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Contents

Yet, reserve requirements are on the wane worldwide. In many countries reserve requirements are no longer seen as a vehicle to directly control the money stock but rather as a vehicle to facilitate control over short-term interest rates. As such, depending on a country's institutional framework, there may be scope for reducing or even eliminating reserve requirements.

Weiner examines the monetary policy implications of lower reserve requirements, focusing on the United States, Canada, and Germany. He provides a detailed analysis of current operating procedures, stressing that reserve requirements may still have an important, albeit different, role to play in the monetary policy process.

Until recently, most economists agreed that movements in the quantity of money help to forecast changes in national output. This generally accepted usefulness of money as an economic indicator is one reason the Federal Reserve has continued to monitor the monetary aggregates despite significant changes in the economy and financial markets.

Recent research, however, suggests that money lost the ability to forecast economic activity after the 1970s. If this finding is correct, money no longer provides policymakers with information about future economic activity.

Becketti and Morris investigate the claim that money lost the ability to predict economic activity after the 1970s. They find that, except during the early 1980s, money has remained a useful indicator of future economic activity.

The world watches with wonder at the momentous transformation now taking place in the former Soviet Union. Amid the manifold uncertainties surrounding the economic transition under way, many regard the establishment of a market-based food system to be prerequisite to success elsewhere in the economy.

Drawing on their August trip to Russia and Ukraine, Barkema, Drabenstott, and Skold review the problems facing the farm and food sector in the former Soviet Union. The authors then outline the building blocks for moving to a market-based food system. They conclude that critical legislative reforms for agriculture could come quickly, but building necessary market institutions, enhancing entrepreneurial skills, and upgrading technology will require years, even decades. The road may be long, but the United States will have an unparalleled opportunity to market its world-class food technology in this part of the world.

Macroeconomic Policy and Long-Run Growth

J. Bradford De Long and Lawrence H. Summers

The long-run trend of productivity growth is the sole important determinant of the evolution of living standards. The current recession has seen as large a fall in American consumption per capita as any post-World War II recession—a year-over-year decline of about 2.3 percent. Yet the post-1973 productivity slowdown in the United States has been an order of magnitude more significant, reducing current consumption by nearly 30 percent. And the post-1973 productivity slowdown has been more severe outside than inside the United States. While the growth rate of output per worker in the United States slowed by 1.4 percentage points per year comparing the 1950-73 with the 1973-90 period, productivity growth has slowed by 4.5 percentage points per year in Japan, 4.2 percentage points per year in Germany, and by 1.9 percentage points for the Organization for Economic Cooperation and Development (OECD) as a whole.

This paper addresses the role of macroeconomic policies in determining long-run rates of productivity growth. We begin by highlighting aspects of the interspatial and intertemporal variation in productivity growth which suggest that much of what is important for raising growth rate lies in the domain of structural policy, since macroeconomic policies are less than dominant in determining rates of productivity growth. We then take up what we regard as the two fundamental macroeconomic decisions any society makes: how aggregate demand (or its near-equivalent nominal income) will be managed, and how total output will be allocated between consumption and various forms of investment. Our policy conclusions can be stated succinctly:

- Much of the variation in productivity growth rates cannot be traced to macroeconomic policies and must be attributed to structural and external factors. It is implausible that the deterioration in productivity performance between the 1970s and 1980s is the result of macroeconomic policies that were inferior in the 1980s. Bad macroeconomic policies can insure dismal performance. But good macroeconomic policies, while necessary, are not sufficient for outstanding productivity performance.
- Monetary policy that either encourages high inflation or permits large-scale financial collapse

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can inflict severe damage on productivity growth. Countries in which workers, investors, and entrepreneurs have confidence in the political independence of an inflation-fighting central bank have attained significantly more price stability. There is some evidence, however, of productivity costs from excessively zealous anti-inflation policies.

- Even substantial increases in investments that yield social returns of even 15 percent per year will have only modest effects on observed rates of productivity growth. Only increases in specific investments with *very high* social returns well in excess of private returns have a prospect of arresting any substantial part of the productivity slowdown.
- International comparisons suggest a special role for equipment investment as a trigger of productivity growth. This suggests that neutrality across assets is an inappropriate goal for tax policies, and that equipment investment should receive special incentives.

The paper is organized as follows. The first section examines the productivity growth record, focusing on the extent of variations in productivity growth across countries and across decades. The second section considers the role of nominal demand management policy. The third section examines the relationship between rates of investment and rates of return. It highlights the difficulty of raising growth rates by magnitudes comparable to the extent of the productivity slowdown through general increases in investment, and emphasizes the importance of strategic high-return investments. The fourth section highlights the special role of equipment investment in spurring growth. The article concludes by commenting further on the policy implications of our analysis.

THE GROWTH RECORD

The slowdown in productivity growth

The principal information that is available for making judgments about the determinants of productivity and the role of policies is the historical record.

Table 1 reports rates of output per worker growth by decade for the United States, other major OECD economies, and other industrial economies. In the United States, GDP per worker as estimated by Summers and Heston (1991)[1] grew at 2.0 percent per year in the decade from 1950 to 1960, by 2.5 percent per year in the decade from 1960 to 1969,[2] and by only 0.5 percent per year in the decade from 1969 to 1979. It has only partially recovered to 1.4 percent per year in the decade from 1979 to 1990. Comparing the past two decades to the two decades beginning in 1950, the rate of growth of output per worker has fallen by 60 percent. A doubling of output per worker took 31 years at the pace of growth seen over 1950-69; it would take 73 years at the pace of growth of 1969-90.

While the American productivity slowdown has been pronounced, Table 1 demonstrates that it has been relatively mild by international standards: the slowdown of 1.3 percentage points per year experienced by the United States comparing the 1970s and 1980s to the 1950s and 1960s has been smaller than the slowdown in the average OECD, or industrial economy. Rates of growth throughout the industrial world in recent decades have been far below the rates seen in the first few post-World War II decades that workers, managers, and politicians then took for granted. From 1950 to 1960 GDP per worker in the OECD grew at a rate of 3.0 percent per year, and from 1960 to 1969 growth was 3.5 percent per year. But from 1969 to 1979 average growth in output per worker in the OECD was only 1.8 percent per year, and over 1979 to 1990 only 1.6 percent per year.

In light of the fact that productivity growth has declined much more rapidly outside than inside the United States, it may seem surprising to foreign observers that concerns about future living standards and about competitiveness are so especially pronounced in the United States. Part of the explanation may lie in the increasing openness of the American economy over the last decade, and in the emergence of large trade deficits. Another

Table 1

Rates of Productivity Growth by Decade

Economy	1950-60	1960-69	1969-79	1979-90	1985-91
United States	2.0	2.5	.5	1.3	1.2
Japan	6.7	8.4	4.4	3.0	3.8
Germany	6.4	4.1	2.5	1.6	2.9
France	4.3	4.8	2.8	1.1	1.9
U.K.	2.5	2.3	2.1	1.7	1.8
Canada	1.8	2.6	.7	1.2	1.0
Italy	6.0	5.2	3.7	1.9	2.3
Total OECD*	3.0	3.5	1.8	1.6	
Industrial Pacific Rim Economies+	6.7	6.2	4.4	3.6	
Industrial Latin American Economies++	2.7	2.8	2.1	-1.7	
Average Industrial Economy	3.3	3.7	2.4	1.0	

* Total OECD product divided by number of OECD workers.

+ Our list of industrialized Pacific Rim economies initially includes only Japan. Hong Kong and Singapore join the list in 1960. Korea, Malaysia, and the economy of the Taiwan province are added to the list in 1979.

++ Argentina, Chile, Colombia, Costa Rica, Mexico, Uruguay, and Venezuela.

part of the explanation is surely that other countries continue to grow more rapidly than the United States, albeit by a smaller margin even as they approach U.S. productivity levels. Relatively slow U.S. productivity growth was much less of a concern when American standards of living were far ahead of standards of living abroad than it is today, as foreign standards of living approach American levels. We therefore turn to a consideration of the extent to which the patterns of growth illustrated in Table 1 can be explained by the convergence hypothesis—the idea that the further a country is behind the more rapidly it can grow by importing technology in order to catch up.

Cyclical adjustment

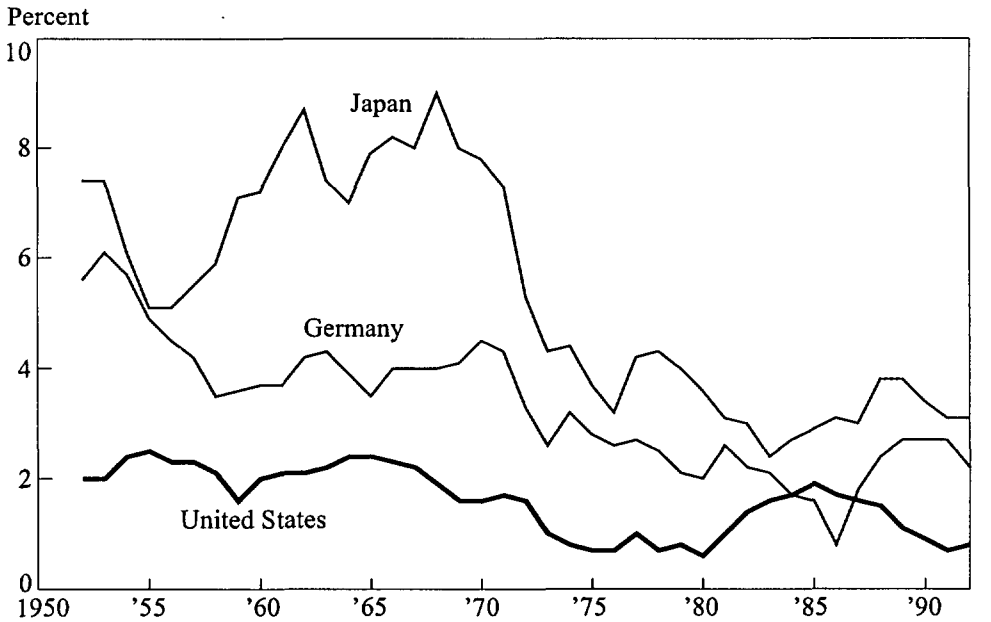
Chart 1 plots centered five-year moving averages of annual growth in cyclically adjusted output per worker[3] since 1950 in the three largest OECD economies: the United States, Japan, and West Germany.[4] Chart 2 plots a centered five-year moving average of output per worker growth in the OECD. The cyclical adjustment makes no significant difference to the pattern of productivity growth. The 1980s see a marked productivity growth slowdown relative to the 1950s and the 1960s—the United States is the only economy in which the 1980s appear better than the 1970s. And the late 1980s show signs of a deterioration of cyclically adjusted productivity growth in the United States back to the rates of the 1970s.

Even after an adjustment for the business cycle, it appears clear that productivity growth in the industrialized world is much slower than it was two decades ago. And for the industrialized world

Chart 1

Cyclically Adjusted Real GDP per Worker Growth

Centered Five-Year Moving Averages



as a whole, productivity growth appears to have declined further in the 1980s from its relatively disappointing level in the 1970s. It is apparent that for the OECD as a whole, for Japan, and for Germany that cyclically adjusted productivity growth has become markedly slower in the 1980s than it was even in the 1970s. The United States is an outlier in experiencing faster trend productivity growth in the 1980s than in the 1970s. And U.S. underlying productivity growth is noticeably slower in the late than in the mid-1980s.

Growth and "convergence"

When World War II ended, there was an enormous gap in technology, organization, and productivity between the United States and other industrial economies. This gap had widened over the preceding quarter century, as Europe served as the battleground for two extraordinarily destructive wars punctuated by an era of instability and slow growth. This has led many to attribute fast post-World War II growth in the non-U.S. OECD to "catch-up" or a "rubber-band effect" as other industrial economies quickly covered the ground the United States had broken in the 1920s and 1940s.[5] Some have attributed the larger productivity growth slowdown outside than inside the United States to the reduced opportunities for "catch-up" and technology transfer left after the successful growth of the first post-World War II generation.

A substantial literature has by now examined the convergence hypothesis. A typical conclusion is that within the set of relatively well-to-do economies there is evidence of a convergence effect, though such an effect is not present when very

Chart 2

Cyclically Adjusted Real GDP per Worker Growth

Five-Year Moving Average for the OECD

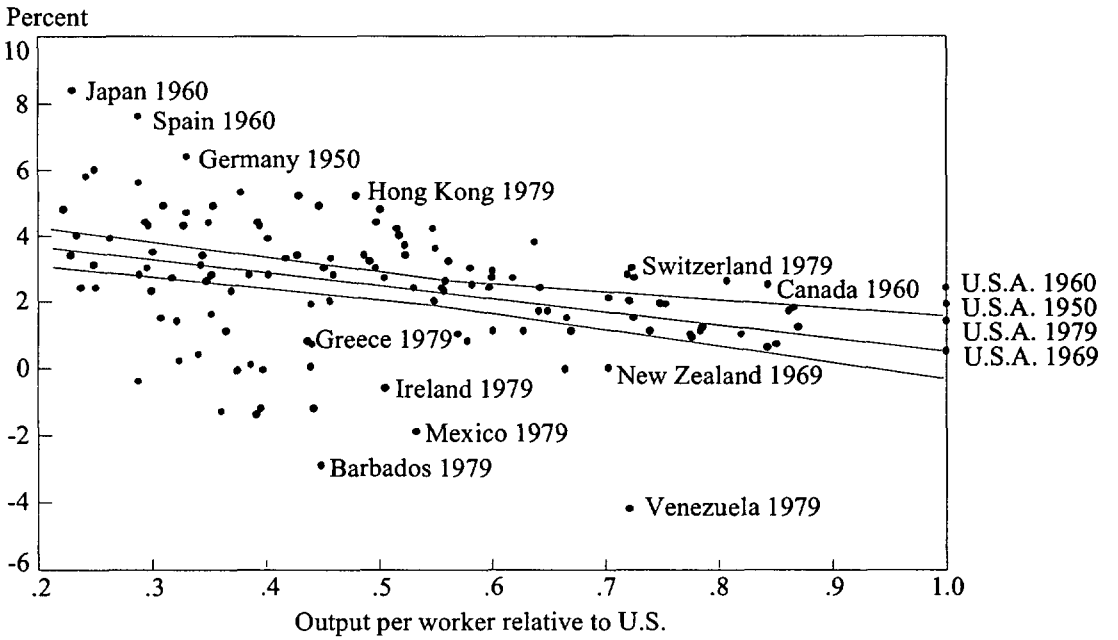
poor economies are added to the sample unless additional control variables are included in the analysis. Chart 3 presents a scatter plot of ten-year growth rates against initial relative incomes for all industrial economies for which data were available.[6] A negative relationship is apparent with the data suggesting that a percentage point increase in the gap between a country's relative income and the United States is associated with an 0.036-percentage-point increase in its annual productivity growth rate. This estimate is relatively large compared to others in the literature on convergence.[7]

Given this estimate of the magnitude of the convergence effects, it is a simple matter to construct estimates of "convergence adjusted" growth rates. For example, Germany in 1960 was at 52 percent of the U.S. productivity level, so convergence effects are estimated to account for 0.036* (1-0.52), or 1.7 percentage points' per year worth of its productivity growth between 1960 and 1970. By 1980, German relative productivity had risen to 73 percent of U.S. productivity so convergence accounted for much less—only 0.9 percentage points' worth of German productivity growth.

Table 2 reports estimates of convergence-adjusted productivity growth rates. Since the United States is always the most productive country according to these estimates, its convergence-adjusted growth rate is always just equal to the raw growth rate reported in Table 1. Comparing Tables 1 and 2, it is apparent that convergence accounts for much of America's relatively slow productivity growth compared to other OECD nations. But growth performance was poor in the 1970s and the

Chart 3

Inverse Relationship Between Output per Worker Levels and Growth Rates in the Post-World War II Era



1980s even after adjusting for convergence effects. And even the convergence-adjusted slowdown has been greater outside the United States and Canada.

Causes and consequences

The principal lesson that emerges from this brief review of productivity growth experience is that no simple macroeconomic explanation is likely to account for a large part of the variations in productivity growth. Much of the problem for simple macro arguments comes from the slowdown between the 1970s and 1980s outside the United States. The very broad extent and long duration of the slowdown suggests that broad, general explanations are in order—not explanations that are limited in scope to particular economies in particular years. It is tempting to attribute the productivity slowdown to the rise of OPEC, and to conclude that the rapid rise in oil prices in the 1970s had longer-lasting and more damaging effects on industrial economies than people at the time realized. A major difficulty with this explanation is that although the 1970s see rapidly rising real oil prices, the 1980s see falling real oil prices. Yet growth does not appear to have recovered.

It is also tempting to attribute responsibility to mistakes in monetary and exchange rate policy in the inflationary 1970s. Inflation harms the ability of the economy to allocate resources to appropriate uses, and interacts with the tax systems of industrial economies in important ways that threaten to significantly derange the market mechanism. Nevertheless, it is once again difficult to attribute much responsibility for the productivity slowdown to the long-run consequences of the inflation suffered in

Table 2

Convergence-Adjusted Rates of Productivity Growth by Decade

Economy	1950-60	1960-69	1969-79	1979-90	1985-91
United States	2.0	2.5	.5	1.4	1.2
Japan	3.7	5.7	2.3	1.8	3.0
Germany	4.0	2.4	1.1	.7	2.1
France	2.2	3.0	1.4	.3	1.0
U.K.	.8	.7	.5	.3	.5
Canada	1.3	2.1	.2	.7	.5
Italy	3.6	3.1	2.1	1.0	1.6
Total OECD	1.5	2.0	.6	.4	
Industrial Pacific Rim economies	3.3	3.1	1.4	1.5	
Industrial Latin American economies	.0	.3	-.4	-3.6	
Average industrial economy	.9	1.6	.5	-.5	

the 1970s, because the 1980s have not seen faster growth.[8]

To the extent that the 1980s did see deterioration in macroeconomic policy in individual nations, those nations were not the nations in which the slowdown gathered strength. It is the United States, where macroeconomic policy is most often thought to have taken a seriously wrong turn. Yet the magnitude of the growth slowdown in the United States, whether adjusted for convergence and for the business cycle or not, is less than in many other OECD nations.

Yet another possibility is that the engine of growth is slowing down because we are reaching the limits of the technologies of the industrial revolution. All previous bursts of human technological creativity have eventually run into limits. Why should industrialization be different? Herman Kahn was perhaps the most prominent thinker to expect that in the end the industrial revolution would produce a rise in living standards and productivity levels that would follow not an exponential but a logistic curve.[9] Perhaps we are seeing the inflection point. This possibility should be kept in mind.

Even if changes in macroeconomic policies do not account for the bulk of variations in growth rates, it does not follow that they are irrelevant. We therefore turn in the next three sections to scrutinizing the relationship between macroeconomic policies and long-run growth. We consider in the second section the role of demand management policy in creating the framework of price stability and high capacity utilization necessary for the market system to work well. In the third and fourth sections we consider the impact of policies on the savings and investment mix, and the influence of the savings and investment mix on growth.

THE MANAGEMENT OF NOMINAL INCOME

Despite the overwhelming importance of productivity growth as a determinant of living stand-

ards, most macroeconomic textbooks concentrate on cyclical fluctuations in output and employment, and on inflation.[10] To use slightly dated parlance, most of the emphasis is on stabilization rather than growth policies. This emphasis reflects broader social priorities. The media everywhere track unemployment fluctuations much more attentively than productivity fluctuations. Job creation is much more prominent in political debates than productivity enhancement.

Since the end of the Second World War, governments in most industrialized countries most of the time have felt an obligation to use the tools of monetary and fiscal policy to mitigate recessions and avoid depressions without allowing inflation to reach unacceptable levels. The textbook view has been that the macroeconomic objectives of output stabilization and inflation control are essentially independent of the objective of rapid long-run growth. As the textbooks tell the story, cyclical fluctuations of an economy around its potential or full employment level of output depend on aggregate demand and its determinants. Long-run growth depends on supply factors such as the accumulation of physical and human capital and technological progress. It is now generally accepted that while inflationary policies can impact levels of output in the short run, they cannot raise and run the risk of reducing long-run levels of output.

Given the importance attached by policymakers to mitigating cyclical fluctuations and maintaining low inflation rates, it is worthwhile to inquire whether there are important connections between stabilization policies and productivity growth that are not reflected in the textbook model. Two potentially important connections stand out. First, as many monetarists argue, countries that are more credibly committed to price stability have as a consequence less inflation, and as a result the market system functions better.

Second, as many Keynesians argue, policymakers who are too willing to accept recessions may do semi-permanent damage to their economies. Recessions mean less investment in human and physical capital. When recessions lead to prolonged unemployment, human capital atrophies.[11]

Central banks and stable price levels

The extent to which a country chooses to allow monetary policy to be made without political control is probably a good proxy for its relative commitment to price stability as opposed to actively combating recessions. Here we extend some earlier work on central bank independence by considering its relationship to productivity growth.

To varying degrees, post-World War II industrial economies have delegated the management of nominal income to central banks. In some countries—like Italy, New Zealand, and Spain—the central bank is subject to relatively close control by the executive. In other countries—like Germany and Switzerland, with the United States relatively close behind—the central bank has substantial independence from the executive. The degree to which central banks are independent, and have the freedom to shape their own demand management policy safe from strong short-run political pressures, changes only slowly over time as institutions, attitudes, and operating procedures change.[12]

The strong inverse correlation between central bank independence and inflation has been has been highlighted by a number of authors, including Alesina (1988), and Grilli, Masciandaro, and Tabellini (1991). These authors consider two different ways of measuring central bank independence: the first the index constructed and used by Alesina (1988),[13] and the second an index constructed by Grilli, Masciandaro, and Tabellini (1991). Alesina's (1988) index rates the political independence of the central bank on a scale of 1 to 4 as determined by the institutional relationship between the central bank and the executive and the frequency of contacts between central bankers and executive branch officials. Grilli, Masciandaro, and Tabellini's (1991) index considers a wider range of considerations, of which the most important is the

ability of the government to force the central bank to finance its deficits.[14]

Here we reproduce and extend Alesina and Summers' (1991) analysis of the relationship between central bank independence and real aspects of economic performance. Alesina's (1988) index covers 16 OECD nations.[15] Grilli, Masciandaro, and Tabellini calculate index values for 14 of these nations. We interpolated values of the GMT index for the two missing OECD nations, Norway and Sweden, from a linear regression of the GMT index on the Alesina index. We then scaled both indices to have a mean of zero and a unit standard deviation, and averaged them to obtain a single overall index of "central bank independence." A higher value of the index corresponds to a more independent central bank. In our sample the two most independent central banks are those of Switzerland and Germany, followed by the United States. The least independent are New Zealand, Spain, and Italy.

Chart 4 plots the average inflation rate, in percent per year, experienced by an OECD economy over 1955-90 on the vertical axis and the value of the "central bank independence" measure on the horizontal axis. This graph shows a near-perfect inverse correlation between central bank independence and average inflation rates.[16] In this sample four-fifths of the variation in average inflation rates over the 1955-90 generation can be accounted for by the Alesina-Grilli, Mascandiaro, and Tabellini measure of central bank independence. Given that the index was constructed without reference to inflation outcomes by examining the institutional structure of the central bank-government relationship, this is a remarkably high correlation.

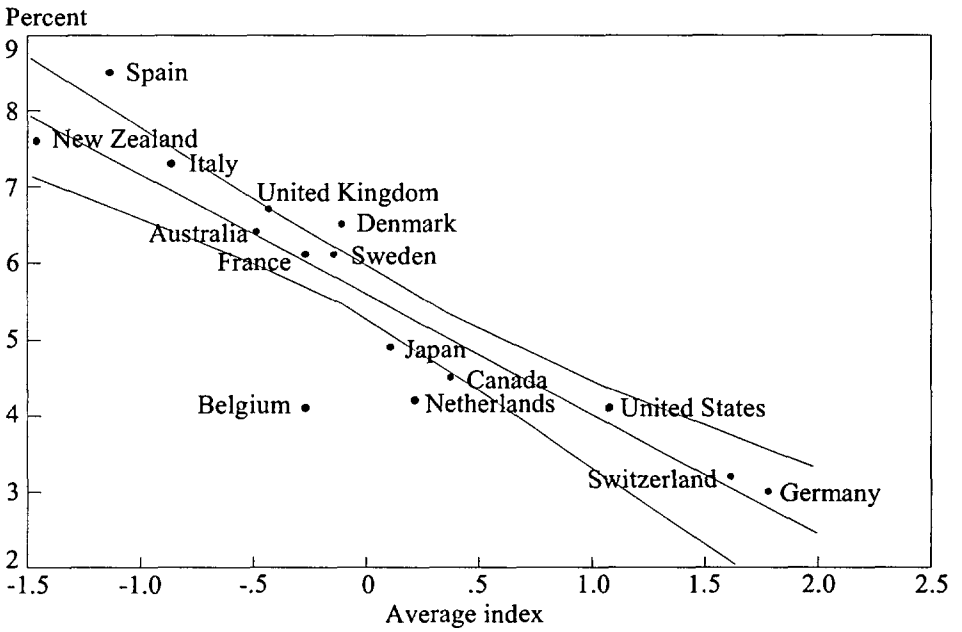
The institutional independence of the central bank, as measured by the Alesina and by other indices, is usefully thought of as determined before and independently of the macroeconomic shocks and policies of the post-World War II era. Central bank laws and traditions change only slowly, and do not in the short run reflect the relative aversion of individual governments or finance ministers for inflation. In the long run periods of high inflation do appear to trigger reform of the central banking laws in a way to grant the bank more independence.[17] But in the short run it is difficult to think that the association between low inflation and central bank independence reflects anything but central bankers' willingness to act according to their own aversion to inflation, whenever the institutional structure allows them freedom to do so.[18]

Do independent, inflation-averse central banks buy low rates of price increase at the price of high unemployment, or low growth? Alesina and Summers (1991) report no association—either substantively or statistically significant—between central bank independence and high unemployment or slow growth—and conclude that "the monetary discipline associated with central bank independence reduces the level and variability of inflation, but does not have either large benefits or costs in terms of real macroeconomic performance." Here we make an even stronger case for the positive effects of central bank independence. Alesina and Summers (1991) examined the correlation between central bank independence and GDP per worker growth, and found no relation, as is shown in Chart 5.

Here we regress GDP per worker growth over 1955-90 on both the degree of central bank independence and also on the initial level of GDP per worker, to pick up the convergence effects discussed in the preceding section. Chart 6 plots the partial scatter of output per worker growth and central bank independence. The difference between a point's vertical location and the dotted horizontal line in the middle of the graph measures the difference between the actual output per worker growth rate over 1955-90 and the level of growth that would have been predicted, given the correlation between initial GDP per worker levels and subsequent growth, if central bank independence had no association with growth. The horizontal axis scale is determined by the difference between the actual measure of central bank independence and what one would have expected central bank independence to be given the correlation of independence and the initial GDP per worker level.[19] A

Chart 4

Inflation and Central Bank Independence



partial scatter plot shows the relationship between a pair of variables after each has been adjusted by the relationship it has with the other factors included in the analysis.

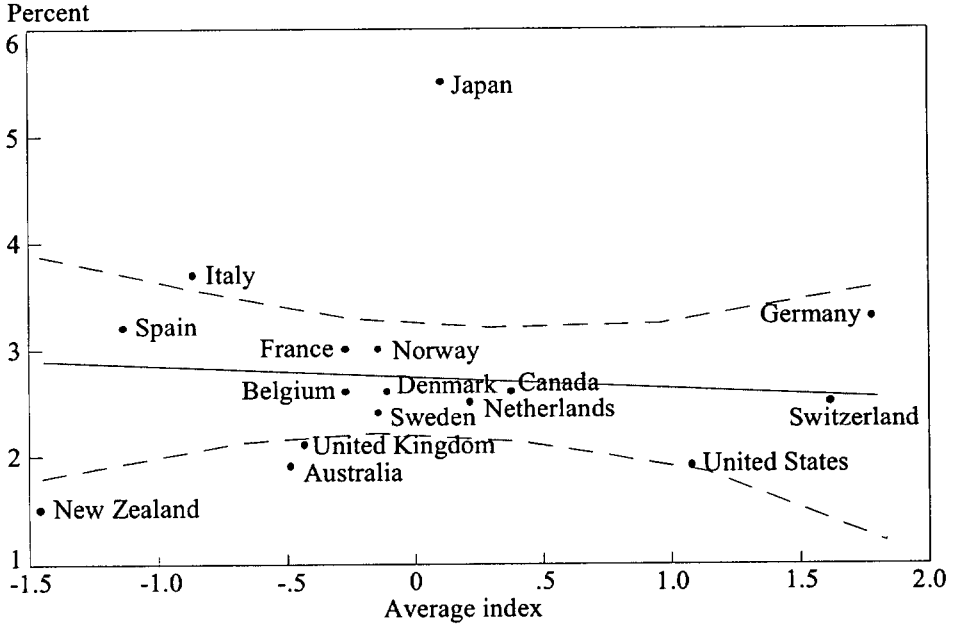
Economies that were relatively rich in 1955 tend to have independent central banks. But such economies also have smaller opportunities for rapid growth through technology transfer. Chart 6 shows that, holding constant initial output per worker levels, a shift in degree of independence from that possessed by Italy's central bank to that possessed by the U.S. Federal Reserve—an increase of two units in the Alesina-Grilli, Mascandiaro, and Tabellini index—is associated with an increase in the rate of GDP per worker growth of 0.8 percentage points per year.

Chart 6 cannot be interpreted as a structural relationship, showing that independent central banks are the key to very rapid growth. All of the other determinants of economic growth are omitted from the regression. The inclusion of some of these other determinants, such as investment, greatly attenuates the significance and magnitude of the central bank independence variable. Furthermore, it may be that the association between central bank independence and rapid growth is spurious. Both may reflect organized disciplined and market-committed governments.

Nevertheless, the strong partial correlation between growth and central bank independence is striking. There is surely no reason to suspect that inflation-averse central banks have significantly lowered growth rates in the OECD over the past generation: anyone wanting to make such a case would have to make the unconvincing argument that the negative effects of central bank inde-

Chart 5

Output per Worker Growth and Central Bank Independence



pendence on growth have been overbalanced by other factors that by coincidence just happened to also be present in economies with independent central banks. Some portion of the positive association between central bank independence and economic growth may well arise because an independent central bank and a low-inflation environment allow the price system to work more effectively.

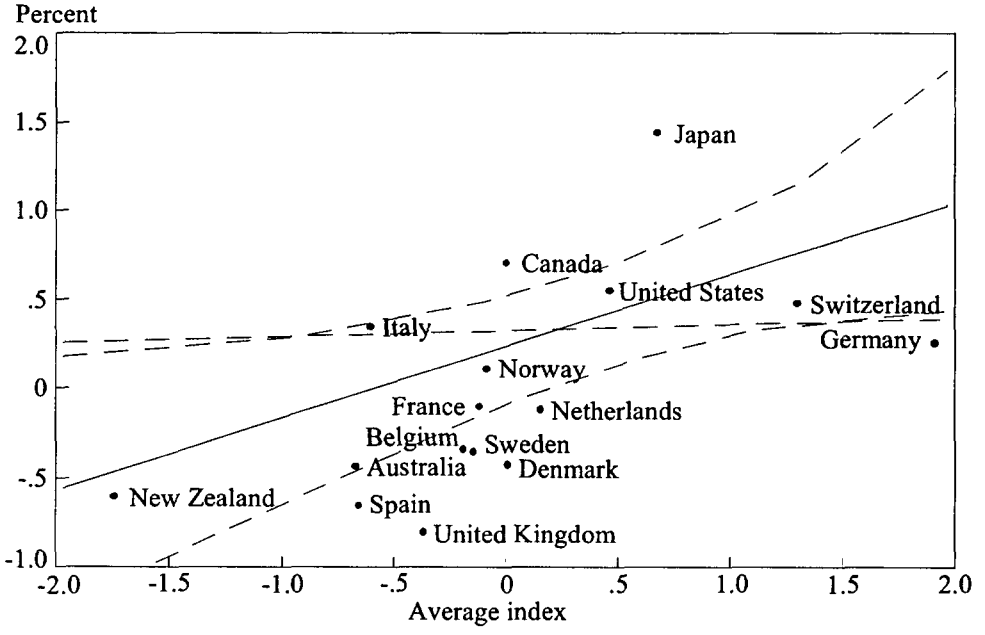
Can there be too much pursuit of price stability?

The evidence in the preceding subsection provides no support for the idea that a more politically driven and therefore recession sensitive monetary policy increases long-run productivity growth. And there is some weak suggestion in the data that it may even reduce productivity growth. This should not be too surprising. As Chart 7, based on Alesina and Summers (1991) demonstrates, there is no evidence that more politically responsive monetary policies actually mitigate cyclical variability in output. And there is no sign that they lead to lower rates of unemployment. Hence, they do not reap any benefits from avoiding recessions.

In light of the zero inflation targets that have been set in a number of countries, periodic proposals for a zero inflation target in the United States, the very low rates of inflation now prevailing in much of the industrialized world, and the commitment of many traditionally inflationary economies to fixed exchange rates, it seems worthwhile to ask: can austerity be overdone? At the grossest level, the answer to the question is surely "yes." Monetary policies in the early years of the Depres-

Chart 6

Central Bank Independence and Economic Growth, Controlling for Initial GDP per Worker Levels



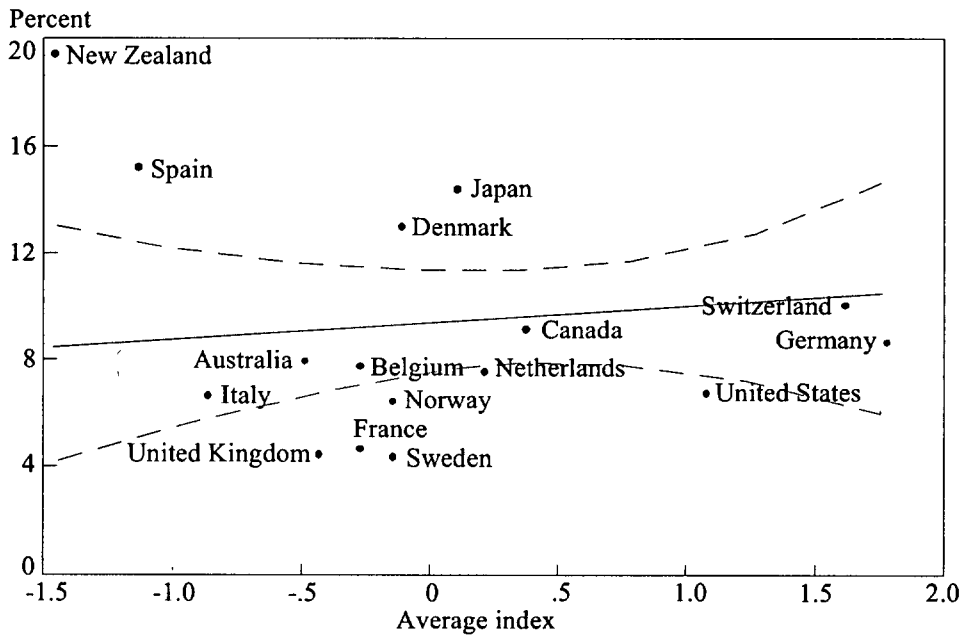
sion in the United States by allowing a deflation that penalized debtors at the expense of creditors surely contributed to the depth of the Depression. As historians of the Great Depression like Friedman and Schwartz (1962) and Temin (1990) have long emphasized, the U.S. Federal Reserve allowed the money stock to contract in Depression in large part because they feared the inflationary consequences of being seen to move away from the operating procedures they believed had been traditional under the gold standard.

Even leaving dramatic instances of policy failure like the Depression aside, we suspect it would be a mistake to extrapolate the results on the benefits of central bank independence too far. On almost any theory of why inflation is costly, reducing inflation from 10 percent to 5 percent is likely to be much more beneficial than reducing it from five to zero. So austerity encounters diminishing returns. And there are potentially important benefits of a policy of low positive inflation. It makes room for real interest rates to be negative at times, and for relative wages to adjust without the need for nominal wage declines. It may also be more credible than a policy of zero inflation and therefore it may require smaller output losses as the public overestimates the monetary authority's willingness to meet nominal demands. More generally, a policy of low inflation helps to avoid the financial and real costs of a transition to zero inflation.

OECD experience does not permit a judgment of the merits of very low inflation, since the two countries with the lowest average inflation rates after 1955, Switzerland and Germany, have inflation rates

Chart 7

The Variance of Real GDP Growth and Central Bank Independence



that have averaged 3 percent per year, a rate at which prices double every generation. As Chart 6 illustrated, these two countries have growth records that are less than what one would have predicted on the basis of convergence effects and an assumption that each additional point on the central bank independent indices carries the same growth benefits.

Furthermore, the macroeconomic strain associated with strong disinflation in New Zealand and Canada in recent years, and the extraordinary strains imposed on European countries as the ERM forced rapid disinflation up to its recent suspension, both point up the potential transition costs of moving to regimes of strict price stability.

These arguments gain further weight when one considers the recent context of monetary policy in the United States. A large easing of monetary policy, as measured by interest rates, moderated but did not fully counteract the forces generating the recession that began in 1990. The relaxation of monetary policy seen over the past three years in the United States would have been arithmetically impossible had inflation and nominal interest rates both been three percentage points lower in 1989. Thus, a more vigorous policy of reducing inflation to zero in the mid-1980s might have led to a recent recession much more severe than we have in fact seen.

REVERSING THE PRODUCTIVITY SLOWDOWN: HIGHER INVESTMENT

One of the most fundamental economic deci-

sions that any society makes is the decision as to how resources are to be allocated between the present and the future, or equivalently between consumption and investment. Strategies for increasing the rate of growth in living standards invariably emphasize in some way increasing investment in the future, while sometimes recognizing that this will mean reduced consumption in the present, at least in a fully employed economy. Here we examine briefly the potential contribution of increased investment to economic growth. We highlight some relatively dismal scientific arithmetic demonstrating that only very high-return investments or huge increased in investment rates have the potential to dramatically alter growth rates.

A very simple arithmetic relationship, Equation 1, is useful in thinking about the relationship between investment and growth:

(1) $\Delta g = r\,\Delta(I/Y)$

In words, the equation says that the instantaneous increase in an economy's growth rate from an increase in its investment share is the product of two things: the increase in the share of output that is invested, and the social rate of return on the investment. For example, if an economy increases its investment share by 3 percent of GDP and the investment yields a 10 percent rate of return, its instantaneous output growth rate will rise by 0.30 percentage points.

For the purpose of thinking about long-run growth rates, the instantaneous growth rates of Equation 1 exaggerate significantly the potential of increased investment for two reasons. First, as more and more capital of any given type is accumulated, diminishing returns are likely to set in. Second, capital depreciates and so an increase in the investment rate ultimately leads to a higher capital stock, but not one permanently increasing at faster than the long-run output growth rate. Calculations presented in De Long and Summers (1991) suggest that for standard growth models calibrated to the U.S. experience a given boost to investment would increase growth rates over a 20-year period by approximately half of the boost's initial effect on the growth rate.

Equation 1 has dismal implications for both efforts to explain variations in growth rates on the basis of differences in investment rates, and efforts to increase growth rates by increasing investment shares. In the first section we noted that productivity growth in the OECD as a whole has fallen by 1.8 percentage points per year comparing the 1960s to the 1980s. To boost long-run growth back up to its earlier, higher level through increasing investment shares—even investments that yielded 15 percent per year—would on the basis of De Long and Summers' (1991) calculations require an increase of 24 percentage points in the investment share of national product. It is logic of this type that explains why growth-accounting exercises in the tradition of Solow (1957) typically assign so small a role to capital accumulation in accounting for productivity growth.

With respect to living standards, the arithmetic is even more discouraging. If investments earn even a 15 percent return, it will be seven years before permanent increases in investment begin to pay off by generating higher levels of consumption: for the first six years the increase in output generated by past higher investment is more than offset, in terms of current consumption, by the deduction necessary to finance this year's higher investment.

What are the policy implications? The first obvious implication is that raising the *quality* of investment is very important relative to raising the quantity of investment. With most economies investing in excess of a quarter of GDP in private capital, schooling, infrastructure, and research and development, relatively small percentage-point changes in the rate of return on investment can induce large increases in growth. Finding the highest return investments, and managing public investments as efficiently as possible, is therefore crucial.

Second, it appears very unlikely that there are

many investments left open that have ex-ante private returns far above 10 percent per year. Take as an example investing in going to college. At present the average gap in earnings between young (25 to 34) white males with no college and with B.A.s is about 70 percent. This is a huge gap: in today's America, going to college is one of the best investments anyone can make. But spending four years in college has substantial costs: the four years' worth of wages not earned while the student is out of the labor force, and perhaps half again as much in the direct cost of education. Comparing the 70 percent increase in wages accruing to those with B.A.s to the roughly six years' worth of income that the B.A. costs to acquire reveals that investments in higher education promise a rate of return of about 10 percent per year. Thus even an investment as worthwhile for an individual, and as attractive for society, as college is in the class of investments that cannot be expected to lead to large boosts in the growth rate.

In order to identify investments with high enough social returns to have a substantial impact on growth, it is necessary to find investments with substantial external benefits—benefits not captured by the entity undertaking the investment. Identifying and promoting such strategic investments is a critical way in which public policy can promote growth. Much of this involves policy with a structural or microeconomic dimension, which lies outside the scope of this paper. We do present some evidence in the next section suggesting that policies promoting equipment investment can have large external benefits.

Third, it appears that in the United States today deficit reduction can have at most a minor impact on long-run growth rates. It is surely worthwhile to reduce the deficit: from the point of view of the country as a whole deficit reduction has no cost—what we would pay now in increased taxes we would save in lowered future taxes—and promises significant benefits by evening out the cross-generational tax burden and removing a source of uncertainty about the long-run commitment of the United States to low inflation. But deficit reduction is not a policy that would reverse the productivity slowdown. Since one percentage point of GDP's worth of deficit reduction would not induce a full percentage point's increase in national savings, the effect of each percentage point of deficit reduction on long-run growth would in all likelihood be smaller than even the modest increases calculated above.

We are led to conclude that policies to boost the share of output devoted to investment in general are worth undertaking on their own terms: they do promise benefits worth more than their costs. But they are not going to advance the ball very far in the game of economic growth. "Three yards and a cloud of dust" is what they will produce. Only "long ball" investments that have large external benefits and promise extremely high social returns will have the potential to significantly accelerate growth.

The observations that economies do exhibit substantial differences in their rates of productivity growth, and that these differences must be a consequence of decisions about resource allocation suggest that such high-return investments do exist. The challenge for economic research and policy is to find them.

SUPERNORMAL RETURNS: INVESTMENT IN EQUIPMENT

The cross-section correlation of growth and equipment investment

Is there in fact reason to believe that shifts in rates of investment, especially of particular kinds of investment, might have large effects on economic growth rates? In earlier work, De Long and Summers (1991),[20] we argued that the cross-sectional distribution of growth rates across economies in the post-World War II period strongly suggests that investments in machinery and equipment are a strategic factor in growth, and do carry substantial external benefits.

The idea that machinery investment might be necessary for rapid productivity growth is not new. Economic historians have written of the close association of machinery investment and economic growth since the beginning of the Industrial Revolution. New technologies have been *embodied* in new types of machines: at the end of the eighteenth century steam engines were necessary for steam power, and automatic textile manufacture required power looms and spinning machines; in the early twentieth century, assembly line production was unthinkable without heavy investments in the new generations of high-precision metal-shaping machines that made parts interchangeable and assembly lines possible. Recent innovations fit the same pattern: basic oxygen furnace and continuous-casting steel-making technologies need oxygen furnaces and continuous casters. "Flexible system" implementations of mass production need numerically controlled machine tools.

Here we document the close association of equipment investment and economic growth. We present regressions of economic growth on equipment investment, and on other factors that are plausible determinants and correlates of growth, over a period 1960-85 chosen to maximize the number of economies in our sample. We restrict our attention to that group of economies, whose growth we tracked in the second section, that had already proceeded relatively far along the road of industrialization by 1960.[21] Our sample is further restricted by data availability.

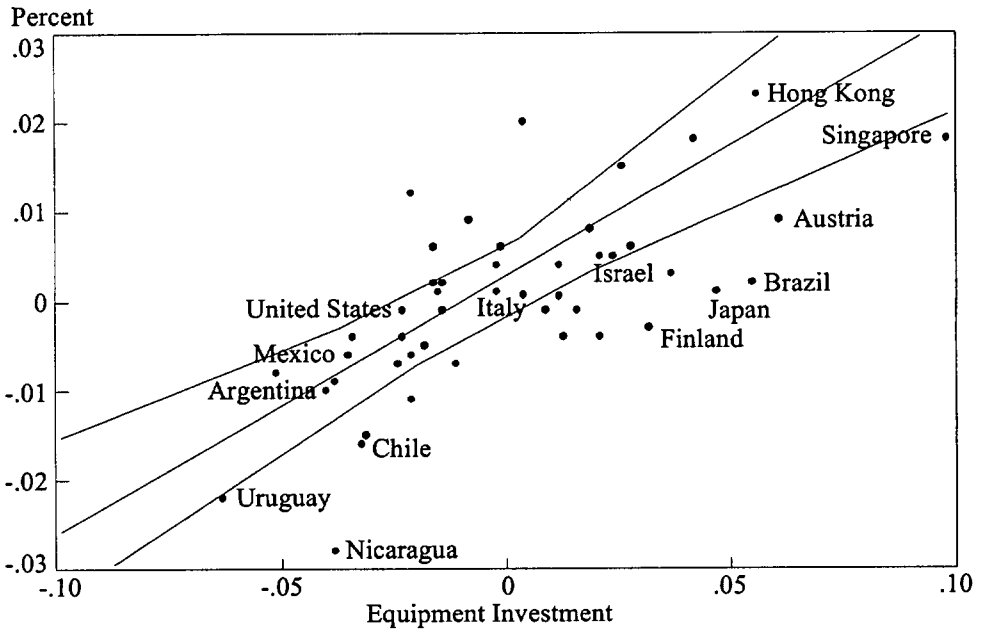
Since we study the correlation of growth not with just total investment but with the different subcomponents of investment, our sample is restricted to nations that were surveyed in one of the U.N. International Comparison Project (ICP) benchmarks, and for which we have relatively detailed information on relative price and quantity structures, at least for benchmark years. In the end, our sample consists of 47 economies.[22] An important additional advantage of our ICP data is that it takes account of differences across countries in the relative prices of capital goods. Other comparisons of investment across countries measure "investment effort"—how much of consumption is foregone as a result of the investment decisions made in an economy. Since relative prices of capital goods vary widely, investment effort can be a poor guide to the actual quantity of new capital purchased and installed. We believe that this is one reason why the conventional wisdom is that the cross-nation investment-growth relationship is weak. ICP data are sensitive to this potential difficulty: it allows us to study not the association between growth and investment effort but the association between growth and investment.

Chart 8 and Equation 2 below[23] show the strong association between differences in machinery investment rates and differences in economic growth rates that we typically find. Equation (2) below reports the estimated equation from a regression of growth in GDP per worker over 1960-85 on five factors. First comes the 1960 productivity gap vis-à-vis the United States. This factor is included to account for the potential gains from acquiring and adapting the technologies of the industrial West open to poorer economies. Because of this factor, we would expect poorer economies to grow faster than richer ones if other things were equal. The second factor is the rate of labor force growth. A faster rate of growth of the labor force implies that a greater share of national product must be devoted to investment—both in physical capital and in education—simply to keep the average level of skills and the amount of physical capital used by the average worker constant.

The third factor is the average secondary school enrollment rate over the sample. This is a proxy for the rate of investment in human capital through formal education. However, it is not a very good proxy (Schultz 1992). In our regressions the secondary school education rate does not appear to be a strong and significant independent correlate of growth. But it is premature to conclude that education is not important: education almost surely is important. Instead, the lack of signifi-

Chart 8

Partial Scatter of 1960-85 Growth and Machinery Investment



(2) GDP/Wkr Growth = 0.262 (Eq. Inv.) + 0.069 (Non-Eq. Inv.) + 0.032 (Prod. Gap) - 0.082 (Lab. Fce. Gr.) - 0.004 (Sec.Ed.)
(0.048) (0.028) (0.007) (0.169) (0.010)

$R^2 = 0.654$ SEE = 0.0079 n = 47

cance of our human capital investment proxies in our cross-national regressions should most likely be attributed to the large divergence between measured schooling and actual skills learned. The fourth factor is the average rate of investment over 1960-85 in machinery and equipment. This factor is a measure not only of accumulation but also a proxy for a number of ways in which investment might lead to higher productivity through technology transfer, and through learning by doing.

The fifth and last factor is the rate of investment in categories other than machinery and equipment. This factor measures the importance of capital accumulation in general, for there is no special reason to believe that nonmachinery investment should be especially fruitful either as a carrier of new technologies or as a major source of informal education through learning-by-doing.

The data used are a later vintage of those used in De Long and Summers (1991).[24] Not surprisingly, the results are similar. Equipment investment has a very strong association with output per worker growth. In this sample, each extra percentage point of total output devoted to investment in machinery and equipment is associated with an increase of 0.26 percentage points per year in economic growth. Nonmachinery investment has a statistically significant association with growth, but the magnitude of the coefficient is only one-quarter as large as for machinery investment—and is not out of line with what one would predict from the "standard model" discussed above. The difference between the equipment and the nonequipment investment coefficient is highly significant, with a

t-statistic on the difference of more than three.[25]

Chart 8 shows the partial scatter of growth and machinery investment. Important observations in generating the high machinery investment coefficient include Singapore, Japan, Israel, and Brazil—all with high machinery investment rates and high growth rates—and Argentina, Chile, Jamaica, Nicaragua, and Uruguay with low growth and low rates of machinery investment. U.S. vs. Japan thought: difference in equipment investment accounts for two percentage points of U.S.-Japan growth gap.

Nonmachinery investment plays a much smaller role in accounting for differences in output per worker growth. And labor force growth and the school enrollment rate do not have any significant effect—although as noted above, this may tell us more about the inadequacy of the secondary school enrollment proxy than about the true relationship between schooling and growth.

Equipment investment and growth: Causation

The strong correlation between machinery investment and economic growth does not necessarily imply that a boost in machinery investment shares is the best road to a growth acceleration. It could be that machinery and growth are correlated not because an ample *supply* of machinery leads to fast growth, but because fast growth leads to a high *demand* for machinery. Even if a high rate of machinery investment is a cause and not a consequence of rapid growth, it is not necessarily the case that the entire estimated coefficient on machinery investment in our cross-nation regressions can be interpreted as measuring the growth boost that would be produced by a policy-induced shift in the machinery investment share. A high rate of machinery investment might well be a signal that an economy has a climate favorable to growth, and that a number of other growth-causing factors omitted from the list of independent variables are favorable as well. In this case, the high coefficient on machinery investment would reflect both the direct effect of machinery investment on growth and the extra correlation arising because a high rate of machinery investment is a proxy for the presence of other growth-producing factors.

The first possibility—that machinery is more effect of rapid growth than cause—we dismissed in De Long and Summers (1991) because a high rate of machinery investment and pace of growth were correlated not with relatively high, but with low machinery prices.[26] If machinery were the effect of fast growth, it would be because fast growth would shift the demand for machinery outward, and move the economy up and out along its machinery supply curve. Thus, we would see fast growth and high machinery investment correlated with high machinery prices. Instead, we see fast growth and high machinery investment correlated with low machinery prices. To us, this supply-and-demand argument is powerful evidence that fast growth is not a cause but an effect of a high rate of machinery investment.

There remains the possibility that the high equipment investment coefficient arises in part because machinery investment is a good proxy for other, hard to measure factors making for economic growth. In such a case the association between equipment investment and growth would not be a "structural" one, and policy-induced boosts in rates of investment in machinery and equipment would be unlikely to raise output growth rates as much as the cross-nation correlations suggest.

In general, the assertion that the strong association between machinery investment and growth reflects a structural causal relationship running from machinery to growth is a claim that a given shift in machinery investment—however engineered—will be associated with a constant shift in growth. The next best thing to direct experimental evidence is the examination of different dimensions of variation in machinery to see whether dimensions of variation in machinery investment driven by different factors have the same impact on growth. To do this, we examine the relationship

between growth and various components of equipment investment associated with different aspects of national economic policies.[27]

Table 3 reports such regressions of growth on different dimensions of variation in machinery investment. The estimated machinery investment coefficient measures the association between output growth and that portion of machinery investment that is correlated with the particular instrumental varible. In addition to the baseline case without any instruments, four sets of instrumental variables are used: the average nominal savings share of GDP over 1960-85, Aitken's (1991) estimates of the deviation of the real relative price of machinery and equipment from its value expected given the economy's degree of development, and World Bank estimates of tariff and nontariff barriers to imports of machinery and equipment.

As Table 3 shows, no matter which of these dimensions of variation in machinery investment we examine, the association of machinery investment and growth remains approximately the same. Estimated coefficients range from 0.196 to 0.271. The similarity of the association with growth of these different dimensions of variation in machinery investment provides powerful evidence that the machinery-growth nexus is "structural," and does not arise in any large part because a high rate of machinery investment is a signal that other growth-related factors are favorable.

In spite of the similarity of the estimated machinery investment coefficients, the different instrumental variables regressions do capture different aspects of the variation in machinery investment. In the second line of Table 3—which shows the effect on growth of that component of machinery correlated with aggregate nominal savings rates—the most influential observations are the Asian trio of Japan, Singapore, and Hong Kong with high, and Ecuador, Uruguay, and Switzerland with low savings, equipment investment, and growth rates. The third line—showing the effect of that component of equipment investment correlated with a low real price of machinery—has fewer data points and a somewhat different set of influential observations: the three most influential high-growth high-investment low-price economies are Japan, Israel, and Greece.

The different regressions in Table 3 do indeed examine different components of the variation of equipment investment rates across countries. Yet all of the estimated coefficients are very similar. We think it very unlikely that the association of growth with each of these components of equipment investment would be equally strong if equipment investment were merely a signal, and not an important cause, of growth.

The point made in this section—that there are some investments, investments in machinery and equipment, that have the potential to boost total factor productivity directly by sparking technology transfer and learning-by-doing—is far from new. It was a centerpiece of the analysis of Kennedy's Council of Economic Advisors, which blamed what they saw as slow productivity growth in the 1950s on a falling and misallocated share of investment (Tobin and Weidenbaum 1988). The 1962 *Economic Report of the President* called for increased investment in plant and equipment, subsidized by accelerated depreciation and an investment tax credit. In their view productivity growth and capital accumulation were closely linked:

> [When] investment was more rapid, there was an accompanying acceleration of productivity gains.... Investment in new equipment serves as a vehicle for technological improvements and is perhaps the most important way in which laboratory discoveries become incorporated into the production process. Without their embodiment in new equipment, many new ideas would lie fallow.... This interaction between investment and technological change permits each worker to have not only more tools, but better tools as well.[28]

This section has focused on equipment investment almost exclusively, because unlike other forms of potentially strategic high-return investment, like R&D or education, it is substantially

Table 3

Instrumental Variables Regressions of Growth on Machinery Investment

Instrument	Machinery investment	Other investment	Labor force growth	Productivity gap	R^2 (2d stage)	SEE	n
No instruments	.250	.070	-.030	.034	.652	.008	47
	(.040)	(.028)	(.126)	(.006)			
Savings rate	.224	.079	-.037	.031	.507	.009	46
	(.059)	(.034)	(.151)	(.008)			
Relative price of machinery	.210	.092	-.103	.040	.610	.008	31
	(.086)	(.045)	(.164)	(.011)			
Tariffs and nontariff barriers on capital goods	.196	.077	.016	.027	.309	.011	39
	(.136)	(.048)	(.208)	(.011)			

influenced by macroeconomic policy tools. The policy instruments with the potential to increase equipment investment are clear enough, and are those identified by the Kennedy Council of Economic Advisors in its 1962 reports: high rates of national saving by making possible looser monetary policy reduces the cost of capital and encourages equipment investment. Increased national saving caused by tighter fiscal policy or increased private saving raises equipment investment. Tax incentives, such as the American investment tax credit, that favor equipment investment are particularly desirable because they are well-targeted. Trade policies that ensure that capital goods imports are not penalized are important in making sure that a high investment effort is translated into a high rate of equipment effort.

CONCLUSION

In concluding this paper in 1992, it is worth recalling the observation with which we began. The productivity slowdown is not just an American phenomenon. It is a worldwide event that has occurred in countries with widely varying micro and macroeconomic policies. This suggests that even with all the political courage in the world, there is no macroeconomic magic bullet that has the potential to reverse the productivity slowdown. Better, more responsible macroeconomic management is surely helpful. And increases in national saving that flow into general increases in investment surely can make a contribution.

If public policy in the industrialized world does succeed in reversing any large part of the productivity slowdown, its success will have an important microeconomic component. Policy will succeed either by changing incentives in such a way that average returns on investment significantly increase, or by successfully raising the share of national output that is devoted to forms of investment that have large external benefits and therefore very high social returns.

In keeping with this paper's macroeconomic perspective and some of our own earlier research,

we have highlighted equipment investment as a class of investment that is likely to have especially large social returns by supporting the development and introduction of new technologies. Certainly cases can also be made for strategically selected investments in infrastructure and in education. These cases must rely on external benefits of a kind that are difficult to measure. Studies of the travel time savings from highways, or the wage increases from better schooling do not suggest the kind of extraordinary returns or externalities that are necessary if increases in these categories of investment are to offset a large part of the productivity slowdown. The quantification of the possible external benefits of various forms of public investment should be a critical research priority. And even in the absence of compelling evidence of external benefits, there is a case for increasing public investment in those countries where investment rates have lagged and are low by international standards.

A crucial remaining issue is the apparent conflict between our emphasis on support for critical strategic investments and conventional policy wisdom that reductions in budget deficits and increases in national saving are desirable in the United States and in Europe. In fact there is no conflict. Reductions in budget deficits over the medium term are desirable on stabilization policy grounds apart from any effect that they might have long-run growth prospects. And, assuming strategic investments with very high returns can be identified, there is no reason why they should be financed out of reductions in other investment rather than out of consumption. Reducing budget deficits is good macroeconomic policy. But it is unrealistic to hold out the hope that reduced budget deficits alone will restore the magic of an earlier era, when standards of living in the industrialized world doubled in one generation rather than in two or more.

Appendix

Growth and Equipment Investment with Different Sets of Additional Growth Factors

Table A1

Regressions of 1960-85 Growth on Equipment Investment and Different Sets of Additional Variables for Industrial Economies

Equipment investment	Other investment	Productivity gap	Labor force growth	Secondary education rate	Govern. consump. expend.	Public investment	Continent	R^2	SEE
.262	.069	.032	-.082	-.004				.65	.008
(.048)	(.028)	(.007)	(.169)	(.010)					
.255	.059	.034	-.025					.63	.008
(.039)	(.027)	(.006)	(.127)						
.256	.060	.034	-.028		-.027			.65	.008
(.040)	(.027)	(.006)	(.126)		(.020)				
.240	.059	.035	-.083			.041		.67	.008
(.036)	(.025)	(.006)	(.118)			(.076)			
.206	.042	.029	.107				Continent: Prob(F) = .320	.68	.008
(.048)	(.030)	(.007)	(.181)						
							Africa = .026		
							(.005)		
							Asia = .027		
							(.004)		
							Europe = .027		
							(.003)		
							North America = .020		
							(.003)		
							Oceana = .017		
							(.008)		
							South America = .019		
							(.003)		

Endnotes

[1] Throughout this paper we use the Summers and Heston (1991) estimates of GDP per worker levels (the most current version of the cross-country database also discussed in Summers and Heston (1988 and 1984)), extended from 1988 to 1991 using OECD estimates of real growth rates. The Summers and Heston estimates have the merit of paying close attention to accurately measuring purchasing power parities, and have the further merit of assessing growth rates at a constant set of prices. However, analyses using World Bank or OECD estimates of relative GDP per worker growth rates do not lead to significantly different conclusions as long as we restrict our attention to relatively rich and industrialized economies.

[2] We end the decade of the 1960s in 1969 so as not to distort long-run growth estimates by having one of our periods end during the trough of the 1970 recession. Similarly, we end the decade of the 1970s at the peak of 1979, and we end the 1980s at the peak of 1990 so as not to conflate shifts in long-run growth with the effects of the transitory recessions.

[3] In calculating our centered moving averages for the most recent years 1990-92, we use OECD forecasts of output and employment growth rates over 1992-94 .

[4] Our cyclical adjustment procedure is based on a regression of year-to-year productivity growth on the change in the unemployment rate separately for each economy. It allows for a one-percentage-point rise in the natural rate of unemployment in Germany as a result of reunification.

[5] For example, see Wallich (1955) and Abramovitz (1986), which contain very good analyses of the post-World War II German *Wirtschaftswunder* and of long-run cross-country productivity growth, respectively. De Long and Eichengreen (1991) argue that rapid post-World War II western European growth was too fast to be attributed to a "rubber-band effect."

[6] We define an industrial economy as one in which GDP per worker levels as estimated by Summers and Heston exceed a quarter of the U.S. for more than one of the benchmark years demarcating decades. The industrial economies plotted in Chart 1 are the same set included in Table 1.

[7] See De Long (1988), Baumol and Wolff (1988), Dowrick and Nguyen (1989), and Baumol, Blackman, and Wolff (1989).

[8] It may be that we are simply too impatient, that few believed until the later 1980s that inflation would remain below 4 percent per year where it had been pushed over 1979-1983, that as a result few of the benefits of predictable low inflation were gained in the 1980s, but that the 1990s will see rapid growth as resources finally flow out of their low social return inflation havens and into activities where they yield high social rates of return but were in the past heavily taxed by inflation. To date we see few signs of such beneficial adjustment and reallocation in response to today's low-inflation environment. But we hope that we are wrong in our skepticism.

[9] See Kahn, Brown, and Martel (1976). The one of their arguments that we find most interesting is their belief that the technologies of the industrial revolution are of limited value in boosting productivity in the tertiary sector of nonagricultural, nonextractive, and nonindustrial activities. They expected the primary and secondary sectors to shrink to such a small portion of the economy that even rapid continued technological progress in agriculture and industry would have only limited effects on living standards.

[10] With the exception of Mankiw (1990).

[11] Thus, the rise in European unemployment in the early 1980s appears to have had long-lasting detrimental effects on European economies' productive capacities far beyond any expected at the start of this decade. See Blanchard and Summers (1986).

[12] See Rogoff (1985). As Alesina and Grilli (1991) make the argument, the median voter, the one whose preferences are decisive in elections, would want the management of nominal demand and the control of monetary policy to be in the hands of those who are more inflation averse than she is—though *ex post* such a voter would wish that monetary policy were more expansionary and that inflation were higher.

[13] Based on the index of Bade and Parkin (1982).

[14] For a more detailed explanation of the differences between the two indices, see Alesina and Summers (1991).

[15] Including the 12 nations considered in Bade and Parkin (1982). The 16 nations in Alesina's (1988) sample are Australia, Belgium, Canada, Denmark, France, Germany, Italy, Japan, the Netherlands, Norway, New Zealand, Spain, Sweden, Switzerland, the U.K., and the United States.

[16] As Alesina and Summers report, there is a strong correlation between central bank independence and low inflation variability as well.

[17] The most striking example is the independence of German central bankers since the 1923 hyperinflation. As Alesina and Summers (1991) note, disappointment with relatively high inflation in Canada and New Zealand has recently triggered increases in the independence of their central banks. Cukierman, Webb, and Neyapti (1991) discuss how this generation's inflation shapes next generation's central banking laws.

[18] Italy, for example, had in 1950 a tradition of aversion to inflation: it had used its Marshall Plan aid to pay off its government debt, and before the Great Depression the Fascist government had thought it willing to deflate internal prices by one-third to reestablish the exchange rate at the *quanta novanta*. Yet since 1955 with a central bank largely dependent on the executive, Italian inflation has been the third highest in our OECD sample.

[19] The R^2 from the regression of average GDP per worker

growth on initial level and central bank independence is 0.72, with a standard error of the estimate of 0.53 percent per year. On average, a unit increase in the index is associated with an increase in growth rates of 0.408 percentage points per year, and this coefficient has an estimated t-statistic of 2.51.

[20] See also De Long (1992), Jones (1992), or De Long and Summers (forthcoming).

[21] We eliminate the poorest economies from our sample because we are not certain that their experience contains useful lessons for the analysis of growth in the rich OECD.

[22] The data underlying the cross-sectional regressions are a later vintage of the data used in De Long and Summers (1991). See De Long and Summers (1992) for more details.

[23] An appendix table provides results for a number of different specifications, showing that the strong association of machinery investment and growth holds true for the inclusion or exclusion from the analysis of a number of different alternative sets of growth factors.

[24] The major changes are the use of the trade data from Lee (1992) to sharpen estimates of the proportion of investment devoted to machinery and equipment, and a fuller exploitation of OECD real investment component estimates.

[25] De Long and Summers (1991) consider a number of alternative breakdowns of investment. The bifurcation into equipment and nonequipment is most successful at accounting for cross-national differences in productivity group.

[26] De Long and Summers (1991) examined the robustness of our conclusions by performing a number of additional tests as well. In addition to instrumental variables estimates like those reported below, we also examined the differential associations of extensive and intensive growth and machinery investment, and examined shifts in growth and machinery investment rates across subperiods of the post-World War II era.

[27] By examining the coefficient produced by different two-stage least squares regressions of growth on equipment investment with different sets of instruments. This procedure can be viewed as an informal Hausman-Wu test of the proposition that the equipment-growth relationship is a structural one uncomplicated by omitted variables or simultaneity.

[28] Tobin and Weidenbaum (1988), p. 215.

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Policies for Long-Run Economic Growth: A Summary of the Bank's 1992 Symposium

By George A. Kahn

The potential rate of economic growth in the industrialized countries is now only half what it was in the 1960s. Growth of world saving and productivity has also declined, suggesting continued low economic growth in the future. If these trends persist, standards of living in the industrialized countries will improve only marginally. This prospect has generated proposals for reversing the growth slump of the past two decades.

To explore policies to increase growth, the Federal Reserve Bank of Kansas City invited distinguished central bankers, academics, and financial market participants to a symposium entitled "Policies for Long-Run Economic Growth." The symposium was held August 27-29, 1992, in Jackson Hole, Wyoming. In opening comments, Federal Reserve Chairman Alan Greenspan underscored the importance of the topic by emphasizing the role of long-term forces in shaping short-term economic developments. "It has become ever more apparent . . . that what policy needs most at this stage are models that effectively tie down the developing long-term forces impinging on our economies. For unless we have some insight into how current short-term aberrations will evolve into the long term, our overall policy posture will surely prove inadequate."

Throughout the symposium, most participants agreed that economic policymakers should pay more attention to long-run growth. But participants disagreed on specific policies to promote growth. While some of the participants, mostly from the United States, advocated government programs to increase growth, other participants emphasized increased reliance on free and open markets.

This article summarizes the papers presented at the symposium and the discussions they stimulated. The first section of the article reviews evidence on the growth slowdown and discusses traditional and new theories of economic growth. The second section examines economic policies to promote growth. The third section provides a synthesis of the issues from the perspective of overview panelists and others with a broad outlook.

THE ECONOMIC GROWTH SLOWDOWN: EVIDENCE AND THEORY

To set the stage for a discussion of policies to promote growth, the symposium began by exam-

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ining the causes of the growth slowdown and the contributions of new economic theories in explaining economic growth. Participants disagreed about the relative importance of various possible causes of the growth slowdown but agreed that economic theory had advanced considerably in recent years in explaining patterns of long-term economic growth.

Evidence

In a panel discussion, Michael Darby, Horst Siebert, and Kumiharu Shigehara addressed the causes of slower economic growth. Darby questioned the extent to which long-term growth had actually declined in the United States because he felt measures of growth were biased. While the other participants acknowledged the measurement problem, they viewed the growth slowdown as real. Siebert, focusing primarily on Germany, emphasized a wide variety of structural, supply-side, and other forces. Shigehara, focusing on countries belonging to the Organization for Economic Cooperation and Development (OECD), suggested that structural problems, not supply factors, explained the bulk of the slowdown.

Darby argued that much—if not all—of the economic growth slowdown in the United States was an illusion stemming from faulty measurement. Estimating the real value of a country's output has become more difficult as the share of services and high-tech goods in GDP has grown. For example, price changes are difficult to disentangle from quality changes in the high-tech sector. Official statistics likely overstate price increases of many high-tech goods, while underestimating improvements in quality. While increased quality of a good should be reflected in real GDP, a price change should not. Likewise, in the service sector, output is often measured by hours of input without accounting for possible increases in productivity. These two biases lead to estimates of GDP growth that are too low. Moreover, because the service sector has grown relative to the goods sector over the last dozen years, the downward bias to real GDP growth has increased. Darby claimed that this downward bias accounts for most, if not all, of the decline in real economic growth in the United States.

Nevertheless, Darby still saw a problem. With the maturing of the baby boom generation and the assimilation of immigrants into the labor force, the quality of the labor force should have increased and contributed more to economic growth than it apparently did. Even if the entire growth "slowdown" was the result of measurement error, current growth rates would still be too low given recent developments in the labor force.

Most other participants disagreed with the view that the decline in growth in the United States or elsewhere could be attributed mostly to measurement problems. For example, Siebert argued that a variety of real economic forces caused Germany's growth rate to slow over the past 40 years, then pick up slightly in the late 1980s. These forces included variations in the growth of factors of production and their productivity, changes in the relative prices of natural resources, instability in trade and macroeconomic policy, and changes in the economy's fundamental structure.

Central to Siebert's argument was the relationship between growth in the labor force and growth in the capital stock. As growth in the labor force slowed after the 1950s in Germany, the productivity of the capital stock declined and labor productivity increased. Despite the increase in labor productivity, output growth declined. More recently, as both factors of production have increased simultaneously, output growth has begun to pick up. From this experience, Siebert concluded that diminishing returns to capital limit output growth when the labor force is stable. Only with both labor and capital growing together is overall GDP growth maximized.

Within this general framework, Siebert identified other factors that have contributed to the growth slowdown. First, the oil price shocks of 1973-74 and 1979-80 reduced the productivity of

capital and contributed to the slowdown in economic growth. Environmental regulation had similar effects. Second, whereas in the 1950s Germans viewed competition as the guiding force for economic institutions and policy, building safety nets for individuals became more important in later years. As a result, while Japan and the United States were creating jobs in the 1970s and early 1980s, Germany was losing jobs. Third, increased government spending and higher taxes contributed to slower growth in Germany. Finally, Siebert asserted that the rate of creation of new knowledge had slowed. Siebert concluded that to continue contributing to the German growth turnaround, policy should focus on improving institutional arrangements, rather than "influenc[ing] economic activities ad hoc."

Shigehara rejected explanations of the growth slowdown that relied solely on "traditional" factors, emphasizing instead the role of "structural" factors. Shigehara surveyed a wide range of factors that have traditionally been identified as contributing to slower growth. Among these factors are higher oil prices, less investment in research and development, a less-skilled labor force, and greater instability in financial markets. Shigehara also identified the economic characteristics that newer economic research has associated with rapid growth: high saving, a well-educated labor force, the free flow of technology across countries, export orientation, low government spending, and political stability.

Shigehara argued that while these traditional factors may have contributed to the postwar growth experience of many industrialized countries, they are insufficient to explain all of that experience. Many of the traditional factors turned from negative to positive in the 1980s, yet economic growth in most countries remained sluggish or deteriorated. This observation led Shigehara to focus on structural problems. These problems include high and variable inflation, rigid labor and product markets, and instability of macroeconomic policy. According to Shigehara, these structural problems hindered long-run decision making and reduced the competitiveness of markets. Only by addressing these structural problems, Shigehara argued, will the economic growth slowdown be reversed.

Theory

Until recently, economists questioned whether policymakers could influence an economy's long-run growth rate. For example, economic theory held that higher rates of saving and investment could temporarily boost output growth, thereby permanently increasing long-run standards of living. But theory suggested that higher rates of saving and investment could not permanently increase output growth or the growth rate of living standards. In contrast, newer economic theories suggest a greater role for policy in determining long-run growth.

Charles Plosser provided a survey of both the old and the new growth theories. He concluded that the new theories had much to offer in explaining differences in growth rates across countries and across time. Gregory Mankiw, commenting on Plosser's paper, agreed that the new theories had contributed to our understanding of the growth process. Nevertheless, he argued that the old theories could be resurrected as an explanation of growth if they were reinterpreted in a more general context.

Plosser explained why the old growth theories provide limited scope for policy, while new theories provide ample scope for policy. In the old theories, diminishing marginal returns to capital limit the role of increased saving and investment. An increase in investment, for example, temporarily boosts growth of the per-capita capital stock and growth of per-capita output. But, as the per-capita capital stock grows, the return to capital falls. Eventually, growth of the per-capita capital stock and of per-capita income slows to a rate proportional to the exogenous rate of technological progress. Increasing savings and investment

therefore raises the per-capita capital stock and eventually raises output per capita. It does not, however, lead to a permanent increase in the per-capita growth rate of either the capital stock or output.

Plosser described ways some economists have changed their thinking about growth and, in the process, have undone the constraint of diminishing marginal returns to capital. One way is to incorporate into theories of economic growth capital goods that can be produced without using nonreproducible inputs. Examples of such goods are human capital and the "state of knowledge." As long as the production of these capital goods has no limit, sustainable growth is possible. Another way is to incorporate capital goods—human or physical—with external effects and spillovers. If capital has these effects a case can be made for government subsidization of its production. For example, if one worker's education and training increase the productivity of other workers, subsidizing training and education may increase economic growth and welfare. In summing up the implications of the new growth theory, Plosser said, "societies that save and invest more will generally grow faster in the long run."

Mankiw agreed that the new theories had contributed to our understanding of economic growth but preferred to work within the framework of the traditional theory. By generalizing the traditional theory's concept of capital to include human capital, Mankiw estimated that capital's share of GDP would increase from one-third to four-fifths. Mankiw claimed this higher capital share could explain international differences in income per person within the framework of the traditional theory.

The more general version of the traditional theory led Mankiw to identify four "secrets" to fast growth. First, start from behind—countries with low initial standards of living tend to grow faster than counties with high living standards. Second, save and invest. Third, educate the young. And fourth, keep population growth low. Mankiw argued that these four secrets often go unexploited because they involve sacrifice today for higher living standards tomorrow. Few politicians, Mankiw asserted, were willing to make that tradeoff.

POLICIES TO PROMOTE GROWTH

Evidence and theory suggest that economic policy affects long-term growth—sometimes for good, but also sometimes for bad. The possibility that policies can enhance or undermine an economy's potential for growth underscores the need for careful evaluation of policies to promote growth. Participants at the symposium focused on three types of policies—macroeconomic policies, human capital policies, and investment policies. Most participants agreed on the need for macroeconomic policies to create a stable economic environment and human capital policies to enhance labor productivity. But participants disagreed sharply about the desirability of investment policies.

Macroeconomic policies

Participants agreed broadly on the role of macroeconomic policy in promoting growth. J. Bradford De Long and Lawrence Summers argued that good macroeconomic policies are necessary—although not sufficient by themselves—for strong productivity performance. Although De Long and Summers thought macroeconomic policies could not explain the bulk of the growth slowdown, they still considered them relevant. In particular, they saw two important links between macroeconomic policy and long-run growth.

The first link is the contribution an independent central bank can make to growth. Countries with independent central banks committed to price stability are more likely to have low and stable inflation and therefore better functioning market systems. With more efficient markets, a country can potentially grow faster. De Long and Summers presented evidence to support this view. In particular, they showed that countries with the most independent central banks—Germany, Swit-

zerland, and the United States—had the lowest average rates of inflation and fastest average rates of growth. In contrast, countries with the least independent central banks—Italy and Spain—had higher inflation and slower growth.

The second link is the damage caused by recessions. Recessions reduce investment in physical capital. In addition, human capital deteriorates when unemployment rises for a prolonged period. De Long and Summers found no evidence that a monetary policy geared more to fighting recessions than inflation raises long-term growth. Still they questioned the benefits of an overzealous pursuit of price stability. They argued that a policy of low inflation—as opposed to no inflation—avoided the financial and real costs of pursuing further disinflation. Moreover, they argued that the benefits of reducing inflation from a low rate to zero were substantially less than the benefits of reducing it from a high rate to a low rate.

Allan Meltzer, commenting on the paper by De Long and Summers, questioned the view that central bank independence leads to stronger growth. He gave two examples where the relationship broke down. First, Germany did not have an independent central bank before 1971, yet the German economy grew rapidly. And second, the strong commitment to price stability of the United States and Britain under the gold standard did not result in rapid growth.

Lawrence Kudlow agreed with De Long and Summers that an independent central bank contributed to low inflation and, therefore, to faster growth. But, in his discussion of their paper, he emphasized the role of financial capital. Since the late 1980s, Kudlow argued, the macroeconomic environment in the United States has not been conducive to financial capital formation. Growth has suffered because of increases in capital gains tax rates, longer depreciation schedules, tighter regulations on banks, higher income and payroll taxes, and sharp increases in government spending and in the federal budget deficit. In addition, other features of the tax code have been unfavorable to capital formation—for example, the double taxation of dividends and incentives favoring debt over equity finance. Kudlow's prescription for faster economic growth was to reverse these fiscal and regulatory disincentives to the formation of financial capital.

C. Fred Bergsten also agreed that macroeconomic policy was important but stressed fiscal policy rather than monetary policy. He argued that an important step to take was reducing the federal government budget deficit and, eventually, running budget surpluses. The 1980s saw a decline in both public and private savings. Bergsten argued that reducing budget deficits would help reverse this decline.

Human capital policies

Conference participants agreed that growth of human capital—that is, investment in education and training—contributes importantly to economic growth. Robert Barro offered international macroeconomic evidence supporting the idea that human capital is an important determinant to growth. Lawrence Katz provided corroborating evidence from microeconomic studies. And James Miller, III, presented several specific policy recommendations.

Barro found that growth was faster in countries with more human capital. He pointed to a number of channels through which human capital contributed to growth. First, human capital increases growth by spurring investment in physical capital. Second, accumulating human capital increases wages and therefore raises the opportunity cost of bearing children. As a result, families have fewer children but invest more human capital in each child. Finally, holding birth rates and investment in physical capital constant, human capital still contributes directly to economic growth. Barro argued that with more education people use new technologies more effectively, thereby raising productivity and output growth.

Katz, looking at the microeconomic evidence,

agreed with Barro. Katz summarized the findings of several studies that looked directly at the relationship between an individual's education and productivity. These studies attempted to isolate the effect of education on productivity, holding constant such variables as natural ability and family background. If education had no independent effect on productivity—apart from reflecting an individual's innate ability or family background—then investment in education would not, in itself, increase human capital or productivity. However, Katz's review of the microeconomic evidence demonstrated an independent role for education. In a study of identical twins reared in the same family, for example, schooling was shown to raise productivity, earnings, and thereby economic growth.

In addition, microeconomic research has also identified other ways human capital contributes to growth. First, research supports Barro's suggestion that education of the work force increases investment in physical capital. In a study cited by Katz, industries with highly educated workers were found to invest more heavily in new technology. Second, research reviewed by Katz supported the view that there are spillover effects to education. These spillover effects imply that educating one worker increases the productivity of other workers. Thus, the social returns to education exceed the individual returns. Finally, Katz provided evidence that education not only contributes to growth, but also contributes to a more equal distribution of the benefits of growth.

Miller, agreeing that education contributes to growth, suggested ways to improve education in the United States. Specifically, he suggested ways to improve "lower education"—kindergarten through twelfth grade—where he felt the United States compared unfavorably with other countries. Noting that spending per pupil had increased steadily in the United States while performance had deteriorated, Miller questioned the effectiveness of policies that simply spent more money on education. Instead, he suggested structural reforms. One suggestion was to increase competition in the provision of lower education by allowing parents greater choice in selecting schools for their children. Another suggestion was to rely more on private or quasi-private schools as providers of lower education. In this way, lower education in the United States might more closely resemble the U.S. system of higher education, which is the envy of the world.

Investment policies

While participants generally agreed on macroeconomic and human capital policies to promote growth, they disagreed sharply on investment policies. Three views about investment policies emerged. The first view held that programs should be adopted to stimulate specific forms of investment. The second view held that investment incentives would work better under some circumstances than under others. The third view held that policymakers should try to minimize their influence over markets, eliminating distortionary tax incentives across the board.

The case for investment incentives. De Long and Summers, looking at a cross-section of countries in the postwar period, found that countries with higher investment in machinery and equipment had faster rates of growth. Investment in equipment and machinery, they argued, carried substantial external benefits and could significantly boost productivity growth. For example, they found that total output rises 0.26 percentage points for each extra percentage point of total GDP allocated to investment in machinery and equipment. De Long and Summers argued that this strong relationship implied policymakers could boost growth by stimulating machinery and equipment investment. In particular, De Long and Summers advocated a permanent investment tax credit targeting equipment investment. In addition, they favored open trade policies without restrictions on capital goods imports and tighter fiscal policies to boost national savings.

Bergsten agreed that to boost growth in the

United States investment needed to be targeted in "strategic directions" that would earn a supernormal return. Bergsten estimated that to increase growth significantly, the overall investment rate would have to rise eight percentage points and be targeted in areas that yield substantial external effects. A one-percentage-point annual increase in the investment rate sustained for eight years would increase productivity growth from the 1-percent rate of the last decade to 2 percent in eight years. Bergsten also argued that investment needed to be stimulated without exacerbating the external deficit, which he thought should be eliminated. Bergsten therefore argued that the national savings rate needed to rise in lockstep with the national investment rate.

The qualified case for investment incentives. Alan Auerbach argued that the link between investment in physical capital and economic growth is uncertain. Standard economic models do not clearly spell out how increased investment leads to faster long-term growth. Moreover, if investment's contribution to growth comes largely from spillover effects, more needs to be learned about the nature of these spillovers and about which investments have the greatest spillover effects.

Assuming that investment has these effects and therefore makes a contribution to growth, Auerbach argued that tax incentives to investment would be an appropriate policy. Evidence suggests that tax policies do affect the amount and type of investment that takes place. Although little is known about which types of investment yield the highest social returns—other than De Long and Summers' evidence for equipment and machinery—more is known about designing incentives for investment. Auerbach argued that these incentives should be designed to apply to new investment that would not otherwise have taken place. They should be permanent. And they should be directed primarily at encouraging investment not at savings. Tax incentives for savings are not always channeled into the most socially productive domestic investments. Some of the increased savings may be invested in foreign countries, in housing, or in other forms of investment that contribute less to growth.

Martin Feldstein agreed there was a case for investment incentives but disagreed with Auerbach's view that incentives for investment were more important than incentives for savings. Feldstein argued both types of incentives were important and that investment incentives work best when accompanied by savings incentives. He suggested three reasons why savings incentives were needed. First, the savings rate in the United States is so low that even if all net savings were invested in physical capital, investment spending would still be inadequate. Second, the national savings rate constrains domestic investment in the long run. As a result, countries with high savings rates tend to have high investment rates. Third, savings incentives do not cost the government tax revenue. While the government loses personal income tax revenue through savings incentives such as Individual Retirement Accounts, it gains corporate tax revenue through the resulting increase in the capital stock. These increases largely or entirely offset the personal income tax losses.

The case against investment incentives. Other participants at the conference argued forcefully against tax incentives for investment or savings. Norbert Walter thought it would be too difficult to decide which types of investment were best for growth. The market, he said, is best suited to determine which investments promote growth. Government, he added, can most effectively promote growth by improving market conditions rather than pursuing "quick fixes." Moreover, selective investment incentives complicate tax systems, which are already too complicated and unfair.

Walter offered two examples of how competitive and open markets are more important for growth than targeted investment incentives. A positive example is Europe 1992, which has resulted in deregulation, keener competition, and the redefinition and redistribution of markets. Businesses responded to these market incentives by investing long term in Europe. Looking forward to the com-

pletion of the single European market, they increased fixed capital formation 50 percent in the second half of the 1980s. A negative example is German unification. Large government-support measures for eastern Germany have not yet produced the desired results. East Germany demonstrates the low efficiency of strong tax incentives. From these examples, Walter concluded that Auerbach's analysis of the postwar United States is interesting but not very useful for the "urgent" cases in Europe.

Kudlow and Meltzer also argued for a free market approach. Kudlow argued that investment in equipment had in fact been quite strong during the 1980s. He pointed out that, relative to the 1959-90 period as a whole, the 1980s saw a surge in spending on equipment. Reacting to suggestions that tax policy target specific investments, Kudlow worried who would be choosing the targets and how those targets would be chosen. Rather than rely on policymakers to make these decisions, Kudlow preferred to let rates of return and relative prices determine the allocation of investment spending.

Similarly, Meltzer thought subsidies for equipment investment were unlikely to significantly boost long-term productivity. He argued that many "one-time" changes after World War II, such as sweeping reductions in trade barriers and the replacement of old capital, led to the strong productivity growth from 1950 to 1969. Thus, the rapid growth experienced during these early postwar years should be seen as an aberration. It is therefore unlikely that subsidizing capital accumulation can significantly raise the recent trend in productivity growth. Meltzer concluded that growth of productivity and living standards depend on the United States and other industrialized countries opening markets that have recently been restricted by quotas.

OVERVIEW OF THE ISSUES

A prominent academic and several high-level policymakers offered broad observations and policy prescriptions. Stanley Fischer examined why policymakers had not taken more positive steps to stimulate growth. Otmar Issing and W. F. Duisenberg provided policy prescriptions from a European central banking perspective. Domingo Cavallo and Jacob Frenkel focused largely on how to promote growth in economies that have suffered macroeconomic instability.

Why policy advice goes unheeded

Fischer argued that most of the policy prescriptions of the new growth theory are the same prescriptions that have been offered by the World Bank and the International Monetary Fund for years: Keep budget deficits small; keep inflation low and stable; do not overvalue the exchange rate; keep the economy open to international trade; deregulate; privatize; keep the tax system simple; and invest in physical capital, infrastructure, and human capital.

Why has this advice not been followed more closely? Fischer suggested that one reason is the advice is too general. For example, it offers no specifics on how to go about increasing investment or reducing budget deficits. Nor does the advice provide guidance on how to balance the short-run costs of policies to promote growth against the long-run benefits. Reducing inflation and budget deficits lowers growth in the short run but contributes to growth in the long run. Few policymakers, Fischer argued, would ignore short-run costs in addressing long-run problems.

According to Fischer, the best time to deal with inflationary and fiscal obstacles to growth is when the economy is strong. Then, monetary and fiscal policy tools will more likely be available for short-run stabilization when the economy is weak. Unfortunately, this advice has not been followed. In the United States, fiscal policy is unavailable to boost the economy in the short run because the budget deficit was not reduced when the economy was strong. In Germany, monetary policy has had to cope with fiscal stimulus stemming from unifi-

cation. Monetary policy has been tight because Germany did not pay for unification with fiscal policy. Given Europe's exchange rate mechanism, tight German monetary policy has led to an economic slowdown throughout Europe.

Perspectives of two European central bankers

Issing viewed monetary policy geared strictly toward achieving and maintaining price stability as contributing importantly to long-run economic growth. He rejected the view that monetary policymakers could stimulate economic growth in the short run while maintaining a credible commitment to price stability. Moreover, he asserted that an independent monetary policy geared toward price stability disciplines fiscal policy and labor markets. Excessive budget policies and struggles between labor and management for income shares, Issing argued, "will come up to the limits set by monetary policy." By imposing these limits, a monetary policy committed to price stability contributes further to economic growth.

Duisenberg largely echoed Issing's views on the role of monetary policy. Duisenberg argued that economic policy should be oriented primarily toward creating an environment conducive to growth, not toward giving special incentives to specific activities. Monetary policy's role in creating the proper economic environment is to ensure price stability. Price stability is the only monetary policy objective that can be sustained in the long run. And it is the only policy that minimizes the risk of sudden policy changes. Price stability therefore contributes the most to reducing macroeconomic policy uncertainty.

Economic stabilization as a prerequisite to growth

Cavallo and Frenkel emphasized the importance of stabilizing an economy before enacting policies to promote growth. Cavallo drew lessons from Argentina's efforts to reorganize its economy. He argued that reorganizing the economy was "the basic prerequisite" to achieving faster long-term growth. In reorganizing economic activity, Argentina has emphasized "greater transparency and better planning in the public sector and greater competition and improved performance in . . . the private sector." Five key measures have been taken or are under way in Argentina. They include liberalizing trade, reforming the public sector and recreating a market economy, introducing currency convertibility, reforming fiscal and tax policies, and restructuring internal and external debt.

The program to restructure the Argentine economy is succeeding. For example, inflation has come down and interest rates have fallen. Tax receipts have risen sharply, and substantial privatization has occurred. The reorganization plan has helped stabilize the economy and allowed Argentina's productive resources to be used more efficiently. Only with this step largely accomplished, Cavallo argued, could Argentina now begin trying to increase investment to stimulate growth.

Frenkel reiterated Cavallo's views, arguing that promoting growth is like a two-stage rocket. The first stage requires stabilization of the economy. Only after the first stage has run its course can policymakers concern themselves with the second stage—growth. Frenkel argued the first stage—stabilization—is particularly problematic for many countries. He pointed to four "Achilles' heels." First, policymakers are impatient and sometimes try to move to the second stage before completing stabilization programs. Second, stabilization programs often lead to extremely high interest rates. Third, to the extent policymakers use the nominal exchange rate as a tool of stabilization, real exchange rates appreciate sharply. And fourth, when governments cut spending to reduce deficits, they often cut spending on infrastructure, exactly the kind of spending required for growth.

In summing up, Frenkel argued that stabilization and growth required looking at the composition of economic aggregates, not just at the

aggregates themselves. For example, not only is the size of the budget deficit important, but so is the composition of its components—government spending and tax revenues. Stabilization and growth require government spending oriented toward investment rather than consumption. Similarly, taxes should promote production, not consumption.

CONCLUSIONS

The slowdown in long-term economic growth in the industrial countries has sparked a debate about how policymakers can promote faster growth. Participants at the symposium generally agreed that increasing savings and investment, building human capital, and pursuing stable economic policies would contribute to faster growth. Participants disagreed, however, about specific policies. While some participants, mostly from the United States, favored various tax incentives for investment and possibly savings, other participants favored greater reliance on free and open markets. But these differences did not overshadow the consensus of the participants that economic growth is a critical policy issue that can no longer be ignored.

POLICIES FOR LONG-RUN ECONOMIC GROWTH

A symposium sponsored by the Federal Reserve Bank of Kansas City

August 27-29, 1992

Session I Chairman

ALAN GREENSPAN
Chairman, Board of Governors of the Federal Reserve System

Causes of Declining Growth

MICHAEL DARBY, Professor, University of California, Los Angeles

KUMIHARU SHIGEHARA, Head of the Department of Economics and Statistics, Organization for Economic Cooperation and Development

HORST SIEBERT, President, Kiel Institute of World Economics

Theories and Evidence of Growth

CHARLES PLOSSER, Professor, University of Rochester

Commentary

N. GREGORY MANKIW, Professor, Harvard University

Macroeconomic Policies to Promote Growth

LAWRENCE H. SUMMERS, Vice President and Chief Economist, The World Bank

J. BRADFORD DE LONG, Professor, Harvard University

Commentary

C. FRED BERGSTEN, Director, Institute for International Economics

LAWRENCE KUDLOW, Chief Economist and Senior Managing Director, Bear Stearns & Co., Inc.

ALLAN MELTZER, Professor, Carnegie-Mellon University

The Importance of Growth to Developing Countries

DOMINGO CAVALLO, Minister of Finance, Argentina

Session II Chairman

W. F. DUISENBERG
President, Central Bank of the Netherlands

Investment Policies to Promote Growth

ALAN AUERBACH, Deputy Chief of Staff, Joint Committee on Taxation

Commentary

MARTIN FELDSTEIN, President, National Bureau of Economic Research
NORBERT WALTER, Chief Economist, Deutsche Bank

Human Capital Policies to Promote Growth

ROBERT J. BARRO, Professor, Harvard University

Commentary

LAWRENCE KATZ, Professor, Harvard University
JAMES C. MILLER, III, Chairman, Citizens for a Sound Economy

Overview Panel

STANLEY FISCHER, Professor, Massachusetts Institute of Technology
JACOB A. FRENKEL, Governor, Bank of Israel
OTMAR ISSING, Member of the Directorate, Deutsche Bundesbank

POLICIES FOR LONG-RUN ECONOMIC GROWTH

The potential rate of economic growth in industrialized countries is only half what it was in the 1960s. Growth of world saving and productivity has also declined, suggesting low economic growth in the future. If these trends persist, standards of living in the industrialized countries will improve only marginally. To evaluate what policies should be adopted to reverse the growth slump of the last two decades, the Federal Reserve Bank of Kansas City hosted a symposium on "Policies for Long-Run Economic Growth," at Jackson Hole, Wyoming, on August 27-29, 1992. The symposium proceedings will be available soon.

For a copy of the current or past symposium proceedings, please write:

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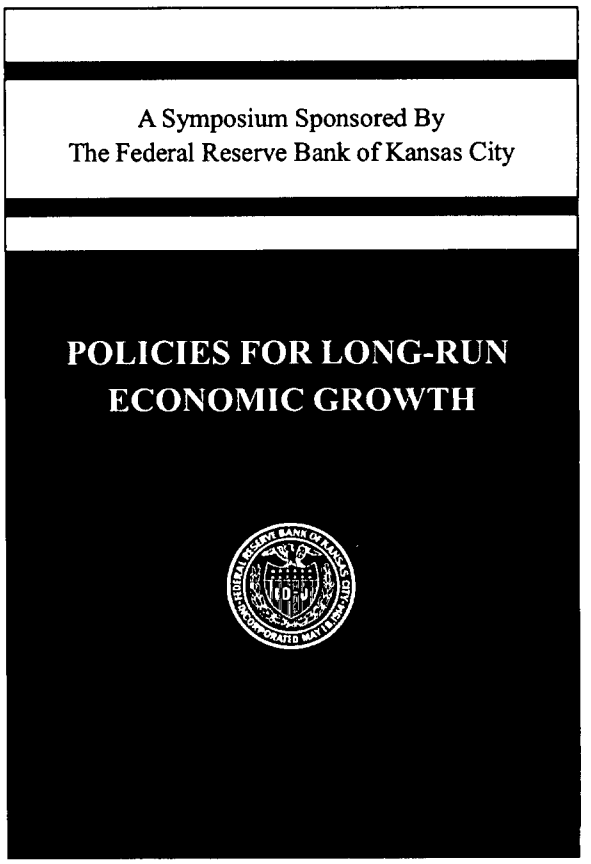

PAST SYMPOSIUMS

Policy Implications of Trade and Currency Zones (1991)

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Price Stability and Public Policy (1984)

Industrial Change and Public Policy (1983)

The Changing Role of Reserve Requirements in Monetary Policy

By Stuart E. Weiner

Reserve requirements have traditionally been viewed as an integral part of the monetary control process. In conjunction with central bank control over the supply of reserves, reserve requirements have been seen as placing an upper limit on deposit creation, helping central banks directly control the growth of money and credit.

Yet, reserve requirements are on the wane worldwide. Central banks have been reducing or eliminating them in an effort to make banks and other subjected depository institutions more competitive. In the past two years, for example, the Federal Reserve has lowered requirements on transactions deposits and eliminated requirements on time deposits. The central banks of Switzerland, New Zealand, Australia, and Canada have eliminated their requirements. And the German Bundesbank reportedly has considered lowering its requirements. How does one reconcile these actions with the traditional view of reserve requirements and monetary control?

The answer is, in many countries the traditional view no longer holds. Reserve requirements are no longer seen as a vehicle to directly control the money stock but rather as a vehicle to facilitate control over short-term interest rates. As such, depending on a country's institutional framework, there may be scope for reducing or even eliminating reserve requirements.

This article examines the monetary policy implications of lower reserve requirements. The article focuses on the United States, Canada, and Germany. The first section outlines the traditional "multiplier" view of reserve requirements, showing that in this context the recent reductions in requirements would be cause for concern. The second section shows, however, that in a broader context, one in which most central banks now operate, the recent reductions are not necessarily cause for concern. Indeed, one can view the reductions as secondary to more fundamental policy decisions made much earlier. The third section provides a more detailed analysis of current operating procedures, stressing that reserve requirements may still have an important, albeit different, role to play in the monetary policy process.

RESERVE REQUIREMENTS IN A MULTIPLIER FRAMEWORK

Discussions of reserve requirements and monetary policy have typically taken place in the context of the multiplier model of the money supply. This model has come to provide the basic textbook

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framework for examining many monetary control issues. In this framework, reserve requirements play a crucial role.

The multiplier model

The multiplier model emphasizes the direct link between reserve requirements and monetary control. The simplest version of the model assumes that all money, M, is held in the form of bank demand deposits, D, that is,

(1) $M = D$.

Banks are required to hold a fraction of their assets as required reserves, RR, against these deposits,

(2) $RR = rrr * D$.

The central bank sets the required reserve ratio, rrr, at a value between 0 and 100 percent and also supplies the reserves. Rewriting (2) yields

(3) $D = (1/rrr) * RR$.

And, substituting (1) into (3) implies

(4) $M = (1/rrr) * RR$.

Thus, the money supply is a multiple of reserves. If the central bank wishes to expand the money supply, it adds reserves; if it wishes to contract the money supply, it drains reserves. The "multiplier," $1/rrr$ provides the link between changes in reserves and changes in the money supply. The multiplier, in turn, is determined by the level of reserve requirements. The higher the required reserve ratio, the smaller the multiplier, and vice versa.[1]

Reserve requirements clearly play an important role in this model. First, for a given level of reserves, they impose an upper limit on the money supply. Algebraically, the money supply can be no higher than $(1/rrr)$ times RR. In practical terms, what this is saying is that banks face a limit on the amount of deposits they can create for a given amount of reserves.

Second, reserve requirements are a crucial factor in determining the size of money supply "misses." Suppose, for example, the central bank seeks to attain a certain level of the money supply but finds out too late that reserves are too plentiful. The unexpected surplus in reserves will lead to an undesired surplus in money. The size of the money supply overshoot will depend critically on the level of reserve requirements—the higher the required reserve ratio, the smaller the multiplier, hence, the smaller the overshoot. The reverse is also true, of course—the lower the required reserve ratio, the greater the overshoot.

This key result, that lower reserve requirements imply less monetary control in the presence of reserve disturbances, carries over into more complex versions of the multiplier model. Introducing currency into the model, for example, changes the form of the multiplier but not the basic result.[2] Nor does incorporating more than one type of deposit.[3] The message remains the same: monetary control suffers the lower are reserve requirements.

The decline in reserve requirements

Notwithstanding the above discussion, reserve requirements are on the decline worldwide. Several central banks have reduced or eliminated statutory requirements in recent years. At the same time, deregulation and innovation have allowed a growing portion of deposits to escape reserve requirements. Consequently, many countries have experienced steady declines in effective required reserve ratios, that is, in the ratio of required reserves to the money supply.

Table 1 shows the decline in statutory reserve requirements in the United States, Canada, and Germany over the past 20 years. The most dramatic decline has occurred in Canada. A key provision of comprehensive financial market legislation proclaimed in June 1992 sets the marginal reserve requirement to zero and eliminates all reserve requirements over a two-year phaseout

Table 1

Statutory Reserve Requirements, Selected Years

(Percent)

	1974	1989	1992
Transactions deposits			
United States	18[a]	12	10[b]
Canada	12	10	0[c]
Germany	19.1[d]	12.1	12.1
Term deposits			
United States	8[a]	3	0
Canada	4	3	0[c]
Germany	13.25[d]	4.95	4.95

[a] Effective January 1 through December 11, 1974.

[b] Effective April 2, 1992.

[c] The marginal reserve requirement is zero. Overall reserve requirements are being phased out over a two-year period that began in mid-1992.

[d] Effective January 1 through August 30, 1974.

Note: Figures shown are highest marginal ratios; in some cases, applicable marginal ratios may vary according to specific type of deposit, location of depository institution, or level of deposit liabilities.

Sources: Federal Reserve System; Bank of Canada; Deutsche Bundesbank.

period.[4] The United States also has seen recent declines. In December 1990, the Federal Reserve eliminated reserve requirements on term deposits. In April 1992, it lowered requirements on transactions deposits. German reserve requirements also are markedly lower today than 20 years ago, and German officials reportedly have considered lowering them further (Evans).

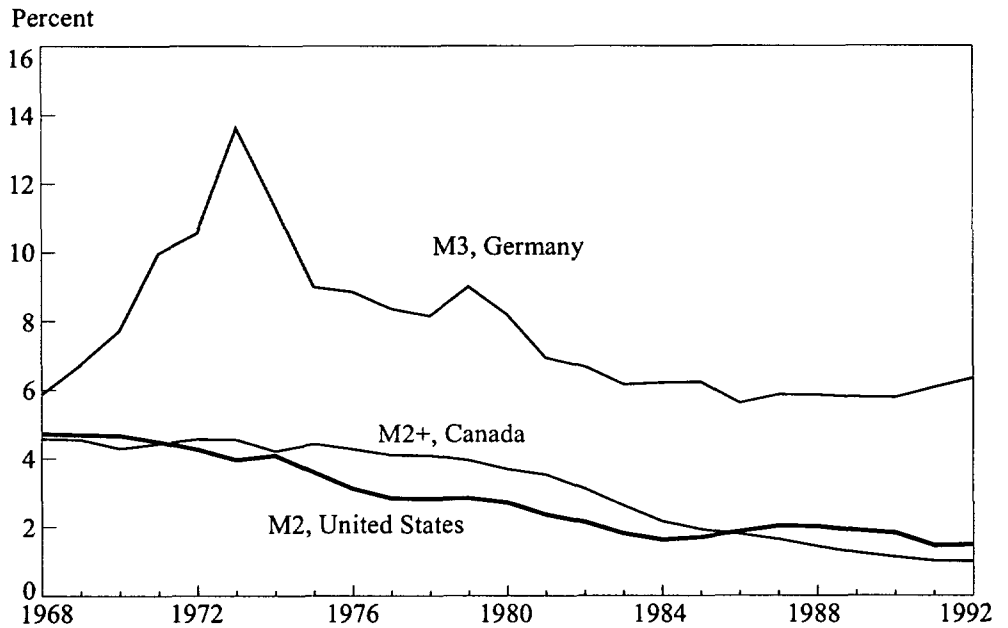
The principal reason central banks have been reducing reserve requirements is to ease the burden on subjected depository institutions and thereby allow them to become more competitive. Reserve requirements impose a cost on depository institutions and their customers. Because reserves typically do not earn interest—and in the United States, Canada, and Germany they do not—reserve requirements force depository institutions to forego interest income. Some reserves would be held in the absence of reserve requirements but a portion would not. The interest that is foregone on involuntarily held reserves is in effect a tax that is either borne directly by the institutions and their shareholders or passed on to customers via lower deposit rates, higher borrowing rates, or reduced services. Like any other selective tax, the reserve tax distorts the allocative process. It makes banks and other subjected institutions less competitive, channeling financial resources away from them and toward potentially less productive uses at institutions not subject to reserve requirements.[5]

Central banks are very aware of the burden of reserve requirements. In announcing its December 1990 reserve requirement reduction, for example, the Federal Reserve noted that "lower reserve requirements . . . will reduce costs to depository institutions" (Board of Governors 1990). In announcing its April 1992 reduction, the Federal Reserve stressed that "the reduction . . . will reduce funding costs for depositories and strengthen their balance sheets. Over time, it is expected that most of these cost savings will be passed on to depositors and borrowers" (Board of Governors 1992).[6] Similarly, the Bank of Canada has emphasized that the recent financial market legislation "will result in increased competition" (Bank of Canada 1991a), and the German Bundesbank has acknowledged that reserve requirements "create a certain competitive bias" against German banks vis-a-vis Euromarket competitors (Pohl). Hence, the move toward lower reserve requirements.[7]

Reductions in statutory requirements, however, are not the only reason for a decline in effective reserve ratios. Deregulation and innovation have also played important roles. Precisely because reserve requirements are a tax, financial institutions have a strong incentive to avoid them,

Chart 1

Effective Required Reserve Ratios

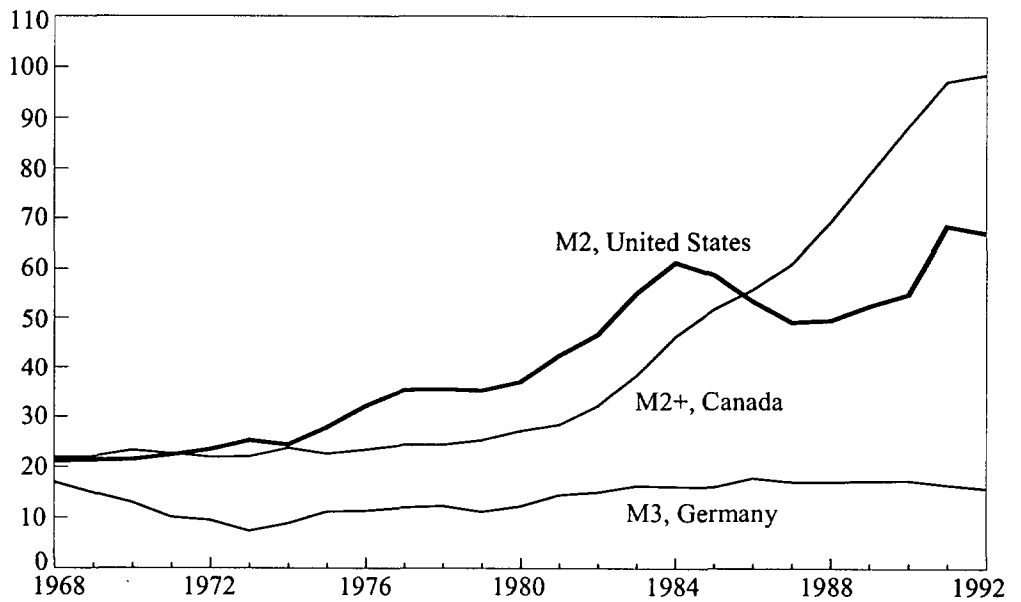


Note: Calculated as required reserves divided by monetary aggregate, based on nonseasonally adjusted, nonbreak adjusted average annual data. Figures for 1992 computed as average of January-May for Germany and Canada, as average of January-June for the United States.
Source: Federal Reserve *Bulletin;* Bank of Canada *Review; Monthly Report of Deutsche Bundesbank.*

either by taking advantage of changes in rules or by innovating around existing rules. Much of the decline in the Canadian effective reserve ratio in the 1980s, for example, was attributable to strong growth in nonreservable deposits at trust and mortgage loan companies, including mortgage loan subsidiaries of chartered banks. This growth was made possible by earlier deregulation.[8] Much of the decline in the U.S. ratio in the 1970s was attributable to banks leaving the Federal Reserve system, a very blunt form of innovation. And there are numerous other examples.[9] Acting in tandem with the reductions in statutory requirements, deregulation and innovation have contributed to the steady decline in effective reserve ratios.

The extent of the decline in effective reserve ratios is shown in Chart 1. From a high of 13.6 percent in 1973, the German effective reserve ratio has declined to 6.3 percent in 1992. Likewise, the Canadian ratio has fallen from 4.5 percent to 1.0 percent over the same period, while the U.S. ratio has fallen from 4.0 percent to 1.5 percent. And as effective reserve ratios have declined, effective money multipliers—defined as the ratio of the money supply to required reserves, that is, the reciprocal of the reserve ratio—have risen (Chart 2).[10] In the context of the multiplier model discussed above, the decline in reserve ratios (increase in money multipliers) would appear to be cause for concern from a monetary control standpoint. Feldstein, for example, has argued that it is. The next section takes up this issue.

Chart 2
Required Reserve Money Multipliers



Note: Calculated as required reserves divided by monetary aggregate, based on nonseasonally adjusted, nonbreak adjusted average annual data. Figures for 1992 computed as average of January-May for Germany and Canada, as average of January-June for the United States.
Source: Federal Reserve *Bulletin;* Bank of Canada *Review; Monthly Report of Deutsche Bundesbank.*

RESERVE REQUIREMENTS IN A BROADER FRAMEWORK

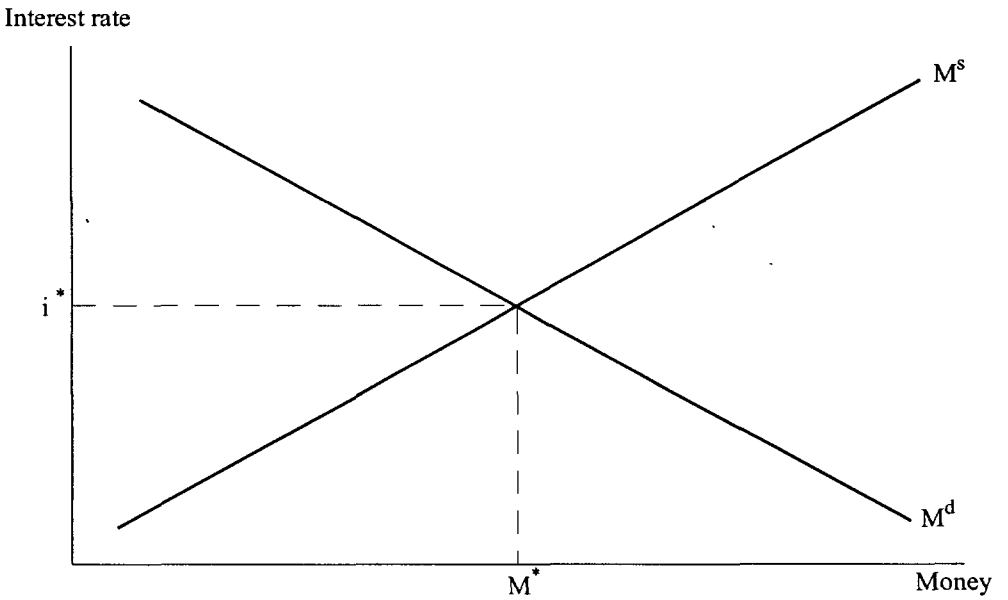
Should the decline in reserve requirements alarm monetary policymakers? The multiplier model of the previous section suggests yes. A richer model developed in the first part of this section also initially suggests yes. But by enriching that model even further and incorporating central banks' current focus on interest rates, the answer becomes no.

Money supply and demand

The multiplier model of the preceding section indicates that the decline in reserve requirements could impair monetary control. One might suspect, however, that a richer model, a model that explicitly considers money demand as well as money supply and allows both money demand and money supply to be sensitive to interest rates, would yield different results. In fact, the results of the much simpler model continue to hold. As long as the central bank continues to operate in a way that relies on the direct link between reserves and the money supply, monetary control suffers when reserve requirements decline.

In examining this issue, it is useful to adopt a money supply and demand framework like that depicted in Figure 1. Money stock levels are measured on the horizontal axis and market interest rates are measured on the vertical axis. The equilibrium levels of the money stock and interest rate, M^* and i^*, respectively, are determined where money supply equals money demand, that is, at the intersection

Figure 1
Supply of and Demand for Money



of the money supply and money demand curves.

The money supply curve is derived from a series of equations similar to those underlying the multiplier model. For simplicity, it is again assumed that all money is held in the form of demand deposits, that is,

(5) $M = D$.

Also as before, banks are required to hold a fraction of their assets as reserves against these deposits,

(6) $RR = rrr^* D$.

However, banks are now permitted to hold excess reserves as well, so that total reserves are the sum of required reserves and excess reserves,

(7) $TR = RR + ER$.

By assumption, excess reserves do not earn interest. As a result, excess reserves are negatively related to the market interest rate. An increase in the market interest rate, for example, will lead banks to hold fewer excess reserves because excess reserves become more costly in terms of the interest foregone.

As in the multiplier model, the central bank sets the required reserve ratio, *rrr*, and supplies the reserves, *TR*. However, a distinction is now made between two types of reserves provided: nonborrowed reserves, which the central bank supplies via open market operations, and borrowed reserves, which the central bank supplies via direct lending at an administered interest rate. Thus, total reserves

can also be expressed as the sum of nonborrowed and borrowed reserves,

(8) $TR = NBR + BR.$

Like excess reserves, borrowed reserves are assumed to be sensitive to interest rates. Specifically, borrowed reserves are positively related to the market interest rate. An increase in the market interest rate, for example, will lead banks to borrow more from the central bank as alternative sources of funds become relatively more expensive.

Equations (5) through (8) can now be combined to derive the money supply curve. Rewriting (6) yields

(9) $D = (1/rr)*RR$.

Substituting (5) into (9) implies

(10) $M = (1/rr)*RR.$

From (7) and (8),

(11) $RR + ER = NBR + BR,$

or, rearranging terms,

(12) $RR = NBR + BR - ER.$

Finally, substituting (12) into (10) yields

(13) $M^S = (1/rr)(NBR + BR - ER).$

Thus, the money supply is determined by the required reserve ratio and the levels of nonborrowed reserves, borrowed reserves, and excess reserves. The money supply curve slopes upward because increases in the market interest rate encourage borrowings and discourage excess reserves, boosting the money supply.

The money demand curve, in contrast, slopes downward on the assumption that money assets do not pay a market rate of return. When the market interest rate declines, the opportunity cost of holding money also declines, reducing the incentive for households and businesses to economize on their money holdings. Hence, the demand for money increases. Conversely, when the market interest rate rises, the demand for money falls.

Lower reserve requirements reduce monetary control in this framework. Disturbances in either money demand or money supply will cause greater movement away from the desired money stock.

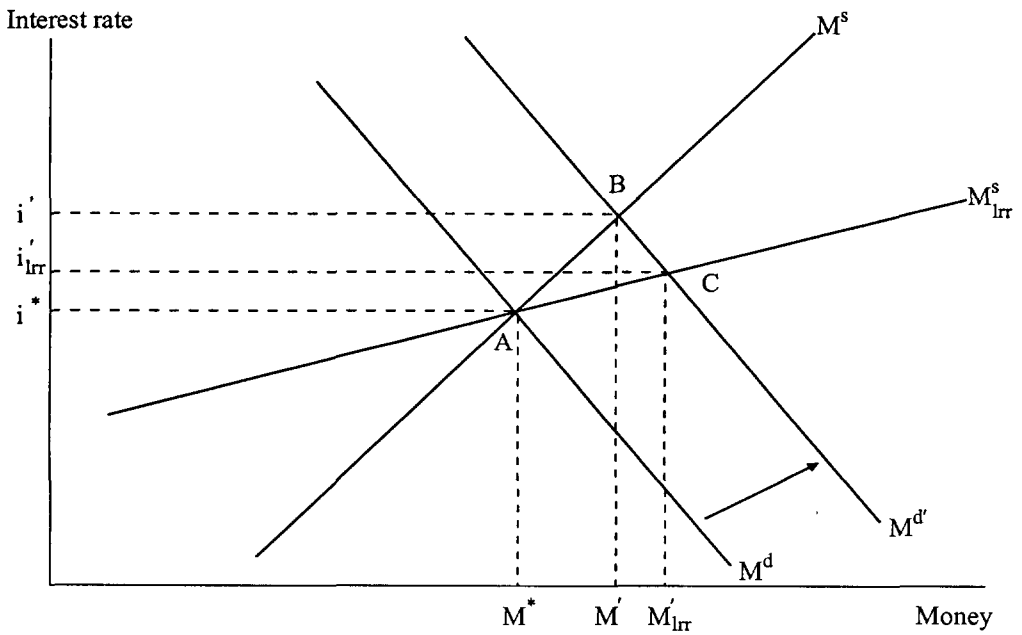
Figure 2 shows the effect of a disturbance in money demand. Suppose M^* is the central bank's target level of the money stock, M^d and M^s are the money demand and money supply curves, and the economy initially is in equilibrium at point A. Now suppose the money demand curve shifts to $M^{d'}$. This shift could arise either because of an increase in the transactions demand for money due, say, to higher income growth, or because of an increase in the demand for money vis-a-vis other assets in the public's investment portfolio. Whatever the reason, the economy moves to the new equilibrium point B, and the money stock increases to M'. The central bank finds that its target has been exceeded.

The overshoot would be even greater, however, with lower reserve requirements. Manipulation of equation (13) reveals that a lower required reserve ratio implies a flatter money supply curve. Analytically, at a given interest rate, banks have more free reserves with which to make loans and create deposits.[11] The flatter money supply curve $M^s{}_{lrr}$ reflects such a decline in reserve requirements. Note that the same money demand disturbance now leads to equilibrium point C, and the money stock now increases to M'_{lrr}, a larger deviation from M^*. Thus, monetary control is worsened.

The same result holds in the case of a money supply disturbance. This point is illustrated in Figure 3. M^s is assumed to be the initial money supply curve, and $M^s{}_{lrr}$ is assumed to be the money supply curve after reserve requirements have been lowered. Suppose the initial money supply curve shifts rightward to $M^{s'}$, a result, say, of banks unexpectedly deciding to increase borrowings or lower excess reserves. The economy moves to equilibrium point B, and the money stock increases

Figure 2

Money Demand Shock in Presence of Lower Reserve Requirements



to M'. An identical shift in Ms_{lrr}, in contrast, moves the economy to equilibrium point C and increases the money stock to M'_{lrr}, a level exceeding M'. So again, monetary control is worsened.

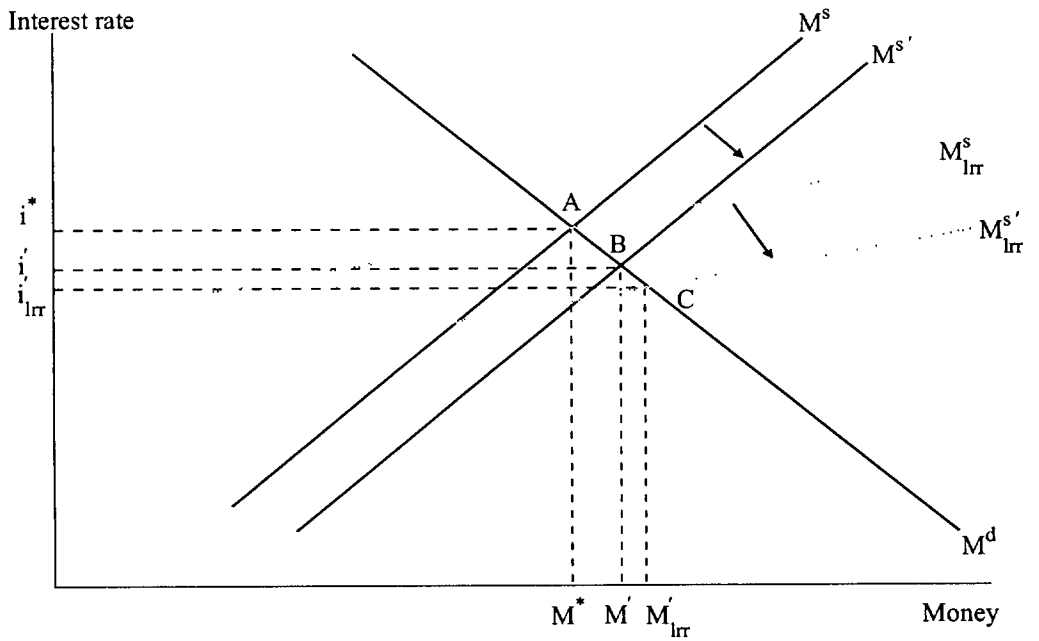
Operating procedures and intermediate targets

The results discussed so far all seem to indicate that lower reserve requirements impede monetary control. But a crucial underlying assumption has been that central banks seek to achieve monetary control by exploiting the direct link between reserves and the money supply. This approach to policy, referred to as a "reserves operating procedure," is not the only approach available to central banks. Central banks may instead seek to control the money stock by controlling short-term interest rates, that is, by following an "interest rate operating procedure." Or, central banks may choose to deemphasize monetary control altogether and focus on interest rates as their principal "intermediate target." In such situations, it may be possible to reduce or even eliminate reserve requirements without deleterious effect. The money supply and demand framework developed above again proves useful in examining these issues.

First, however, it is necessary to carefully define some terms. The distinctions among "ultimate goal variables," "intermediate targets," "operating procedures," and "instruments" are very important in discussing the monetary policy implications of lower reserve requirements. Ultimate goal variables are the long-run objectives of the central

Figure 3

Money Supply Shock in Presence of Lower Reserve Requirements

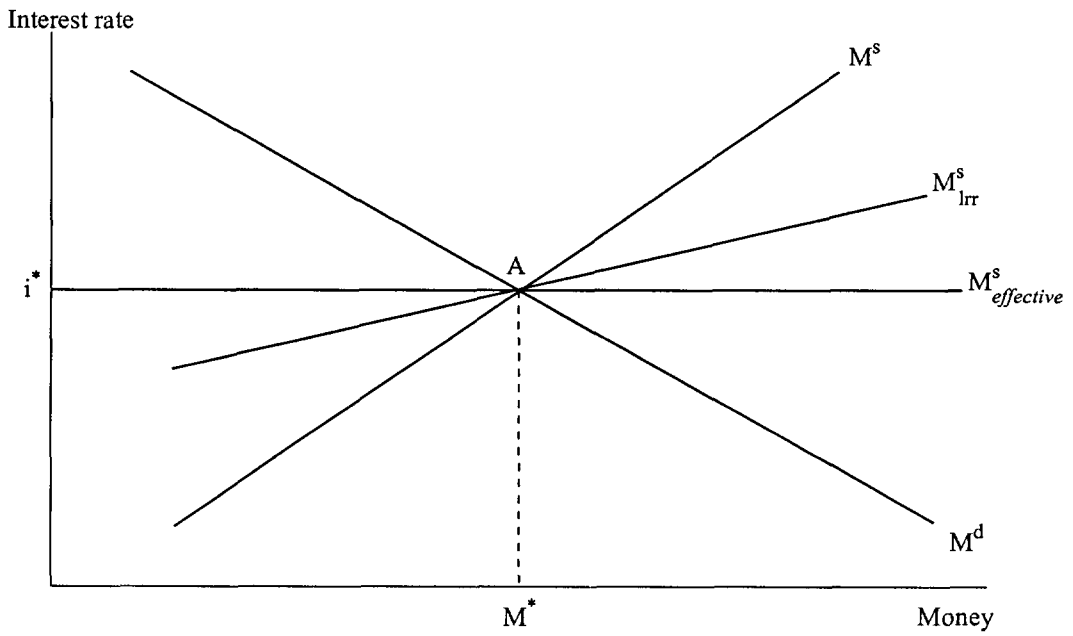


bank. In most countries, these objectives are price stability and sustainable real growth. Central banks cannot directly control ultimate goal variables, however, so they seek instead to control some intermediate target that is thought to be closely related to the ultimate goal variables. Candidates for intermediate targets may include the money stock, medium or long-term interest rates, the exchange rate, or a credit aggregate. Even intermediate targets are difficult to control over a short period of time, however, so central banks establish an operating procedure to guide them in their day-to-day policy actions. Central banks may elect to target reserves, for example, or alternatively may attempt to keep short-term interest rates at a certain level. Finally, in implementing policy on a day-to-day basis, central banks have two primary instruments at their disposal, open market operations and direct lending to depository institutions.[12]

Lower reserve requirements impede monetary control only in the case where the central bank has adopted a reserves operating procedure to achieve its money stock intermediate target. This policy pairing was implicit in the discussion of the preceding subsection. There it was assumed the central bank sought a certain level of the money stock, M^*, and provided an amount of reserves it thought consistent with that money stock. Disturbances in either money demand or money supply then led to deviations from the targeted money stock, deviations made worse by lower reserve requirements.

But as an alternative the central bank could have attempted to achieve its money target by

Figure 4
Interest Rate Operating Procedure



controlling short-term interest rates. That is, it could have adopted an interest rate operating procedure. Under such a procedure, reserve requirements become irrelevant from a direct monetary control standpoint.

The money supply and demand diagram in Figure 4 illustrates this point. Its basic features are identical to those of earlier diagrams. As before, M^* is assumed to be the central bank's target level of the money stock, and M^s and M^s_{lrrr} are the money supply curves before and after a reduction in reserve requirements. What is different in Figure 4 is the mechanism for achieving M^*. Rather than providing a predetermined level of reserves and relying on the direct link between reserves and the money supply to achieve M^*, the central bank focuses instead on achieving the market interest rate i^* associated with equilibrium point A—and M^*. That is, it provides whatever reserves are required to achieve i^* and, hopefully, M^*. In effect, the central bank continuously shifts the upward sloping M^s or M^s_{lrr} curve to the right and left, adding and draining reserves, the intent being to hold the effective money supply curve horizontal at the chosen interest rate in the hope it will cross the money demand curve at the targeted money stock. This horizontal effective supply curve is shown as $M^s_{effective}$ in Figure 4.[13]

A crucial implication is that the level of reserve requirements is now irrelevant. The fact that lower reserve requirements lower the slope of the money supply curve is unimportant—the effective money supply curve is $M^s_{effective}$ in either case. Thus, reserve requirements no longer play a

direct role in monetary control.[14]

Going one step further, there is no inherent reason why a central bank need target the money stock. It could be the case that another intermediate target, say, a medium-term interest rate, is deemed to be more closely related to the ultimate goal variables. If so, monetary control can be deemphasized or even abandoned, in which case reserve requirements again become irrelevant as a vehicle for directly controlling the money stock.

Thus, if a central bank chooses to target the money stock via an interest rate operating procedure, or chooses to target some intermediate target other than the money stock, reserve requirements lose their traditional monetary control function. Many central banks, including the Federal Reserve, the Bank of Canada, and the German Bundesbank, have made such choices.

Policy choices

Observers both inside and outside the respective institutions agree the Federal Reserve, the Bank of Canada, and the German Bundesbank are currently following interest rate operating procedures paired with varying degrees of adherence to a money stock intermediate target.[15] Although the three banks have different techniques for implementing policy, their overriding policy orientations are quite similar.

The Federal Reserve's current operating procedure is to target the federal funds rate, the interest rate banks charge each other for overnight loans. The federal funds rate, in turn, strongly influences other short-term market interest rates.

The Federal Reserve's current intermediate target can best be described as a hybrid. The Federal Reserve continues to set annual target ranges for M2 and M3, the broadest measures of the money stock. But the Federal Reserve also carefully monitors medium and long-term interest rates, credit availability, the exchange rate, and incoming data on real growth and inflation. Monetary aggregates' status as intermediate targets has slipped in recent years. As Chairman Greenspan recently explained in discussing the current operating procedure, "policy tactics have evolved away from according top priority to short-run control of any monetary aggregate and hence also away from an operating procedure that targets on a reserve aggregate" (Greenspan 1992a).

The Bank of Canada has adopted a comparable policy approach. It too focuses on short-term interest rates in its day-to-day policy, and it too has reevaluated its intermediate targets. In his most recent annual report, for example, Governor Crow noted that "In putting its policy into effect, the Bank operates at the short end of the financial market. . . . This involves influencing the rate on overnight financing in the money market" (Bank of Canada 1991a). Regarding intermediate targets, the Bank of Canada no longer establishes formal monetary targets but instead monitors an array of economic variables much like that of the Federal Reserve.[16] Indeed, an alternative characterization of both the Bank of Canada's and the Federal Reserve's current approach is that neither has an intermediate target per se but rather a collection of "information variables," variables that help guide policy decisions but are not targets themselves. For example, Charles Freedman, Deputy Governor of the Bank of Canada, recently described the Bank of Canada's policy structure as one without a formal intermediate target.

German monetary policy has a similar orientation, although geared somewhat more toward traditional monetary control considerations. Like the Federal Reserve and the Bank of Canada, the Bundesbank follows an interest rate operating procedure. Bundesbank officials have described the procedure as one in which, to varying degrees, "key interbank rates are normally kept within narrowly conceived tolerance ranges" (Dudler).[17] Unlike the Federal Reserve and the Bank of Canada, however, the Bundesbank has not deemphasized the money stock as an intermediate target. The Bundesbank continues to set an annual target

for M3, the broadest measure of the German money supply, and M3 remains its principal intermediate target. However, the Bundesbank is flexible when deemed necessary. For example, exchange rate considerations have forced the money target to be compromised on occasion.[18]

What are the relative merits of one intermediate target over another or one operating procedure over another? It is beyond the scope of this article to go into much detail, but it is useful to sketch some of the relevant issues.

Most analyses of intermediate target choice focus on the types of disturbances hitting an economy.[19] An economy subject to frequent shocks in money demand emanating from portfolio shifts, for example, is best served by an interest rate intermediate target. Such an approach insulates the real economy from unwanted fluctuations, and while the money stock may increase or decrease unexpectedly, such movements have no effect on the inflation rate. An economy subject to frequent shocks in money demand emanating from unexpected changes in consumer or business spending, on the other hand, is best served by a money stock intermediate target. By allowing interest rates to adjust, a money stock target prevents large fluctuations in real growth and at the same time keeps inflation close to its desired level.[20] Money supply disturbances, such as unintended overprovision or underprovision of nonborrowed reserves or unexpected changes in borrowed or excess reserves, can be accommodated under either an interest rate or a money stock intermediate target.

Most analyses of operating procedure choice proceed along similar lines. A reserves operating procedure is more effective in dealing with spending disturbances, while an interest rate operating procedure is more effective in dealing with portfolio disturbances. An interest rate operating procedure is also superior in the case of money supply shocks.

Thus, according to these studies, a central bank will presumably choose its intermediate target and operating procedure on the basis of the types and relative frequency of disturbances impacting an economy. Mention should be made as well of another group of studies that seeks to explain central banks' policy choices in terms of certain nondisturbance factors, for example, financial market concerns or credibility considerations.[21] Whether the choices made by the Federal Reserve, the Bank of Canada, and the Bundesbank are consistent with these frameworks is left for others to study.

What is relevant here is the implication of the operating procedure/intermediate target choice for the role of reserve requirements. To restate: if a central bank chooses to target the money stock via an interest rate operating procedure (the Bundesbank), or chooses to target some intermediate target other than the money stock (the Federal Reserve and the Bank of Canada, both of which use an interest rate operating procedure in any case), reserve requirements lose their traditional monetary control function. That is, reserve requirements no longer serve as a vehicle for directly controlling the money stock. Nevertheless, reserve requirements may still have a role in monetary policy, that of facilitating control over short-term interest rates. This issue is taken up in the final section.

CURRENT ROLE OF RESERVE REQUIREMENTS

The previous section stressed that many central banks, including the Federal Reserve, the Bank of Canada, and the German Bundesbank, are currently following interest rate operating procedures. In such an environment, reserve requirements are unnecessary from a direct monetary control standpoint. However, depending on the institutional structure within a country, reserve requirements may still have an important monetary policy role to play. By definition, an interest rate operating procedure requires close control over short-term interest rates. Reserve requirements may prove useful, or even necessary, in facilitating this control. It has been argued, in particular, that reserve require-

ments are needed on these grounds in the United States and Germany but are not needed in Canada.

The interbank market

Most central banks following interest rate operating procedures do so by targeting interbank interest rates. These are the rates banks and other depository institutions charge one another for short-term, typically overnight, loans. Interbank rates, in turn, strongly influence other short-term interest rates. As noted previously, for example, the Federal Reserve targets the federal funds rate, which has an important effect on other short-term private rates as well as on U.S. Treasury bill rates. Similarly, the Bank of Canada focuses on the overnight money market rate, while the Bundesbank pays close attention to the overnight call money rate, also referred to as the day-to-day money rate.[22]

Like any other market interest rate, an interbank rate is determined through the interaction of the supply of and the demand for funds. In this case, the supply ultimately comes from the central bank, while the demand comes from depository institutions.[23]

Depository institutions have two reasons for desiring interbank funds.[24] One, they may want to use interbank funds to help meet their reserve requirements. A depository institution short on reserves can raise funds in several ways. It can call in loans or sell securities out of its portfolio, for example. Alternatively, it can borrow funds in the interbank market.

The second reason depository institutions may want to use interbank funds is to help meet their clearing needs. Although payments systems vary widely across countries, one common feature is the maintenance of accounts at the central bank or elsewhere through which depository institutions settle their payments with one another. To replenish or augment an account used for check clearing or wire transfers, for example, a depository institution may wish to turn to the interbank market to raise funds.

Two conditions are necessary for an interest rate operating procedure to be effective. First, the central bank must have close control over the supply of interbank funds on a weekly or even daily basis. Second, the demand for interbank funds must be reasonably predictable. If these two conditions are met, the central bank will be able to anticipate and offset unwanted movements in the target interbank rate. If the conditions are not met, the interbank rate will fluctuate undesirably. To the extent reserve requirements help stabilize the demand for interbank funds, they facilitate an interest rate operating procedure.[25] It is in this context that the Federal Reserve, the Bank of Canada, and the Bundesbank now discuss the monetary policy merits of reserve requirements.

Current practices

The Federal Reserve operates in what might be considered a traditional institutional framework. Banks and other depository institutions are subject to reserve requirements. Depository institutions can meet their reserve requirements either through their holdings of vault cash or by maintaining reserve balances at the Federal Reserve. For many institutions, vault cash holdings are adequate. For others, reserve balances must also be held. Reserve balances are not idle funds, however, but rather can be used to clear transactions with other depository institutions. Many institutions use their reserve balances to clear and settle checks, for example. Reserve requirements are said to be binding if an institution is forced to hold more reserve balances than it would want to hold solely for clearing purposes.

The Federal Reserve is able to exercise very close control over the supply of interbank funds. To be sure, control is not perfect—on any given day, unanticipated supply factors (for example, currency drains or float increases) can generate an underprovision or overprovision of reserves. But in general the Federal Reserve has a very good idea of the level of funds in the interbank market and can

take steps via open market operations to adjust that level when necessary.[26] Thus, the first condition for a successful interest rate operating procedure is met.

The second condition, a predictable demand for interbank funds, is also reasonably well met. Again, surprises are not uncommon. Banks will often hold fewer or greater excess reserves than expected or borrow more or less at the discount window than anticipated. But on average such surprises are manageable. It has been argued that binding reserve requirements facilitate this relatively stable demand by ensuring that a given level of reserve balances will be held.[27]

The potential importance of reserve requirements in this context was illustrated following the December 1990 elimination of reserve requirements on nontransactions deposits. Many depository institutions found that reserve requirements were no longer binding, implying that their holdings of reserve balances were dictated by clearing needs alone. Such needs were often difficult to forecast. Other institutions were still bound by the requirements, but because the overall requirements were now lower, institutions were less willing to hold excess reserves early in the reserve-averaging period for fear of not being able to run sufficient offsetting deficits later in the period. These and other considerations led depository institutions to act less predictably in the interbank market. The result: the federal funds rate showed considerable volatility for many weeks thereafter.[28]

The April 1992 reduction in reserve requirements on transactions deposits, in contrast, was not nearly as disruptive. For one thing, depository institutions had gained valuable experience in managing lower reserve balances. Second, they were given more time to prepare for the change. And third, and probably most important, the level of reservable deposits was sufficiently high to generate a relatively high level of required reserves even after implementation of the reduction. As a result, the Federal Reserve was able to maintain close control over the federal funds rate.[29]

Are further reductions in reserve requirements possible? The potential tradeoffs are clear. Further reductions would further lower the reserve tax, benefiting U.S. depository institutions and their customers. But further reductions might also bring greater interest rate volatility, diminishing the efficacy of current Federal Reserve procedures.[30]

The Bank of Canada operates in a very different institutional framework. Within two years, reserve requirements will be completely eliminated. But because of the unique structure of the Canadian payments system and the framework it has instituted, the Bank of Canada is confident its interest rate operating procedure will not be adversely affected.

The Canadian financial system is highly concentrated. A dozen or so banks, trust and mortgage loan companies, and credit unions account for the lion's share of assets held by Canada's roughly 800 depository institutions. Within the banking sector, for example, the six largest banks controlled 90 percent of all bank assets at the end of 1991.[31]

The payments system in Canada is also highly centralized. Canada has a national payments system operated by the Canadian Payments Association but settling on the books of the Bank of Canada. Thirteen large depository institutions, including eight banks, have "Direct Clearer" status. Direct Clearers are required to hold clearing balances at the Bank of Canada. While these balances do not earn interest, they can be maintained at low levels—the "requirement" is that they not be negative at the end of the day. Through these accounts, daily net clearing gains and losses vis-a-vis other Direct Clearers are settled. Direct Clearers represent not only themselves but may also act as clearing agents for other depository institutions (that is, indirectly clearing members of the Canadian Payments Association). Thus, in effect, all payment items are settled on the books of the Bank of Canada.[32]

The Bank of Canada puts these arrangements to good use in implementing its interest rate operating procedure. On the supply side, the Bank is able to exercise close daily control over the supply of interbank funds by transferring federal govern-

ment deposits into and out of the settlement accounts of the Direct Clearers. This technique, the "draw-down/redeposit mechanism," is the Bank of Canada's principal operating tool. On the demand side, the framework ensures that the direct clearers have a more or less determinate target each day. As well, the Bank closely monitors and gauges the demand for settlement balances by contacting the large direct clearers.[33]

Thus, in a manner very different from the Federal Reserve, the Bank of Canada meets the two conditions necessary for an effective interest rate operating procedure. Notably, reserve requirements play no role.

The Bundesbank operates in an environment much closer to that of the Federal Reserve. The German banking system is relatively diffuse, with the payments system not inextricably linked to the central bank.[34] Like its two counterparts, the Bundesbank is successful in maintaining close control over the supply of interbank funds.[35] Like the Federal Reserve, it sees reserve requirements as an important factor helping to stabilize the demand for interbank funds.

Helmut Schlesinger, President of the Bundesbank, recently declared reserve requirements "an indispensable targeting instrument... unmistakingly enhance[ing] the efficiency of monetary policy" (Schlesinger). His predecessor, Karl Otto Pohl, held similar views, explaining that "If there were no reserve requirements, the banks would attempt to minimize their balances at the Bundesbank to the greatest extent possible... something which could lead to extreme interest rate responses on the money market" (Pohl).[36] German banks, like U.S. banks, would prefer not to pay a reserve tax. But their doing so in effect helps the Bundesbank control short-term interest rates.

SUMMARY

It remains an open question whether the Federal Reserve and the Bundesbank will follow the Bank of Canada and further reduce reserve requirements. It is clear, though, that monetary policy discussions will turn on interest rate considerations, not on direct monetary control considerations. While to varying degrees central banks still seek to target the money stock over longer periods of time, in the short run most use an interest rate operating procedure. Under such a procedure, reserve requirements play a different monetary policy role than that traditionally espoused. Reserve requirements are seen not as an instrument for directly controlling the money stock but rather as a tool for facilitating control over short-term interest rates. It is in this context that future debates over reserve requirements will take place.

ENDNOTES

1 Early multiplier studies include Brunner, and Brunner and Meltzer. More recent treatments include Garfinkel and Thornton, Cacy and Winningham, and virtually any money and banking or intermediate macroeconomics textbook. Many multiplier models choose to emphasize the monetary base (reserves plus currency) rather than reserves; that is, the "multiplier" is calculated as the money stock divided by the base. In such models, it is still the case that a decrease in reserve requirements leads to a larger multiplier, implying a reduction in monetary control.

2 By introducing currency into the model, where c equals the public's desired currency-to-deposit ratio, the multiplier becomes $(1+c)/rr$. Note that, as in the simpler case, a decrease in the required reserve ratio increases the multiplier, implying less monetary control.

3 It is straightforward, for example, to accommodate nonreservable time deposits. It is also straightforward to accommodate interest-insensitive excess reserves (interest-sensitive excess reserves are modeled explicitly in the money supply and demand framework of the next section). For an example of a fully developed multiplier model, see Mishkin, pp. 356-58.

4 Strictly speaking, then, it is not the Bank of Canada per se but the Canadian federal government that has eliminated reserve requirements. Included in the legislation are a number of other provisions designed to enhance competition among financial institutions. Of course, it has been left to the Bank of Canada to implement the elimination of reserve requirements, a process the Bank began on November 18, 1991

(Bank of Canada 1991a, p. 30). The marginal reserve requirement is zero during the two-year phaseout period.

[5] It has been argued that a portion of the reserve tax is offset by benefits. Prior to the 1980 Monetary Control Act, for example, member banks of the Federal Reserve received free services such as check clearing and collection. In Germany, banks are permitted to borrow a large amount of funds at the below-market discount rate. In Canada, banks until recently had more lending powers than competitors. Nevertheless, virtually all analysts agree the reserve tax is still burdensome on net.

[6] See also Greenspan 1992a and 1992b.

[7] An alternative way of reducing the reserve tax would be to pay interest on reserves, an idea supported by the Board of Governors of the Federal Reserve System (Greenspan 1992a and 1991). But in the United States, at least, such a policy has always been resisted by the Congress because of the resulting revenue loss for the government. For discussion, see Weiner; Meulendyke; and Goodfriend and Hargraves.

[8] See Kryzanowski and Roberts; Clinton.

[9] An important example in the United States is the growth of money market mutual funds in the late 1970s and early 1980s. The argument that reserve requirements induce innovations has been advanced by several authors (Greenbaum).

[10] U.S. M2 includes currency, demand deposits, other checkable deposits, savings deposits (including money market deposit accounts), small time deposits, overnight repurchase agreements and overnight Eurodollars, and general-purpose and broker-dealer money market funds. Canada M2+ includes currency, demand deposits less private sector float, personal savings deposits, nonpersonal notice deposits, deposits at trust and mortgage loan companies and savings banks, deposits and shares at credit unions, and holdings of money market mutual funds and annuities issued to individuals. German M3 includes currency, sight deposits, time deposits, and savings deposits. For the United States, it would be preferable to calculate the effective required reserve ratio as required reserves *behind M2 deposits* divided by M2 (the approach followed in the Canadian and German cases). Unfortunately, complete U.S. data are not available, so in early years some of the reserves in the numerator were actually held against non-M2 M3 deposits, causing the measured effective ratio, and hence the decline, to be somewhat overstated. However, by calculating reserves against transaction deposits as a fraction of M2, thus establishing a lower bound for the true effective reserve ratio, one can safely infer that the true effective reserve ratio has indeed declined sharply.

[11] Let FR = free reserves = $ER - BR = \alpha - \beta i$ where i = market interest rate and $\beta > 0$. Then rewriting equation (13),

$$M^S = \frac{1}{rrr}(NBR - FR) = \frac{1}{rrr}(NBR) - \frac{1}{rrr}(\alpha - \beta i).$$

$$\frac{dM^S}{di} = \frac{-1}{rrr}(-\beta) = \frac{\beta}{rrr}, \text{ implying}$$

as rrr decreases, $\frac{dM^S}{di}$ increases, that is, the M^S curve becomes flatter.

[12] For discussions of the target hierarchy, see Sellon and Teigen (1982a and 1982b), Freedman, Friedman, and Sellon.

[13] In the absence of disturbances to money demand and money supply, an interest rate operating procedure and a reserves operating procedure yield equivalent outcomes. In terms of Figure 4, for example, an absence of shocks implies equilibrium point A, with a money stock M^* and interest rate i^*. But if money demand and money supply are subject to shocks, the alternative operating procedures imply very different outcomes. By its very nature, an interest rate operating procedure strives, at least initially, to keep the interest rate at its current level, so that any shock translates fully into a deviation in the money stock. A reserves operating procedure, in contrast, accommodates movements in the interest rate, with the result that shocks translate into both money stock and interest rate deviations.

[14] For formal derivations of this key result, see Kaminow, Laufenberg, and Horrigan.

[15] Surveys of current operating procedures in several countries include Kneeshaw and Van den Bergh; Batten and others; Bernanke and Mishkin; Kasman; and Morton and Wood. Country-specific analyses include Greenspan (1992a) and Meulendyke (United States); Clinton; Freedman; Freedman and Dingle (Canada); and Dudler; Neumann (Germany).

[16] The Bank of Canada abandoned monetary targets in 1982.

[17] In the same citation, Dudler characterizes the Bundesbank as not following a "pure 'interest rate' strategy," but stresses as well that short-run procedures neither are based on a "rigorous 'money multiplier' approach." Analysts outside the Bundesbank typically characterize the Bundesbank's approach as an interest rate operating procedure (Neumann; Kasman). An interest rate operating procedure also appears implicit in recent statements by Bundesbank presidents Schlesinger and Pohl.

[18] See Issing (1992a and 1992b) for a description of the importance currently accorded money stock targeting. See Kahn and Jacobson for a discussion of foreign exchange considerations.

[19] A seminal work is Poole. A particularly useful, comprehensive treatment is provided by Sellon and Teigen (1982a and 1982b).

[20] Of course, an interest rate intermediate target can be equally effective to the extent the central bank (i) can identify a shock as emanating from a change in spending, and (ii) can immediately adjust its intermediate interest rate target to the appropriate level.

[21] For discussion, see Goodfriend (1991 and 1992).

[22] The Bank of Canada and the Bundesbank seek to closely

influence longer term money market rates as well. As a signal, the Bank Rate, which is tied to the 90-day Treasury bill rate at Thursday tender, is important in Canada. The one and two-month repurchase agreement rates are important in Germany. For detailed discussion, see citations in note 15.

23 Some depository institutions may be "suppliers" in the sense they lend funds in the interbank market; however, the funds available to the financial system as a whole are ultimately provided by the central bank.

24 The term "interbank funds" is used broadly. In some countries, funds are rarely lent and borrowed directly between banks, in which case a more descriptive term for "interbank funds" might be "clearing balances" or "settlement balances."

25 This is a point made by several authors, including Freedman and Kasman. The two conditions for an effective interest rate operating procedure can be stated in terms of the money supply curve, equation (13): the first, the central bank must have close control over the (net) supply of interbank funds corresponds to close control over NBR; the second, the (net) demand for interbank funds must be reasonably predictable, corresponds to predictable movements in BR and ER. It is also worth noting that reserve requirements, by inducing innovations (see note 9), could induce more portfolio-related money demand shocks than would otherwise be the case, making attainment of an intermediate target (money stock or interest rate) more difficult. But within the context of an interest rate operating procedure, and, specifically, the day-to-day control of an interbank interest rate, reserve requirements are a stabilizing factor.

26 For a discussion of Federal Reserve open market operations and factors affecting the supply of reserves, see Roth.

27 Chairman Greenspan in a recent letter stressed the role played by reserve requirements in stabilizing reserve demand: The most important current advantage [of reserve requirements] is that reserve requirements provide for a reasonably predictable demand for overall reserve balances. They do so by keeping required operating balances at a relatively stable level above the quite variable amount needed to clear volatile payments. Such a predictable demand is essential for the effective implementation of open market operations in avoiding unnecessary fluctuations in the federal funds rate (1992a).

28 For a discussion of some the problems associated with the December 1990 episode, see Meulendyke; and Dumitru and Stevens.

29 For discussion, see Gilbert.

30 Within the Federal Reserve there are different views on the desirability or practicality of further reductions. For example, Greenspan (1992a and 1991) and Muelendyke take cautious positions; Stevens endorses further reductions at this time. In considering further reductions, the Federal Reserve might also wish to consider changes in discount window operation, a point made by Muelendyke. Under current law, the reserve requirement on transactions deposits cannot be lowered below 8 percent.

31 For a discussion of the Canadian banking system, see Kryzanowski and Roberts.

32 For a description of the Canadian payments system, see Bank for International Settlements and Crow. It should be noted that U.S. depository institutions, in addition to holding reserve accounts, also have the option of holding separate "clearing balance accounts" at the Federal Reserve. However, this is an optional program and very different from the Canadian case. For a description of the U.S. payments system, see Bank for International Settlements. For a brief discussion of Federal Reserve clearing balance accounts, see Stevens.

33 For a detailed description of the Bank of Canada's planned operating procedure without reserve requirements, see Bank of Canada 1991b and 1987; Clinton; Longworth; and Sufrin and Amsden.

34 For a discussion of the German banking system, see Pozdena and Alexander. For a discussion of the German payments system, see Bank for International Settlements.

35 For description of Bundesbank policy instruments, see Deutsche Bundesbank 1989 as well as the relevant citations in note 15.

36 See also Deutsche Bundesbank 1990 for Bundesbank perspectives on reserve requirements.

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Does Money Still Forecast Economic Activity?

By Sean Becketti and Charles Morris

Until recently, most economists agreed that movements in the quantity of money help to forecast changes in national output. This generally accepted usefulness of money as an economic indicator is one reason the Federal Reserve has continued to monitor the monetary aggregates despite significant changes in the economy and financial markets. Indeed, weakness in the monetary aggregates was the first reason given by the Federal Reserve for the four most recent cuts in the discount rate.

New research, however, challenges this consensus view (Friedman and Kuttner). The results of this research suggest that money lost the ability to forecast economic activity after the 1970s. If this finding is correct, money no longer provides policymakers with information about future economic activity.

This article investigates the claim that money lost the ability to predict economic activity after the 1970s. The results from this study suggest that, except during the early 1980s, money has remained a useful indicator of future economic activity. Of course, this does not mean that money is the best or only indicator of future economic activity.[1]

The first section of this article explains why money should be a useful indicator of future economic activity and discusses some of the reasons the money-output relationship may have changed. The second section examines previous research on the ability of money to forecast economic activity. The third section presents new evidence showing money's undiminished ability to forecast economic activity.

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WHY SHOULD MONEY FORECAST ECONOMIC ACTIVITY?

Money is useful for forecasting economic activity only if there is a systematic and stable relationship between money and economic activity. Virtually all modern theories of the macroeconomy claim that money is systematically related to future economic activity. But changes in financial markets in the 1980s may have altered money supply and money demand relationships and thereby obscured money's ability to forecast economic activity.

Why money is related to economic activity

Most macroeconomic theories agree that money is related to economic activity. In these theories, the relationship between money and economic activity depends on whether changes in the money stock are due to shifts in money supply or money demand. For example, increases in money

supply spur economic activity, while increases in money demand tend to dampen economic activity. And, these shifts in money supply and demand affect output indirectly, through their effects on interest rates.[2]

Money supply. Shifts in money supply are positively associated with output through their effect on interest rates. Money supply increases, for example, drive down interest rates to persuade investors to hold the additional money balances. The decline in interest rates, in turn, boosts interest-sensitive components of spending, such as investment. Thus, increases in money supply reduce interest rates and increase output.

For money supply shifts, the change in interest rates—and therefore the change in output—depends on the interest elasticity of money *demand.* Specifically, the more elastic is money demand, the smaller is the change in interest rates and, therefore, in output.[3] Suppose the supply of money increases. If money demand is very sensitive to changes in interest rates—money demand is very elastic—interest rates need not fall far for money demand to equal money supply. As a result, the increase in output is small. On the other hand, if money demand is inelastic, interest rates must fall a lot for money demand to equal money supply, and the increase in output is greater. Thus, the size of the interest rate effect of a shift in money supply is inversely related to the interest elasticity of money demand.

Money demand. Shifts in money demand are negatively associated with output through their effect on interest rates. Suppose money demand increases. To increase their money holdings, investors sell bonds, driving up interest rates. The increase in rates depresses output. Thus, increases in money demand increase interest rates and reduce output.

When the demand for money shifts, the size of the interest rate effect depends on the interest elasticity of the money *supply.* Specifically, the more elastic is money supply, the smaller is the change in interest rates and output. The elasticity of supply depends primarily on the Federal Reserve's operating procedure. For example, suppose the Federal Reserve targets interest rates—that is, the Fed adjusts the money supply to hold interest rates at some target level.[4] This choice of operating procedure makes the money supply curve perfectly elastic. When money demand increases, interest rates do not change at all because the Fed supplies whatever quantity of money is needed to meet the increase in demand. As a result, under this operating procedure, a shift in money demand has no interest rate effect on output.

Alternatively, suppose the Fed emphasizes controlling the quantity of money—that is, the Fed attempts to hold the money stock within a narrow band and allows interest rates to vary more. This choice of operating procedure makes the money supply curve relatively inelastic. Now, when money demand increases, interest rates must rise to keep households and firms satisfied with the roughly fixed stock of money. Under this operating procedure, a shift in money demand has a substantial interest rate effect on output. These two examples illustrate that the size of the effect of a shift in money demand on output is negatively related to the interest elasticity of money supply.

Why the relationship between money and economic activity may have changed

Financial markets witnessed significant developments in the 1980s—deposit rate deregulation, substitutes for deposits, and changes in Federal Reserve operating procedures.[5] Deposit rate deregulation and substitutes for deposits may have changed the impact of money supply shifts by changing the interest elasticity of money demand. The net effect of these developments is difficult to determine, however, because they have opposite effects on the elasticity of demand. In contrast, the interest elasticity of money supply unambiguously fell in response to the change in the Federal Reserve's operating procedure in

1979. The fall in the supply elasticity increased the impact of money demand shifts. This increased impact was temporary, however, because the change in Fed operating procedures was temporary.[6]

Changes in the impact of money supply shifts. Deposit rate deregulation strengthened the interest rate effect of money supply shifts by decreasing the elasticity of demand for some components of money, such as time deposits.[7] To see why, suppose the money supply decreases, causing market interest rates to rise. Before deregulation, rates on time deposits could not rise with market rates because banks could not raise deposit rates above regulatory ceilings. As a result, the spread between market rates and the return on money would widen, driving down the demand for money. Since deregulation, however, banks can increase deposit rates and retain some of their deposits. As a result, for a given increase in market interest rates, the demand for money falls less than it did before deregulation. In other words, deposit rate deregulation decreased the interest elasticity of money demand.

At the same time, the growth in substitutes for bank deposits such as stock and bond mutual funds may have increased the interest elasticity of money demand (Sellon). Again, consider the example of a rise in market interest rates. Before the increase in popularity of mutual funds (but after deposit rate deregulation), individuals might have responded by switching some of their funds from demand deposits to small time deposits, whose rates vary with market rates. Because both demand and small time deposits are part of some measures of the money stock, the increase in interest rates would have had little effect on such measures. But since mutual funds have grown in popularity, individuals might now move some funds out of deposits altogether and into stock or bond mutual funds. Such a portfolio shift would reduce the money stock. In this way, substitutes for deposits may have increased the interest elasticity of money demand.

Overall, it is difficult to determine whether the impact of money supply shifts on output became stronger or weaker in the 1980s. The decrease in the elasticity of money demand due to deposit rate deregulation may have been canceled by the increase in elasticity due to the growth in popularity of stock and bond mutual funds.

Changes in the impact of money demand shifts. The changes in Federal Reserve operating procedures changed the impact of money demand shifts by drastically changing the interest elasticity of money supply. Before October 1979, the Fed conducted monetary policy by targeting short-term interest rates. Under this procedure, the money supply was highly elastic. As a result, money demand shifts had virtually no effect on output. From October 1979 through October 1982, the Fed placed greater emphasis on managing the growth of the monetary aggregates and allowed interest rates to vary more than before. This change drastically reduced the elasticity of money supply.[8] As a result, money demand shifts had a large effect on interest rates and, therefore, on output.

The change in operating procedures was temporary. After October 1982, the Fed returned to an operating procedure that placed greater emphasis on short-term interest rates, making money supply highly elastic again. Thus, the change in the impact of money demand shifts was only temporary.

PREVIOUS RESEARCH ON WHETHER MONEY FORECASTS ECONOMIC ACTIVITY

Money can help forecast economic activity if there is a significant statistical association between money and future economic activity. Research that examines data through the early 1980s presents mixed results, with some studies finding a consistently strong association between money and future output, and others finding little association. More recent research that includes the entire 1980s suggests that this association dropped and possibly disappeared in the 1980s.

Evaluating money's ability to forecast economic activity

Money helps forecast economic activity if it is reliably associated with future output. Most previous studies of the relationship between money and economic activity rely on the so-called Granger test to determine if there is a reliable association (appendix). In the simplest, bivariate version of this test, a measure of output is regressed on past values of itself and on past values of a measure of money. If money is statistically significant in this regression, then money provides information about future output over and above that provided by past values of output. In other words, a significant Granger test indicates that money forecasts economic activity.[9]

A tougher, multivariate version of the Granger test adds additional variables, such as prices and interest rates, to the bivariate regression. These other variables also contain information about future output. If money is still statistically significant after additional variables are added to the regression, then money contains information about future output beyond the information contained in these additional variables.

Previous research

The modern analysis of the association between money growth and future output growth begins with Sims's (1972, 1980) introduction of Granger tests into the debate. Sims (1972) found that money had a significant ability to forecast economic activity when real output was regressed on lagged values of itself and of money.[10] However, in a Granger test that also included short-term interest rates, money did not appear to add predictive information to that already contained in interest rates (Sims 1980).[11] Sims's studies shed no light on any changes in money's ability to forecast economic activity in the 1980s because the sample in his studies ends in 1978.

Following Sims, many researchers used Granger tests to investigate whether money forecasts economic activity. These tests gave different answers depending on the variables used to measure money and output, on the frequency of observation of the data (monthly or quarterly), on the specification of the Granger test regression, and on the sample used in the regression.[12] Eichenbaum and Singleton, for example, found that the association between money and future output appeared to weaken when data from the early 1980s were included. Other researchers, however, found that money improves forecasts of economic activity even with data from the early 1980s. Christiano and Ljungqvist concluded that, at least in a bivariate regression, money does forecast economic activity when data through 1985 are included. Using multivariate Granger tests and data through 1985, Stock and Watson concluded that money significantly improves forecasts of economic activity even when information about past inflation and interest rates is incorporated.[13]

The first study to include data from all of the 1980s was done by Friedman and Kuttner. This study focused more closely on the possibility that money's ability to forecast economic activity diminished in the 1980s. Friedman and Kuttner examined three samples: 1960 through 1990, an early sample (1960-79), and a late sample (1970-90).[14] For each of these samples, Friedman and Kuttner performed a number of multivariate Granger tests.

Friedman and Kuttner found that money's predictive power typically declines when data from the 1980s are included (Table 1).[15] When money and the price level are the only explanatory variables (simple specification), money significantly improves forecasts of economic activity for the entire period and for the early sample that excludes the 1980s. This improvement is indicated in Table 1 by significance levels well below the conventional 5 percent threshold. For the late sample, which concentrates on the 1970s and 1980s, money does not make a statistically significant contribution to forecasts of real growth, as indicated by very high

Table 1

Significance Levels of Granger Tests for M2

(Percent)

Specification	1960:Q2-1990:Q4	1960:Q2-1979:Q3	1970:Q3-1990:Q4
Simple	0	1	8
Extended	71	11	97

Note: The numbers in each column are marginal significance levels for the F-test of the joint hypothesis that all of the coefficients on M2 are equal to zero in a regression estimated over the indicated sample. For example, the "0" in the first row and column indicates that the M2 coefficients are statistically different from zero at less than the one-half of 1 percent level using the simple specification estimated over the entire sample. The simple specification regresses the growth rate of real gross national product (GNP) on lagged values of itself, the growth rate of the GNP deflator, and the growth rate of M2. The extended specification adds lagged values of the change in the 3-month Treasury bill rate and the spread between the 6-month commercial paper rate and the 6-month Treasury bill rate. Four lags of each variable are included in both specifications. The significance levels were calculated by the authors from figures published in Friedman and Kuttner.

significance levels. This finding suggests that the link between money and future output was weaker in the 1980s than before.[16]

When information is included on short-term interest rates and the quality spread (extended specification)—the spread between the rates paid by private corporations and the rates paid by the U.S. Treasury—money adds virtually nothing to forecasts of economic activity. Money's contribution is much closer to being statistically significant when the data from the 1980s are excluded. Even in this early sample, however, money does not significantly add to the information contained in the other variables.

DOES MONEY STILL FORECAST ECONOMIC ACTIVITY?

Previous studies have found that including data from the 1980s reduces money's ability to forecast economic activity. Indeed, the one study that included all of the 1980s found that money's predictive power has disappeared. It is possible, however, that the money-output relationship appeared to break down for all of the 1980s only because the relationship temporarily changed after the Federal Reserve changed its operating procedure. The evidence presented below suggests that the relationship returned to normal after the Federal Reserve abandoned the reserves operating procedure in 1982, and that money once again provides useful information about future economic activity.

Methodology

As in previous studies, Granger tests are used to determine whether money is useful in forecasting economic activity. Money is useful if it provides information not already contained in past observations of output growth. Money is even more useful if it provides information about future economic activity beyond that provided by other variables. Most of the variables used in this analysis are standard—money, inflation, and interest rates. In addition, the quality spread used by Friedman and Kuttner is included because this variable appears to have strong predictive power and

because it appears to contain much of the information contained in the monetary aggregates.

Choosing measures of money, output, prices, and interest rates is difficult because many competing measures are available. In this article, money is measured by the M2 aggregate.[17] Economic activity is measured by the growth rate of real gross domestic product (GDP), and inflation is measured by the growth rate of the implicit GDP deflator.[18] As in most previous studies, the interest rate is measured by the change in the 3-month Treasury bill rate.[19] Finally, the quality spread is measured by the difference between the 6-month commercial paper rate and the 6-month Treasury bill rate, the same measure used by Friedman and Kuttner.[20] The data are quarterly observations from the third quarter of 1960 through the second quarter of 1992.

The final decision before conducting the Granger tests is how many lags of the variables to include in the regression. Friedman and Kuttner use four lags in their study. In our specification, though, the fifth lag of the variables, if included, is statistically significant. In addition, several other statistical criteria point to five as the optimal number of lags. As a result, five lags are used in the regressions reported here.[21]

Empirical results

The empirical results presented here answer three questions about the relationship between money and economic activity. First, is money still useful for forecasting output? Second, if money is still useful, has the nature of the relationship between money and output changed? Finally, how would ignoring money affect the forecast of output growth?

At first glance, M2 appears to have lost its former ability to predict output (Table 2). M2 is highly significant in forecasting output for the entire period: the Granger test is significant at the 2 percent level. When the sample is broken into an early period and a late period, however, M2 is able to predict output only in the early period. The Granger test is significant at the 4 percent level for the period from the third quarter of 1960 through the third quarter of 1979. From 1970 on, the significance level of the Granger test is 24 percent, nowhere near the conventional 5 percent threshold.[22] This evidence is consistent with that found by Friedman and Kuttner.

This evidence is open to two very different interpretations, however, because Granger tests can be insignificant for two different reasons. These Granger tests compare the strength of the money-output relationship to the uncertainty about this relationship. The strength of the relationship is measured by the estimates of the regression coefficients on M2 growth. The uncertainty about this relationship is measured by the standard errors of the coefficients, which depend on how well the Granger test regression fits the data. Thus, the test may be insignificant if the money-output relationship is weak, that is, if the regression coefficients on M2 are small. Alternatively, even when the money-output relationship is very strong, the Granger test may be insignificant if there is a great deal of uncertainty about the money-output relationship, that is, if the regression does not fit the data very well.[23]

Friedman and Kuttner adopt the first interpretation of this evidence. They conclude that the insignificant Granger tests in the late sample indicate a weak money-output relationship in that period. It is possible, though, that these tests indicate greater uncertainty about the money-output relationship in the late sample.

One reason the uncertainty about the money-output relationship may have increased in the late sample is that the money-output relationship changed temporarily during the early 1980s. The Granger test regressions measure the combined effects of money supply shifts and money demand shifts. The effects of money demand shifts—and, thus, the combined effects of supply and demand shifts—changed when the Federal Reserve changed its operating procedures. As a consequence, a single regression estimated across these

Table 2

Significance Levels of Granger Tests for M2

(Percent)

1960:Q3 - 1992:Q2	1960:Q3 - 1979:Q3	1970:Q1 - 1992:Q2	1970:Q1-1992:Q2 excluding 1979:Q4-1982:Q4
2	4	24	2

Note: The numbers in each column are marginal significance levels for the F-test of the joint hypothesis that all of the coefficients on M2 are equal to zero in a regression estimated over the indicated sample. For example, the "2" in the first column indicates that the M2 coefficients are statistically different from zero at the 2 percent level when the regression is estimated over the entire sample. For each sample, the growth rate of real gross domestic product (GDP) is regressed on five lags of itself, the growth rate of M2, the change in the 3-month Treasury bill rate, the difference between the 6-month commercial paper rate and the 6-month Treasury bill rate, and the growth rate of the implicit GDP deflator.

different periods fits the combined data poorly. This poor fit increases the uncertainty about the money-output relationship and, therefore, reduces the significance of the Granger test.[24] Thus, M2 may appear to lose its predictive power in the late sample simply because the money-output relationship changed temporarily during the early 1980s.

In fact, money regains its ability to forecast economic activity when the sample is restricted to periods when the Fed's operating procedure emphasized short-term interest rates (Table 2). This regression was estimated over the late sample excluding data from the fourth quarter of 1979 through the fourth quarter of 1982.[25] In this regression, the Granger test on money is significant at the 2 percent level.[26] In other words, M2 still forecasts economic activity.

Even though M2 continues to forecast economic activity, the nature of the relationship between money and output may have shifted in the 1980s. For example, an increase in M2 growth may signal a much smaller or larger increase in real growth now than it did before the 1980s. Such a change in the money-output relationship would be important information for policymakers.

The Chow test provides evidence on whether the relationship between real growth and other macroeconomic variables, including money, is the same in the 1980s and 1990s as it was in the 1960s and 1970s (Chow). In particular, the Chow test can be used to see whether the coefficients in the Granger test regression change after 1982. If the coefficients are significantly different after 1982, then the relationship between real growth and the explanatory variables in the regression is different after 1982.

Four Chow tests were performed, and none detected any change in the relationship between real growth and other variables after 1982 (Table 3). In the first test, the coefficients on money growth were allowed to change after 1982, but the coefficients on the other variables were restricted to remain the same in both periods. In the second test, all of the coefficients were allowed to change after 1982. The regressions for both of these tests used data from the entire sample. The last two tests repeated the first two tests for the late sample. (The observations from the reserves operating procedure period are excluded from

Table 3

Significance Levels of Chow Tests

(Percent)

Sample	M2	All variables
1960:Q3 - 1992:Q2	57	36
1970:Q1 - 1992:Q2	62	43

Note: The results in the first column are from a regression in which only the coefficients on M2 and the intercept are allowed to change after 1982. The results in the second column are from a regression in which all of the coefficients are allowed to change after 1982. The numbers in each column are marginal significance levels for the F-test of the joint hypothesis that the indicated coefficients changed after 1982. For example, the "57" in the first row in the column labeled "M2" indicates that the coefficients on M2 and the intercept after 1982 are statistically different from the coefficients before 1983 only at the 57 percent level. The period from the fourth quarter of 1979 through the fourth quarter of 1982 is excluded from each regression. For each sample, the growth rate of real gross domestic product (GDP) is regressed on five lags of itself, the growth rate of M2, the change in the 3-month Treasury bill rate, the difference between the 6-month commercial paper rate and the 6-month Treasury bill rate, and the growth rate of the implicit GDP deflator.

both samples.) None of the tests were significant at the conventional 5 percent level.[27]

Since some observers have expressed concerns that M2's usefulness as a guide to future economic activity might have declined recently, it is interesting to see exactly what information M2 has added to recent forecasts of real growth. One way to do this is to reestimate the Granger test regression excluding M2, and then compare its forecasts of real output to those of the original regression that includes M2 (Chart 1). The forecasts that ignore M2 failed to foresee the most recent recession and predicted a much stronger recovery than has occurred (top panel of Chart 1). The forecasts that included information on M2 also missed the recession, but they accurately predicted the weakness of the recovery since the second quarter of 1991 (bottom panel).[28] Of course, this comparison does not imply that forecasts that incorporate information on money are always more accurate than forecasts that ignore money. They do show, though, that money has made a useful contribution to forecasts of real growth in recent quarters.

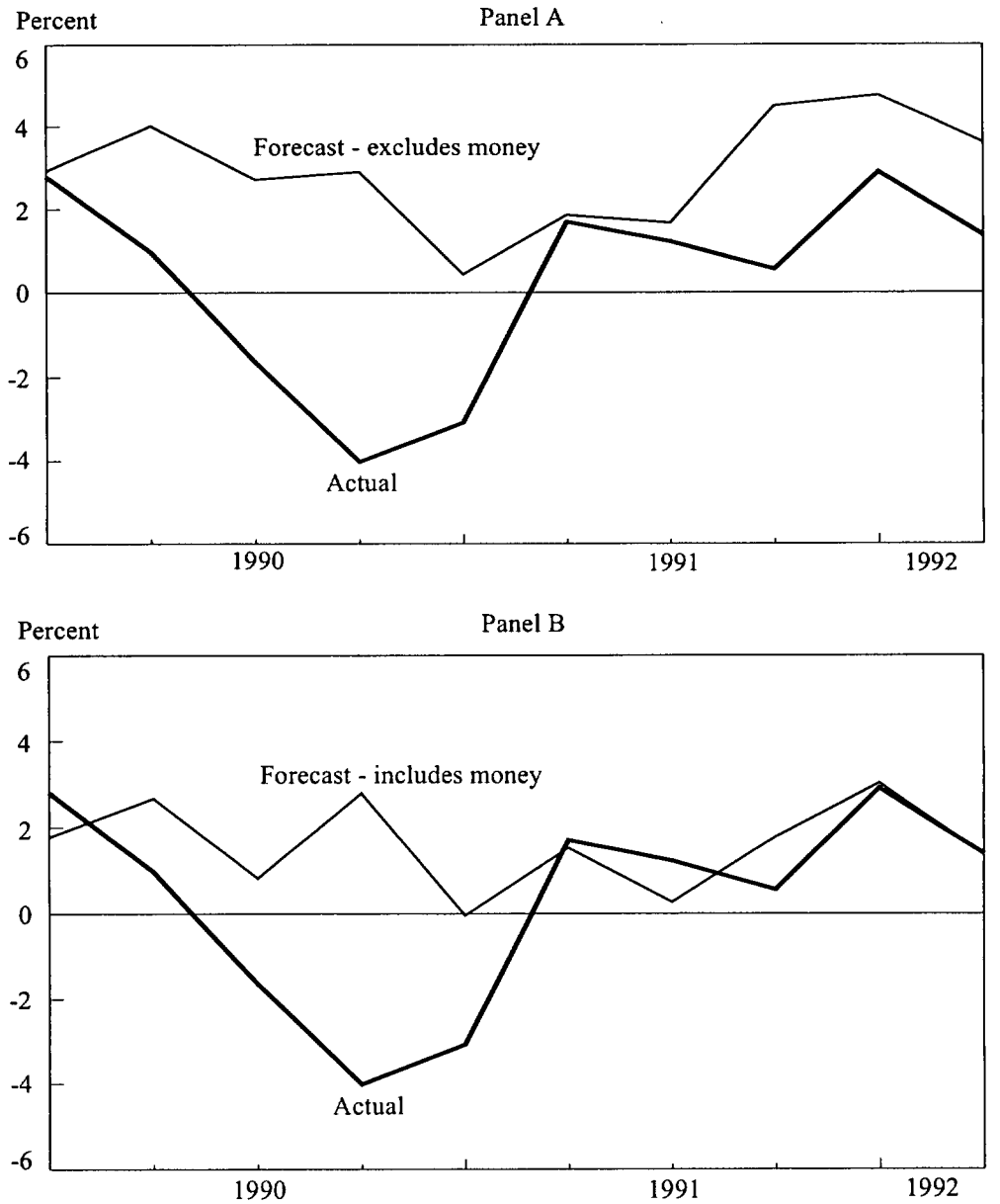
CONCLUSIONS

A number of financial market developments in the 1980s had the potential to alter the relationship between money and future real growth, thereby reducing money's ability to forecast economic activity. Some recent research has found that money's ability to forecast economic activity declined when data from the 1980s are included in the analysis. However, this research overlooks the possibility that the reduction in money's predictive power was temporary.

In particular, the temporary change in the Federal Reserve's operating procedure may have had a powerful effect on the money-output relationship. This article finds that, when the period of this change is excluded from the analysis, money's ability to forecast economic activity is undiminished. Thus, the change in operating procedure may account for the previous research showing that money's ability to forecast economic activity declined in the 1980s.

Chart 1

Effect of Excluding Money on Forecasts of Real GDP Growth



APPENDIX

GRANGER TESTS

Granger tests are statistical tests of the ability of one variable to forecast another (Granger, Sims 1972). These tests are also called Granger causality tests, but this name is misleading since Granger tests provide no information about causality. Instead, they measure the strength of the correlation between the current value of one variable and past values of another.

A Granger test is performed by regressing the variable to be predicted on its own past values and on past values of the variable whose predictive power is being tested. The Granger test is just the F-test of the null hypothesis that the coefficients on the past values of the predictor variable are all zero—that is, that the predictor variable does not contain useful information beyond the information contained in past values of the variable being forecast. If the F-test is significant—if this null hypothesis is rejected—then the predictor variable is said to "Granger cause" the variable being forecast. In this case, the predictor variable is able to forecast the other variable.

To conduct a Granger test of whether money forecasts economic activity, the regression

$$y_t = c + A(L)y_{t-1} + B(L)m_{t-1} + e_t$$

is estimated, where y_t is a measure of output in period t, m_t is a measure of money, c is a constant, and e_t is a random disturbance. The L in A(L) and B(L) is the lag operator, a symbol that indicates lagged values of the variable to the right of the L. Thus,

$$L\ m_t = m_{t-1}.$$

Powers of L indicate the number of times to apply the lag operator. For example,

$$L^3\ m_t = L(L(L\ m_t)) = L(L\ m_{t-1}) = L\ m_{t-2} = m_{t-3}.$$

$A(L)$ and $B(L)$ are polynomials in the lag operator, for example,

$$B(L)m_{t-1} = (b_1 + b_2L + b_3L^2 + \ldots + b_pL^{p-1})m_{t-1}$$
$$= b_1m_{t-1} + b_2m_{t-2} + b_3m_{t-3} + \ldots + b_pm_{t-p}.$$

After the regression is estimated, an F-test is performed for the hypothesis

$$B(L) = 0,$$

that is,

$$b_1 = b_2 = b_3 = \ldots = b_p = 0.$$

If this hypothesis is rejected, then money forecasts economic activity.

A tougher version of the Granger test adds additional variables, such as prices and interest rates, to the regression. These other variables also contain information about future output. In this case, the regression is

$$y_t = c + A(L)y_{t-1} + B(L)m_{t-1} + C(L)x_{t-1} + e_t$$

where x_t is a vector of additional variables and C(L) is a matrix polynomial in the lag operator. If the F-test rejects the hypothesis B(L)=0, money forecasts economic activity even after the history of the variables in x_t is taken into account. If, on the other hand, these other variables contain all the information that is contained in money, the coefficients on money will no longer be statistically significant.

ENDNOTES

[1] Higgins argues that M2 may no longer be the preeminent information variable for monetary policy. This article addresses only whether M2 is a useful information variable, not whether it is the best or preeminent indicator. In addition, even if money is a useful information variable—that is, money does forecast economic activity—money need not be a useful intermediate target for monetary policy. Recent shifts in money velocity, for example, make it difficult for policymakers to target money accurately (Greenspan). Moreover, money could in principle be useful in monetary policy implementation even if it were not a statistically reliable information variable for real economic activity. Real activity is generally considered to be only one of the goal variables of the Federal Reserve's monetary policy. Controlling inflation—and eventually achieving price stability—has been emphasized by the FOMC as the primary objective of monetary policy.

[2] The interest rate effect is not the only channel connecting money and real output: the wealth effect and the credit effect also link money and output. The wealth effect arises because prices do not adjust immediately to changes in the money stock. As a result, a change in the money stock represents a temporary change in real wealth. Households and firms respond to this change in wealth by changing consumption and investment which, in turn, changes output. The wealth effect is not discussed in this article because there is little reason to believe it is responsible for the alleged breakdown in the ability of money to forecast output.

The credit effect arises because bank loans are the primary source of credit for many firms (Morgan). In the credit effect, money stock increases are associated with increases in bank deposits. The increase in deposits stimulates bank lending, which boosts spending by firms. The likely changes in the credit effect are not discussed because they would complicate the exposition without changing the conclusions.

[3] Graphically, when, say, the money supply curve shifts out, the new intersection of supply and demand "slides down" the demand curve. Thus, the location of the new intersection—which determines the fall in the interest rate—depends on the slope (interest elasticity) of the demand curve.

For readability, this article frequently refers to the elasticity of money demand or supply without specifying whether the interest or income elasticity is intended. It is always the interest elasticity.

[4] This simple description abstracts from a host of real world complications. In practice, the Federal Reserve can only target a short-run interest rate, such as the federal funds rate. In addition, the Fed does not have perfect control over broad measures of the money stock, such as M2. Instead, the Fed controls bank reserves to influence the quantity of money. For a more detailed description of Federal Reserve operating procedures, see Meulendyke.

[5] Many other important financial market developments occurred in the 1980s. For example, the monetary aggregates were redefined, new securities were developed in response to higher interest rate volatility, and the savings and loan industry suffered enormous losses. While such developments may have had some influence on the money-output relationship, they would have affected the relationship primarily through other channels.

[6] Changes in the money-output relationship can be caused by changes either in the money-interest rate relationship or in the interest rate-output relationship. Kahn finds a slight change in the interest rate-output relationship. Thus, this article focuses on changes in the money-interest rate relationship.

[7] For reasons that will be made clear in the discussion of new empirical evidence, this article focuses on M2 as the measure of money.

[8] Cook examines the behavior of the federal funds rate from October 1979 through October 1982, when the Fed gave greater emphasis to managing the growth of bank reserves, and finds that the Fed did not completely abandon its interest rate goals. In addition, the Fed does not control broad measures of money, such as M2. For both these reasons, the money supply curve in this period was somewhat, but not perfectly, inelastic.

[9] The Granger test overcomes some of the problems of analyzing only a simple correlation between money and future output. Changes in economic activity are persistent and many economic quantities rise and fall together. Thus, a simple correlation between money growth today and output growth in, say, six months might simply reflect that money and output move together and that periods of unusually slow or fast output growth tend to last longer than six months. In practice, money is useful for forecasting economic activity only if it is correlated with future output after the recent history of output growth is taken into account.

[10] In this study, Sims (1972) ran Granger tests for the ability of both M1 and the monetary base to forecast nominal GNP using quarterly data covering the 1947-69 period.

[11] Sims (1980) calculates the Granger test from a vector autoregression for M1, industrial production, the wholesale price index, and the 4-6 month commercial paper rate using monthly data covering the 1947-78 period.

[12] Blanchard surveys a number of these studies.

[13] Christiano and Ljungqvist analyze monthly M1 and industrial production for the period covering February 1948 through December 1985. Stock and Watson analyze monthly M1, industrial production, the wholesale price index, and the 3-month Treasury bill rate for the period covering January 1959 through December 1985.

[14] Consistent measurements of the monetary aggregates are not available before 1959. The Friedman-Kuttner samples begin in the second quarter of 1960 because their regressions use the growth rate of money, rather than its level, and four lags of each of the explanatory variables. The final observation in their study is the fourth quarter of 1990. The precise samples used by Friedman and Kuttner, then, are 1960:Q2-1990:Q4 (entire sample), 1960:Q2-1979:Q3 (early sample, excluding the 1980s), and 1970:Q3-1990:Q4 (late sample).

[15] Friedman and Kuttner analyze the ability of the monetary base, M1, and M2 to forecast economic activity. Only the results for M2 are presented here, because the new research presented in the next section found a significant relationship between money and future output only for M2. For the simple specification (money, prices, and output), Friedman and Kuttner found the strongest association between M2 and future economic activity. For the extended specification described in the next paragraph, M1 had a stronger association with future output than the other aggregates.

[16] If money has significant predictive power before the 1980s and little or no predictive power from 1980 on, Granger tests will be less significant the greater is the share of 1980s data in the sample. This consideration may explain why money is highly significant in Granger tests covering the entire postwar period, which include a relatively large amount of pre-1980s data, and insignificant in Granger tests covering only the 1970s and 1980s.

[17] Regressions were also run using the monetary base and M1 as measures of money. Only M2 was found to forecast economic activity.

[18] Many previous studies used measures of output and inflation based on gross national product (GNP). GDP-based measures are used here because GDP is now the Commerce Department's preferred measure of aggregate output. Using the growth rates of GNP and the GNP deflator instead of GDP and the GDP deflator does not affect any of the Granger tests reported in the text.

[19] The regressions were also run with the change in the federal funds rate and the change in the 6-month Treasury bill rate. Using these other interest rates did not change any of the results from the Granger tests reported in the text.

[20] First differences of the data were used when necessary to achieve stationarity. Growth rates of the variables were constructed using first differences of the logs. Augmented Dickey-Fuller and Phillips-Perron tests both showed that the level of the 3-month Treasury bill rate and the log levels of real GDP, the GDP deflator, and M2 have unit roots. The null hypothesis of a unit root for the first differences of each of these variables and for the level of the quality spread was easily rejected.

[21] To determine the optimal lag length, regressions with one to eight lags of the explanatory variables were estimated for the same sample period. The Akaike Information Criterion and Amemiya's Prediction Criterion selected five as the optimal number of lags. In addition, the coefficients on the last lags of the explanatory variables were jointly significant in the regression with five lags. The coefficients on the last lags were insignificant in the regressions with more than five lags.

[22] These two subperiods are similar to those used by Friedman and Kuttner. Friedman and Kuttner's early subperiod started one quarter earlier than the one used here because their regression used four lags instead of five. Their late sample covered the third quarter of 1970 through the fourth quarter of 1990.

[23] To show this point formally, write the Granger test regression as

$$y = Xb + e,$$

where y is a vector of T observations on real growth, X is a T by K matrix of obsevations on all the explanatory variables (including lagged values of real growth), b is a vector of coefficients, and e is a vector of random disturbances. Let Q be a p x K matrix of zeroes and ones, a selection matrix that extracts the coefficients on money from b. In other words, Qb is the p x 1 vector of coefficients on the lags of money growth. The F-statistic for the Granger test is

$$(b'Q'[Q(X'X)^{-1}Q']^{-1}Qb/p) / (e'e/(T-K))$$

where b and e are replaced by their ordinary least squares estimates. The numerator of this statistic measures the strength of the money-output relationship; large (absolute) values of Qb increase the numerator and indicate a strong relationship. The denominator of this statistic measures the uncertainty about the relationship, that is, the standard error of the regression. A large standard error increases the denominator and indicates substantial uncertainty.

[24] Technically, it is the *apparent* uncertainty about the money-output relationship that increases when a single regression is fit to the combined data. The standard error of the regression may be the same within each period. But, incorrectly holding the regression coefficients constant across changes in the Federal Reserve's operating procedure magnifies the estimated error variance.

[25] Some people might argue that the relationship between money and output should have become stronger while the Federal Reserve was targeting nonborrowed reserves. Nonetheless, constraining the regression coefficients to remain constant across changes in Federal Reserve operating procedures could well produce an insignificant Granger test. In other words, money might appear to provide no additional information about future output because data from periods with very different money-output relationships were incorrectly pooled.

[26] An alternative way to determine whether M2 forecasts

economic activity after the early 1980s would be to estimate the Granger test regression only for the period after the reserve operating procedure was abandoned. Unfortunately, this period is too short—there are only 38 observations since the fourth quarter of 1982 and the model has 31 right-hand-side variables.

[27] Let After82 be a dummy variable that is 0 from the beginning of the sample through 1982 and 1 afterwards. The first Chow test is performed by estimating

$$Y_t = c + c^* After82 + A(L)y_{t-1} + B(L)m_{t-1} + B^*(L)(After82\, m_{t-1}) + c(L)x_{t-1} + e_t$$

and computing the F-test of the null hypothesis

$$c^* = B^*(L) = 0.$$

(See the appendix for an explanation of this notation.) The second Chow test estimates

$$y_t = c + c^* After82 + A(L)y_{t-1} + A^*(L)(After82\, y_{t-1}) + B(L)m_{t-1} + B^*(L)(After82\, m_{t-1}) + C(L)x_{t-1} + C^*(L)(After82\, x_{t-1}) + e_t$$

and tests the hypothesis

$$c^* = A^*(L) = B^*(L) = C^*(L) = 0.$$

For both tests, the reserve-operating-procedure period (1979:Q4 through 1982:Q4) is excluded.

In the tests that allowed all coefficients to change, the change in the coefficients on money were not significantly different from zero—the marginal significance level of money for the whole sample was 13 percent, while the marginal significance level of money for the late sample was 25 percent.

[28] The predicted values of the Granger test regressions are forecasts of real growth one quarter in the future. The forecasts displayed in Chart 2 are the within-sample predicted values from regressions estimated over the entire sample.

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Agriculture in the Former Soviet Union: The Long Road Ahead

By Alan Barkema, Mark Drabenstott, and Karl Skold

The authors spent two weeks traveling in Russia and Ukraine in August 1992 as participants in a program sponsored by Iowa State University and the Iowa International Development Foundation. The aim of the program is to explain market economics to farm and food executives in the former Soviet Union while encouraging agribusiness ties between the United States and the former republics of the Soviet Union. The authors presented seminars at two newly established Agribusiness Centers at Stavropol, Russia and Kakhovka, Ukraine and took extensive tours of farms and food plants in both regions. The authors also met with key farm officials in Moscow.

The world watches with wonder at the momentous transformation now taking place in the former Soviet Union. Amid the manifold uncertainties surrounding the economic transition under way, many regard the establishment of a market-based food system to be prerequisite to success elsewhere in the economy. Indeed, ubiquitous food lines had stood out as a clarion metaphor of the failure of the command economy. The food lines are mostly gone now—replaced as a rationing agent by higher prices. But what are the prospects for building a market-based food system after more than 70 years of a failed command food system?

This article, after briefly describing the current economic situation, reviews the problems facing the farm and food sector in the former Soviet Union, and then outlines the building blocks for moving to a market-based food system.[1] The article concludes that critical legislative reforms for agriculture could come quickly, but building necessary market institutions, enhancing entrepreneurial skills, and upgrading technology will require years, even decades. Though the road may be long, the United States will have an unparalleled opportunity to market its world-class food technology in this part of the world.

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THE ECONOMIC BACKDROP

The reform of agriculture will take place against an extraordinarily difficult general economic backdrop. Real output is falling, the ruble is declining as inflation soars, and living standards are sinking as real incomes drop and wealth evaporates.

The economic conditions one finds in the former Soviet Union are sobering, to say the least. Through the first half of this year, industrial

output was 13.5 percent less than a year ago. The downward spiral in the economy is being driven by military cutbacks, falling consumer incomes, and halting trade among former republics. While in Moscow, we learned of a modern, 7,000 worker textile plant that was closing because cotton could no longer be obtained from Uzbekistan.

The declining ruble has encouraged barter while wiping out savings. During our two-week stay, the ruble fell from 160 to the dollar to 175. More recently, it has fallen to nearly 400. To avoid the sting of devaluation, businesses and consumers resort to barter. One Ukrainian farm we visited was bartering fruit for Siberian oil. Consumers convert ruble paychecks quickly into hard goods; one young entrepreneur who was making money as a grain broker had filled her home with such hard goods as Japanese VCRs and television sets.

The falling ruble has also wiped out the life savings of many older citizens. A leading professor at an agricultural institute now tends a huge garden and a clutch of chickens to supplement his income. Prospects for his approaching retirement are bleak.

At the personal level, the hardship of life in the former Soviet Union is striking wherever one goes. In Russia, the average annual income at the time of our visit was about 30,000 rubles, or less than $200 at the exchange rates that existed then. Consumer goods are limited and quality is poor. Many goods that American consumers take for granted are priced beyond the reach of average citizens. For example, automobiles cost at least ten years' income. Housing is cramped by American standards—the average family lives in an apartment with 300 to 400 square feet.

Basic foodstuffs were plentiful, but sharp increases in food prices the past year and a half require average consumers to spend a big portion of their income on food. One government official in Moscow offered a casual estimate that on average Russians spend about a third of their income on food, although the fraction varies widely. But others, including the U.S. Department of Agriculture, suggest the average could be as high as 60 percent. Yet despite spending so much, consumers receive poor quality and limited selection. Processed foods and luxury items like fruit juice are in scarce supply. Frozen foods are nonexistent. There is no escaping the fact, therefore, that an overhaul of the food system is long overdue.

CURRENT STATUS OF THE FORMER SOVIET FOOD SYSTEM

We discovered problems throughout the food system in Russia and Ukraine, but in-depth discussions with farm and food managers suggest that the biggest problems lie in food processing and distribution.

Farm production, in many ways, resembles U.S. agriculture. We were impressed by the sheer scale of production agriculture. State and collective farms in the regions we visited generally had 10,000 to 15,000 hectares (25,000 to 37,000 acres). A gridwork of big fields separated by neatly tended windbreaks stretched as far as the eye could see. Each farm was the hub of a village of workers that might number a few thousand. Indeed, the state and collective farms serve as the social fabric in rural areas; they organize schools and medical services, for example. The farms were organized around brigades of workers that might tend a quarter of the farm's land and machinery. Machinery lagged somewhat behind the U.S. technology standard, but the equipment was large and well-matched to the scale of production. Most equipment was stored outdoors and appeared poorly maintained.

Agricultural productivity is mixed when measured against U.S. standards. Crop yields are good. In the Russian region we visited, winter wheat yields were comparable to U.S. yields. Yields from irrigated fruit production in Ukraine compared favorably with arid regions in the United States. But livestock productivity is low compared with the United States. Russian and Ukrainian farms

raise "dual-purpose" cattle—cattle intended for both dairy and beef purposes. The result is poor dairy cows and poor beef cattle. Measured by livestock output per unit of feed input, farms in the former Soviet Union underperform their U.S. counterparts by half.

Moving to private land ownership will lead to more farm output, but the gains may be marginal. Crop yields are high and farms in the former Soviet Union are only slightly behind in cultivation practices. The efficiency of livestock production can be enhanced, but the livestock sector will probably get much smaller as falling incomes and rising prices force consumers to cut back on meat purchases.

Bigger gains in efficiency lie in the food processing segment of the food system, a segment that might best be described as a chaotic black hole. Farm products are converted into food products with little or no guidance from market prices. Consumer demand does not figure into food production decisions. And no one knows how food products are distributed once they leave the plant.

We toured plants making vodka, candy, bread, pasta, dairy products, meat, and canned fruit. The plants are big, but their technology is outdated. Most food products were quite basic, without the added processing most U.S. consumers now expect. Moreover, lacking any federal food safety and inspection laws, hygiene was generally determined by the local manager. In some plants, standards for quality and sanitation were low, and we were reluctant to sample the products that the plant managers graciously offered at the conclusion of our tours.

The biggest problem in food processing and distribution is the utter lack of market-based decisions. Production decisions are made without regard to production costs or product prices. Even though food prices have risen dramatically, production has not changed because the decisions still rest with the government. There is simply no competition in food processing and distribution, which remains a state monopoly.

In short, food processing and distribution in the former Soviet Union are ruled by an engineering rather than an economic mentality. Farm products enter the system, and food products go out. But what products to produce in what quantities for which markets are questions that are never answered in the marketplace. Moving to competitive food processors, a wholesale market that sends accurate price signals, and a rational distribution system amounts to a tall order in the former Soviet Union.

BUILDING BLOCKS FOR A NEW FOOD MARKET

What building blocks are needed to construct a market food system in the former Soviet Union? Our observations suggest four blocks are critical to the building effort. And as with any building job, putting the blocks in place in the proper order is as important as choosing the proper blocks. The first step is to put in place a set of market-based reforms. The second step is to build the institutional framework to support a growing market system. The third step is to provide economic education so the population learns how to use and manage the new market tools and institutions. The fourth step is to replace outmoded technology used in the old food system with up-to-date technology appropriate for a new market system.

Some of the building blocks can be set in place quickly, virtually with the stroke of a pen. But the building effort as a whole will require much more time, probably measured in decades rather than years.

Market-based reforms

The foundation building block of a new farm and food system in the former Soviet Union links two closely related market-based reforms: 1) a balanced macroeconomic policy and 2) a system of market-determined prices to replace the old

command economy. Little progress in establishing a new market-based food system is likely until balance is achieved in macroeconomic policy. While some progress has been made in controlling government budget deficits, huge subsidies to inefficient state enterprises continue to flood the economy with freshly printed rubles. The result is soaring inflation which erodes the value of the ruble and undermines efforts to establish a meaningful system of market prices.

A system of market-determined prices is the second reform essential to rebuilding the food system in the former Soviet Union. Under the old command economy, the dictates of government officials determined what would be produced. In a market economy, on the other hand, prices guide both consumption and production decisions, matching food supply and demand.

A successful market price system requires two key elements. First, producers must be independent. Then they can increase or decrease production when prices signal a change in consumer needs. Second, producers must be financially accountable for their production decisions. In other words, they must be appropriately rewarded for responding to price signals or justifiably penalized for ignoring them. Both requirements are met in a private enterprise system where prospective profits or losses encourage the right responses to price signals.

In contrast, production in the government-controlled food processing plants we visited droned on, oblivious to shifting food prices and profit margins. The bright young manager of a bread factory expressed surprise when we asked about the profitability of his plant. He replied that bread is a staple and therefore must carry a low price, irrespective of how much it costs to produce.

To implement a market price system, then, the former Soviet Union must take the farm and food system out of government control and put it into the hands of private owners. The huge stock of government-owned assets in the former Soviet Union makes privatization of the food system a mind-boggling but essential task.

Institutional framework

As the market food system evolves, a whole new framework of laws, regulations, and institutions will have to be built from the farm gate to the retail shelf.

A critical, immediate need is private ownership of farmland. Today, a private farmer can gain lifetime use of land and pass the right on to heirs—but the farmer's ownership interest is restricted. Farmland in private use cannot be mortgaged, and rental and sale of the land are prohibited during the first ten years of use. The moratorium on farmland sales prevents the use of farmland as collateral to secure credit, hamstringing the privatization process.

To improve the availability of credit for private farmers, it is vital to provide more rights to land owners. With that goal in mind, the Peasant Farmers Union (AKKOR), which represents more than a 100,000 private farmers, and the Agrarian Institute, a Moscow thinktank, are lobbying for new land ownership rules in the Russian parliament. They propose that the moratorium on land sales be shortened to five years, and to three years for farmers who purchased or inherited land. By freeing farmland for use as collateral, these changes might open the door to establishing an effective system for providing rural credit.

Currently the former Soviet Union has no rural credit system. The state remains the main source of credit. Private farmers can borrow from the state, but most money flows through state and collective farms. The Russian government did provide a 1-billion-ruble subsidy in 1991 that was used to guarantee loans to private farmers. And models for a private rural credit system are under discussion, but action appears months or years away.

A market food system will also require a whole new set of market intermediaries linking producers with consumers. Under the old command system, the government monopoly bought and processed raw farm commodities and sold

them to consumers. But now the old command structure must be replaced with a new set of market institutions—including commodity buyers, processors, wholesale distributors, and food retailers.

Some of these market institutions are already springing up. Nearly 700 commodity exchanges are starting up across Russia, partially filling the marketing void left by the demise of the old command system. Many of the exchanges are little more than "flea markets" that will probably evolve into private trading companies. Others are large, highly sophisticated, computerized markets. Foremost among these is the Moscow Commodities and Raw Materials Exchange, where nearly 2,000 registered brokers trade everything from corn to VCRs in a converted post office.

While the new commodities exchanges are an important market link between producers and consumers, they serve a relatively small slice of the food system. Moreover, an antiquated telecommunications system limits the access of most rural residents to the new markets. In rural areas, most marketing operations are primitive. One of our translators, for instance, owned a small food and general merchandise store in Stavropol. He also owned three small trucks that roamed as far as Moscow and St. Petersburg (a round trip of more than 2,000 miles) to scavenge goods to stock his store's shelves. The selection, quantity, and quality of goods available for sale varied widely. While our translator's store appeared successful, his crude merchandise supply network is both a tribute to his entrepreneurial flair and a striking example of the need for new, more efficient marketing institutions.

Economic education

Market-based reforms and supporting institutions are not likely to be successful if no one knows how they should work. More than 70 long years of central planning have virtually wiped out any knowledge of how a market economy and its institutions function.

Time and again in our travels we came face to face with the need for economic education. Many of those who prospered under the old system resist economic reforms today. Some fear a loss of their personal standing. But we also discovered that many remain unconvinced that any significant change in the old system is needed. Instead, the prevailing view is that the failure is not the economic system but outmoded technology. Key officials of the agricultural research establishment recounted for us the critical need for updating production techniques on Russian farms. But they fell silent when we asked about price reform and private ownership of farmland.

Similarly, during our tours of food processing plants, plant managers described in detail production capacities and the strengths and weaknesses of plant equipment. But none could answer our questions on production costs and product pricing. In some cases, when we pressed plant managers about how they made production and pricing decisions, their answers were cut off by local political authorities, who turned out to be former Communist party officials.

Uncertainty over the perils of a market economy is clear among rural residents. Many have a deep, abiding skepticism toward promises from government officials. The rural population has heard for decades pronouncements of initiatives and decrees to improve rural life. But too often the policies implemented locally only benefited the bureaucracy.

Still, many fear the loss of the government refuge. A frequent line of questioning during our seminars was, "What happens if a farmer in the United States cannot repay a bank loan? Do farmers really go bankrupt in the United States? How many people are unemployed in the United States, and how do they live?" One manager of a large collective farm suggested, "I would support a market system in which 70 percent of my crop is sold to the government at a guaranteed price and the other 30 percent is sold at market prices. Otherwise the risks of farming are too great."

Although the majority of the participants in

our seminars viewed a market economy with a mixture of confusion and apprehension, a few wholeheartedly embraced the fledgling market reforms already underway. One group of new private farmers displayed a refreshing entrepreneurial zeal during our visit to their farm near Stavropol. These farmers had formed a partnership after breaking away from a large collective farm. They assured us that their modest farm of about 400 acres of wheat was only a beginning. But the collective farm from which they rented their land and purchased their production inputs was doing whatever it could to discourage them. These new private farmers certainly have a hard road ahead of them, but if they fail it will not be for a lack of determination.

Technology

As we observed the food system in Russia and Ukraine we found that the most critical need for new technology is in the food processing and distribution system rather than on the collective and state farms. To be sure, U.S. farm machinery, genetics, and crop and livestock production practices are generally years ahead of those we saw in Russia and Ukraine. But farm production is not the limiting factor in their food system.

The bottleneck in the system is the processing and distribution channel, which receives raw farm commodities from the farm gate and delivers finished food products to consumers. Much of the food processing equipment we saw is three decades or more out-of-date and also poorly maintained. In addition, most food plants are built on the huge scale favored by government planners in the old system. The large scale of the old plants limits their flexibility to adapt to a new market system where consumer needs—rather than government quotas—are the target. Many of the old plants will be too inefficient to use in the new market economy, creating a need for new, modern plants to take their place.

The need for new technology is enormous, but it is also clear that technology is the fourth building block—not the first—required to build a market food system in that part of the world. The most modern farm and food technology acquired on the most favorable credit terms will not solve the food distribution problems in the former Soviet Union unless the fundamental problems in the economic system are resolved first. The new technology must be built upon a solid foundation of sweeping market reforms, well-functioning market institutions, and a population trained in the workings of a market economy.

WHAT LIES AHEAD?

Today, the food system in the former Soviet Union is trapped in transition between a decaying command structure and a new market system. The old production and distribution system has broken down, but the new system is not yet ready to take its place. As a result, demand for imported food from the United States and elsewhere remains large. But that demand is being sustained only through generous credit allocations.

Looking ahead, the outlook for U.S. grain sales to the former Soviet Union appears bleak. In the next few years, demand for imported grain will drop due to a major prospective adjustment in the livestock industry. Consumers in the former Soviet Union consume first-world quantities of meat on third-world incomes. That cannot continue. Falling meat demand could quickly shrink the need for U.S. grain as livestock production plummets. Longer term, building a market food system will take years, but once built it will mobilize the huge productive capacity of former Soviet agriculture, curtailing the need for U.S. grain.

Building the food system, however, will require an enormous infusion of modern farm and food technology, thus opening a huge new market for U.S. suppliers. The market for farm and food technology in the former Soviet Union is clearly a long-term bet. The long process of political and economic reform has only begun, and the market

institutions that would support the wholesale infusion of new technology are not yet in place. But once the economic foundation is laid, the market may be enormous for U.S. suppliers who carefully and patiently cultivate long-term business relationships in the former Soviet Union.

The former Soviet Union is embarking on a historic economic journey. After more than 70 years of a failed command economy, the food system is in tatters. Faced with poor quality, high-priced food, the people of the former Soviet Union must solve their food problem to ensure broader economic success. Thus far, however, they have taken just a few tentative steps down the long road to a market food system.

ENDNOTE

[1]This article is based on the authors' observations in Russia and Ukraine, the two major food producers among the 15 former republics of the Soviet Union. Russia and Ukraine hold about three-fourths of the arable land and account for about three-fourths of the grain, meat, and milk production of the former Soviet Union.

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