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Remarks by

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For the past two decades, central bankers have largely been successful at subduing the inflationary pressures that threatened to upend market-oriented economic systems a generation ago. The Federal Reserve, during this period, has squeezed out an inflationary excess of liquidity. In Europe, tolerance for inflation has declined dramatically, and a commitment to price stability--long the hallmark of Bundesbank policy--has gained widespread acceptance.

In the past five years or so, two new trends have greatly assisted this process in the United States. One has been the serendipitous emergence of a once- or twice-in-a-century surge in technology. Without the accompanying boost to productivity, our progress toward price stability might well have been marked by the social pressures that arose in many previous episodes of disinflation both here and abroad. The other trend was the growing political commitment to address an outsized federal budget deficit that was absorbing an inordinate share of our national saving. That change in our political environment--accompanied by the faster pace of technology-driven growth--has resulted in a sharp reduction in the unified budget deficit and, more recently, the emergence of a significant surplus. This, in turn, has helped fill the pool of saving that has fed productivity-enhancing and cost-reducing capital formation.

A number of elements came together to make this economic configuration possible. The essential ingredient was the public support that developed as the growth-inhibiting consequences of the inflation of the 1970s became manifest. Without this public recognition and support, it would have been difficult to establish the stable macroeconomic foundation upon which the private sector has built so productively in recent years.

By now, the story of the boom in information technology is well known, and nearly everyone perceives that the resulting more rapid growth of labor productivity is at least partly

enduring. Capital deepening has surged during the past seven years, and innovations, synergies, and networking effects have boosted significantly the growth of multifactor productivity. With output per hour having accelerated, cost pressures have been patently contained.

For the most part, the Federal Reserve generally recognized these changing fundamentals and calibrated American monetary policy accordingly. Although we have learned much about managing the financial backdrop to accelerating economic activity, it is essential that we not be deluded into believing that we have somehow discovered the Rosetta stone of monetary policy. A failure by policymakers to sufficiently appreciate the inevitable uncertainties that they confront could result in unfortunate consequences for the economy.

While we central bankers do not have full knowledge, we have continued to gain insight--albeit slowly--into how market economies function. That learning process has been aided, especially in the United States, by a vast panoply of data and information from both public and private sources. However imprecise, these readings on the economy have helped us steer monetary policy through an inevitably uncertain future.

In practice, it is the joining of ideas and data that drives policy in the face of uncertainty. We seek to array the probabilities of future policy outcomes, attempt to gauge the costs of being wrong in our decisions, and endeavor to choose the policy paths that appear to offer greater benefits and fewer risks.

Whether we choose to acknowledge it or not, all policy rests, at least implicitly, on a forecast of a future that we can know only in probabilistic terms. Even monetary policy rules that use recent economic outcomes or money supply growth rates presuppose that the underlying

historical structure from which the rules are derived will remain unchanged in the future. But such a forecast is as uncertain as any.

This uncertainty is particularly acute for rules based on money growth. To be sure, inflation is at root a monetary phenomenon. Indeed, it is, by definition, a fall in the value of money relative to the value of goods and services. But as technology continues to revolutionize our financial system, the identification of particular claims as money, near money, or a store of future value has become exceedingly difficult. Although it is surely correct to conclude that an excess of money relative to output is the fundamental source of inflation, what specifically constitutes money is a notion that has, so far, eluded our analysis. We cope with this uncertainty by ensuring that money growth, by any reasonable definition, does not reach outside the limits of perceived prudence. But we have difficulty defining those limits with precision, and within any such limits, there remains significant scope for discretion in setting policy.

In history, discretionary monetary policy, of course, has not been without its shortcomings, and the dominant force of accelerating productivity has made our current task of policy calibration especially daunting. Policymakers, in fact all forecasters, invariably construct working hypotheses or models of the way our economies work. Of necessity, these models are a major simplification of the many forces that govern the functioning of our system at any point in time.

Obviously, to the extent that these constructs, formal or otherwise, fail to capture critical factors driving economic expansion or contraction, conclusions drawn from their application will be off the mark.

In practice, we continuously monitor a substantial quantity of incoming data to test the capability of any specific model or hypothesis to explain actual outcomes. When we experience outcomes that do not square with what our models have projected, we form new hypotheses and reconstruct the models to more closely conform with our observations.

With the virtually unprecedented surge in innovation that we have experienced over the most recent half decade, many of the economic relationships embodied in past models no longer project outcomes that mirror the newer realities. Data series that better measure the workings of the so-called new economy are under development. But we still have far more information on the variety of yarns and weaves produced by textile establishments than data on output of the burgeoning software industry or many of the other rapidly growing high-tech industries. The paucity of data for the latter inhibits our ability to fully test our working hypotheses or models in order to detect changes in economic relationships as quickly and confidently as we would like.

Evidence began to accumulate in the early and mid-1990s that prospective rates of return on capital were rising. This was implicit both in the marked rise in investments in high-tech equipment and in the updrift in estimates of the growth of long-term earnings by corporate management, which were reflected in the projections of securities analysts. Nevertheless, we could not be certain whether what we were observing was a short burst of productivity gains or a more sustained pickup in productivity growth. The view that we were experiencing a sustained pickup gained plausibility when productivity growth continued to increase as the expansion lengthened. But importantly, only after we could see evidence in other economic behaviors and in readings from asset markets that were consistent with accelerating productivity did we begin to develop confidence in our analysis.

When confronted with a period of structural change, our policy actions must be based, in large part, on identifying emerging trends from surprises and anomalies in the data and then carefully drawing their implications. It would be folly to cling to an antiquated model in the face of contradictory information.

Some who question the economic implications of the spread of innovation and the step-up in productivity growth hypothesize that the gains are largely confined to the so-called new economy, with little effect on efficiency in the old economy. But this notion fails to capture the dynamics of the marketplace. To be sure, a significant segment of our economy's growth reflects output of high-tech equipment. Moreover, the long-term prospective profit growth of those firms engaged in the computer and telecommunications industries has been revised up during the past five years by more than double the amount for the so-called old-economy industries. But in a meaningful sense, there is, with few exceptions, little of a truly old economy left. Virtually every part of our economic structure is, to a greater or lesser extent, affected by the newer innovations. No old-economy textile plant could exist in today's environment without technologies that Edmund Cartwright could never have imagined.

There are, of course, significant differences in the degree to which the newer technologies have been applied. However, almost all parts of our economy have shared to some extent in the benefits of this wave of innovation.

So it is with some irony that just as we are adapting our old-economy models to the new realities, in drifts an apparition from the past--a spike in oil prices that has potential implications for economic stability and for monetary policy.

The reemergence of oil prices as an important macroeconomic consideration is a reminder that there is less of a stark division between old and new economies than is often loosely suggested. Even the oil industry, a presumed old-economy stalwart, is a surprisingly major player in the new. As a consequence, policymakers will need to consider how changes in technologies and world markets may have altered the response of our economies to oil-price shocks and, thus, how best to respond to them.

Any evaluation of the current oil-price spike, if indeed that is what it is, will require us to delve into the forces of new technology and to understand how significantly the impact of oil on our economy's workings has changed with a generation of innovation.

Largely in response to past oil price increases, the energy intensity of advanced industrial economies has been reduced by half from the levels of the early 1970s. This, of course, does not mean that the effect of any given oil-price increase is half that of a generation ago, because the size of the effect also depends on the potential to reduce energy consumption as prices rise and on the degree to which other energy sources can be substituted for oil as relative prices change.

Most of the oil displacement was accomplished by 1985, within a few years of the peak in the relative price of energy. Progress in reducing energy intensity generally has been far more modest in the last fifteen years--not surprising, given the generally lower level of real oil prices after 1985.

What has changed dramatically in recent years is the production side of oil, which is likely to be a substantial factor in determining the extent and duration of any oil-price spike. Oil, in this regard, has truly become at least an associate member of the new economy.

The development of seismic techniques and satellite surveillance to discover promising new oil reservoirs has more than doubled the drilling success rate for new field wildcat wells during the past decade. New techniques and the use of oil rigs that have more computer chips in them than most modern office buildings facilitate far deeper drilling of promising pools, especially offshore. The newer recovery techniques reportedly have raised the proportion of oil reserves eventually brought to the surface from a third to nearly a half in recent decades.

One might expect that, as a consequence of what has been a dramatic change from the old hit-or-miss wildcat oil exploration and development of the past, the cost of developing new fields and, hence, the long-term marginal cost of new oil have declined.

And, indeed, these costs have declined, but by less than might otherwise have been the case; much of oil development innovation outside OPEC has been directed at overcoming an increasingly inhospitable and costly exploratory environment, the consequence of more than a century of draining the more immediately accessible sources of crude oil.

One measure of the decline in recent years of the marginal cost of additions to oil availability is the downdrift in the prices of the most distant contracts for future delivery of Light Sweet crude oil. Spot prices have soared and plunged, but for the most distant futures contracts--which cover a time frame long enough to seek, discover, drill, and lift oil--prices generally moved lower over the past decade. The most distant futures prices fell from a bit more than \$20 per barrel just before the Gulf War to \$17 to \$18 a barrel a year ago. The current six-year futures contract has risen over the past year to about \$21 per barrel. Arguably, however, this rise is related less to technology and the structure of underlying marginal costs and more to concerns about how quickly new practices will be exploited to expand OPEC's productive

capacity. Having increased output significantly during the past year, only a little excess capacity remains. Moreover, going forward, there is concern that OPEC may choose not to expand capacity adequately from their large proven reserves.

The long-term marginal cost of extraction presumably anchors the long-term equilibrium price and, thus, is critical to an evaluation of the magnitude and persistence of any current price disturbance. Over time, spot prices are inexorably drawn back to the long-term equilibrium price, as the balance between underlying supply and demand is restored.

But in the short run, the price of oil, as that of all commodities, inevitably is influenced importantly by inventory levels, especially when stocks become critically short. Over the years, innovation and consolidation have significantly reduced the operating inventories of crude oil and products required to service a given level of product demand. Excluding these operating stocks, the world oil industry has historically run on a rather thin buffer, roughly a thirteen-day inventory of "usable stocks," according to data from the Energy Intelligence Group.

Thus, when OPEC and its allies cut back oil liftings by more than 3 million barrels a day in 1998 and 1999, against the backdrop of expanding world demand, the buffer of more than fifteen days of usable oil that prevailed at the time rapidly shrank to a little more than ten days. As a consequence, the price of crude oil tripled.

OPEC has since more than restored its output, bringing world production now to record levels--levels that exceed reported demand by nearly 1-1/2 million barrels a day, seasonally adjusted. Inventories of usable stocks are building but have yet to regain normal levels. But the remarkable surge in shipments of home heating oil, both here and in Europe, suggests very heavy

precautionary oil accumulation by dealers and households not covered in the usual data on inventories for the industry.

It would certainly seem that, with inventories building and the spot price of crude oil well above its long-term equilibrium, spot prices would shortly be under significant downward pressure. However, concerns about the potential for political difficulties to impinge on available supplies persist, as has been so evident over the past few weeks. Even before the recent unfortunate developments in the Middle East, demand to augment buffer stocks surged, which has helped to keep prices high. This owed largely to the possibility of a politically driven removal of a significant part of Iraq's 2-1/2 to 3 million barrels a day from global markets at a time when there exists so little available world excess capacity to replace it.

Even though the intensity of oil consumption is markedly below where it was thirty years ago, it still has the potential to alter the forces governing economic growth in the United States. To date, the spillover from the surge in oil prices has been modest. Any effect on inflation expectations, at least as inferred from the behavior of long-term Treasury Inflation-Indexed Securities, has been virtually nil. Moreover, despite some slowing that likely has been related in part to the bite from the so-called "oil tax" on household incomes, the growth of consumer spending has remained firm. But policymakers will need to be on the alert for oil-driven, indeed energy-driven, risks to our expansion.

Looking further ahead, some of those favorable factors that I discussed earlier--in particular, growing fiscal surpluses and accelerating productivity--remain in place, but presumably will not persist indefinitely.

The mounting fiscal surpluses have been an important source of national saving, muting upward pressures on interest rates at a time of strong demand for private credit. By keeping the cost of capital lower than it otherwise would have been, the surpluses have contributed to capital deepening and faster growth of productivity. But I believe most of us harbor doubts about whether the dynamics of the political process, some of which have been on display in the current budgetary deliberations, will allow the surpluses to continue to grow.

Moreover, as I indicated in remarks at Jackson Hole in August, a tapering off of productivity acceleration is inevitable at some point in the future. When that occurs, even should the growth rate of productivity remain high, we could experience less benign readings on cost pressures if the tightness of labor markets persists.

That said, as best we can judge, credible evidence that the rate of structural productivity growth has stopped increasing is still lacking. It is the continuing acceleration of productivity that, by allowing businesses to absorb rising compensation increases without incurring ever-rising unit costs, has been so essential to containing price increases.

We are observing some remarkable structural advances in our economy. Central bankers have learned much about their implications. But, it will be essential for this learning process to continue if we are to recognize and respond effectively to the inevitable surprises placed in our path by a constantly evolving and highly dynamic economy.