe several different states that are not necessarily depicting similar economic conditions One use of the term refers to an ongoing fall in the prices of existing assets Asset prices are inherently volatile, in part because expected returns from real assets can vary for a wide variety of reasons, some of which may be only tangentially related to the state of the economy and monetary policy Nonetheless, a drop in the prices of existing

assets can feed back onto real economic activity, not only by changing incentives to consume and invest, but also by impairing the health of financial intermediaries--as we experienced in the early 1990s and many Asian countries are learning now But historically, it has been very rapid asset price declines—in equity and real estate, especially—that have held the potential to be a virulently negative force in the economy I emphasize rapid declines because, in most circumstances, slowly deflating asset prices probably can be absorbed without the marked economic disruptions that frequently accompany sharp corrections The severe economic contraction of the early 1930s, and the associated persistent declines in product prices, could probably not have occurred apart from the steep asset price deflation that started in 1929

While asset price deflation can occur for a number of reasons, a persistent deflation in the prices of currently produced goods and services--just like a persistent increase in these prices--necessarily is, at its root, a monetary phenomenon Just as changes in monetary conditions that involve a flight from money to goods cause inflation, the onset of deflation involves a flight from goods to money Both rapid or variable inflation and deflation can lead to a state of fear and uncertainty that is associated with significant increases in risk premiums and corresponding shortfalls in economic activity

Even a moderate rate of inflation can hamper economic performance, as I have emphasized many times before, and although we do not have any recent experience, moderate rates of deflation would most probably lead to similar problems Deflation, like inflation, would distort resource allocation and interfere with the economy's ability to reach its full potential It would have these effects by making long-term planning difficult, obscuring the true movements of relative prices, and interacting adversely with institutions like the tax system that function on the basis on nominal values

But deflation can be detrimental for reasons that go beyond those that are also associated with inflation Nominal interest rates are bounded at zero, hence deflation raises the

possibility of potentially significant increases in real interest rates Some also argue that resistance to nominal wage cuts will impart an upward bias to real wages as price stability approaches or outright deflation occurs, leaving the economy with a potentially higher level of unemployment in equilibrium

A deflation that took place in an environment of rapid productivity growth, however, might be largely immune from some of these special problems For example, in the high-tech sector of our economy today, we observe falling prices together with rapid investment and high profitability Although real interest rates may be quite high in terms of this sector's declining product prices, rapid productivity growth has ensured that real rates of return are higher still, and investment in this sector has been robust In practice, firms' decisions depend on an evaluation of their nominal return on investment relative to their nominal cost of capital In this sense, the choice of a specific, sometimes arbitrary, definition of real output and hence of price by government statisticians is essentially a descriptive issue, and not one that directly affects firms' investment decisions This is an illustration of where even individual price *measurement* probably is not always of direct and fundamental importance for private sector behavior

If such high-tech, high-productivity-growth firms produce an increasing share of output in the decades ahead, then, one could readily imagine the economy experiencing an overall product price deflation in which the problems associated with a zero constraint on nominal interest rates or nominal wage changes would seldom be binding Nevertheless, even if we could ensure significantly more rapid productivity growth than we have seen recently, there are valid reasons for wishing to avoid ongoing declines in the general price level If increases in both inflation and deflation raise risk premiums and retard growth, it follows that risk premiums are lowest at price stability Furthermore, price stability, by reducing variation in uncertainty about the future, should also reduce variations in asset values

But how are we to know when our objective of price stability has been achieved? In price measurement, a distinction must be made between the measurement of *individual* prices, on the one hand, and the *aggregation* of those prices into indexes of the overall price level on the other The notion of what we mean by a general price level--or more relevantly, its change--is never unambiguously defined

Issues of appropriate weighting in the aggregation process will presumably always bedevil us But it is the measurement of individual prices, not their aggregation, that pose the most difficult conceptual issues At first glance, observing and measuring prices might not appear especially daunting But, in fact, the problem is deceptively complex To be sure, the dollar value of most transactions is unambiguously exact, and, at least in principle, is amenable to highly accurate estimation by our statistical agencies But dividing that nominal value change into components representing changes in real quantity versus price requires that one define a unit of output that is to remain constant in all transactions over time Defining such a constant-quality unit of output, of course, is the central conceptual difficulty in price measurement

Such a definition may be clear for unalloyed aluminum ingot of 99 7 percent or greater purity in wide use Consequently, its price can be compared over time with a degree of precision adequate for virtually all producers and consumers of aluminum ingot Similarly, the prices of a ton of cold rolled steel sheet, or of a linear yard of cotton broad woven fabric, can be reasonably compared over a period of years

But when the characteristics of products and services are changing rapidly, defining the unit of output, and thereby adjusting an item's price for improvements in quality, can be exceptionally difficult These problems are becoming pervasive in modern economies as high tech and service prices, which are generally more difficult to measure, become ever more prominent in aggregate price measures One does not have to look only to the most advanced

technology to recognize the difficulties that are faced To take just a few examples, automobile tires, refrigerators, winter jackets, and tennis rackets have all changed in ways that make them surprisingly hard to compare to their counterparts of twenty or thirty years ago

The continual introduction of new goods and services onto the markets creates special challenges for price measurement In some cases, a new good may best be viewed as an improved version of an old good But, in many cases, new products may deliver services that simply were not available before When personal computers were first introduced, the benefits they brought households in terms of word processing services, financial calculations, organizational assistance, and the like, were truly unique And, further in the past, think of the revolutionary changes that automobile ownership, or jet travel, brought to people's lives In theory, economists understand how to value such innovations, in practice, it is an enormous challenge to construct such an estimate with any precision

The area of medical care, where technology is changing in ways that make techniques of only a decade ago seem archaic, provides some particularly striking illustrations of the difficulties involved in measuring quality-adjusted prices Cures and preventive treatments have become available for previously untreatable diseases Medical advances have led to new treatments that are more effective and that have increased the speed and comfort of recovery In an area with such rapid technological change, what is the appropriate unit of output? Is it a procedure, a treatment, or a cure? How does one value the benefit to the patient when a condition that once required a complicated operation and a lengthy stay in the hospital now can be easily treated on an outpatient basis?

Although we may not be able to discern its details, the pace of change and the shift toward output that is difficult to measure are more likely to quicken than to slow down How, then, will we measure inflation in the future if our measurement techniques become increasingly obsolete? We must keep in mind that, difficult as the problem seems, consistently measured

prices do exist in principle Embodied in all products is some unit of output, and hence of price, that is recognizable to those who buy and sell the product if not to the outside observer A company that pays a sum of money for computer software knows what it is buying, and at least has an idea about its value relative to software it has purchased in the past, and relative to other possible uses for that sum of money in the present

Furthermore, so long as people continue to exchange nominal interest rate debt instruments and contract for future payments in terms of dollars or other currencies, there must be a presumption about the future purchasing power of money no matter how complex individual products become Market participants do have a sense of the aggregate price level and how they expect it to change over time, and these views must be embedded in the value of financial assets

The emergence of inflation-indexed bonds, while providing us with useful information, does not solve the problem of ascertaining an economically meaningful measure of the general price level By necessity, the total return on indexed bonds must be tied to forecasts of specific published price indexes, which may or may not reflect the market's judgment of the future purchasing power of money To the extent they do not, of course, the implicit real interest rate is biased in the opposite direction Moreover, we are, as yet, unable to separate compensation for inflation *risk* from compensation for expected inflation

Eventually, financial markets may develop the instruments and associated analytical techniques for unearthing these implicit changes in the general price level with some precision In those circumstances, then--at least for purposes of monetary policy--these measures could obviate the more traditional approaches to aggregate price measurement now employed They may help us understand, for example, whether markets perceive the true change in aggregate prices to reflect fixed or variable weight indexes of the components, or whether arithmetic or logarithmic weighting of the components is more appropriate

But, for the foreseeable future, we shall have to rely on our statistical agencies to produce the price data necessary to assess economic performance and to make economic policy In that regard, assuming further advances in economic science and provided that our statistical agencies receive adequate resources, procedures should continue to improve To be sure, progress will not be easy, for estimating the value of quality improvements is a painstaking process It must be done methodically, item by item But progress can be made

In recent years, we have developed an improved ability to capture quality differences by pricing the underlying characteristics of complex products With an increasingly wide range of product variants available to the public, product characteristics are now bundled together in an enormous variety of combinations A "personal computer" is, in actuality, an amalgamation of computing speed, memory, networking capability, graphics capability, and so on Computer manufacturers are moving toward build-to-order systems, in which any combination of these specifications and peripheral equipment is available to each individual buyer Other examples abound Advancements in computer-assisted design have reduced the costs of producing multiple varieties of small machine tools And in services, witness the plethora of products now available from financial institutions, which have allowed a more complete disentangling and exchange of economic risks across participants around the world Although hard data are scarce, there can be little doubt that products are tailor-made for the buyer to a larger extent than ever Gone are the days when Henry Ford could say he would sell a car of any color "so long as it's black "

In such an environment, when product characteristics are bundled together in so many different combinations, defining the unit of output means unbundling these characteristics, and pricing each of them separately The so-called hedonic technique is designed to do precisely that This technique associates changes in a product's price with changes in product characteristics It therefore allows a quality comparison when new products with improved

characteristics are introduced This approach has been especially useful in the pricing of computers But hedonics are by no means a panacea First of all, this technique obviously will be of no use in valuing the quality of an entirely new product that has fundamentally different characteristics from its predecessors The benefits of cellular telephones, and the value they provide in terms of making calls from any location, cannot be measured from an examination of the attributes of standard telephones

In addition, the measured characteristics may only be proxies for the overall performance that consumers ultimately value In the case of computers, the buyer ultimately cares about the quality of services that computer will provide--word processing capabilities, database services, high-speed calculations, and so on But, in many cases, the number of message instructions per second and the other easily measured characteristics may not be a wholly adequate proxy for the computer services that the individual buyer values In these circumstances, the right approach, ultimately, may be to move toward directly pricing the services we obtain from our computers--that is, word processing services, database management services, and so on--rather than pricing separately the hardware and software

The issues surrounding the appropriate measurement of computer prices also illustrate some of the difficulties of valuing goods and services when there are significant interactions among users of the products New generations of computers sometimes require software that is incompatible with previous generations, and some users who have no need for the improved computing power nevertheless may feel compelled to purchase the new technology because they need to remain compatible with the bulk of users who are at the frontier Even if our techniques allow us to accurately measure consumers' valuation of the increased speed and power of the new generation of computer, we may miss the negative influence on some consumers of this incompatibility Therefore, even in the case of personal computers, where

we have made such great strides in measuring quality changes, I suspect that important phenomena still may not be adequately captured by our published price indexes

Despite the advances in price measurement that have been made over the years, there remains considerable room for improvement As you know, a group of experts empaneled by the Senate Finance Committee--the Boskin commission--concluded that the consumer price index has overstated changes in the cost of living by roughly one percentage point per annum in recent years About half of this bias owed to inadequate adjustment for quality improvement and the introduction of new goods, and about half reflected the manner in which the individual prices were aggregated Researchers at the Federal Reserve and elsewhere have come up with similar figures Although the estimates of bias owing to inadequate adjustment for quality improvements surely are the most uncertain aspect of this calculation, the preponderance of evidence is that, on average, such a bias in quality adjustment does exist

The Boskin commission and most others estimating bias in the CPI have taken a microstatistical approach, estimating separately the magnitude of each category of potential bias Recent work by staff economists at the Federal Reserve Board has added corroborating evidence of price mismeasurement, using a macroeconomic approach that is essentially independent of the microstatistical exercises Specifically, employing disaggregated data from the national income and product accounts, this research finds that the measured growth of real output and productivity in the service sector is implausibly weak, given that the return to owners of businesses in that sector apparently has been well-maintained Indeed, the published data indicate that the level of output per hour in a number of service-producing industries has been *falling* for more than two decades It is simply not credible that firms in these industries have been becoming less and less efficient for more than twenty years Much more reasonable is the view that prices have been mismeasured, and that the true quality-adjusted prices have been rising more slowly than the published price indexes Properly measured, output and

productivity trends in these service industries are doubtless considerably stronger than suggested by the published data Assuming, for example, no change in the productivity levels for these industries in recent years would imply a price bias consistent with the Boskin commission findings

A Commerce Department official once compared a nation's statistical system to a tailor, measuring the economy much as a tailor measures a person for a suit of clothes--with the difference that, unlike the tailor, the person we are measuring is running while we try to measure him The only way the system can succeed, he said, is to be just as fast and twice as agile That is the challenge that lies ahead, and it is, indeed, a large one

There are, however, reasons for optimism The information revolution, which lies behind so much of the rapid technological change that makes prices difficult to measure, will surely play an important role in helping our statistical agencies acquire the necessary speed and agility to better capture the changes taking place in our economies Computers, for example, might some day allow our statistical agencies to tap into a great many economic transactions on a nearly real-time basis Utilizing data from store checkout scanners, which the BLS is now investigating, may be an important first step in that direction But the possibilities offered by information technology for the improvement of price measurement may turn out to be much broader in scope Just as it is difficult to predict the ways in which technology will change our consumption over time, so is it difficult to predict how economic and statistical science will make creative use of the improved technology

Such advances must be taken to ensure that our economic statistics remain adequate to support the public policy decisions that must be made If the challenge for our statistical agencies is not to lose in their race against technology, the challenge for policymakers is to make our best judgments about the limitations of the existing statistics, as we design policies to promote the economic well-being of our nations In confronting those challenges, both

government statisticians and policymakers would benefit from additional research by you, the economics profession, into the increasingly complex conceptual and empirical issues involved with accurately measuring price and quantity