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The Instruments of Monetary Policy

By Gordon H. Sellon, Jr.

The implementation of monetary policy by the Federal Reserve System has traditionally involved the use of three main policy instruments: open market operations, the discount rate, and reserve requirements. For many years, the use of open market operations has been the principal instrument of monetary policy. While the discount rate and reserve requirements may or may not be changed in a given year, open market operations have generally been carried out on a daily or weekly basis. As a result of the relatively infrequent use of discount rate and reserve requirement changes, discussions of monetary policy frequently understate their importance. Indeed, it has been fashionable to question whether the Federal Reserve really needs all three policy instruments.[1]

This article argues that the viewpoint claiming all three policy instruments are unnecessary is seriously out of date. The increased emphasis of the Federal Reserve on the control of inflation and the growth of money and credit has led to important changes in policy procedures and institutional arrangements that have both altered and enhanced the use of the discount rate and reserve requirements as policy instruments. A key development is the shift in Federal Reserve policy procedures from interest rate targeting to money and reserve targeting. Most analyses of this change have focused on its broad implications for such issues as monetary control and interest rate volatility. A point that is often overlooked, however, is that this change in policy procedures directly expands the role of the discount rate and reserve requirements as policy instruments. In addition, money and reserve targeting provides a framework in which legislative changes, such as the Monetary Control Act of 1980, and regulatory actions, such as the adoption of contempora-

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[1] Examples of this view can be found in Thomas Mayer, James Duesenberry, and Robert Aliber, *Money, Banking, and the Economy*, W. W. Norton, New York, 1981, pp. 500-19, and Warren L. Smith, "The Instruments of General Monetary Control," in Ronald L. Teigen, ed., *Readings in Money, National Income, and Stabilization Policy*, 4th ed., R. D. Irwin, Homewood, Ill., 1978, pp. 190-212

neous reserve accounting, further enhance the scope for discount policy and reserve requirements in the monetary policy process.

In light of these developments, this article reexamines the role of the discount rate and reserve requirements. The first section provides background information on the three instruments and an overview of their role in the policy process. The next three sections present a detailed discussion of important legislative, regulatory, and policy developments that have changed the role of discount rate policy and reserve requirements. The final section reexamines the usefulness of the discount rate and reserve requirements as policy instruments.

An overview of the policy instruments

Decisionmaking

Authority to change the three main instruments of monetary policy is divided between the Board of Governors and the regional Federal Reserve banks. Decisions on open market operations are made by the Federal Open Market Committee (FOMC), which consists of the seven members of the Board of Governors plus five of the 12 reserve bank presidents. Meeting eight times a year, the FOMC makes general decisions on the course of monetary policy and transmits these decisions in the form of a directive to the manager of the System Open Market Account at the Federal Reserve Bank of New York. The account manager, in consultation with the Board staff and a reserve bank president, makes day-to-day decisions on open market operations consistent with the FOMC directive.[2]

In contrast to open market operations, authority to change the discount rate and reserve requirements does not rest with the FOMC. In the case of reserve requirements, the Board of Governors has authority to implement regulatory changes in the level or structure of reserve requirements within legislative guidelines determined by Congress. Discount rate policy is somewhat more complicated. While the Board of Governors establishes regulations pertaining to the administration of the discount window at the regional banks, discount rate changes are initiated by the regional reserve banks. Thus, the boards of directors of the regional banks are required to meet at least every two weeks to recommend a discount rate. These recommendations are then transmitted to the Board of Governors, which has final authority to approve discount rate changes.[3]

Impact of the policy instruments

The three policy instruments do not affect economic activity directly but rather work through their effects on financial markets. Thus, the policy instruments have their initial impact on the demand for and supply of reserves held by depository institutions. Changes in reserves then influence market interest rates and the amount of money and credit created by financial institutions.

Reserve requirements provide the foundation of the policy process. Depository institutions are required by law to maintain a percentage of the value of transactions accounts and certain other deposit and nondeposit liabilities in the form of reserves. These reserves can be held either as vault cash or as deposits

[2] A detailed discussion of FOMC decisionmaking and the role of open market operations is presented in Paul Meek, *U.S. Monetary Policy and Financial Markets*, Federal Reserve Bank of New York, 1982.

[3] The best source of information on monetary policy decisions is the *Federal Reserve Bulletin*, published monthly by the Board of Governors. Policy actions in a given year are conveniently summarized in the *Annual Report* of the Board of Governors.

at Federal Reserve banks. Because credit creation by financial institutions is based on an expansion of deposit liabilities and deposit liabilities are backed by reserves, the power to set reserve requirements gives the Federal Reserve important leverage over deposit and credit creation.

While the existing level of reserve requirements serves as a constraint on deposit and credit creation, the Federal Reserve can also undertake discretionary changes in the level or structure of reserve requirements to tighten or ease credit restraint. Thus, to slow the growth of money and credit, the Federal Reserve might undertake a general increase in reserve requirements on all deposit liabilities. Alternatively, reserve requirement changes can be used more selectively to influence the growth of specific types of liabilities.

The Federal Reserve can also change the supply of reserves available to financial institutions in meeting their reserve requirements. Through the purchase or sale of government securities in the open market, the Federal Reserve can directly increase or decrease the supply of reserves. Depository institutions can obtain an additional supply of reserves by borrowing from the Federal Reserve through the discount window. By regulating access to the discount window and the discount rate charged on this borrowing, the Federal Reserve controls this secondary source of reserves.

The interaction between reserve demand and supply has an important impact on market interest rates and the growth of money and credit. To the extent that the amount of reserves supplied by the Federal Reserve is greater or less than the amount demanded by financial institutions, there is greater or lesser pressure on short-term market interest rates. Changes in interest rates, in turn, provide incentives for the public to alter its demand for money and credit. Thus, through the use of open market operations, discount rate policy, and reserve requirements, the Federal Reserve can influence interest rates, money, and credit.

Targets and instruments of monetary policy

The roles that open market operations, the discount rate, and reserve requirements play in the policy process depend on the ultimate objectives of policy as well as on the procedures used to achieve these objectives. In recent years the Federal Reserve has put increased emphasis on the goal of long-run price stability. As a means to this end, the Federal Reserve has focused on the short-run control of money growth as measured by the growth of narrow transactions-based aggregates such as M1 and by the broader aggregates, M2 and M3.

Control of monetary growth through the use of the three policy instruments can be approached in two distinct ways. First, the policy instruments can be used in a discretionary fashion. That is, the Federal Reserve can change open market operations, the discount rate, and reserve requirements in response to excessively strong or weak money growth. For example, in an expanding economy the Federal Reserve may want to tighten policy in order to reduce money growth. A more restrictive policy can be implemented by discretionary changes in one or more of the three policy instruments. Thus, the Federal Reserve can sell securities in the open market to reduce the supply of bank reserves directly, raise the discount rate to curb banks' incentive to borrow reserves at the discount window, or raise reserve requirements to increase banks' demand for reserves and reduce potential credit expansion. All three actions tend to raise market interest rates and reduce money growth.

Second, instead of responding to excessive money growth by discretionary actions, the Federal Reserve can try to structure the system of reserve requirements and the discount mechanism so as to reduce the likelihood of excessive money growth. In particular, the level of reserve requirements helps determine the responsiveness of market interest rates to changes in money demand and supply. A higher level of reserve requirements tends to improve automatic monetary control by magnifying the response of interest rates to changes in money demand. For example, a given increase in the public's demand for money raises interest rates by a larger amount, the higher the level of reserve requirements. This occurs because the higher level of reserve requirements constrains the amount of money that banks can supply. At the same time, the higher interest rate tends to have a feedback effect in reducing money demand. In this case, money volatility is reduced while interest rate volatility is increased by a higher level of reserve requirements.[4] Similarly, the structure of reserve requirements on different types of deposits and the terms of discount window borrowing may affect the volatility of money growth around its desired level. Thus, structural changes in the borrowing mechanism and reserve requirements that automatically tend to reduce the volatility of money growth may minimize the need to undertake discretionary policy actions.[5]

[4] In the case of a change in a factor affecting money supply directly, such as a shift in banks' desired holdings of excess or borrowed reserves, higher reserve requirements may reduce the volatility of both money and interest rates.

[5] The distinction between discretionary and automatic monetary control can be pictured in terms of a graph showing the determination of the interest rate and quantity of money by a downward sloping money demand curve and an upward sloping money supply curve. In this framework, discretionary policy actions shift the money supply curve while automatic policy actions change the slope of the money supply curve.

The following three sections examine some of the major legislative, regulatory, and operational decisions that have changed the role of discount policy and reserve requirements in the policy process. In each case, the focus is on whether the structural change strengthens or weakens the contribution of the policy instruments to discretionary and automatic monetary control. In reading the first two sections, which cover legislative and regulatory changes, it is important to recall that most of these changes occurred after the Federal Reserve adopted a reserve targeting procedure in October 1979.[6] Thus, the discussion in these two sections assumes that the Federal Reserve is using a reserve targeting procedure. This is a technical but quite important assumption that is discussed in more detail after presentation of the institutional material.

The Monetary Control Act of 1980

The most important legislative development affecting the role of the policy instruments in recent years is the Depository Institutions Deregulation and Monetary Control Act of 1980. This legislation extends Federal Reserve System reserve requirements and discount window access to all depository institutions. Before the act, only those institutions choosing membership in the Federal Reserve System were subject to Federal Reserve regulations on reserve requirements. In addition, nonmember institutions were not eligible to borrow at the discount windows except in unusual circumstances. Member banks found the requirement to hold noninterest bearing reserve balances increasingly burdensome in the high inflation, high interest rate environment of the 1970s. Consequently, a growing

[6] The exception is the Federal Reserve's use of reserve requirements on managed liabilities, which dates from the late 1960s.

number of institutions chose to relinquish their membership.[7] The loss of membership posed two problems for monetary policy. On the one hand, policymakers feared that monetary control would become increasingly complicated with a decreasing fraction of transactions deposits subject to reserve requirements. At the same time, the voluntary nature of membership severely curtailed discretionary increases in reserve requirements as a policy instrument since institutions could withdraw from the system to avoid the higher reserve requirements.

Passage of the Monetary Control Act effectively eliminated the erosion in the reserve requirement mechanism. At the same time, however, all institutions subject to reserve requirements were granted access to Federal Reserve services including the discount window. Since the policy implications of discount window access are potentially different from those of extended reserve requirements, it is useful to examine the two developments separately.

Extension of reserve requirements

Under the Monetary Control Act, all depository institutions' transactions accounts, nonpersonal time and savings deposits, and certain Eurocurrency transactions were made subject to Federal Reserve System reserve requirements.[8] Thus, reserve requirement coverage under the act is extended to nonmember banks, savings institutions, and credit unions. After a phase-in period, depository institutions are subject to a 3 percent reserve requirement on the first $28.9 million of net transactions accounts and a 12 percent reserve requirement on transactions accounts in excess of the base amount.[9] The Board of Governors is authorized to vary reserve requirements on transactions accounts in excess of the $28.9 million base in a range of 8 to 14 percent, with an additional supplemental requirement of 4 percent possible under special conditions.[10]

Reserve requirements on nontransactions liabilities were also modified. Reserve requirements against personal time and savings deposits were eliminated under the act. They were maintained on nonpersonal time deposits, however. Initially set at 3 percent, they can be varied in a range from 0 to 9 percent. The Board also has the authority to determine the maturity of nonpersonal time deposits that are subject to reserve requirements. Finally, the Board can set reserve requirements for certain Eurocurrency liabilities. These requirements are initially set at 3 percent, the same ratio as that for nonpersonal time and savings deposits. Table 1 provides a summary of the new system of reserve requirements and a comparison with the system in effect before the Monetary Control Act.

The new structure of reserve requirements

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[7] Nonmember institutions were subject to state reserve requirement regulations. Generally, these regulations were seen as less restrictive than Federal Reserve regulations.

[8] The Garn-St Germain Depository Institutions Act of 1982 modifies the 1980 Monetary Control Act by providing that $2 million of reservable liabilities of each depository institution be subject to a 0 percent reserve requirement This exemption amount is adjusted each year for the next calendar year by 80 percent of the percentage increase in total reservable liabilities of all depository institutions measured on an annual basis as of June 30. For more detail, see any issue of the *Federal Reserve Bulletin*, Table 1.15, footnote 5.

[9] For banks and thrift institutions that were not members of the Federal Reserve System on or after July 3, 1979, the phase-in period for the new reserve requirement structure ends September 3, 1987

The amount of transactions deposits against which the 3 percent reserve requirement applies is modified annually by 80 percent of the percentage increase in transactions accounts held by all depository institutions determined as of June 30 each year.

[10] For the conditions under which a supplemental reserve requirement may be imposed, see the *Annual Report*, Board of Governors, 1980, pp. 209-10.

TABLE 1
Reserve requirements of depository institutions
(Percent of deposits)

Type of deposit and deposit interval	Member bank requirements before implementation of the Monetary Control Act		Type of deposit and deposit interval	Depository institution requirements after implementation of the Monetary Control Act	
	Percent	Effective Date		Percent	Effective Date
Net demand			**Net transaction accounts**		
$0 million-$2 million	7	12/30/76	$0-$28.9 million	3	12/29/83
$2 million-$10 million	9½	12/30/76	Over $28.9 million	12	12/29/83
$10 million-$100 million	11¾	12/30/76			
$100 million-$400 million	12¾	12/30/76	**Nonpersonal time deposits**		
Over $400 million	16¼	12/30/76	By original maturity		
			Less than 1½ years	3	10/6/83
			1½ years or more	0	10/6/83
Time and savings					
Savings	3	3/16/67			
			Eurocurrency liabilities		
			All types	3	11/13/80
Time					
$0 million-$5 million, by maturity					
30-179 days	3	3/16/67			
180 days to 4 years	2½	1/8/76			
4 years or more	1	10/30/75			
Over $5 million, by maturity					
30-179 days	6	12/12/74			
180 days to 4 years	2½	1/8/76			
4 years or more	1	10/30/75			

Source: *Federal Reserve Bulletin*, January 1984, p. A7.

has a number of important implications for monetary policy. Generally speaking, the structure is designed to enhance the Federal Reserve's control over the narrowly defined aggregate, M1, consisting of currency, demand deposits, and other transactions accounts. Two features of the new system work to improve M1 control.[11]

The extension of reserve requirements to transactions accounts at all depository institutions contributes to automatic control of M1. The level of reserve requirements on transactions accounts determines the degree of interest rate pressure that occurs in response to stronger or weaker demands for transactions

[11] The discussion in this section is based on a more detailed treatment in J. A. Cacy and Scott Winningham, "Reserve Requirements Under the Depository Institutions Deregulation and Monetary Control Act of 1980," *Economic Review*, Federal Reserve Bank of Kansas City, September-October 1980, pp. 3-16.

balances. Before the Monetary Control Act, the effective reserve requirement on transactions deposits was declining over time as banks left the Federal Reserve System and as new types of transactions accounts with lower reserve requirements were introduced. This downward trend in the level of effective reserve requirements led to a progressive reduction in automatic control of M1. Thus, passage of the act stabilized the effective reserve requirement on transactions deposits and prevented further erosion in monetary control.[12]

The new structure of reserve requirements also improves automatic control of M1 by eliminating undesired variability in money growth due to investor shifts of funds among different types of transactions and nontransactions accounts. The new system improves monetary control in three ways.

First, shifts in transactions accounts between member and nonmember institutions no longer affect M1. Under the old system, a transfer of deposits from a member bank subject to reserve requirements to a nonmember institution would increase excess reserves in the banking system, permitting a multiple expansion of M1. Under the new system, since all transactions deposits have the same reserve requirement, regardless of institution, this type of shift does not affect excess reserves or M1.[13]

Second, in the new system of reserve requirements, all types of transactions accounts at a given institution will have the same reserve requirement. In contrast, under the old system, demand deposits had a higher reserve requirement than other transactions accounts. Thus, shifts between demand deposits and other transactions accounts will no longer affect excess reserves and potential M1 expansion.

Finally, shifts between transactions accounts included in M1 and personal time and savings deposits not included in M1 will have less impact on M1 under the new system. Under the new system, a shift from transactions deposits to personal savings deposits initially reduces M1. However, this effect is subsequently offset by a reduction in required reserves since personal savings deposits are not reservable. This reduction in required reserves permits institutions to carry out a secondary expansion of M1. Under the old system, where personal savings deposits were reservable, a similar transfer of funds released fewer required reserves. Thus, the secondary expansion of M1 would not offset as much of the initial reduction in M1.[14]

While the new structure of reserve requirements tends to enhance the Federal Reserve's ability to control M1, control over the broader aggregates such as M2 and M3 may be weakened. The reason is that reserve requirements on many of the components of the broader aggregates have either been reduced or eliminated. This means that increased demand for these deposits by the public tends to result in a relatively small increase in required reserves

[12] The overall impact on the level of reserve requirements for transactions balances is complicated since member institutions are generally subject to lower reserve requirements and nonmember institutions are subject to higher reserve requirements. The important point, however, is that without the act, reserve requirements on transactions accounts would have declined below the level established in the act.

[13] This result needs to be qualified. As noted above, the first $2 million of reservable liabilities of each depository institution is subject to a 0 percent reserve requirement, while net transactions accounts are subject to a 3 percent reserve requirement on the first $28.9 million, and 12 percent on amounts in excess of the base figure. Thus, shifts of funds between institutions of different sizes will continue to affect required and excess reserves.

[14] Other shifts may strengthen or weaken M1 control. For example, under the new system, shifts between assets such as Treasury bills and time deposits have a smaller impact on M1 because such shifts have a smaller effect on required reserves. On the other hand, deposit shifts between transactions accounts and nonpersonal time and savings deposits continue to affect M1.

and little upward pressure on market interest rates.[15]

In summary, reform of the reserve requirement system under the Monetary Control Act strengthens monetary control by improving the Federal Reserve's ability to control transactions deposits. At the same time, these reforms tend to reduce automatic control over the broader monetary aggregates. Still, the Federal Reserve retains some flexibility in setting reserve requirements on the components of the broader aggregates. As described in the next section, discretionary changes in reserve requirements on these components have been used more frequently as a policy instrument in recent years.

Extension of discount window privileges

The Monetary Control Act also requires changes in discount policy. Before 1980, borrowing from the Federal Reserve was generally limited to member banks. The act broadened discount window access to all depository institutions subject to reserve requirements.

Under current discount window regulations, borrowing is divided into two categories: adjustment credit and extended credit. Adjustment credit is designed to provide institutions a short-term cushion of funds to balance unexpected outflows from reserve accounts. In contrast, extended credit provides a longer term source of funds to institutions having strong seasonal patterns in loan demand or sustained liquidity pressures.

Broadened access to the discount window could have an adverse effect on the Federal Reserve's ability to control monetary growth. A problem could arise, for example, if newly eligible institutions tended to rely heavily on the discount window as a source of funds during a period in which the Federal Reserve was trying to restrain money and credit growth. In practice, however, two developments have minimized the problem.

First, nonmember institutions, such as savings institutions and credit unions, are expected to use special industry lenders, such as the Federal Home Loan banks and corporate central credit union facilities, before turning to the discount window. Indeed, since 1980, these institutions have undertaken relatively little borrowing under the adjustment credit program. Rather, their use of the discount window has generally been confined to borrowing under the extended credit program.

Second, borrowing that has occurred under the extended credit program has not been permitted to add to the total supply of reserves in the banking system. When borrowing occurs under the extended credit program, the Federal Reserve offsets this borrowing by subtracting an equal amount of reserves through open market operations. Thus, broadened access to the discount window under the Monetary Control Act has not had an adverse effect on monetary control.

Regulatory developments

In addition to legislative developments affecting the role of the policy instruments, the Federal Reserve has initiated a number of regulatory changes in recent years aimed at improving the monetary control process. Three of the most significant developments are the adoption of a contemporaneous reserve accounting system, the use of reserve requirements on managed liabilities as a discretionary

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[15] Control of the broader aggregates is also complicated by certain deposit shifts similar to those discussed for M1. Under the new system of reserve requirements, shifts between transactions deposits and nontransactions deposits will have a larger effect on the broader aggregates because of the lower reserve requirements on the nontransactions components. For a further discussion, see Cacy and Winningham.

policy instrument, and the use of a discount rate surcharge mechanism.

Contemporaneous reserve accounting

From September 1968 to January 1984, financial institutions operated under a system of lagged reserve requirements (LRR). Required reserves in a given week were calculated on the basis of deposit levels two weeks earlier. This system was designed to make it easier and less costly for institutions to meet required reserves and to simplify the conduct of daily open market operations by removing the uncertainty associated with forecasting contemporaneous deposit levels.

Critics of lagged reserve accounting argued that the system impaired short-run monetary control. Because of the two-week lag between deposits and required reserves, increases in deposit growth in a particular week would not lead to an immediate increase in required reserves and so would not exert upward pressure on interest rates. Without upward pressure on interest rates, banks would have little incentive to curtail loan and deposit growth. Thus, lagged reserve accounting was seen as impairing the automatic control features of the reserve requirement mechanism.

Under the new contemporaneous reserve requirements (CRR) effective in February 1984, depository institutions that report weekly to the Federal Reserve have to maintain required reserves behind transactions deposits on an essentially contemporaneous basis. That is, these institutions compute their required reserves behind transactions deposits on the basis of average daily deposits over a two-week period that begins on a Tuesday and ends on a Monday. Reserves must then be maintained over a two-week period beginning on Thursday, two days after the start of the computation period, and ending on Wednesday, two days after the end of the computation period.[16]

Contemporaneous reserve accounting is designed to improve monetary control by speeding up the adjustment process for reserves held behind transactions deposits. Unlike the two-week lag for LRR, under CRR, from the time that an institution knows its required reserves at the end of the computation period, it has only two days to adjust fully to its required reserves. The basic idea is that when faced with this shorter adjustment period, institutions will attempt to acquire reserves to support growth of transactions deposits on a more timely basis or, alternatively, will attempt to liquidate assets to reduce their required reserves. In this way, faster money growth will be translated into higher interest rates and reduced loan and credit growth on a more timely basis.

It is difficult to determine whether this change in accounting procedures will significantly improve short-run automatic monetary control. Much depends upon how institutions choose to make reserve adjustments. If they reduce required reserves by curtailing loan and deposit growth, CRR may improve monetary control. However, if institutions tend to make more frequent use of the discount window or make reserve adjustments through excess reserves or managed liabilities, CRR may not significantly improve monetary control.[17]

Reserve requirements on managed liabilities

Historically, discretionary changes in reserve requirements have been used much less frequently than either open market opera-

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[16] For a more detailed discussion of the mechanics of CRR, see R. Alton Gilbert and Michael E. Trebing, "The New System of Contemporaneous Reserve Requirements," *Review*, Federal Reserve Bank of St. Louis, December 1982, pp. 3-7.

tions or discount rate policy. At least three reasons have been advanced to explain the relatively infrequent use of reserve requirement changes. First, a given change in reserve requirements can be a rather blunt policy instrument. That is, an across-the-board increase in reserve requirements affects all institutions, large or small, whether or not they are contributing to a problem of excessive money and credit growth.[18] Second, frequent changes in reserve requirements make it difficult for banks to plan their asset and liability management decisions. Third, before passage of the Monetary Control Act the voluntary nature of Federal Reserve membership may have limited the use of reserve requirements as a policy instrument.

In recent years, the Federal Reserve has focused its discretionary changes in reserve requirements not on demand deposits or other transactions accounts but rather on certain managed liabilities such as large denomination CD's and Eurodollar borrowings. This regulatory development has increased the flexibility of reserve requirements as a discretionary policy instrument by allowing the Federal Reserve to target reserve requirement changes to larger institutions that make extensive use of managed liabilities to fund credit expansion.

The focused use of reserve requirements is a response by the Federal Reserve to the rapid development and creative use of managed liabilities by banks during the 1960s and 1970s. From the banks' standpoint, an attractive feature of managed liabilities is that they are generally subject to lower reserve requirements than demand deposits. Thus, if the banking system can bring about a shift in the composition of its liabilities from demand deposits to managed liabilities, it can effectively lower reserve requirements and thus extend more credit with the same supply of reserves.

While beneficial to banks, managed liabilities can pose problems for monetary policy. In a period in which the Federal Reserve is trying to restrain the growth of money and credit, extensive use of managed liabilities may permit banks to counter policy actions by expanding the amount of credit creation possible with a given amount of reserves. In addition, since increased use of managed liabilities may be associated with slower growth of demand deposits, such transactions measures of money as M1 may give a misleading impression of the tightness of monetary policy. Thus, growth in M1 may shrink at the same time that banks are expanding loans and credit.

Reserve requirements on managed liabilities affect the behavior of banks by changing the cost of these liabilities relative to other sources of funding loan expansion. By raising reserve requirements on a specific type of liability, for example, its use can be discouraged relative to other funding sources. At various times the Federal Reserve has used this instrument in three distinct ways: to control the overall level of managed liabilities, to change the composition of managed liabilities, and to change the average maturity of managed liabilities. Some examples may clarify these uses.

In October 1979, the Federal Reserve tried to reduce growth in the overall level of man-

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[17] A more complete treatment of this issue is found in David S. Jones, "Contemporaneous vs. Lagged Reserve Accounting: Implications for Monetary Control," *Economic Review*, Federal Reserve Bank of Kansas City, November 1981, pp. 3-19.

[18] The Federal Reserve attempted to reduce this problem in 1972 by adopting a system of graduated reserve requirements based on size of deposits. This system replaced a structure in which reserve requirements depended on geographic location. Under a graduated system, reserve requirement changes can be directed at particular deposit size categories and thus at different size institutions. The new system of reserve requirements described above is a graduated system but has a smaller number of deposit size graduations than the old system.

aged liabilities by imposing an 8 percent reserve requirement on the amount by which an institution's total managed liabilities exceeded a base period amount.[19] This action was designed to slow the expansion in bank credit financed through managed liabilities by increasing the cost of the additional use of these liabilities. Subsequently, in April 1980, this marginal reserve requirement was raised to 10 percent as part of the Credit Control Program before being reduced to 5 percent in June 1980 and 0 percent in July 1980 as credit growth slowed.

Discretionary changes in reserve requirements also have been used to affect the composition of managed liabilities. For example, in September 1969 the Federal Reserve imposed a 10 percent marginal reserve requirement on Eurodollar borrowings by U.S. banks. The reason for this action was that banks were apparently avoiding domestic credit restraint by developing overseas sources of funds. Thus, the marginal reserve requirement on foreign borrowing was designed to eliminate the cost advantage of foreign sources of funds. At other times, reserve requirements on Eurodollars have been adjusted to encourage their use. For example, in August 1978, the marginal reserve requirement on Eurodollars was lowered to encourage U.S. banks to borrow abroad and help support the foreign exchange value of the dollar.

Finally, reserve requirement changes have been used in an effort to change the maturity of particular types of managed liabilities. For example, in September 1974 and again in October 1975, the Federal Reserve established differential reserve requirements on large-denomination time deposits with different maturities. Lower reserve requirements were set on time deposits with longer maturities. The purpose of this action was to encourage banks to lengthen the maturity of their time deposits by lowering the relative cost of longer term sources of funds.

It is important to note that these examples of the use of reserve requirements on managed liabilities occurred before passage of the 1980 Monetary Control Act. Provisions of the act have reduced the flexibility of this use of reserve requirements somewhat. For example, the act continues to permit, under ordinary circumstances, differentiated reserve requirements by personal vs. nonpersonal time deposits, by maturity of nonpersonal time deposits, and by nonpersonal time deposits vs. Eurocurrency liabilities. However, reserve requirements on all managed liabilities as employed in October 1979 are no longer permissible. In addition, only in extraordinary circumstances as determined by five board members and after consultation with appropriate congressional committees may reserve requirements be differentiated by types of nonpersonal time deposits or may marginal reserve requirements be imposed on selected types or on all nonpersonal time deposits.

The use of reserve requirements on managed liabilities adds to the flexibility of reserve requirements as a discretionary policy instrument. As noted in the next section, this use of reserve requirements may play a potentially valuable role in control of the broader monetary aggregates.

The discount rate surcharge

As in the case of reserve requirements, it has traditionally been difficult to target discount policy to specific size institutions. To make discount policy more flexible, in March

[19] A marginal reserve requirement applies to increases in a deposit category above a base period amount. Changes in the marginal rate affect the cost of additions to the base period amount but do not force an institution to alter the base period amount.

1980 the Federal Reserve introduced a discount rate surcharge applying to large banks that made frequent use of the discount window. The purpose of the surcharge was to prevent large banks with access to the money markets from borrowing excessively while at the same time providing smaller banks with continued access to the discount window.

As initially structured, the discount rate surcharge applied to banks with deposits over $500 million that borrowed for two consecutive weeks or for more than four weeks in a calendar quarter. The initial surcharge rate was 3 percent. Thus, large banks subject to the surcharge would pay the basic discount rate plus a 3 percent surcharge. The surcharge was removed in May 1980 but was reintroduced in November 1980, and it remained in effect until November 1981. During this latter period, the surcharge rate changed from 2 to 4 percent.

A discount rate surcharge can improve monetary control in two ways. First, the surcharge can be varied independently of the basic discount rate. Thus, the flexibility of discretionary discount rate changes is enhanced to the extent that changes in the surcharge rate can be directed at larger institutions. Second, the surcharge mechanism can improve the automatic nature of the monetary control system. Depending on the relationship among the federal funds rate, the basic discount rate, and the surcharge rate, large banks may have a reduced incentive to use the discount window as a source of reserves. Thus, in a period of monetary restraint, large banks subject to the surcharge may be encouraged to limit deposit and credit extension because of the higher cost of obtaining reserves through the discount window.[20]

The choice of monetary policy targets

The role that the discount rate and reserve requirements play in the policy process depends not only on institutional factors but also on the Federal Reserve's choice of policy targets. Curiously, most textbook discussions of the policy instruments place little or no emphasis on the relationship between policy targets and instruments. In contrast, this section argues that recent Federal Reserve decisions to target money and reserves rather than interest rates have expanded the scope to use the discount rate and reserve requirements.[21] Two issues are emphasized in this discussion: the use of a reserve approach rather than an interest rate approach to monetary control, and the implications of targeting several monetary aggregates.

Interest rate vs. reserve targeting

In October 1979, the Federal Reserve made a much-publicized change in its monetary control procedures. Until then, the Federal Reserve attempted to control monetary growth through control of short-term interest rates, specifically through control of the federal funds rate. Under this system, the FOMC chose a target interest rate that was believed to be consistent with a desired money growth rate and changed the interest rate target only if money growth deviated significantly from its desired path. In October 1979, the Federal

[20] The discount rate surcharge is analyzed in more detail in Gordon H. Sellon, Jr., and Diane Seibert, "The Discount Rate: Experience Under Reserve Targeting," *Economic Review*, Federal Reserve Bank of Kansas City, November 1982, pp. 3-18.

[21] The evolution of Federal Reserve targeting procedures and its policy implications are discussed in Gordon H. Sellon, Jr., and Ronald L. Teigen, "The Choice of Short-Run Targets for Monetary Policy," Part I, *Economic Review*, Federal Reserve Bank of Kansas City, April 1981, pp. 3-16, and Part II, May 1981, pp. 3-12.

Reserve shifted to the use of a nonborrowed reserve target in order to control money growth. In this framework, the FOMC chooses a target path for nonborrowed reserves that is thought to be consistent with desired money growth. The nonborrowed reserve target is then maintained unless money growth deviates substantially from its desired path.[22]

The 1979 change in operating procedures was designed to improve automatic control of money growth. Under an interest rate targeting procedure, increased money demand is initially accommodated by the Federal Reserve. That is, as increased demand for money expands banks' demands for required reserves, the Federal Reserve supplies more nonborrowed reserves to maintain the target interest rate. Under a reserves targeting procedure, in contrast, the supply of nonborrowed reserves is held constant in the face of increased demand for reserves. Thus, banks must either obtain additional reserves through the discount window or cut back loan and deposit growth to reduce their demand for required reserves.

What is the role of the policy instruments under the two operating procedures? Given the flexibility of open market operations on a daily or weekly basis, it is the principal policy instrument under either system. That is, under an interest rate targeting procedure, open market operations are used to maintain the target interest rate in the presence of changes in reserve demand and supply. Similarly, under a nonborrowed reserves procedure, open market operations are used to maintain the target level of nonborrowed reserves. The real question, then, is whether the discount rate and reserve requirements make an independent contribution to monetary control under either system.

Under an interest rate targeting procedure, the discount rate and reserve requirements play little part in the monetary control process. As long as open market operations are directed toward maintaining a constant interest rate, discretionary changes in the discount rate and reserve requirements have little impact on money and credit growth.[23] For example, a discount rate increase is normally thought to increase market interest rates. Under an interest rate target, however, open market operations routinely offset the effect of the discount rate increase by providing more nonborrowed reserves. Thus, while the discount rate increase may reduce reserves provided through the discount window, open market operations provide an equal amount of nonborrowed reserves, leaving the total supply of reserves and interest rates unchanged.[24] Similarly, an increase in reserve requirements is normally thought to result in greater demand for reserves and upward pressure on interest rates. With an interest rate target, however, open market operations again provide additional reserves. Since the increased demand for reserves is met by an additional supply of reserves, there is no upward pressure on interest rates or stimulus to reduce money and credit growth.[25]

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[22] A good discussion of the change in operating procedures is found in "Monetary Policy and Open Market Operations in 1979," *Quarterly Review*, Federal Reserve Bank of New York, Summer 1980, pp. 50-64.

[23] Under an interest rate approach, discount policy can affect the amount of discount window borrowing and may have some impact on the distribution of reserves in the banking system. Similarly, reserve requirements may not affect M1 control directly but may have an impact on other aspects of bank behavior.

[24] Discount policy under interest rate and reserve targeting is analyzed in more detail in Gordon H. Sellon, Jr., "The Role of the Discount Rate in Monetary Policy. A Theoretical Analysis," *Economic Review*, Federal Reserve Bank of Kansas City, June 1980, pp. 3-15.

[25] The role of reserve requirements under different targeting procedures is discussed in Ira Kaminow, "Required Reserve Ratios, Policy Instruments, and Money Stock Control," *Journal of Monetary Economics*, Vol. 3, No. 4, October 1977, pp. 389-408.

Discount rate policy and reserve requirements play a potentially more important role under reserve targeting. The reason is that with a nonborrowed reserve target, open market operations do not automatically offset discount rate and reserve requirement changes. For example, a discount rate increase tends to put upward pressure on market interest rates and to reduce money growth. In this instance, open market operations are directed at keeping nonborrowed reserves constant rather than increasing nonborrowed reserves as under the interest rate targeting approach.

Similarly, with a nonborrowed reserve target, an increase in reserve requirements puts upward pressure on market interest rates and reduces money growth. Since open market operations are directed at maintaining a fixed supply of nonborrowed reserves, the increased demand for reserves is not accommodated as it would be under an interest rate target. In general, then, the decision to target nonborrowed reserves opens up a greater scope for the use of discount rate policy and reserve requirements.[26]

Multiple aggregate targets

Since the beginning of formal monetary targeting in the mid-1970s, the Federal Reserve has set targets for a variety of monetary aggregates ranging from transactions-based M1 to such broader aggregates as M2 and M3, as well as measures of credit or debt. The primary reason for multiple targets is the belief that no one aggregate is sufficiently reliable to be used as the exclusive focus of monetary policy. While the Federal Reserve has generally emphasized control of M1, on several occasions the behavior of M1 has been deemphasized and increased weight placed on the broader aggregates. The most recent example is the decision in late 1982 and 1983 to deemphasize M1 because of distortions in its behavior caused by deregulation and financial innovation.

Problems arise, however, in trying to control a broadly defined monetary aggregate consisting of both transactions and nontransactions components. One difficulty is that there is little automatic control of the nontransactions components. Indeed, the restructuring of reserve requirements under the Monetary Control Act and the adoption of contemporaneous reserve accounting were aimed primarily at improving control of transactions deposits. These structural changes worsen or, at best, have no effect on control of nontransactions deposits.

At the same time, the financial deregulation of recent years may have increased the difficulty of controlling the broad aggregates through the use of open market operations and discount rate policy. As nontransactions deposits have come to pay market rates of interest, the interest sensitivity of the broader aggregates has probably declined. Thus, much larger changes in interest rates through open market operations or discount rate policy may be required to achieve the same degree of control over these aggregates.

These considerations suggest a broader

[26] It is important to distinguish clearly the concepts of automatic and discretionary control when evaluating the impact of reserve requirement changes. With a nonborrowed reserves target, in practice, the Federal Reserve would probably cushion the immediate effect of a reserve requirement change by altering nonborrowed reserves. At the same time, however, the new reserve requirement changes the slope of the money supply function and thus affects the degree of automatic monetary control. Thus, in practice, under a nonborrowed reserves procedure, reserve requirement changes would probably not be made to bring about immediate reserve adjustments, but rather, would be aimed at improving automatic monetary control. In contrast, with an interest rate target, reserve requirement changes do not contribute either to discretionary or to automatic monetary control since the form of the money supply function does not enter into the determination of the equilibrium interest rate and quantity of money.

potential role for the use of reserve requirements as a policy instrument. Two different approaches to the use of reserve requirements to control the broader aggregates are possible. The first approach, discussed earlier, is the discretionary use of reserve requirement changes on certain types of managed liabilities. By using these reserve requirements to alter the relative cost of different liabilities, the Federal Reserve can directly affect the growth rates of particular components of the broader aggregates. As noted above, however, provisions of the 1980 Monetary Control Act have reduced the flexibility of this type of reserve requirement change.

A second approach to the use of reserve requirements would be to improve automatic control over the broader aggregates. One suggestion in this regard is the use of so-called "shadow reserve requirements," where nonreservable components of a broad aggregate can be assigned reserve requirements in the process of computing a nonborrowed reserve target.[27] That is, growth in these deposits above a desired level would be treated as if these deposits were subject to reserve requirements. A corresponding downward adjustment in the nonborrowed reserve target would be made to offset this growth. In this way, excessive growth in these deposits would lead to upward pressure on interest rates that would tend to reduce the demand for these deposits and slow the growth of the broader aggregates.

The role of the policy instruments

In light of these legislative, regulatory, and policy developments, it is appropriate to reconsider the roles that the three instruments play in the monetary policy process. The thesis of this article is that these institutional developments generally enhance the importance of discount policy and reserve requirements. This position contrasts sharply with the traditional academic view that highlights the role of open market operations and deemphasizes the contribution of discount rate policy and reserve requirements to monetary policy. The traditional view appears to be based on the observation that historically the Federal Reserve has made relatively infrequent use of discount policy and reserve requirements as policy instruments. The major difficulty with this view is a failure to recognize that the role of the policy instruments depends crucially on the Federal Reserve's choice of policy targets and that the choice of policy targets has evolved considerably in recent years.

As shown in the preceding section, the Federal Reserve's decision to target short-term interest rates or reserves is the principal determinant of the role of discount rate policy and reserve requirements. The choice of an interest rate targeting approach implies that short-run monetary policy can be conducted through the use of a single policy instrument. Given the administrative flexibility of open market operations, discount rate policy and reserve requirements contribute little to monetary policy. In contrast, under a reserve targeting approach, all three instruments have an independent effect on interest rates and money growth. Thus, within this framework, legislative and regulatory actions that change the structure of discount policy and reserve requirements can make an important contribution to monetary control.

The traditional view of the policy instruments developed over a period when the Federal Reserve generally pursued an interest rate targeting approach to monetary policy. In this

[27] The case for the use of "shadow reserve requirements" is developed in Marcelle Arak, "Control of a Credit Aggregate," *Quarterly Review*, Federal Reserve Bank of New York, Winter 1982-83, pp. 10-15.

context, the traditional view accurately portrayed the subsidiary role of discount rate policy and reserve requirements. With the advent of reserve targeting, however, the traditional view clearly needs modification and more attention needs to be paid to the potential contributions of discount rate policy and reserve requirements.[28]

Role of the policy instruments under reserve targeting

While all three policy instruments are potentially important in the reserves approach to monetary control, they are not interchangeable. Each instrument has specific advantages and disadvantages that condition its use in particular situations and define its role in the policy process.

The use of open market operations continues to be the principal discretionary policy instrument under reserves targeting. Open market operations are used on a daily and weekly basis both to achieve the target level of reserves and to adjust this target in response to stronger or weaker money growth. The use of open market operations has two advantages as a discretionary policy instrument. First, open market operations have greater administrative flexibility than a change in discount rate policy or reserve requirements. Open market operations can be carried out on a daily basis in amounts tailored to meet existing reserve needs. Second, open market operations tend to be less subject to announcement effects. Open market operations are done frequently enough that their use is not viewed as a reliable signal of major policy changes. At the same time, however, this latter feature can turn into a disadvantage when the Federal Reserve wants to signal a policy change to financial markets.

Under a reserve targeting approach, reserve requirements can contribute to both automatic and discretionary monetary control. Reserve requirements affect the degree of automatic monetary control in two ways. First, the level of reserve requirements determines the amount of interest rate pressure that occurs in response to faster or weaker money growth. Before the Monetary Control Act, the downward trend in effective reserve requirements on transactions deposits led to a progressive weakening in automatic monetary control. With passage of the act, the effective reserve requirement on transactions deposits was stabilized, thus contributing to automatic monetary control. At the same time, changes in the structure of reserve requirements removed unnecessary variability in the money supply due to certain types of shifts among transactions and nontransactions deposits in different depository institutions. The adoption of contemporaneous reserve accounting should also improve automatic monetary control to the extent that it accelerates the response of bank reserve demand and interest rates to faster or weaker money growth.

Reserve requirements play a less important role as a discretionary policy instrument. A change in the overall level of reserve requirements continues to be a blunt and administratively complex policy instrument. Thus, general reserve requirement changes are likely to be infrequent under reserve targeting. With the

[28] In October 1982, the Federal Reserve decided to place less weight on M1 as a policy target because of impending innovations in the financial system. This decision required changes in the Federal Reserve's short-run operating procedures, as described by Governor Wallich in the accompanying article. Under these revised procedures, the level of nonborrowed reserves continues to be the short-run operating target. However, changes in required reserves are accommodated by changes in nonborrowed reserves unless a decision is made to alter the degree of reserve provision. In this system, discount rate changes have an effect on market rates similar to that under a pure nonborrowed reserves procedure, but reserve requirement changes would probably contribute little to automatic monetary control.

advent of several money targets, however, selective reserve requirement changes on specific types of deposits may have become a more useful discretionary instrument. The new structure of reserve requirements is designed to improve automatic control over transactions deposits. As such, it makes little contribution to automatic control of the major nontransactions deposits included in the broader aggregates. Thus, in this framework, changes in reserve requirements on nontransactions deposits can play an important role in controlling growth in the broader aggregates.

The role of discount rate policy under reserves targeting is more complicated than the other two instruments. In principle, discount rate policy has implications for both automatic and discretionary monetary control. In practice, however, there is considerable controversy over whether discount policy strengthens or weakens monetary control and whether discount rate changes are a useful discretionary instrument.

Whether discount rate policy aids or hinders automatic monetary control depends on differing views as to why institutions use the discount window. Those believing that borrowing weakens monetary control argue that banks typically use the discount window as an inexpensive source of funds for loan and credit expansion. Thus, it is argued, if the discount windows were closed or the discount rate set equal to market rates, banks would be forced to compete for a fixed supply of reserves and would limit loan and credit expansion. In contrast, those believing that the discount window improves monetary control argue that borrowing cushions the money supply from unexpected changes in the distribution of reserve demand and supply. Without a discount window, these disturbances would increase money volatility and force the Federal Reserve to take offsetting open market operations.[29]

The use of the discount rate as a discretionary instrument is also somewhat complicated. Generally speaking, under reserve targeting, discount rate changes and open market operations have similar effects on interest rates and money growth. For example, in responding to excessive money growth, the Federal Reserve can tighten policy by using open market operations to reduce the supply of nonborrowed reserves or by increasing the discount rate to discourage banks from obtaining reserves through the discount window. There is an asymmetry to the use of discount rate changes that is often overlooked, however. A change in the discount rate affects the supply of reserves only to the extent that it alters banks' incentive to use the discount window. If market rates are below the discount rate, banks undertake minimal discount window borrowing. In this case, discount rate changes have little effect on borrowing and so have little impact on market interest rates and money growth. Thus, this asymmetry tends to limit the usefulness of discretionary changes in the discount rate.[30]

In a situation where the discount rate is below market rates, a discount rate change may have an advantage over open market operations. Discount rate changes tend to be more visible. That is, they may have significant effects on market interest rates by signaling changes in the direction of monetary policy. The role of these announcement effects has been the subject of controversy. Some have defended the use of discount rate changes to signal policy changes by citing the difficulty of using open market operations to provide this information. Others have argued that

[29] For a discussion of these opposing views, see Sellon, "The Role of the Discount Rate in Monetary Policy," especially pp. 11-15.

[30] The impact of discount rate changes under reserves targeting is analyzed in more detail in Sellon and Seibert.

the announcement effects of discount rate changes may be unreliable.[31] That is, financial markets may not receive the correct policy signal. To the extent that discount rate changes convey important information about future monetary policy, however, discount rate changes have an additional role to play in the monetary policy process.[32]

Summary and conclusions

In recent years a number of important legislative, regulatory, and policy developments have altered the role of the discount rate and reserve requirements in the monetary policy process. The key development is the change in the Federal Reserve's targeting procedures. The use of a reserves approach to monetary control and the emphasis on multiple monetary targets have widened the scope for discount rate policy and reserve requirements. Within this new policy framework, structural changes in the reserve requirement and discount mechanisms have further enhanced the role of these instruments. Thus, the traditional view that deemphasizes the contribution of the discount rate and reserve requirements should be replaced by a more balanced view of the role of the policy instruments.

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[31] A good discussion of this viewpoint is contained in Warren L. Smith, "The Instruments of General Monetary Control," pp. 199-203.

[32] A recent study suggests that discount rate changes have significant announcement effects that reinforce the basic thrust of monetary policy. See V. Vance Roley and Rick Troll, "The Impact of Discount Rate Changes on Market Interest Rates," *Economic Review*, Federal Reserve Bank of Kansas City, January 1984, pp. 27-39.

Recent Techniques of Monetary Policy

By Henry C. Wallich

Federal Reserve policies are subject to widely differing interpretations. This would probably be the case even if all members of the Federal Open Market Committee shared an identical interpretation, which is hardly plausible. If 12 people are always of the same view, 11 are dispensable. But even at the level of the techniques by which FOMC policy is implemented, there may be different views of "how monetary policy really works." In this paper I provide my own view, which may not be shared by every member of the committee and the staff, and in all details possibly by none.

Today it seems to be widely believed that the Federal Reserve's present technique for controlling the monetary aggregates is the same as that in use prior to October 1979, before the reserve-targeting method was initiated. Observers have noted that the funds rate has moved smoothly, as was the case before October 1979 when the Federal Reserve was controlling the growth of money by influencing the quantity demanded via the funds rate and short-term interest rates generally. The policy record now speaks of "the degree of reserve restraint." Since the record began to speak of the operating instruments in these terms, there have been no sharp, sustained interest-rate movements such as were characteristic of the tight reserve-targeting procedure after October 1979. How are these observations to be interpreted?

Recent funds-rate movements have indeed differed noticeably from the volatility of the period from October 1979 through the fall of 1982, after which the automatic character of the reserve-targeting method was largely modified. Changes in overall reserve positions of depository institutions since the fall of 1982 largely have reflected deliberate policy judgments rather than an automatic response to deviations of monetary aggregates from preset target paths. Nevertheless, the Federal Reserve has not reverted entirely to the old technique. One piece of evidence is the temporary quarter-end statement-date pressures that still affect the funds rate. These pressures were largely absent prior to October 1979.

While short-term interest rates, and, among

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them, the funds rate, have reassumed some of the role they played in controlling the money supply before October 1979, a new layer of indirect control has been added to the pre-1979 procedures, employing a market mechanism. It is not the funds rate that is used as the operational instrument but a level of nonborrowed reserves derived as the difference between estimated total reserves and the desired level of borrowing at the discount window. This can also be viewed as aiming at a particular level of borrowing implemented by means of the nonborrowed-reserves path. The resulting funds rate reflecting this level of borrowing, therefore, has some input from very short-term market forces. The procedure amounts to an indirect way of influencing the funds rate and other short-term rates which, in turn, affect the demand for money. Observers may differ as to whether, given the relative frequency of nonborrowed-reserve path adjustment, this procedure is better described as targeting on the nonborrowed path or on the level of borrowing.

From the point of view of the market, where I believe these things are well understood, the focus on the level of borrowing is significant because it leads to a different interpretation of Desk operations. The funds rate level at which the Desk enters the market to conduct open market operations does not convey the decisive message that the market tries to unravel, as it did in the days before October 1979. It is not indicative of any particular rate desired by the Desk. It is simply the rate that happens to prevail on a day when the manager believes that reserves should be added or drained in order to achieve the desired level of discount-window borrowing on average for the reserve-maintenance period. The action reflects the Desk's assessment of reserve availability, rather than a desire to move the funds rate, although the action, of course, may affect the rate. Some aspects that may create a contrary impression are dealt with later in this paper.

Direct and indirect targeting

What is the advantage of pursuing indirectly a target that can also be influenced or controlled directly? Principally, it is to give greater scope to market forces. Direct action runs the risk of introducing discontinuities and rigidities. It foregoes the opportunity of benefiting from a smoothing effect of the market. Judgment errors in setting the objective of direct actions are less likely to be corrected by the input from the market. This applies primarily when "indirection" implies an interaction between a price and a quantity. It applies also, however, to the relationship of two quantities, such as when borrowed reserves or total reserves are determined by operating on nonborrowed reserves. At the same time, one must keep in mind that indirection, giving room to market forces, can introduce a degree of slippage that may interfere with attainment of the target.

The issue whether to address a target variable directly or indirectly is posed at various stages in the monetary-policy transmission mechanism. At each stage, policy confronts, in simplest terms, a price and a quantity. It can determine price directly, by operations in the market, and allow quantity to be determined indirectly. Alternatively, it can determine quantity directly, with varying degrees of precision, and thereby influence price indirectly. In one or two instances, the key relation may be between two quantities, one or both of which are parts of a larger total.

For a discussion of some of the alternatives available at each stage in the transmission mechanism, the following stages are relevant, in descending order of closeness to the real sector and ascending order of controllability by the central bank:

1. Intermediate targets–the money supply and interest rates, principally long-term rates.

2. Instrumental targets–total reserves and money-market rates.

3. Operating targets–nonborrowed reserves implied by borrowed reserves intentions and the funds-rate range.

These layers could perhaps be structured somewhat differently and even telescoped, but they reflect the hierarchy of markets and instruments as they appear to me.

Intermediate targets

At the level of intermediate targets, the policymaker confronts, in simplest terms, the relationship between money and interest rates. He can influence either one directly–money by means of a total reserves technique, relying on the money multiplier, or interest rates by buying and selling at a given rate. Alternatively, he can influence each variable indirectly–the money supply through short-term interest rates, interest rates through the money supply. It need hardly be said that this two-variable relationship functions within a general-equilibrium model with many variables determined simultaneously.

Why should the policymaker prefer one intermediate target or the other, and why, having made his choice, should he prefer the direct or the indirect technique, if he is given the choice only between money supply and interest rates as intermediate targets?

As for the choice of intermediate target, this presumably will depend on the policymaker's view of the transmission mechanism of monetary policy. He may believe that expenditure behavior of firms and households is driven by interest rates–in the broad sense of including all kinds of monetary and nonmonetary returns–or by the money supply, for instance, through a real-balance mechanism. If he believes, as I do, that monetary policy works primarily through interest rates, he must choose between implementing his interest-rate policy directly, through market intervention, or indirectly, through the money supply. In the very short run, setting interest rates directly usually–not always–is possible for the central bank, through discount-rate and open-market operations. In an extreme sense, it could do so by simply pegging a rate through unlimited purchases and sales of securities at that rate. Naturally, if the interest rate established by this technique is not consistent with a stable rate of inflation, it will have an increasingly disequilibrating effect, causing inflation to accelerate or decelerate. Inability to guess or calculate the equilibrium interest rate gives the policymaker an important reason for not trying to set it directly but instead letting the market do so.

To be sure, the policymaker also does not know what rate of money growth will generate equilibrium (constant-inflation) interest rates; but his risk of error is smaller. If he sets an inflationary rate of money growth, the long-run result will be stable, not explosive, inflation. Thus, letting the market set the interest rate for a given money-growth target is a safer way of achieving an equilibrium interest rate than trying to set it directly.

A secondary reason for choosing a money-supply target is its public information effect. Setting (and adhering to) a target informs the public that an effort is being made to control inflation. Reducing the target over time creates a desirable and persuasive expectation of secularly diminishing inflation. Setting interest rates directly would not clearly convey a sense of controlled and diminishing inflation. The role of interest rates in curbing inflation is widely misunderstood. Not a few members of the public apparently believe that because interest enters into many prices, higher interest rates mean more inflation, which is to say that the micro effects outweigh the macro effects. Public support for a money-supply targeting policy is likely to be stronger than for an interest-rate policy, although the experience in recent years of very high interest rates under a money-supply regime may have changed that perception somewhat. In short, the advantage of influencing interest rates by targeting money is that it gives the market a chance to prevent errors that might occur if interest rates were set directly.

Instrumental targets

If it is decided to target on money, whether because the policymaker believes that money drives the economy directly, or because he believes that targeting money is a good way of indirectly targeting interest rates which then drive the economy, again there is both a direct and an indirect technique, this time at the instrumental target level, applying to time horizons of a month or two. The central bank can target on total bank reserves which, together with the money multiplier, determine the money supply. This is a relatively direct approach, giving only limited leeway to market forces via endogenous variation in the multiplier. Slippage, of course, is still possible if control of reserves is less than perfect, or if the multiplier is unstable owing to shifts among deposit categories, changes in excess reserves, and other factors. Even given such slippage, the interaction of a relatively rigid money-supply mechanism with a demand for money that is itself stochastic probably will produce sizable variability of interest rates, at least over the short and intermediate run.

One indirect technique of controlling the money supply at the instrumental target level involves control of short-term interest rates themselves so as to evoke a level of demand for money and a resultant stock equal to the target for the money supply. Given the demand curve for money, a shift in the supply curve changes interest rates along the demand curve, as reserves are added or drained to achieve the desired rate level. The money stock, in this framework, depends on the position and shape of the money-demand curve; it is demand-determined. This approach therefore gives the market greater scope for influencing the money stock. As a result, the money stock is vulnerable to error both in estimating the money-demand function and in predicting the values of arguments in that function, particularly income. Moreover, there is a substantial lag in the impact of money-market rates upon the amount of money demanded, with about half of the effect being estimated to occur within two or three months. In any event, in this process, interest rates are likely to be far less variable than under the reserves approach. The danger is that changes in money-market rates will not be made quickly enough when the level consistent with the targeted money supply has been misjudged.

Another indirect technique is to target on nonborrowed reserves, which allows both short-term interest rates and the money stock to be determined in part by the public's demands for money and by the depository institutions' demands for borrowed reserves. This approach is, in a sense, a compromise between total reserves and interest rates as instrumental targets, with the outcome for interest-rate variability likely to fall between these alternative regimes.

Operating targets

Finally, at the level of day-to-day or week-to-week operating targets, which are those the Federal Reserve can control most closely (various components of reserves, and the federal funds rate), a choice once more must be made between direct and indirect approaches to targeting reserves or the funds rate, respectively. Using total reserves as the day-to-day operating target–which the Federal Reserve has never done–would be a very direct approach, leaving little scope to the market. All kinds of slippage–especially by means of the discount window, but also through reserve carryovers–have to be avoided, or else changes in these magnitudes would have to be compensated by open-market operations. These would have to be massive, since in open-market operations a multiple of the initial increase, for example, in discount window borrowing would be required in order to offset further borrowing as banks sought to make up for further absorption of reserves by open-market operations. Quite possibly, banks would seek to protect themselves by carrying large and variable excess reserves, thereby possibly introducing slippage between total reserves and the money supply. All this severely limits the possibility of targeting on total reserves, to say nothing of the consequences for interest rate variability.

Targeting on nonborrowed reserves–which the Federal Reserve did after October 1979 and still does on a day-to-day basis–is a more indirect technique. The various elements of slippage in the process–discount-window borrowing, reserve carryover and, until recently, the effect of lagged reserve requirements–allow the market some leeway. Targeting on nonborrowed reserves also allows for a degree of automaticity. A deviation of the monetary aggregates from target alters required reserves. Given a constant supply of nonborrowed reserves, the deviation changes discount-window borrowing and tends to alter the funds rate and other short-term rates. These rate changes–downward when the monetary aggregates are undershooting the target, and upward when they are overshooting–tend to push the money supply back toward target over time. The strength of this automatic control feature, however, is at best moderate. While this technique was in use from October 1979 to fall 1982, it had to be supplemented on occasion by discretionary action in changing the discount rate, or in raising or lowering the nonborrowed-reserves path, thus reducing or increasing the need for borrowing and thereby accentuating the change in short-term rates.

A second alternative, also at the day-to-day operating level, is targeting on the funds rate. Once more, there is a choice between relatively direct and indirect techniques. The direct approach, in its extreme form, was represented by the familiar pegging operations practiced during and immediately after World War II. The Fed fixed certain rates by buying and selling (mostly buying) Treasury obligations throughout the maturity spectrum at fixed prices. A different, much less drastic, approach was that employed before October 1979. A range was set for the funds rate, sometimes as narrow as one-half percent and rarely more than 1 percent. This range was subject to revision between FOMC meetings if growth in money and/or credit moved outside specified "tolerance" bounds. The Desk bought and sold securities so as to keep the rate within the range, or around a particular area of it, on a weekly average basis and at times on a daily basis. Reserves under this procedure became demand-determined, which made timely adjustment of the funds-rate range very important.

The procedure gave some scope to market forces, in the sense that the funds rate was able to move, although only moderately, in response to market forces such as reserve supplies and bank reserve management strategies. It gave further scope to the market in the sense that control of the money supply was relatively indirect. Because demand forces were allowed so much influence on the growth of money, the procedure, in turn, yielded to a nonborrowed-reserve strategy beginning in October 1979.

Since the fall of 1982, the nonborrowed-reserve strategy and its automaticity have given way to a technique that allows the funds rate to be determined by the market, through the targeting of discount-window borrowing from one reserve-maintenance period to the next, implemented by allowing a flexible nonborrowed-reserves path. At the FOMC meeting, an intended borrowing level is set, as a policy decision. This level of borrowing is then deducted from the total of required reserves consistent with the target path for the money supply and an assumed level of excess reserves–in order to derive an initial path for nonborrowed reserves. However, during the intermeeting period, as money and reserve demands deviate from the trajectories set at the time of the FOMC meeting, the intended borrowing level is sought through appropriate adjustments to the initial nonborrowed-reserves path.

The post-fall 1982 procedure differs from the post-October 1979 procedure in that, as anticipated total-reserve demand diverges from initial projections, nonborrowed reserves are adjusted weekly in seeking to achieve a chosen level of borrowed reserves. In contrast, under the October 1979 procedure, borrowing was allowed to change consistent with the attainment of a nonborrowed-reserves path targeted for the entire intermeeting period–although subject to technical adjustments. An assumed level of borrowing under the older procedure was set only initially at the beginning of the inter-FOMC period, but borrowing would subsequently diverge from that initial assumption reflecting unforeseen movements in the demand for money and reserves. This was the automatic feature of the technique which at times was reinforced by discretionary path changes.

The relation of the borrowing level to the funds rate, which has been one of the most familiar features of the money market, always has been relatively loose. Since a chosen level of borrowing is consistent with any of a range of values of the funds rate, current operating procedures cannot be regarded as a form of rate-pegging. Demands for discount borrowing by banks no doubt reflect market judgments about present and future deposit flows and likely reserve conditions. Since these considerations play an important role in determining the funds rate, it is clear that the present procedure allows at least one additional degree of freedom with respect to the pre-October 1979 technique.

Interpretations of desk operations

From the point of view of the Fed watcher, the present technique offers problems of interpretation quite different from those of the pre-October 1979 procedure. Under the old procedure, the rate at which the manager entered the market was highly significant. Ordinarily, it meant that he did not want the rate to move substantially beyond that point, or even that he would like the rate to stop somewhat short of the rate at which he had entered. When the market had had an opportunity to explore the upper and lower limits of the range, it had a fairly good understanding of prevailing policy. So long as the market believed that the rate objective remained unchanged, moreover, it would help the manager stabilize the rate, believing that when it had reached one of the limits any move could only go in the other direction.

Today, the funds rate range set by the FOMC is much wider than before October 1979, typically 400 basis points. Its extremes, in fact, are rarely explored. So long as the level of borrowing is maintained, there is little reason to expect the funds rate to move strongly, at least for longer than transitory periods. The manager's entry into the market does not signify that one of the limits of the range has been reached, but that, given the borrowing target and the associated nonborrowed-reserves path, reserves need to be added or drained according to Fed projections of reserve availability. In some degree, this is indicated by the fact that entry continues to occur at a set time of day instead of, as during the pre-October 1979 regime, at varying times prompted by intra-day movements in the funds rate. When the reserve objective has been reached, there is no reason why the rate should not move against the intervention if that is the direction of market pressures.

Uncertainty about the reserve projections available to the Desk sometimes may create the impression that the Desk is indeed working to influence the funds rate directly instead of seeking to influence the borrowing level. In the absence of trustworthy projections, the funds rate at times may be a more accurate indicator of reserve availability than the reserves projections. If the manager decides to act on the signal from the funds rate in assessing the volume of reserves needed, he may create the appearance that he is working to influence the rate rather than the supply of nonborrowed reserves consistent with the intended borrowing level.

In setting the intended borrowing level, the FOMC must make an assumption about excess reserves. This can be regarded as a technical assumption, however, to be modified later by the staff implementing the directive in accordance with evidence of changes in the demand for excess reserves. Ordinarily such changes are not large and can be reasonably well evaluated.

The degree to which the funds rate is determined more reliably by borrowed reserves or by net borrowed reserves (borrowed reserves less excess reserves) is unresolved. There are partisans of both borrowed and net borrowed reserves. Econometric work does not seem to give a decisive answer. It should be noted, however, that when the value of required reserves is known, as under lagged reserve requirements, any nonborrowed-reserves target, rigorously pursued over the reserve-maintenance period, is equivalent to a net-borrowed-reserves target. Under contemporaneous reserve requirements, the same is true to the extent that required reserves can be estimated and that nonborrowed reserves are made to vary with required reserves. A word may, therefore, be appropriate at this point about the recently introduced contemporaneous reserve requirements.

Contemporaneous reserve requirements

The shift from lagged to contemporaneous reserve requirements (CRR) reflects a phase in Federal Reserve thinking when it seemed particularly important to tighten and speed up the response of reserve conditions to deviations of M1 from its target path. Lagging required reserves by two weeks implies that, during this period, the expansion of deposits is not directly constrained by reserve availability. Banks theoretically could create deposits without limit, although it strains credulity that they would exploit this opportunity, not knowing where the reserves would come from two weeks later or what they would cost. More plausibly, the response of banks to changes in deposits and the associated changes in short-term interest rates, may be somewhat delayed by the two-week lag in the need to put up reserves. Actually, under its reserve-targeting strategy, the Federal Reserve in effect often cut the two-week lag to one, by recalculating the average level of borrowing implied by a constant intermeeting average level for nonborrowed reserves as soon as incoming weekly deposit data indicated changes in future borrowing needs. This was done by lowering or raising the weekly nonborrowed-reserves path, thereby producing some borrowing response one week earlier than it would have occurred otherwise. The recent move to CRR thus potentially speeds up initial responses by one week rather than two.

In any event, CRR seemed a logical complement to the automaticity of the reserve strategy. Their adoption reflected a degree of frustration stemming from the fact that the adverse features of the strategy, in the form of greater variability of interest rates, were much in evidence, while improved control over the money supply was less so. The change seemed unlikely to do harm and capable of doing some good. It implied an effort to go as far as possible in the direction of making the rigorous reserves strategy effective.

Subsequent experience with the behavior of M1 was largely responsible for making this approach less viable. Changes in operating techniques, beginning in the fall of 1982, therefore, downgraded the role of M1 and reduced the degree of automaticity. This seemed to make moot the case for CRR, at least for the duration of this policy approach. On the other hand, concern that CRR would lead to greater volatility of interest rates diminished for the same reason. What remained was a moderate potential improvement in the reserve aggregates to money-supply relation that may help reduce one element of slippage in the mechanism and that expanded the menu of feasible operating procedures for future consideration.

Some comments on the aggregates

A major reason for modifying the automatic reserve-targeting technique has been the erratic behavior of M1 demand relative to its primary determinants. This, in turn, seems to have reflected, at least in part, the transition to a different composition of the aggregate, in the course of the rapid increase in NOW accounts and, subsequently, super-NOWs. Approximately one-fourth of M1 now bears explicit interest. For the $90 billion of regular NOW accounts, this rate is not a market rate, though it is for the $40 billion of super-NOWs. It will become so, for the regular NOWs, as the minimum balance to open super-NOW accounts–which have no interest-rate ceiling–declines to $1,000 in January 1985 from the present level of $2,500 and then is entirely eliminated in January 1986. The ceiling rate on regular NOWs is close enough to the market, however, to allow small changes in market rates to produce large variations in the opportunity cost of holding regular NOW balances, so long as their rate typically remains at the present ceiling levels. For the time being, this may have made M1 more interest-elastic than before.

However, as the share of super-NOWs grows, and particularly when the minimum-balance requirement for all NOW accounts is removed, rates on the interest-bearing component of M1 increasingly will be market-related. This would reduce, perhaps substantially, the interest elasticity of this aggregate. The control of M1 through an interest-rate strategy then would function largely to the extent that interest rates influence GNP and thereby M1 demand. Of course, the possibility of controlling M1 through a total-reserve strategy would remain. But, given a low M1 interest elasticity, the demand for the aggregate would not be much affected by interest-rate variations. Interest-rate volatility resulting from an effort to control M1 through total reserves, therefore, might become even more severe.

Instability in the demand function for M1 during 1982–which did not occur for the first time in that year–along with the impending introduction of MMDAs and maturing of All Savers Certificates–prompted the downgrading of the aggregate as a target in 1982. The demand function seems to have stabilized somewhat in the meantime, but with altered properties. For instance, the large interest-bearing component in M1 is likely to produce more rapid growth of the entire aggregate in the future, relative to nominal income and other monetary aggregates. In past years, the difference in the growth rate between M1 on one side, and M2 and M3 on the other, averaged on the order of 3 percentage points, with cyclical variations. A secular difference of 1-2 percentage points now seems more likely. This smaller difference is reflected in the Federal Reserve's 1984 targets of 4-8 percent for M1 and 6-9 percent for M2 and M3. At constant rates of interest, velocity may tend to grow in the 1-2 percent range.

Currency also seems to have been experiencing some instability. Until very recently, its average rate of growth had risen to 10 percent or so. This would not by itself be enough to disrupt seriously the rehabilitation of M1 as a usable target. Its implications are more serious for the monetary base. With currency growing at 10 percent, setting base growth much below its 1983 average rate of almost 9 percent would mean that total reserves, which make up only 20 percent of the base, would have to decline. Reservable deposits would have to do likewise. This, in turn, would, of course, have a severe impact on M1, the deposit component of which is the principal user of reserves. Accommodating changes in the composition of M1, on the other hand, i.e., by offsetting fluctuations in the currency/deposits ratio, would be tantamount to targeting on reserves.

M2 has also undergone a change that over several years has substituted market-related for regulated interest rates. The interest sensitivity of the aggregate accordingly must be presumed to have diminished. M2, in this sense, has already undergone some of the development that may be ahead for M1. Not enough time has passed, however, to provide adequate data for a test.

Can we shed velocity?

Recent vicissitudes of the aggregates, and prospective future changes, raise questions about the time-honored concept of velocity. The notion of a simple velocity relation between nominal income and money is so deeply embedded in the lore of money that it may seem quixotic to try to eradicate it. Nevertheless, in my view, that is what should be done. It is, after all, a primitive concept, clearly inferior to that of a demand function for money. Its calculation leaves out of account the effects of interest rates, wealth, inflation, and other arguments that may play a role in the money-demand function. Its theoretical foundations are weak, unless the demand function is connected to a velocity expression. Secularly, it should decline if money is a luxury good. Historically, since World War II, that has not been its trend, although the upward trend of interest rates and inflation during that period is partly responsible. The most appropriate way of defining velocity, by relating money to income with a lag, or without, is heuristically rather than theoretically founded.

Debates about whether or not there have been shifts in velocity, and how they should be reflected in money-supply targeting, are conducted much more meaningfully in terms of the stability of the demand function for money. Otherwise, changes in velocity that occur along a stable demand function may be confounded with changes associated with a shift in the function. Velocity may even remain stable while offsetting changes occur within the demand function. The principal loss from shedding the simple notion no doubt would be to the reputation of the economic profession, that would probably be accused once more of creating an unnecessary confusion.

Oil Shale in the United States: Prospects for Development

By Mark Drabenstott, Marvin Duncan, and Marla Borowski

Oil shale development again is a matter of debate. For decades, developers claimed that if oil prices increased only a few dollars a barrel, the country's abundant deposits of oil shale would become a viable source of energy. The claim seemed justified when oil prices jumped sharply in 1973 and 1979. Major energy companies responded by laying plans for multibillion-dollar investments to produce oil from shale. The oil glut that developed in 1982, however, put many of these investments on hold.

The recent boom and bust cycle in oil shale development had a significant economic impact on Rocky Mountain states. Colorado's western slope, with its rich shale deposits, experienced a particularly sharp swing in both economic activity and expectations for future growth.

The Rocky Mountain region and the oil shale industry now look to the future. Will oil shale become economically viable? Or will it remain an energy resource locked away underground?

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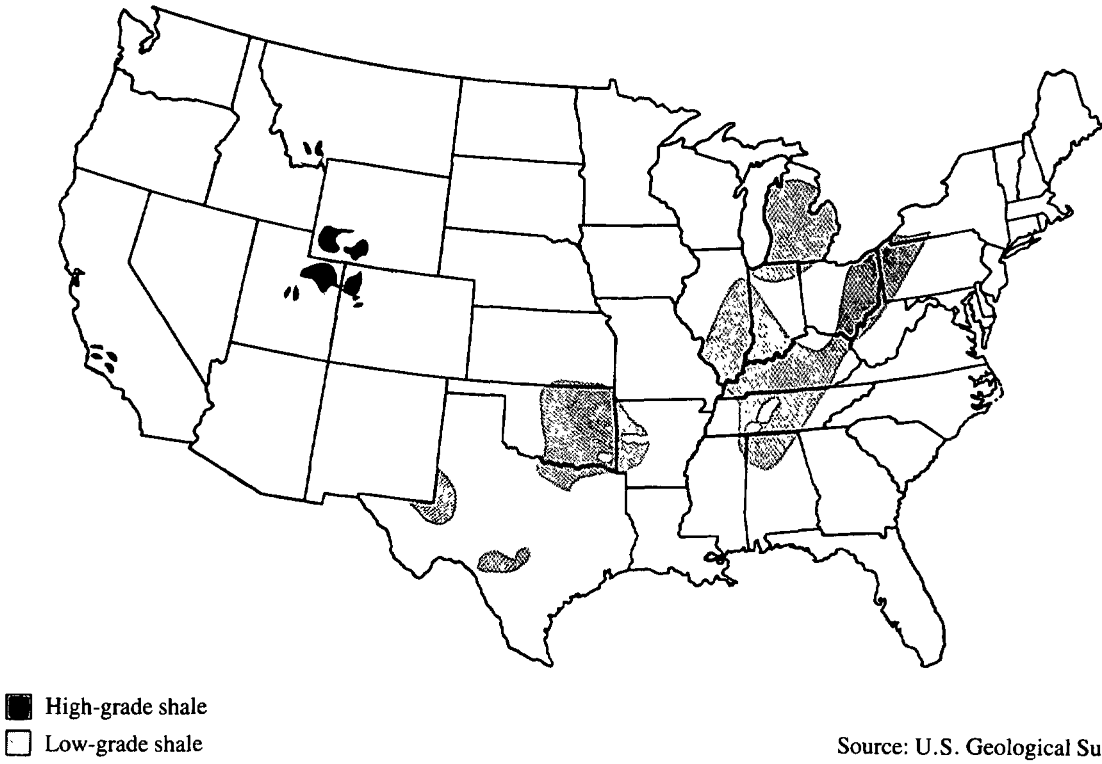
This article suggests an uncertain outlook for oil shale. The article describes oil shale resources in the United States and discusses the effects of oil shale development on Colorado's Western Slope. Finally, the article analyzes four factors that are likely to determine the future of oil shale development.

The oil shale resource

Oil shale deposits are primarily marlstone, a sedimentary rock. Oil is locked in the shale rock as a rubbery substance called kerogen. To separate the kerogen, the shale must be heated to about 900°F, a process called retorting. The raw shale oil extracted by retorting is different from conventional crude oil and must be specially treated to make syncrude, a refinery-ready substitute for crude oil.

Although oil shale deposits sometimes contain other minerals in commercially valuable quantities, the value of oil shale usually depends on its kerogen content. High-grade deposits can yield 30 or more barrels of oil per ton of rock. The United States is believed to have about 8 percent of the world's oil shale– an oil equivalent estimated at 168 trillion barrels. The deposits underlie parts of 14 states,

FIGURE 1
U.S. oil shale deposits

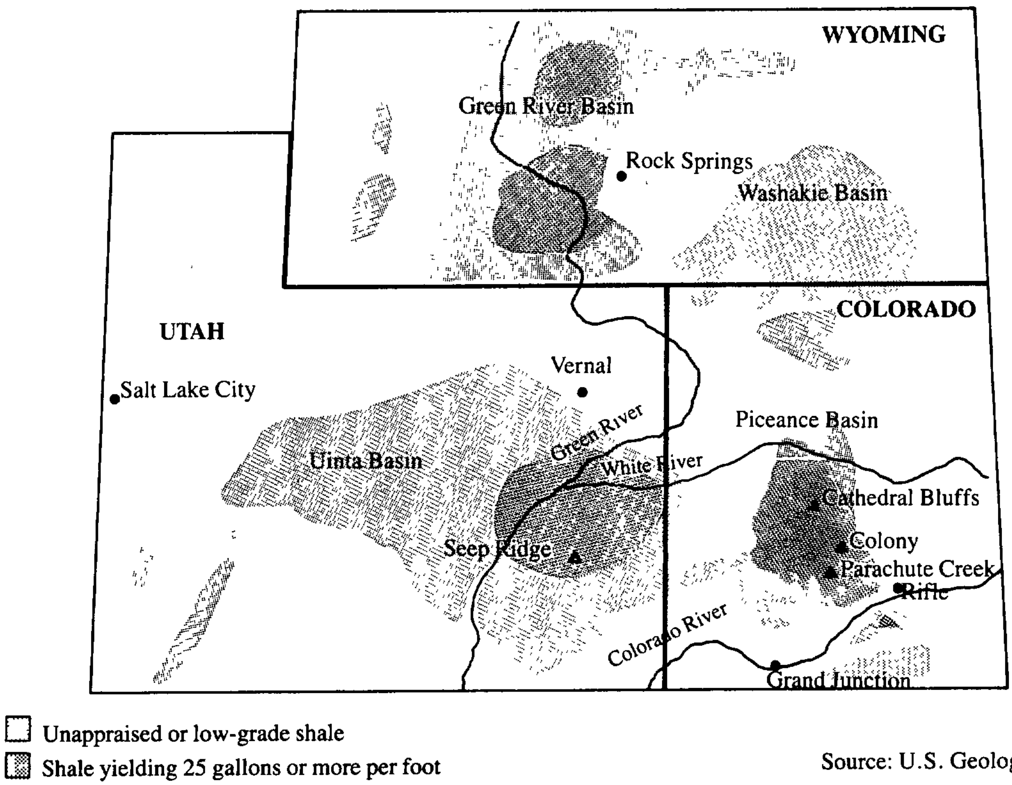


Source: U.S. Geological Survey

or about a fifth of the nation's land mass (Figure 1). The richness of these deposits varies widely. Estimates of the lower quality deposits in the central and eastern United States run about 3 trillion barrels of oil equivalent. The marine shales underlying Alaska are thought to contain 450 billion barrels of oil equivalent in high-quality deposits and a large but unknown amount in lower quality deposits. Another 157 trillion barrels are in shale associated with coal and scattered deposits throughout the country. The country's richest deposits, however, are in the Green River formation underlying Colorado, Utah, and Wyoming (Figure 2).

The Green River formation contains an estimated 8 trillion barrels of oil equivalent. Sixty percent of the country's highest grade deposits are in this formation, 11 percent of its medium-grade deposits, and 3 percent of its lowest grade deposits. About 67 percent of oil shale in the Green River formation is in the Piceance Basin in Colorado, shown in Figure 2. The Uinta Basin in Utah contains about 18 percent and the Green River and Washakie Basins in Wyoming only about 15 percent. Because more than 90 percent of the richest shale is in the Piceance Basin, most of the oil

FIGURE 2
Green River Formation



Source: U.S. Geological Survey

shale development has been in that area.

Industry development

Oil shale development has been associated with rapid growth in energy demand and fears of falling energy supplies. The first development began about 1850, but collapsed when oil was discovered at Titusville, Pennsylvania, in 1859. Development began again in the early 1900s, peaked during World War I, and then collapsed with the discovery of large Texas oil deposits in the late 1920s. A new surge of interest during World War II passed when Middle East oil became available in the late 1940s.

With the Arab oil embargo and rapidly rising world oil prices in the 1970s, attention turned again to oil shale. Development has been abetted more recently by loan and price guarantees by the U.S. Synthetic Fuels Corporation, a public corporation charged by Congress with spurring the development of alternative energy sources. The result of this recent attention was the largest of the recurring oil shale booms. Activity was centered mostly in northwestern Colorado but also to some extent in adjacent regions of Utah.

As recently as August 1981, at least 16 major oil shale projects were in various stages of consideration, experimentation, construction, or production (Table 1). In short, a truly spectacular oil shale boom was expected to bring permanent change to the historically weak economy of northwestern Colorado.

But even as activity began to increase, economic forces were at work that would burst the development bubble. Higher energy prices had brought greatly increased energy exploration and development, as well as greatly increased energy conservation. A deep and prolonged worldwide recession reduced world energy demand. World crude oil prices fell to about $29 a barrel in 1983 and have continued to decline in real terms. The world energy recession that began in early 1982 has not yet ended.

Thus, the economics of oil shale development changed drastically after 1981. Recognizing the change, Exxon and its partner Tosco closed down their giant Colony project in mid-1982, signaling the end of the oil shale boom. Other projects also were closed or scaled back. Only a few major projects are still moving toward commercialization in Colorado and Utah, and two of them represent different phases of the same development.

Four western oil shale projects have received federal assistance to facilitate oil shale development (Table 2). Because of the long lead times required for developing a commercial-sized plant, only these four projects are expected to produce substantial amounts of shale oil over the next several years.

Union Oil, which owns oil shale lands, started constructing Phase I of its Parachute Creek project in 1981. This project was the first commercial-size mine and retorting facility in the Piceance Basin (Figure 2). Several years had already gone into planning the project and building infrastructure. Construction was completed by late 1983, and Union Oil began final preparations for producing shale oil. The plant is expected to begin producing 10,000 barrels a day in 1984.

Development on tracts leased from the federal government is progressing slowly. The Cathedral Bluffs project, which has received Synthetic Fuels Corporation support, is in the design and engineering phase. Operations have been suspended on the Rio Blanco Oil Shale project, although research and development work continues. Partners in the White River Shale project in Utah have withdrawn their request for financial assistance from the Synthetic Fuels Corporation while they evaluate and review project plans.

Most developments on private, state-owned, or Indian land are still in the planning and research and development stages. In Utah, the Seep Ridge project is completing a seven-year research and development program and raising equity capital before beginning commercial construction. The Paraho-Ute project is still satisfying management and partnership conditions set by Synthetic Fuels and expects to sign a letter of intent by the end of the year. In Colorado, the Clear Creek development is in the pilot-plant state. Development of the large Colony project was stopped in mid-1982, and only certain construction, maintenance, and reclamation activities are still underway.

The economic impact of oil shale development

Oil shale development has long been marked by booms and busts. Moreover, each period of development has been accompanied by rapid increases in real energy prices, increased investment by energy companies, and high expectations of its economic effects. Every period of development also has col-

TABLE 1
Major oil shale projects in Colorado and Utah as of August 1981

Project	Developer	Production target (barrels per day)
Rio Blanco	Gulf and Standard Oil of Indiana	50,000 by early 1990s
Cathedral Bluffs	Occidental and Tenneco	95,000 by early 1990s
White River	Sunedco, Phillips, and Sohio	100,000
Colony	Exxon and Tosco	47,000 by 1987
Long Ridge (Parachute Creek)	Union Oil	50,000 by 1990
Pacific	Superior, Sohio, and Cleveland Cliffs	15,000 by 1987, 50,000 ultimately
Sand Wash	Tosco	50,000
Logan Wash	Occidental	500
Geokinetics	Geokinetics	2,000 by 1982
BX	Equity Oil	Unspecified
Paraho-Ute	Paraho Development and 14 industrial sponsors	8,000 by 1984, 30,000 by 1986
Horse Draw	Multi Mineral Corporation	50,000 by 1989
NOSR	DOE and DOD	Up to 200,000
Superior	Superior, Sohio, and Cleveland Cliffs	Up to 23,000
Clear Creek	Standard Oil of California	100,000 by mid-1990s
Bart In Situ	Texaco	Unspecified

Source: Colorado Energy Research Institute and Colorado School of Mines Research Institute, *Oil Shale 1982: A Technology and Policy Primer*, pp. 42-43.

lapsed with declines in real energy prices.

As recently as 1981, a panel appointed by the governor of Colorado expected that state's shale oil production to reach 200,000 barrels a day by 1990.[1] More optimistically, the U.S. Office of Technology Assessment expected production in Colorado to reach 400,000 barrels a day. Forecasts by other groups for the year 2000 ranged from 400,000 to 4 million barrels a day.

The development foreseen by all these forecasts was expected to have marked effects on the economy of Colorado's ten northwestern counties. The population of those counties, estimated at 175,000 in 1981, was expected to at least triple by the year 2000. Forecasts of spending on housing in those ten counties ranged from $1.5 billion to $18.7 billion (1979 dollars), depending on the shale oil production scenario assumed. Private sector investment in shale oil plants over the rest of the century was expected to range from $15.3 billion for the low production scenario to $200 billion for the high production scenario (1979 dollars). Public financing requirements for construction of public facilities were forecast to range from $400 million to $5.8 billion (1979 dollars).

Sharp increases were expected in the use of water, already scarce in that area. Annual

[1] *Oil Shale 1982: A Technology and Policy Primer*, Colorado Energy Research Institute and Colorado School of Mines Research Institute, Denver, November 1981, pp. 84-88.

TABLE 2
Synthetic Fuels Corporation oil shale projects

Project (developer)	Estimated authority (billions) of dollars)	Technology	Production capacity (barrels per day)	Ultimate production potential* (barrels per day)	Status
Parachute Creek, Phase I (Union Oil Co.)	$—	Union B Surface retort	10,400	—	A $0.4 billion price guarantee transferred from the DOE
Parachute Creek, Phase II (Union Oil Co.)	$2.70	Union C Surface retort	42,152	90,000	Letter of intent executed
Cathedral Bluffs (Occidental Petroleum Corp., Tenneco Oil Co.)	$2.19	Modified in-situ and Union B	14,100	100,000	Letter of intent executed
Seep Ridge (Geokenetics)	0.05	True in-situ	1,000	8,000	Letter of intent authorized
	$4.94		67,652	198,000	

*The estimates of ultimate site expansion potential are based on current Synthetic Fuels staff opinion on the land, water, and resource availability for each project and the assumption that environmental limitations can be appropriately mitigated. The estimates should not be considered as reflecting the sponsors' current planning for site development.

Source: Synthetic Fuels Corporation.

water usage for shale oil production by the year 2000 was expected to range from 72,000 to 753,000 acre feet. Shale oil production exceeding one million barrels a day was expected to require constructing new water storage facilities, purchasing water rights from current owners, and importing water from other river basins.

The recent oil shale boom has ended and the economic cost of the bust is now being assessed. Since Colony was the largest of the oil shale projects, its impact on Colorado's Western Slope economy also was large. Thus, a review of Colony's impact, both in boom and in bust, helps put oil shale development in an economic perspective.

Economic impact of the Colony project

The shutdown of the giant Colony project–after an investment of some $1 billion–raises questions about the effect of such boom and bust development on northwest Colorado. Designed to produce 47,000 barrels of shale oil a day, the Colony project would have employed more than 3,000 workers at the peak of its construction.[2] Completed, it would have taken 1,200 permanent employees. About 2,100 workers were employed in construction there when the project shut down.

In addition to direct employment associated with the Colony project, indirect employment in project-related work, such as trucking, and unrelated industries, such as banking and food service, was expected to add about 9,000 new residents to the area by 1984 or 1985.[3] Most

[2] Wayne Lee Hoffman, "Coping With Boom and Bust: The Colony Oil Shale Project," *Natural Resource Development*, Vol. 2, No 1, Center for Public-Private Sector Cooperation, University of Colorado at Denver, March 1983, pp. 29-58.

[3] Hoffman, p. 35.

of these new residents would have been in Colorado's Garfield and Mesa counties. Exxon's new town development of Battlement Mesa was planned for an eventual population of 20,000 to 25,000.

The shutdown brought rapid reductions in Colony project employment. From more than 1,900 Garfield and Mesa county people employed in early 1982, the figure fell to 239 in late 1982.[4] About one-half to two-thirds of these workers had moved into the area to work on the project. Most of them moved on to other construction projects or to other oil shale projects in the area. The shutdown also triggered layoffs at supplier and contractor firms far from Colorado.

The rapid influx of people–with further inflows expected–resulted in substantial new public investment in roads, water treatment plants, schools, and other public facilities. No new public debt was incurred, however, because the increased expenditures for capital and services were financed entirely by the firms developing oil shale, by state mineral trust funds and severance taxes, by local general fund surpluses, and by taxes collected while growth was rapid. A system of county permits allowed local jurisdictions to negotiate for substantial infrastructure and services support from the firms developing the oil shale projects. Spending on public safety also increased significantly.

On balance, because up-front investment capital was available, local jurisdictions affected by the Colony project were able to upgrade their public facilities and services substantially. These communities now have excess capacity for accommodating future growth.

With the boom over, these local jurisdictions will likely contract for several years. Sales tax revenues will decline, although the real estate tax base is larger because of new private construction. The Colony project has provided some transitional help with local budgets. Other oil shale projects, such as Union Oil's, will also help. Public budgets will, nevertheless, decline. Demand for public service will also fall, though probably not as fast as revenue.

Private interests other than energy companies also participated in the development boom, making substantial investments in rental housing and local businesses. These investments, profitable only if the rapid population growth had continued, likely will suffer losses. For example, houses at Battlement Mesa are now being offered for rent at well below previously prevailing rental rates, thus lowering rates for rental housing throughout that area. As a result, apartment investments that seemed sound at earlier rental rates may no longer be profitable. Financially weak investors could be forced out of business.

A large part of the economic effect of oil shale development on these ten counties has been borne by the energy companies themselves–through the state's share of federal payments and through payments and infrastructure investment in local jurisdictions. That means local jurisdictions have been largely protected from financial problems resulting from the oil shale boom.

Private business firms have not been as fortunate. Some firms have been adversely affected as projects phased down. But the biggest adjustment for the private sector probably has been the lowering of expectations of future economic growth. At the time of the Colony shutdown, for example, officials in Colorado's Department of Natural Resources used a computer model to forecast the effect of oil shale development on Garfield and Mesa counties. According to their forecast, if the

[4] Hoffman, p. 41.

Chevron and Colony projects were closed out and the Union project produced only 10,000 barrels a day, total employment in Garfield county in both 1985 and 1990 would be about half what it would have been if high levels of development had continued at all three projects.[5] Total personal income also would be less than half as high, reflecting the relative importance of oil shale development in mostly rural Garfield county. Population in Mesa county, more urban than Garfield county and with less oil shale development, would be about 80 percent of what it would have been in 1990. Personal income would be about 75 percent of what it would have been with rapid oil shale development.

While oil shale development had a drastic effect on the economy of northwest Colorado, the adverse aspects of both the boom and the bust that followed were substantially mitigated by the cooperation of energy developers and all levels of government. Thus, the area's public and private sectors were able to adapt to the changing level of oil shale development with much less trauma than had been initially expected. The effects were mitigated almost completely for the public sector, but less so for the private sector. Even there, however, the greatest impact of the bust was the trading down of expectations of future economic growth rates. Still, the prospect for future development holds promise for both energy firms and the communities contiguous to such development.

The future for oil shale

The future for oil shale depends on a number of economic and technological factors. Four factors will be particularly important: oil prices, technology and economies of shale oil production, energy policy, and environmental impacts.

Oil prices

To be a viable source of energy, oil shale must be competitive in price with other forms of energy. Prospects for oil shale development, therefore, hinge to a great extent on the future of oil prices.

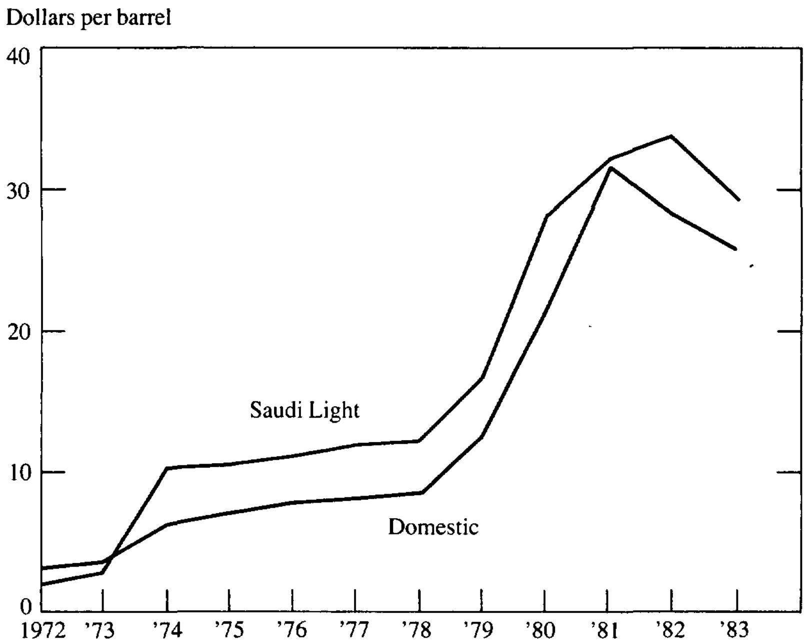
Over much of the past decade, oil prices have reflected price fixing by the Organization of Petroleum Exporting Countries (OPEC). In 1973, OPEC exercised enough control to triple prices. Crude oil prices rose from roughly $3.50 a barrel to about $10.50 (Chart 1). And in 1979, OPEC took steps that led to a near tripling in oil prices.

Although oil prices seemed headed even higher after this second round of tightening, they suddenly began declining in 1981. Two developments brought this about. One was a sharp slowing in the growth of world energy demand as industrial countries slipped into recession. Widespread efforts had already been made to improve energy efficiency. Taken together, recession and greater efficiency resulted in an 11 percent decline in total U.S. energy consumption between 1979 and 1982. The second development was that higher oil prices led to increased energy production in the United States and other non-OPEC countries. Decontrol of oil and natural gas prices spurred exploration and development. Coal production also increased substantially throughout the 1970s and early 1980s. Increased oil production in non-OPEC countries, such as Mexico and Great Britain, also raised world oil supplies.

A primary result of declining oil prices since 1981 has been the shelving of many oil

[5] Colorado Department of Natural Resources, Executive Director's Office Memorandum, May 5, 1982, Tables 2, 4, 5, and 7.

CHART 1
Price of crude oil



Source: Chase Econometrics

shale projects. The critical question for shale development now, therefore, is the future course of oil prices.

Total oil supplies will probably be fairly large for the next five years. Domestic crude oil supplies remain large compared with the 1970s. Moreover, if oil prices increase, exploration and development would also increase rapidly, adding to energy supplies. Foreign oil supplies will also continue to be large. Oil-producing countries with sizable foreign debts, such as Mexico, Venezuela, and Nigeria, will keep production high to service their debt with oil earnings. Many Middle East oil-producing countries have economic development programs that must be financed with oil revenues. Thus, total world oil supplies will probably remain ample.

U.S. energy demand, meanwhile, will likely grow slowly. Although economic expansion will lead to more energy use, continued gains in efficiency will limit the growth in demand. As one example of the improvement in efficiency, the United States now uses 15 percent less energy to produce a dollar of real GNP than it did five years ago. As a result, total energy use actually declined 1 percent in 1983, even though that was a year of strong economic growth. Thus, while total energy consumption in the United States will continue to grow, the growth will be much slower than in the 1970s.

On balance, oil prices may increase modestly in nominal terms over the next five years, but prices are expected to continue declining in real terms. This suggests, other things equal, that oil shale development will become less economical. But this near-term oil price outlook–and more especially the longer term outlook–is subject to a range of economic and political events that could force a change. A sudden disruption of world oil supplies could quickly make shale oil more attractive. But for rapid oil shale development to occur, expectations of high oil prices would have to hold for an extended period.

Economics of oil shale production

Oil shale's ability to compete with petroleum depends not only on oil prices now and in the future, but also on the relative cost of producing oil from shale. That cost depends largely on technology.

Three methods can be used to retort shale oil. In surface retorting, the shale is mined, crushed, and then heated in a retort above ground. In another, called in-situ retorting, the oil is recovered by heating the shale underground and then piping the raw shale oil to the surface for further treatment. The third method, modified in-situ retorting, combines the other two methods. Part of the shale is mined for retorting on the surface. The mine creates an underground working area where other shale can be shattered by explosives and heated to separate the kerogen. The resulting raw shale oil is then pumped to the surface and treated, along with the surface-retorted oil, to make syncrude.

Although further technological improvements or even breakthroughs lie ahead, the oil shale industry expects developments over the next decade to be based on current technologies. Of these, surface retorting processes appear most likely to succeed.

Given current technology, the critical question is how well syncrude can compete in terms of cost with conventional crude oil. The answer is not very well, at least at present.

Industry estimates made in 1981, the most recent year that such data are available, set the total cost of finding, developing, and producing a barrel of conventional crude oil at about $15 (Table 3). Production costs included in this nominal-dollar estimate–the cost of operating and maintaining wells–are the average for old and new wells. Since production costs for new wells, especially offshore, on the North Slope, or in the Overthrust Belt, are higher than for old wells, some per-barrel costs are much higher than this estimate suggests.

The Synthetic Fuels Corporation estimates that, in 1984 dollars, syncrude from Phase I of Union Oil's Parachute Creek project will cost about $35 a barrel (Table 3). After full development of Phase II, Union's syncrude costs could drop to about $29 a barrel, again in 1984 dollars. The Synthetic Fuels Corporation believes these estimates are accurate to within 20 percent. The estimates do not include an imputed return on equity capital. Inclusion of a 12 to 15 percent return would push the per-barrel costs still higher.[6]

Partly because of technical uncertainties in plant operation, costs for shale oil projects are not known exactly. Cost overruns for plant construction pose a sizable risk, given the large capital outlays required. The estimated cost of a 50,000-barrel-a-day surface retorting plant, for example, was $138 million in 1968, $450 million in 1974, and $1.7 billion in 1980.[7] When the two phases of Union Oil's

[6] The Office of Technology Assessment estimated in 1980 that surface retorted shale oil would cost $48.20 a barrel, assuming a 12 percent rate of return on equity, and $61.70 a barrel, assuming a 15 percent rate of return on equity

TABLE 3
Comparison of syncrude and crude oil costs

	Surface retort syncrude oil (per barrel in current dollars)		
	Capital[1]	Operation[2]	Total
Parachute Creek Project			
Phase I			
(10,000 barrels/day)	$6.57	$28-$30	$34.57-$36.57
Phase II			
(42,000 barrels/day)	$7.70	$21-$22.50	$28.70-$30.20
Total			
(52,000 barrels/day)	$7.48	$21-$22.50	$28.48-$29.98
	Conventional crude oil (per barrel in current dollars)		
	Exploration and Development[3]	Production[4]	Total
1981	$7.78-$8.86	$7.14	$14.92-$16.00
1982	$7.29-$8.31	NA	NA
1983	$6.03-$6.87	NA	NA

[1]Source: Synthetic Fuels Corporation, Union Oil Parachute Creek Project Letter of Intent. Per-barrel costs based on 30-year plant life with 330 operating days per year.
[2]Source: Synthetic Fuels Corporation.
[3]Source: James C. Dyer, "The Cost of Reserves by Discovery vs. Acquisition," *Oil and Gas Journal*, December 19, 1983.
[4]Source: American Petroleum Institute, *Basic Petroleum Data Book*, Vol. III, No. 3, Tables V. 10, IV. 5, and XIII. 9.

project are completed in 1985, plant costs will exceed $3.85 billion.[8] Although part of the increase in cost has been due to inflation, much of it results from uncertainty about plant engineering. Operating costs are even more uncertain because the economies of scale for commercial retorting are still not fully understood. Uncertainties in forecasting total production costs translate into a high discount rate for oil shale projects that reduces the likelihood of private development without government assistance.

[7] Office of Technology Assessment, *An Assessment of Oil Shale Technologies*, June 1980, p. 186.

[8] Synthetic Fuels Corporation, Letter of Intent, Union Oil Parachute Creek Oil Shale Project, December 1983.

Although costs of production favor conventional crude oil, current cost comparisons are extremely tenuous at best. The shale oil projects now underway are the first efforts to produce shale oil on a commercial scale. No one knows for sure how well current technologies will work on a commercial scale.[9] Nor does anyone know what the final unit cost will be. Until more is known, current estimates suggest that conventional crude oil likely will

[9] Union Oil has encountered engineering problems as its Parachute Creek project scales up from pilot plant to commercial production levels. Time-consuming mechanical modifications have been required in the several months since construction was completed. For a more complete discussion, see "Shale project hits another roadblock," *Rocky Mountain News*, May 1, 1984.

remain much less expensive to produce than syncrude.

Federal energy policy

Federal energy policy has been critical to oil shale development. Although the future scope and direction of federal oil shale policy are uncertain, the infant status of the industry suggests that the government's influence on development will remain substantial.

Oil shale development is part of an overall federal energy policy that also includes other programs. Deregulation of oil and gas prices, the strategic petroleum reserve, higher gasoline taxes, research and development grants, and tax inducements are also used to achieve national energy objectives. Benefits and costs of these programs will influence future government support for oil shale.

Government involvement in stimulating oil shale development has been justified on grounds of the benefits to the country. Foremost among these benefits has been that commercial-scale plants provide critical experience with retorting technology. This experience provides a form of insurance against future disruptions in oil supplies. If shale oil ever did become economically viable, it would reduce the country's dependence on imported oil and contribute to a stronger balance of payments.

Because these benefits generally meet with approval, the real issue is whether a commercial industry would develop without any government assistance. The government's program has mitigated the significant risks private firms face in full-scale commercial development. There are technical risks in moving shale oil production from the pilot stage to a commercial operation. Largely a matter of engineering, these problems will be fully resolved only by trial and error. Examples of potential technical problems in surface retorting include handling the large amounts of shale that feed into the retort and controlling the separation of sticky kerogen from spent shale. Economic risks arise from the uncertainty of not knowing the costs of production. Finally, institutional uncertainties result from a complex set of changing government regulations. Environmental regulations are a particular concern to developers because the final scope and tenor of regulations is still in doubt.

The Office of Technology Assessment concluded in 1980 that the combination of these risks would impede the development of anything but a very small shale oil industry. The number of projects now underway suggests that federal assistance was necessary to spur development.[10]

The Synthetic Fuels Corporation provides federal assistance to oil shale development. Created in 1980 by the Energy Security Act, the corporation was intended to help develop synthetic fuels production capacity of 500,000 barrels a day by 1987 and 2 million barrels a day by 1992. To meet these targets, Synthetic Fuels was given authority to make loan and price guarantees to developers of oil shale and other synthetic fuels projects.

Synthetic Fuels committed about $5 billion in total budget authority to oil shale projects in 1982 and 1983, one-third of its total budget authority for all synthetic fuels programs. Three major projects received price guarantees, loan guarantees, or both (Table 2). The support initially committed to a project is the maximum that can be allocated over the life of the project. Once the maximum is reached, no further support is allowed. Oil shale projects were selected to achieve two basic objectives.

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[10] For a full discussion of impediments to commercial development of oil shale production, see Edward D. Merrow, "Constraints on the Commercialization of Oil Shale," Department of Energy Report R-2293-DOE, September 1978.

First, Synthetic Fuels wanted to encourage development of oil shale in its various states: deep deposits, bluff deposits, and shallow deposits. Second, recognizing that potentially significant technological breakthroughs might be made, it wanted to support various retorting technologies.[11]

Government support for oil shale development may be more limited in the future. Current support is aimed at enabling the oil shale industry to overcome the uncertainties of commercial startup. Once commercial plants are operating and more is known about the true costs of producing shale oil, developers may have to carry out additional development on their own. Nevertheless, if oil prices were to escalate sharply in the next ten years, support for public assistance could emerge again. It is much more likely, however, that any future public effort to encourage shale oil development will center on research to improve recovery techniques.

In many respects, current public support of oil shale development is a grand experiment. The public is investing substantial funds in a fledgling industry that offers potential benefits to the country. The size of the potential benefits and the number of risks facing private developers may justify this support. Conversely, oil shale development could prove too costly as an energy alternative. Once the experiment is over, the shale oil industry will very likely have to stand on its own feet.[12]

Environmental impacts

Oil shale development will bring a host of environmental problems to western mountain states. Because current technology points to an industry built on surface retorting, a range of issues involving the quality of air, water, and land will be important to the development of oil shale.

Crushing and processing mined shale will create dust and pollutants that will reduce visibility and degrade the quality of the air. Pollutants created during processing, primarily sulfur dioxide, nitrogen dioxide, and particulates, could have potentially serious effects, such as acid rain. High elevation lakes could be especially susceptible to damage from acid rain. The severity of visibility and air quality problems cannot be accurately predicted.

The processing of shale creates two potential water pollution problems. The main concern is with the discharge of contaminated process water at the surface. That problem might be reduced by treating waste water to industrial standards and reusing it. Developers are planning to discharge no surface water. They will dispose of any untreatable wastes in the spent shale.

But surface runoff and leaching from spent

[11] While the Synthetic Fuels Corporation has committed $5 billion to oil shale development, much of this could be recovered by letting Synthetic Fuels share in revenues if oil prices rise. In the Union Oil project, for example, Synthetic Fuels agreed to guarantee a price of $60 a barrel in 1983 dollars for ten years. As long as market oil prices remain below this real price, Synthetic Fuels must make up the difference, up to a maximum total subsidy of $4.25 billion. During the ten-year price guarantee period, if market oil prices rise above the $60 guaranteed real price, Synthetic Fuels receives 70 percent of the excess. Moreover, for a period of six years beyond the first ten years, Synthetic Fuels shares 50 percent of the difference between the market price and $32.55 a barrel (1983 dollars) and 70 percent of the difference between the market price and $45 a barrel (1983 dollars). Thus, if market oil prices rise sufficiently during the project's first 16 years, a large portion of the initial public subsidy could be recovered through revenue sharing. On the other hand, if market oil prices are stable or decline during the next 16 years, little if any public subsidies will be recovered. Synthetic Fuels optimistically estimates that a significant portion will be recovered and the final subsidy cost may be only about $1 a barrel, or about $350 million.

[12] That time could come sooner than previously expected. Congress currently seems to be reevaluating its earlier decision to support synfuels development with public funding. This could lead to reduced support for oil shale projects.

shale pose a more perplexing problem. Runoff of toxic wastes into mountain streams could present a serious problem. Although several methods of controlling leaching have been proposed, none have yet been proven. Significant leaching would reduce the quality of underlying aquifers. Extensive research is being done on this problem.

The availability of water could be more important to development of the oil shale industry than water quality problems. Water is a precious resource in the Colorado River Basin, and extensive processing of oil shale would substantially increase overall demand for available water supplies. If a large-scale oil shale industry becomes viable, however, water will very likely be allocated by pricing.

Another environmental issue involves reclaiming land where spent shale is deposed. The primary problems are in controlling leaching of hazardous wastes and restoring vegetation to limit erosion. The land reclamation problems appear manageable. With intensive cultivation, vegetation can be established directly on processed shale. But covering the shale with at least one foot of top soil or similar material reduces the time required for revegetation and leaves a more stable topography in the long run. Although land reclamation techniques share many common features, reclamation plans must be site-specific.

A series of federal and state regulations set environmental standards for air, water, and land. Under the Clean Air Act, the best available control technology has to be used to comply with national and state air quality standards. The Clean Water Act sets quality standards for any surface water discharge. Any toxic wastes from spent shale could be subject to the Resource Conservation and Recovery Act. Although no federal legislation has been written for managing the reclamation of spent shale, the Surface Mining and Control and Reclamation Act serves as a model for setting standards for shale projects on federal tracts.

Altogether, environmental issues have the effect of raising the cost of shale oil and slowing its development. Compliance with all the environmental regulations has been estimated as adding 10 to 20 percent to the cost of shale oil.[13] Beyond these direct costs, compliance also exacts a cost in time. More than 100 permits, many environmentally related, must be obtained to construct an oil shale plant. Obtaining these permits takes considerable time and effort.[14]

The environmental impacts of oil shale development are significant and largely unknown. Whether current environmental concerns are valid remains to be seen. But until much more is known about the effects of commercial shale oil production, environmental issues will be a factor slowing oil shale development.

Thus, oil shale's future will depend on oil prices, costs of production, energy policy, and environmental issues. Another boom and bust cycle would bring a new round of economic effects to the Western Slope. Because local governments there still have excess capacity in public infrastructure and services, they can accommodate a new development surge. The region and the oil shale industry, however, both hope for steadier growth in the years ahead.

Summary

The development of an oil shale industry has had its ups and downs throughout this century. Despite vast reserves of recoverable shale oil, energy prices usually have not been

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[13] *Oil Shale 1982: A Technology and Policy Primer*, p. 67.

high enough to make extraction of that oil commercially viable. The tripling and then tripling again of world oil prices in the 1970s gave initial promise that development had become economically feasible.

After only a few years of rapid development activity, however, the effort was brought to a near-halt by falling world oil prices. The results were a substantial reduction in economic activity for northwestern Colorado and, maybe more importantly, sharply lower expectations for the region's future economic growth. In both the upturn and the downturn, the local public sector was essentially shielded from financial stress because the energy companies helped fund public spending on infrastructure and services.

The future for oil shale remains uncertain. A few energy companies continue to pursue their development plans. To spur development of commercial scale plants, Synthetic Fuels Corporation has made loan and price guarantees to energy firms. Some projects may soon be extracting oil, providing needed technological and financial information on various techniques of oil extraction. But the future for oil shale remains clouded by uncertainties regarding the cost of producing syncrude and future oil prices. Environmental issues could also hamper oil shale development. Therefore, oil shale remains, as it has for more than a century, a technical and economic enigma that has only begun to be understood and developed.

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[14] The cost of complying with air, water, and land environmental standards differs considerably The Office of Technology Assessment concluded in 1980 that air quality controls would add 3 to 5 percent to the cost of syncrude, water quality controls would add about 1 percent, and land reclamation would add less than 1 percent.

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