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Energy and American Agriculture

By Marvin Duncan and Kerry Webb

American farmers have long prided themselves on their ability to produce abundant supplies of food and fiber. To accomplish this feat — and to do it profitably — American farmers have increasingly relied upon agricultural production practices that are both capital intensive and energy intensive. Their success has been premised on the ready availability of inexpensive energy. Agricultural producers, as well as those who supply inputs and market the products, must now consider their roles in an environment in which energy is no longer inexpensive and in which its ready availability is becoming questionable.

In the most basic sense, agricultural producers are in the energy conversion business: Producers grow plants to convert sunlight into an energy source useful to human beings as a foodstuff-either directly as a food or indirectly as an input into livestock production. Other inputs, including fossil fuels, are used to augment this energy conversion process. The increasing scarcity and cost of fossil energy will require greater attention in the future to the efficiency of energy use — both in terms of economic efficiency and of engineering efficiency.

This article examines the issue of energy use in U.S. agriculture. The energy efficiency of U.S. agriculture is compared to that of under-developed economies. Energy use trends and energy sources used in agriculture are discussed. Finally, the questions of economic and engineering efficiency in energy use are examined along with probable future directions in energy use trends.

.ENERGY USE IN PERSPECTIVE

The U.S. population consumes energy far in excess of its proportion to the world population. As recently as 1975, the energy used by the U.S. economy was an estimated 71.7 quadrillion British thermal units (Btu's).[1] The United States, with 5 per cent of the world's population, accounted for about 29 per cent of world energy consumption in that year. At the same time, the entire Sino-Soviet block — with about 28 per cent of the world's population — accounted for only about one-fourth of the world's energy consumption. Moreover, by some estimates, U.S. energy consumption is expected to more than double by the year 2000.

Though large in absolute terms,. the proportion of U.S. energy consumed in the food and fiber sector is relatively small. The sector requires only about 13 per cent of total energy consumed domestically each year in the

[1] A Btu is the quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit at or near its maximum density.

Table 1
BTU'S USED IN U.S. FOOD AND FIBER SECTOR BY MAJOR TYPES OF INDUSTRIES

Item	1970* Trillion Btu's	1970* Per Cent	1980 Trillion Btu's	1980 Per Cent	Change in Per Cent
Type of industry use:					
Farm production	1,051.4	22.5	1,095.3	21.1	+ 4.2
Farm family living	554.6	11.9	499.2	9.6	−10.0
Food and kindred product processing	1,302.9	27.9	1,548.3	39.8	+ 19.8
Marketing and distribution	832.7	17.9	988.9	19.0	+ 18.8
Input manufacturingt	925.3	19.8	1,063.8	20.5	+ 15.0
Total	4,666.9	100.0	5,195.5	100.0	+ 11.3

'For some industries data are for 1971, 1972, or 1973.
†Includes estimates for six selected industries.
SOURCE: Committee on Agriculture and Forestry, United States Senate, **The U.S. Food end Fiber Sector: Energy Use end Outlook,** September 20, 1974.

United States. (Table 1 contains data on energy use by the U.S. food and fiber sector by type of industry for 1970 with estimates for 1980.) Energy use in the food and fiber sector has increased rapidly, however—about three times between 1940 and 1970, while farm output almost doubled over roughly the same period.'

Farm energy use accounts for only 3 per cent of the total U.S. energy consumed.[3] Further, farm production uses only slightly more than one-fifth (line 1 of Table 1) of the energy used in the U.S. food and fiber sector. That expenditure of energy and its efficient use have resulted in a number of benefits to U.S. consumers. There has been an abundant and dependable supply of high-quality food for consumers. At the same time, the increasing productivity of U.S. agriculture—largely the result of replacing labor with machinery and fossil energy—has released large numbers of people for employment in other sectors of the economy. Food prices are substantially lower than they would be without mechanization and the productivity gains that come with energy intensive farming. Finally, U.S. agricultural production is so abundant that the products from nearly one-third of the country's harvested acres are exported; and the foreign exchange earnings of these exports ($24 billion in fiscal 1977) have paid for a large part of this country's energy imports in recent years.

U.S. agriculture, however, is sometimes accused of being energy inefficient when compared to agricultural production in other countries. Indeed, it has frequently been suggested that energy scarcities and resultant higher energy costs will ultimately cause U.S. agriculture to adopt the more labor intensive practices of the third world countries. But when data on energy efficiency are examined, the

2 Harold O. Carter and James G. Youde, "Some Impacts of the Changing Energy Situation on U.S. Agriculture," *American Journal of Agricultural Economics.* Volume *56,* Number 5, December 1974, p. 881.

3 *Energy Use in Agriculture: Now and for the Future,* Council for Agricultural Science and Technology, Report Number 68, August 1977, Ames, Iowa, pp. 1-3.

Table 2
ENERGY USE PER HECTARE IN RICE PRODUCTION IN VARIOUS COUNTRIES'

Country	Installed Horse-power Per Hectare Farm Machines and Draft Animals Only	Energy For Farm Operations Million Btu's Per Hectaret	Energy For Irrigation and Nitrogen Fertilizers Manufacture Million Btu's Per Hectare	Total Energy Input Per Hectare Million Btu's	Rice Yield Kilograms/ Hectare	Energy Intensity Million Btu's Per Ton of Rice
India	0.7	20	6.5	26.5	1,400	19
China	0.7	20	12	32	3,000	10.7
Taiwan	0.5	10	22	32	4,000	8
Japan	1.6	10	25	35	5,600	6.2
U.S.A.	1.5	7	25	32	5,100	6.3

'Total grain production depends not only on seed variety, soil quality, etc., but also on the mix of grains grown. Therefore, comparing a single grain gives a better comparison of the energy intensity of various farming methods.
†Energy used to perform various tillage, planting, and harvesting activities.
SOURCE: Arjun Makhijani, **Energy and Agriculture in the Third World, Ballinger** Publishing Company, Cambridge, Mass., **1975,** p. **17.**

popular notion—that subsistence farming uses less energy per unit of production than American agriculture—is not supported.

Table 2 contains data pertaining to the relative energy efficiency of various countries in the case of rice production. Although it is true that developed countries such as Japan and the United States use substantially greater amounts of installed horsepower, fertilizer, and irrigation energy per hectare in rice production than the developing countries, when noncommercial energy sources are taken into account, there is a surprisingly small difference in the total energy input per hectare among the five countries.[4] Japan and the United States have substituted machine power with vastly superior productivity for labor and animal power. Japanese and U.S. rice yields, as a result of superior production techniques and seedstocks, are markedly higher than in India or China. Moreover, when the Btu's required to produce a ton of rice are calculated, it is clear that the energy efficiency of the more mechanized rice production is superior to that of the labor and animal intensive agriculture. Thus, while U.S. farmers use more fossil energy per hectare than the farmers of most other countries, the energy use per unit of product is much lower for U.S. farmers than for their counterparts in underdeveloped countries.

The common belief that energy use in agriculture in underdeveloped countries is far less than in developed countries is based on the comparative use of fossil fuels, nuclear energy, and hydroelectric power. The energy sources common to poor people—wood, crop residues, animal manure, and human and animal labor—are not usually taken into account. When these noncommercial energy sources are included, the total energy use in agriculture per hectare in underdeveloped countries often exceeds that in industrialized countries. Noncommercial energy sources make an important contribution to the total energy

[4] One hectare is equal to 2.47 acres.

supply of underdeveloped countries as well. In fact, on a per capita basis, they may provide up to 70 per cent of the total energy requirements of many underdeveloped countries.[5] The principal difference in energy use between developed and underdeveloped countries is not that substantially less energy is used in the latter countries, but rather how little useful work is obtained from the energy used there as compared to developed countries.

ENERGY USE PATTERNS

Because energy used in U.S. agricultural production amounts to about only 3 per cent of total U.S. energy consumption, conservation measures directed at farming alone would have a limited effect in alleviating a national energy crisis. However, as fuel costs increase, there is a great incentive for farmers to use energy efficiently and conservatively. By knowing just how energy is being used in agriculture, it can be determined where it might be conserved.

Since the turn of the century, energy use in agriculture has changed dramatically. Since 1910, the amount of land harvested in the United States has remained relatively constant. However, the average index of crop production in the country nearly doubled between the 1911-20 decade and the decade of 1967-76.[6] The bulk of this increase can be accounted for by energy intensive technology. While the average index of farm labor fell 74 per cent, the average indices for machinery and agricultural chemicals rose 382 and 2,312 per cent, respectively, between the two periods. Research suggests that about half of the increase in energy inputs has gone to improve productivity (with such inputs as fertilizers and chemicals), while half has been used to replace labor (with such inputs as larger machinery).

Complete data on energy consumption in agriculture are not available for all recent years. However, the U.S. Department of Agriculture (USDA) has made an intensive effort to calculate farm production energy use for 1974.[7] Chart 1 summarizes energy use in U.S. agricultural production. According to the USDA, over 1.3 quadrillion Btu's of direct energy input went into agricultural production that year. An additional 700 trillion Btu's of indirect energy went into production of fertilizer, pesticides, and other agricultural chemicals. Crop producing activities used 89 per cent of the total consumption, while livestock production used only 11 per cent. The production of corn, soybeans, winter wheat, and grain sorghum consumed half the energy used in crop production nationally. More energy is used in corn production than any other crop; however, the production of tobacco and citrus fruits is far more energy intensive on a per acre basis.

About one-fifth of the 1974 total consumption of energy in U.S. farming was accounted for by agriculture in Tenth Federal Reserve District states.[8] Within these states, planting, cultivating, and harvesting used 20 per cent of the crop producing energy. Indirect energy in fertilizer and pesticides accounted for another 37 per cent of the District's energy use in crop production. The increasing use of irrigation within the District resulted in one-fourth of the total crop energy being used for

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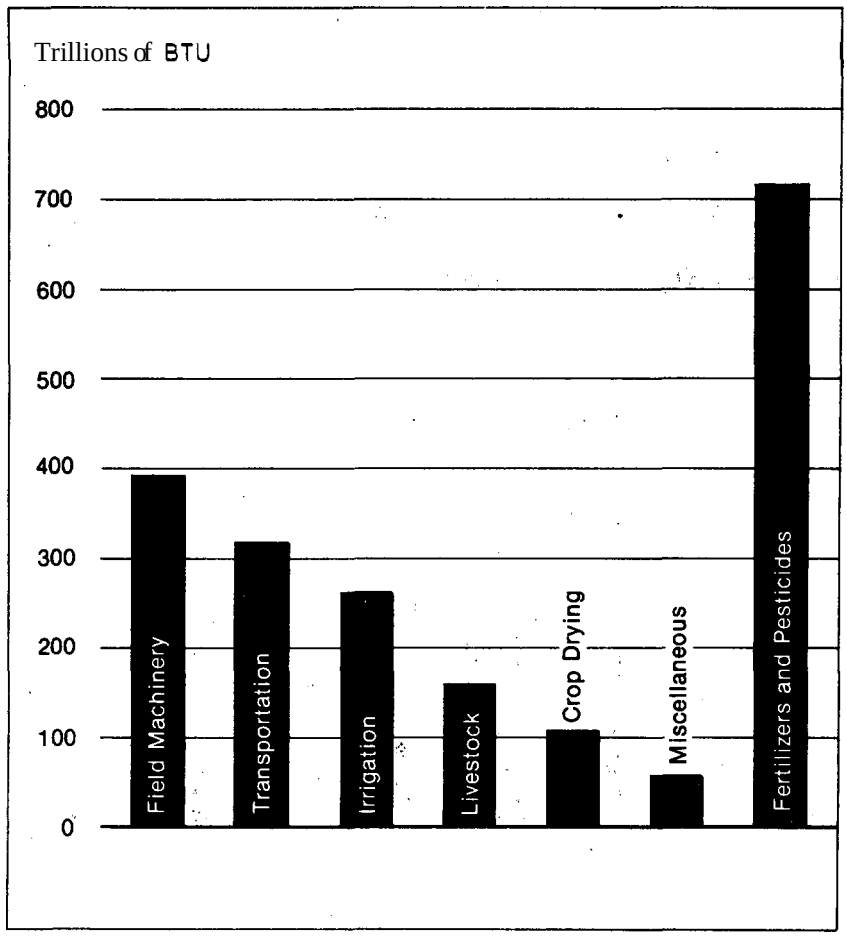
5 Arjun Makhijani, ***Energy and Agriculture in the Third World.*** Ballinger Publishing Company, Cambridge, Massachusetts. 1975. pp. 15-20.

6 U.S. Department of Agriculture, ***Changes*** in ***Farm Production and Efficiency.*** 1977, Statistical Bulletin Number 581, Washington, D.C., November 1977, pp. 6-7.

7 U.S. Department of Agriculture, ***Energy and U.S. Agriculture: 1974 Data Base,*** Volume 1, (Washington. D.C., Government Printing Office, September 1976).

8 The Tenth District includes Colorado, Kansas, Nebraska. Wyoming, most of New Mexico and Oklahoma, and 43 counties in western Missouri.

Chart 1
ENERGY USE IN U.S. AGRICULTURAL-PRODUCTION

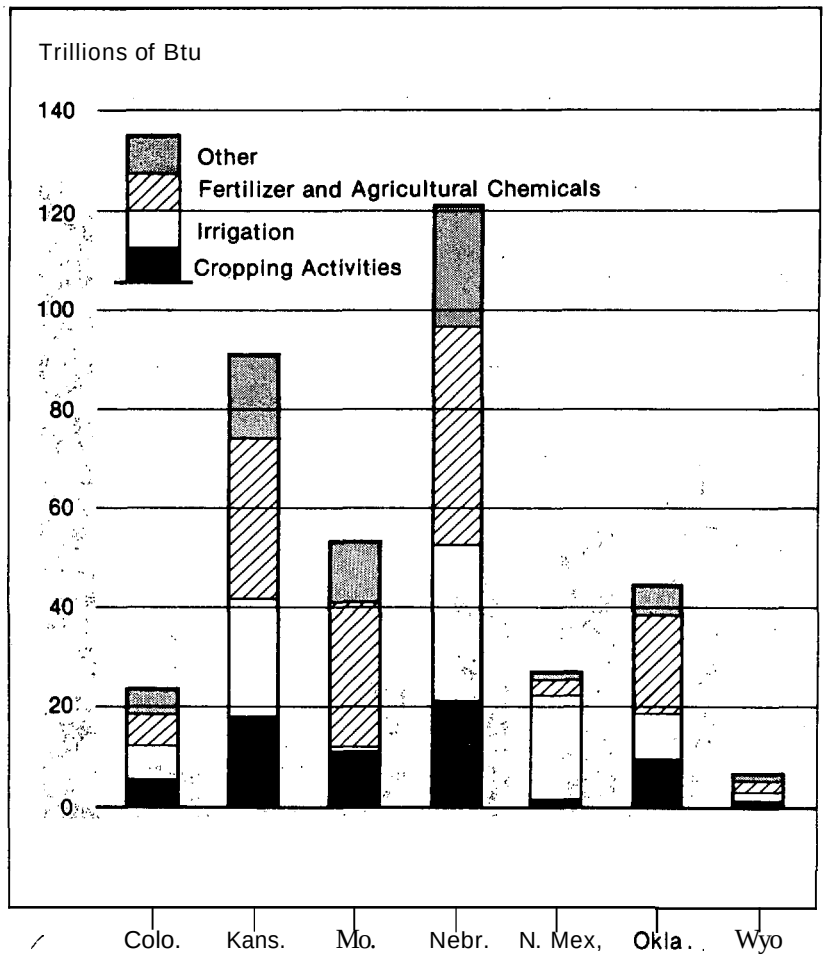


SOURCE: **Energy and** U.S. **Agriculture: 1974 Data Base.**

that purpose. This figure is substantially higher than for the nation as a whole, where only **15** per cent of the crop energy was used for irrigation. Crop drying and farm vehicle use made up the remainder of the energy consumption.

Direct energy used in livestock production is small (Chart 1) compared to that used in producing crops. In 1974, cow-calf operations used the greatest amount of such energy, although milk cows were the most energy intensive on a per head basis among various livestock. In Tenth District states, feed handling consumed the most energy, using up 41 per cent of the livestock energy budget. Lighting, heating, ventilation, and water supply consumed **12** per cent, while farm vehicles used 33 per cent of the livestock energy. Charts **2** and 3 show the proportion of energy consumed by various operations in District states.

Chart 2
ENERGY USED TO GROW CROPS



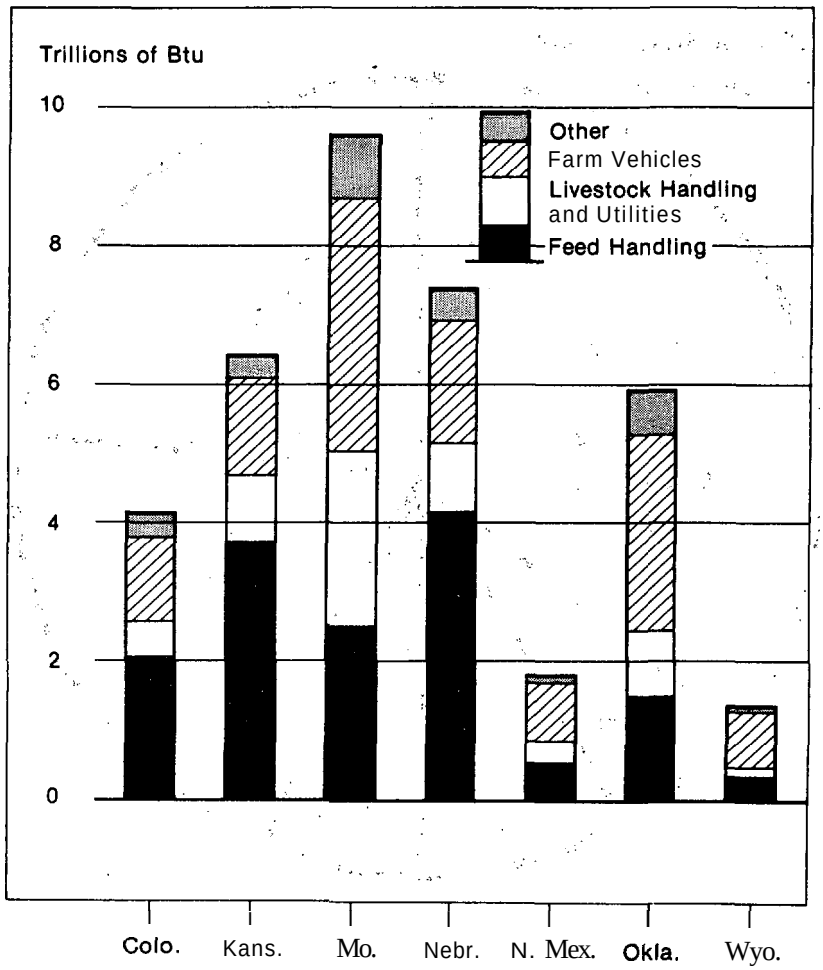
SOURCE: **Energy and** U.S. **Agriculture: 1974 Data Base.**

Energy Sources

Knowing how energy is used on the farm is only part of the information needed to understand agriculture's energy problems. The sources of energy also need to be identified so that their importance and substitutability can be analyzed. It should be noted that energy sources or fuels are generally not substitutable on a one-for-one basis. Moreover, even when converted to equivalent energy units, various fuels are not at all equivalent in terms of cost. Thus, energy use decisions must be tempered by technological and economic considerations, in addition to availability constraints.

Direct farm energy in 1974 was derived from six main sources: gasoline, diesel fuel, fuel oil, LP gas, natural gas, and electricity (Chart 4).

Chart 3
ENERGY USED TO RAISE LIVESTOCK



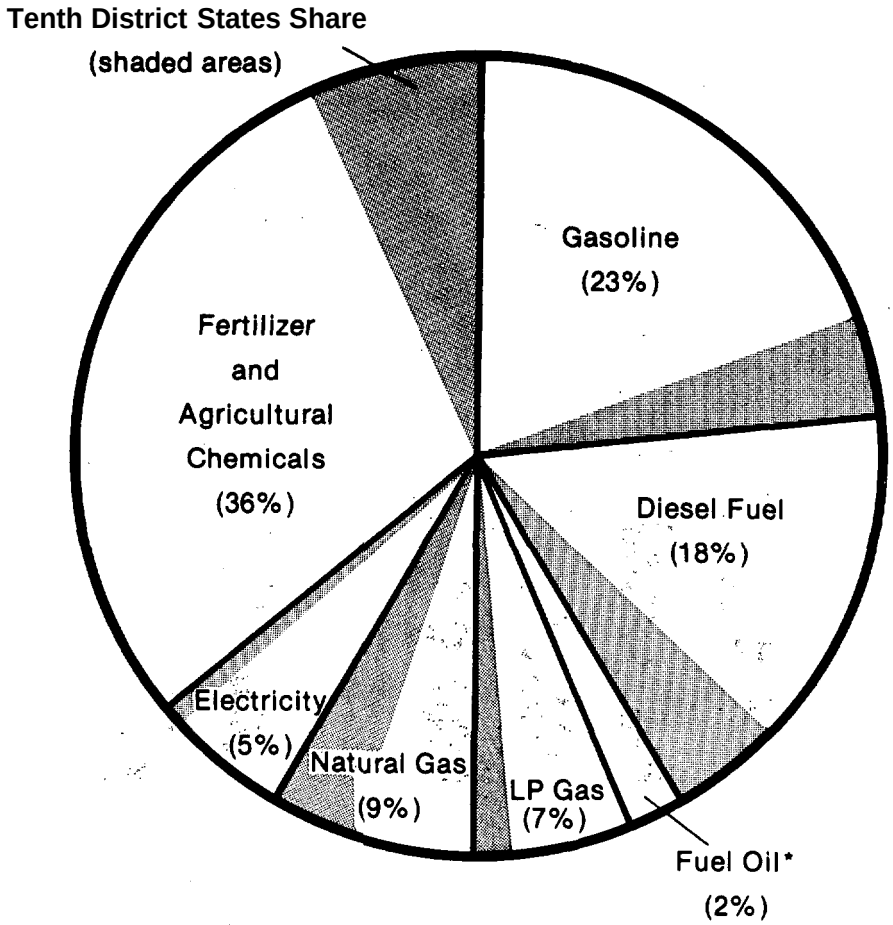
SOURCE: **Energy and** U.S. **Agriculture: 1974 Data Base.**

Indirect energy consumption used in the production of fertilizers and agricultural chemicals is also shown in the chart.

Gasoline and diesel fuel are used in growing most crops and also serve as the fuel sources for two-thirds of the energy required for livestock production. Fuel oil is mainly used to protect citrus fruit'from frost and also in drying crops. Next to gasoline and diesel fuel, LP gas is the most versatile energy source and serves as a major input in many field operations, crop drying, and brooding. The energy from natural gas and electricity is used to fuel the bulk of the nation's pumped irrigation.

Tenth District states account for 30 per cent of the total pump-irrigated acreage in the United States. Thus, rising fuel costs will become extremely important to farmers in this

Chart 4
AGRICULTURAL ENERGY USE BY VARIOUS FUELS
U.S. AND TENTH DISTRICT STATES



'Less than one per cent of the fuel oil is used by Tenth District states.
SOURCE: Energy and U.S. Agriculture: 1974 Data Base.

region as profit margins come under increased pressure, For example, at present, pumped irrigation depends almost entirely on natural gas and electricity. Because irrigated farms produce a relatively small proportion of the total crop output, it is very difficult for rising energy costs to be passed on to the consumer. Substitution of other fuels or other inputs (for example, more fertilizer and less water) may be possible to a limited extent. However, switch-over costs and the availability of other fuels and inputs make it doubtful that farmers could reduce their costs very much—at least in the near future. Although some conservation measures (for example, minimum tillage practices) may help, the dependence on energy

for irrigation leaves producers with few alternatives, other than to absorb the increased production costs.

Energy Costs

In **1974,** the cost for farm energy totaled over **$4.2** billion and amounted to almost **6** per cent of total production expenses. From **1973** through **1977,** direct agricultural energy costs have risen as follows: gasoline, **69** per cent; diesel fuel, **99** per cent; fuel oil, **109** per cent; LP gas, **130** per cent; natural gas, **220** per cent; and electricity, **59** per cent.[9] The proportion of total farming costs attributable to energy has risen sharply and can be expected to increase in the years ahead as fuel costs increase relative to the prices of other inputs.

Although farmers in Tenth District states used **20** per cent of the nation's agricultural energy, the District's energy bill **($704** million in **1974)** amounted to only **16** per cent of the total **U.S.** agricultural energy cost. When the various fuel costs are examined, expenditures for gasoline total **41** per cent of the Tenth District's energy budget, even though gasoline supplies only **29** per cent of the direct energy. On the other hand, natural gas expenditures amount to only **4** per cent of the energy bill yet provide one-fourth of the Tenth District's energy. These differences reflect the variations in market prices of the various fuels and also the different market situations through which each fuel is supplied. For example, the high gasoline and diesel fuel prices paid by the farmer are linked to the cost of imported oil. Likewise, interstate natural gas prices are artificially low due to government price regulations. Table **3** shows the proportionate consumption and the costs of fuels used in Tenth District agriculture. Cost differentials suggest to some observers that technological movements toward the use of more natural gas would be profitable. However, recent price increases and the prospect for further substantial increases if price deregulation occurs will likely limit increases in natural gas use.

[9] Direct agricultural energy costs do not include the cost of energy used in the production of fertilizer, chemicals, and machinery, or energy used in farm family living.

POLICY CONSIDERATIONS

Public policy questions regarding energy use in agriculture have recently been addressed from two quite different points of view. One point of view suggests that price signals in a market economy are sufficient to guarantee efficient use of energy. The other point of view suggests that it is necessary to examine the conversion ratios of energy in agriculture to establish efficient energy use. The former viewpoint examines economic efficiency while the latter is concerned with engineering efficiency.

Economic Efficiency

The economic efficiency viewpoint is intuitively attractive. In a market economy where relative prices guide resource use, those inputs with the greatest output efficiency relative to their respective costs are the ones used in production. If all input and product prices are established in the market place, if the prices established are true measures of the value society places on the goods, and if all prices are known to producers, then profit maximizing behavior by producers will at the same time result in the most efficient use of resources—including energy resources. Thus, when the **1976** average cost of employing a farm laborer for **10** hours is **$26.50,** but the physical work he performs can be purchased as electricity for only 3 cents, it is not surprising

Table 3
TENTH DISTRICT FUEL CONSUMPTION AND EXPENDITURES IN 1974

Energy Source	Per Cent of Tenth District Agricultural Energy Use	Per Cent of Tenth District Agricultural Energy Expenditure	1974 Average Tenth District Cost/1,000,000 Btu
Gasoline	29.4	41.1	$3.64
Diesel fuel	31.1	29.2	2.48
Fuel oil	0.1	0.1	2.50
LP gas	10.3	11.3	2.93
Natural gas	24.5	4.3	0.50
Electricity	4.6	14.0	8.04

SOURCE: Developed from USDA data.

that U.S. agricultural production is energy intensive.

However, not all the criteria outlined above are met.in the real world. Some problems exist. Various government price control mechanisms — such as regulating interstate natural gas prices while allowing intrastate natural gas prices to seek market -determined levels— distort relative resource price comparisons. Additionally, maintaining the price of domestic (U.S.) crude oil below the world crude oil price also distorts relative resource prices.

The further question of whether world market. prices accurately reflect the value society places on energy is an exceedingly difficult one. Do administered OPEC oil prices represent petroleum's true market value? Do present market prices for energy reflect all costs of production — including costs typically borne wholly or partially by society--such as those associated with water and air pollution or land reclamation? If petroleum supplies have finite limits, should petroleum be valued at today's world price or should a much higher value be placed on it to limit its current use and conserve the supply for future generations? These questions — for which there presently are no generally agreed upon answers — serve to warn policymakers that the present pricing structure for energy resources may not ,result in socially optimal energy' use patterns.

Engineering Efficiency

Engineering efficiency examines the ratio of energy output per unit of energy input. In a perfectly competitive market system such calculations would be considered little more than an academic exercise. However, in an environment in which constraints on market prices do exist, such calculations could be valuable in identifying those production processes which are the least energy efficient. The degree of engineering efficiency is primarily determined by the technology available for production and processing of inputs and outputs. This technology, in turn, reflects the current state of the art as well as tastes and preferences of people. High relative energy costs will likely stimulate new technology with greater energy efficiency. Likewise, changes in consumers tastes and preferences toward food products requiring less processing and transportation presumably could improve the food system's energy efficiency. For example, over 45 per cent of the energy expended in the food and fiber sector in 1970 went for food processing and marketing

which directly reflected consumer preference (Table 1).

Consideration of energy efficiency suggests energy policy alternatives. For example, Cornell University researchers have suggested that in corn production—which they assume typifies energy requirements in U.S. crop production—the energy resulting from an acre of harvested corn may be as much as 3.7 times as great as the on-farm energy expended in its production.[10] Considering these data in light of the need to supply food to an ever increasing world population, the potential increase in food production resulting from energy intensive agriculture is particularly appealing.

On the other hand, if energy used in the production of farm machinery and food processing were added to on-farm energy usage, research has shown that three times as much energy is required to produce the product as is consumed at the table.[11] These findings, coupled with calls for energy conservation and nonreliance on foreign energy sources, have led to suggestions for a more labor intensive agricultural production system along with reduced processing and transportation of foodstuffs.

On balance, energy efficiency must be viewed in both an economic sense and an engineering sense. Changes in energy prices relative to product prices and increased public recognition of the need for energy conservation can be expected to have an impact on agricultural production. In the future, farm equipment will be engineered for greater energy efficiency and will be more closely scaled to the demands for particular jobs. However, the capital stock for agriculture and for other basic industries was put in place under conditions of low energy prices. Consequently, more energy efficient machines will be incorporated into the capital stock only as rapidly as that stock becomes obsolete or worn out. Rapidly increasing energy prices will hasten such obsolescence, of course. Irrigation water will be used much more sparingly with little loss in productivity. New tillage practices will reduce energy consumption. Plant breeding advances will incorporate greater disease and pest resistance as well as greater resistance to adverse weather. Greater use of solar energy and biomass conversion will occur in those situations for which they are adapted—such as grain drying and heating or cooling brooder and farrowing houses.[12] Additionally, land tenure patterns adapted to fossil energy intensive agriculture are amenable to change only over a long period. On balance, then, the changes that occur are likely to be gradual but the cumulative impact could be substantial.

CONCLUSION

The productivity enjoyed by U.S. agriculture is largely based upon high levels of commercial energy (fossil fuel) consumption. This dependence frequently has led to suggestions that U.S. farmers return to a more labor intensive agriculture, in order to conserve increasingly scarce energy and to augment the energy supplies of developing nations. However, when the total energy use in food production is examined for the United States and for countries with labor intensive agricultural systems, the argument loses much

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10 David Pimental, *et al.* "Food Production and the Energy Crisis," *Science.* Volume 182, November 2, 1973, p. 445.

11 Michael J. Perelman, "Mechanization and the Division of Labor in Agriculture," *American Journal of Agricultural Economics.* Volume 55, Number 3, August 1973, p. 524.

12 Biomass conversion generally refers to the production of a gaseous or liquid energy source from plant or animal matter—usually from residues.

of its appeal. For what stands out in such a comparison is that the **U.S.** system produces far more food per unit of total energy used than the typical system of developing countries, with their intensive use of human and animal labor.

Nonetheless, **U.S.** farmers produce in a market economy. As energy prices climb relative to the cost of other inputs, farmers will shift toward more energy' efficient production techniques. These shifts will likely occur rather slowly—as equipment wears out or becomes obsolete as a result of new and more efficient technology—but the cumulative result will be quite significant. While **U.S.** farmers will probably continue to use energy intensive production techniques, there seems to be little doubt that as energy costs escalate, commercial energy sources will be used much more efficiently in the future.

The Federal Reserve and the Government Securities Market

*By Margaret E. Bedford**

The Federal Reserve System has held Federal Government securities since 1917, when the U.S. Treasury issued a large supply to help finance World War I. Initially, System purchases were made to provide a market for Federal securities and to supplement Reserve Bank earnings. Through its participation in the Government securities market, the System discovered that it could influence bank reserves and money and credit conditions in the economy. System procedures for participation in the market were formalized in the Banking Acts of 1933 and 1935, which gave the Federal Open Market Committee (FOMC) power to determine the extent of System operations.

Federal Government securities are now the Federal Reserve's largest asset, and the System buys or sells Government securities almost every business day. This article discusses the Federal Reserve's holdings of and transactions in U.S. Government securities. The first section deals with trends in the Federal Reserve's holdings since 1950. The second section treats short-run fluctuations in the System's portfolio. In the third section, the article discusses the types of transactions used by the Federal Reserve to purchase and sell securities, and the fourth section analyzes the impact of these transactions on the Government securities market.

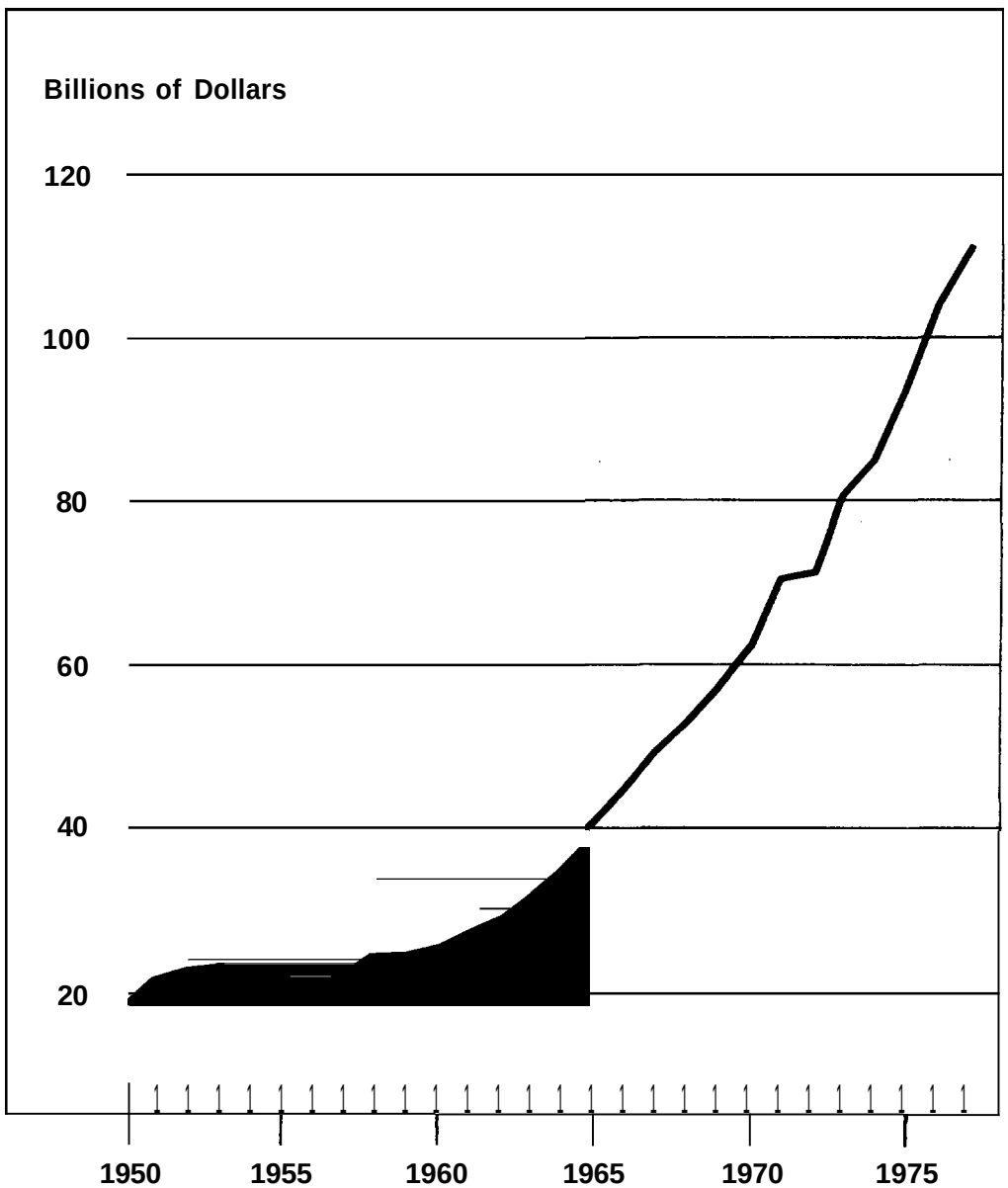
TRENDS IN FEDERAL RESERVE HOLDINGS OF U.S. GOVERNMENT SECURITIES

The Federal Reserve System's holdings of U.S. Government securities increased from $21 billion at the end of 1950 to $111 billion at the end of 1977. (See Chart 1.) Throughout the period, System holdings consisted mainly of marketable U.S. Treasury securities, which amounted to $103 billion at the end of 1977. Since 1971, the System has been authorized to purchase and sell Federal agency obligations outright, and holdings of these securities were $8.5 billion at the end of 1977. As a percentage of total U.S. Government and Federal agency securities outstanding, Federal Reserve System holdings increased from 8.1 per cent in 1950 to 13.6 per cent in 1977.

As a percentage of total Federal Reserve

***J. A. Cacy, Vice President and Senior Economist, advised in the preparation of this article.**

Chart 1
FEDERAL RESERVE HOLDINGS OF U.S. GOVERNMENT AND FEDERAL AGENCY SECURITIES
(End of year, 1950-77)



SOURCE: Federal Reserve Bulletin.

assets, security holdings increased steadily from 44 per cent in 1950 to 81 per cent in 1977. System holdings of Government securities have grown much more rapidly in the 1960's and 1970's than in the 1950's. The average annual growth rate of System security holdings was 8.7 per cent in 1970-77, 8.5 per cent in 1960-70, and only 2.8 per cent in 1950-60.

The growth in the Federal Reserve's holdings of U.S. Government and Federal agency securities is related to the System's major purpose, which is to foster growth in the nation's supply of money and credit that will encourage economic growth, stable prices, high employment, and balance in international transactions. The System influences monetary growth by providing for growth in the nation's monetary base, which consists, of certain liabilities of the Federal Reserve—member bank reserves plus currency in circulation outside member banks.

To bring about growth in the monetary base, the Federal Reserve increases its assets. When the System acquires assets, such as securities, the seller of the assets receives a claim on the Federal Reserve, which can be deposited in a bank or converted into currency. The base increases in either case, due to an increase in member bank reserves or in currency outside member banks. (In practice, member bank reserves automatically rise when the System purchases securities because a Reserve Bank credits the account of a member bank designated by the security dealer for the amount of the securities sold.) While increases in System assets support growth of the base, declines in System assets lead to reductions in the base. Also, increases in System liabilities, other than those included in the base, result in declines in the base, while decreases in nonbase liabilities lead to increases in the base.

The relationship between the monetary base and Federal Reserve assets and liabilities may be stated as a balance sheet equation such as:

(1) Monetary base = F.R. holdings of securities
+ other F.R. assets
— F.R. liabilities, other than the base.

or

(2) F.R. security holdings = monetary base
— other F.R. accounts,

where other F.R. accounts equals other F.R. assets minus F.R. liabilities, other than the base.[1] Equation (2) may be used to determine the amount by which Federal Reserve holdings of securities need to grow. The change in these holdings depends on the needed growth in the monetary base[2] minus any rise in other F.R. accounts, or plus any decline in other accounts.

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[1] Technically, the other factors affecting the monetary base include some items that are not on the Federal Reserve's balance sheet, but are U.S. Treasury account items. These include Treasury currency outstanding and Treasury cash holdings. The effects on the monetary base of changes in Treasury currency outstanding are similar to those of a change in a Federal Reserve asset, while the effects of changes in Treasury cash holdings are similar to the effects of changes in Federal Reserve liabilities. The term—other F.R. accounts—will be used throughout this article for simplicity.

[2] The need for growth in the monetary base is determined by the desired changes in the money supply, currency and bank deposits, to support economic growth. Increases in the public's demand for currency must be supported dollar for dollar by increases in the base. Increases in bank deposits are supported by smaller increases in the base, since member banks are required to keep only a fraction of their deposits as reserves. Increases in reserves to support deposit growth reflect, in part, reserve requirement ratios and other factors that affect the volume of reserves per dollar of deposits. Average reserve requirements for member banks have generally declined in the postwar period, reducing the need for growth in bank reserves to support deposits. Since reserve requirements differ between member and nonmember banks, by size of institution, and among classes of liabilities—demand, savings, or time deposits, and other borrowed money—shifts in deposits

Since movements in other F.R. accounts are largely independent of Federal Reserve control,' the System must offset changes in these accounts with changes in security holdings to ensure needed growth in the base.

Using equation (2) to analyze changes in security holdings in the 1950-77 period, the monetary base rose $79 billion during the period with an increase in currency accounting for more than three-fourths of the rise. (See Table 1.) During the same period, other F.R. accounts fell $6 billion. Thus, the Federal Reserve increased its Government security holdings $86 billion to support the rise in the base and to offset the decline in other F.R. accounts.

The decline in other F.R. accounts in the 1950-77 period reflects gold outflows (i.e., a decline in gold certificates held by the Federal Reserve) and an increase in Treasury deposits at the Federal Reserve, which'were only partly offset by increases in Federal Reserve float and "all" other F.R. accounts. The all other F.R. accounts category includes assets such as loans to member banks and Treasury currency outstanding and liabilities such as Treasury cash holdings and foreign and other deposits at Reserve Banks. Some of these items are on the balance sheet of the Treasury rather than the Federal Reserve but affect the monetary base.

In the more recent 1970-77 period, the rise in Federal Reserve holdings of Government securities was about the same as the increase in the monetary base, since other F.R. accounts did not change much. The small change in other F.R. accounts reflects a large increase in Treasury deposits at Reserve Banks which was mostly offset by increases in other factors. A rise in the gold certificate and SDR account supported increases in the monetary base in the most recent period, while declines led to reductions in the base in the earlier periods.

SHORT-RUN FLUCTUATIONS IN FEDERAL RESERVE HOLDINGS OF GOVERNMENT SECURITIES

While Federal Reserve holdings of Government securities have generally increased over the long run, they fluctuate sharply in the short run. These fluctuations accommodate short-run changes in the monetary base, which result from temporary and seasonal movements in reserves and changes in the public's demand for currency. Also, short-run changes in securities offset changes in other F.R. accounts, which are subject to wide swings that, unless offset, would result in undesirable changes in the base. In 1977, the weekly absolute average change in other Federal Reserve accounts was $2.1 billion, compared with $0.7 billion for the monetary base. (See Table 2.) Thus, most of the $2.0 billion

2 (Cont.)

among the various categories or between banks alter the growth in deposits that can be supported by a given volume of reserves. Also, changes in regulations—such as allowing member banks to begin counting vault cash as reserves in 1960, the change to lagged reserve accounting in 1968, and the changes in the timing of crediting reserve accounts for checks cleared in 1972—have an impact on the volume of bank reserves needed. Growth in reserves is also affected by banks' demand for excess reserves, which in turn may be influenced by regulatory provisions such as carry-over provisions in reserve accounting.

3 The Federal Reserve does have control over some of the factors affecting "other F.R. accounts." Other accounts include Federal Reserve holdings of bankers' acceptances which may be increased or reduced at the discretion of the Federal Reserve. Other accounts also include borrowings by member banks from the Federal Reserve, over which the Reserve Banks have administrative control. Member banks' borrowing may fluctuate in response to Federal Reserve monetary policy. Generally, when the Federal Reserve tightens its monetary policy stance and interest rates rise, member banks increase their borrowing at the Federal Reserve discount window. On the other hand, an easing in policy usually leads to a decline in member bank borrowing. Acceptances and member bank borrowing are of relatively minor importance in the long run. The Federal Reserve has reduced acceptance holdings in recent years, and repayment of member bank borrowings have absorbed reserves slightly on average in the 1970-77 period.

Table 1
CHANGES IN FEDERAL RESERVE HOLDINGS OF SECURITIES, THE MONETARY BASE, AND OTHER ACCOUNTS
(Based on annual averages of daily figures, billions of dollars)

	1950-60	1960-70	1970-77	1950-77
F.R. holdings of U.S. Treasury and Federal agency securities	+8.0	+31.8	+45.8	+85.6
Monetary base	+6.3	+27.6	+45.4	+79.3
Member bank reserves	+2.1	+ 9.8	+ 6.7	+18.7
Currency*	+4.2	+17.8	+38.7	+60.7
Other F.R. accountst	–1.6	– 4.2	– 0.4	– 6.2
Gold and SDR's	–4.9	– 7.4	+ 1.2	–11.1
Treasury deposits at Federal Reserve Banks	+0.1	– 0.6	– 6.3	– 6.8
Federal Reserve float	+0.6	+ 1.8	+ 0.7	+ 3.1
All other F.R. accounts	+2.6	+ 1.9	+ 4.0	+ 8.5

'Vault cash of member banks was allowable as reserves as follows: None, June 21, 1917-Nov. 30,-1959; part, Dec. 1, 1959-Nov. 23, 1960; all, beginning Nov. 24, 1960. Therefore, currency includes member bank vault cash in full in 1950 and in part in 1960; while member bank reserves include vault cash in part in 1960 and in full in 1970 and 1977.
†An increase (decrease) in Federal Reserve assets is entered as a positive (negative) figure, while an increase (decrease) in Federal Reserve liabilities is entered as a negative (positive) figure.
Details may not add to totals due to rounding.

absolute average change in security holdings was due to fluctuations in other F.R. accounts.[4] Chart 2 shows the close short-run relationship between holdings of Government securities and other F.R. accounts.

Short-run changes in Federal Reserve holdings of Government securities were much larger in 1977 than in **1970,** as shown in Table 2. While part of the increase may be attributable to higher levels, absolute average weekly changes as a percentage of the average level increased from 0.6 per cent in **1970** to **1.9** per cent in **1977.** Taking into account the changes in levels, the greater fluctuations in security holdings were due to larger movements in other F.R. accounts, as fluctuations in the monetary base were equal in **1977** and **1970.**

The greater changes in other F.R. accounts were due mainly to a rise in the average change in Treasury deposits at Federal Reserve Banks from **$124** million, or **11** per cent of the level in **1970,** to **$2.1** billion, or **28** per cent of the level in **1977.** In **1970,** the Treasury kept deposits at Federal Reserve Banks at a fairly stable level and allowed its deposits at commercial banks to

[4] The Federal Reserve has some control over changes in other F.R. accounts since these include the Federal Reserve's holdings of acceptances and member bank borrowing. However, the absolute average change in both acceptances held by the Federal Reserve and member bank borrowing was less than $0.2 billion in 1977.

Table 2
ABSOLUTE AVERAGE WEEKLY CHANGES IN FEDERAL RESERVE HOLDINGS OF SECURITIES, THE MONETARY BASE, AND OTHER ACCOUNTS

	Absolute Average Weekly Changes			
	(Levels, Millions of dollars)		(As a percentage of the annual average level)	
	1970	1977	1970	1977
F.R. holdings of U.S. Government and Federal agency securities	364	1,984	0.6	1.9
Monetary base	435	724	0.6	0.6
Member bank reserves	317	562	1.1	1.6
Currency (outside member banks)	301	592	0.6	0.7
Other F.R. accounts	335	2,104	1.7	11.1
Treasury deposits at FRB's	124	2,110	11.3	28.4
Federal Reserve float	321	535	11.0	14.6
All other F.R. accounts	182	275	1.0	1.2

fluctuate. In the 1970's, the Treasury changed its cash management policies and began calling deposits from commercial banks more quickly, thus increasing balances at the Reserve Banks and increasing the volatility of these deposits.[5] Starting in May 1978, the Treasury will be allowed to invest its balances in interest-bearing notes at financial institutions. This will reduce the week-to-week changes in Treasury deposits at Reserve Banks, but the amount of the reduction remains uncertain.

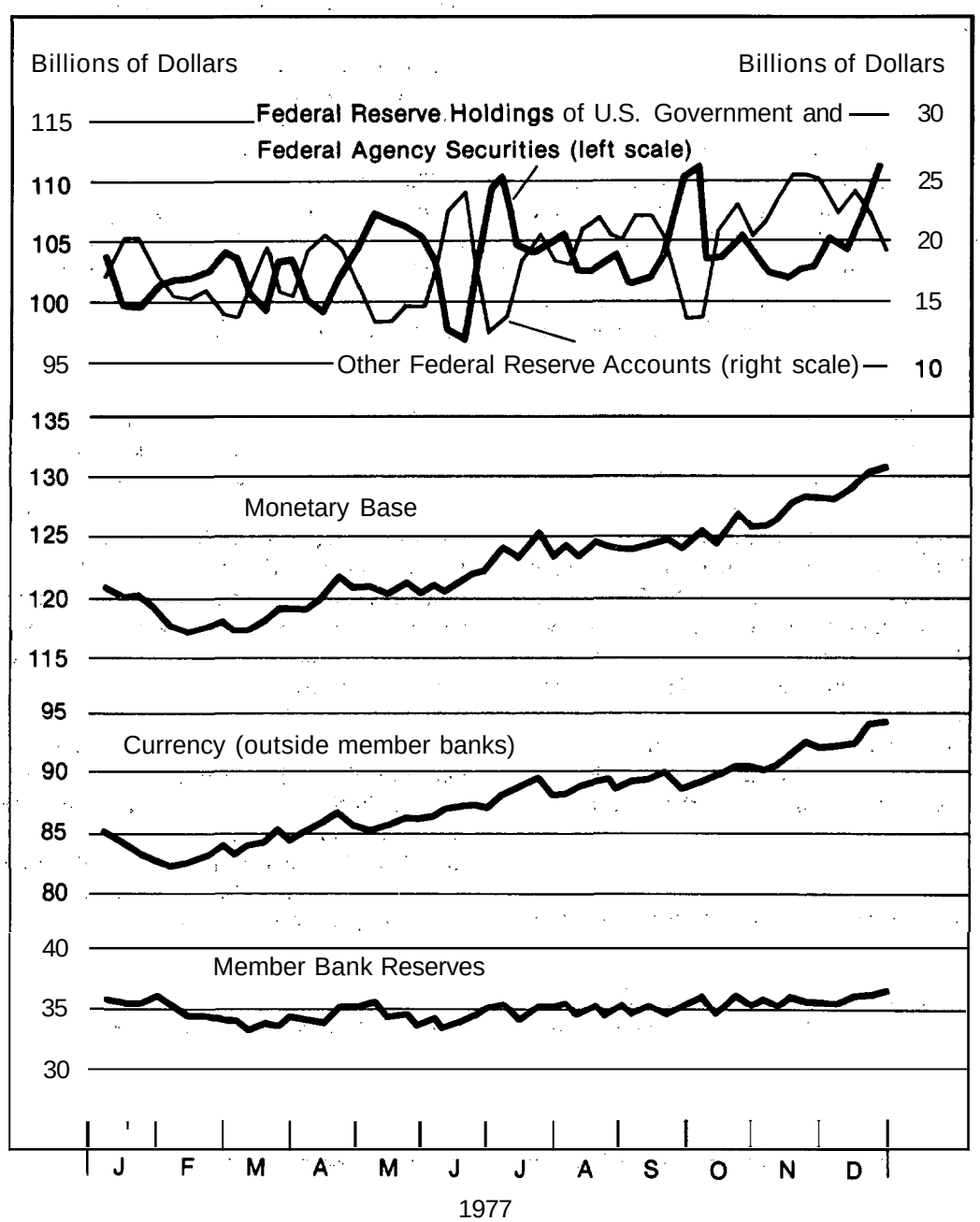
FEDERAL RESERVE TRANSACTIONS IN GOVERNMENT SECURITIES

The large fluctuations in the Federal Reserve's holdings of Government securities require the System to conduct a large volume of transactions in these securities. The System Open Market Account (SOMA) conducts transactions in U.S. Government and Federal agency securities with either foreign accounts or domestic security dealers.[6] Several types of transactions are used, including outright

[5] For an explanation of the changes in the Treasury's procedures and their effect on the volatility of Treasury deposits at Reserve Banks, see Peggy Brockschmidt, "Treasury Cash Balances," Federal Reserve Bank of Kansas City Monthly Review. July-August 1975.

[6] Open market transactions are also conducted in bankers' acceptances but these have been of relatively minor importance in recent years when compared with transactions in U.S. Government and Federal agency issues. In March 1977, the Federal Reserve announced that it would no longer purchase or sell bankers' acceptances outright except under unusual ,circumstances, since the market for bankers' acceptances is well developed and efficient and no longer in need of support through Federal Reserve participation. The System remains a participant in the market through its repurchase agreements with dealers that are secured by bankers' acceptances and by serving as agent in buying and selling acceptances for the accounts of foreign central banks. At the end of 1977, SOMA holdings of bankers' acceptances were less than $1 billion. The activities of SOMA in the bankers' acceptance market will not be discussed further in this article.

Chart 2
FEDERAL RESERVE SECURITY HOLDINGS, MONETARY BASE, AND OTHER ACCOUNTS



purchases and sales of securities, redemptions of maturing securities, repurchase agreements (RP's), and matched sale-purchase agreements (MSP's).

Outright transactions are conducted with foreign accounts or domestic dealers with no agreement to reverse the transaction. Reserves and base money are provided when the System buys securifies and are absorbed when it sells or redeems securities. A repurchase agreement involves the purchase of securities by the Federal Reserve from a dealer with the condition that the dealer will buy back the same securities at a predetermined price or yield after a stated period of time, not exceeding 15 days. An RP may be terminated by either party prior to maturity unless a nonterminable contract is made. RP's initially provide reserves but absorb them again when terminated. Matched sale-purchase agreements, often referred to as reverse RP's, involve the sale of Treasury bills at stated prices by the Federal Reserve to a domestic dealer or foreign account with the condition that the System will buy the securities back after a stated period, normally less than 7 days. MSP's initially absorb reserves but provide them again when terminated.[7]

The particular transaction chosen and whether it is with the domestic market or foreign customers depends on the objective to be achieved — provision or absorption of reserves or investment needs of foreign customers. The technique used also depends on the magnitude and duration of the reserve need. RP's and MSP's are generally used on a temporary basis to offset short-run fluctuations in reserves, and outright transactions are used when it is necessary to supply or absorb reserves for longer periods.

The volume of transactions the SOMA conducts in Government securities depends mainly on the objectives of monetary policy as established by the Federal Open Market Committee (FOMC). At any point in time, objectives typically involve maintaining the interest rate on Federal funds within a specified range. The Federal funds rate is the rate at which banks are willing to lend or borrow immediately available reserves, usually on an overnight basis; it is used as an indicator of the degree of pressure on bank reserves. The specified range for the funds rate is chosen to be consistent with longer run objectives of monetary policy, which involve providing the volume of reserves and base money needed to support adequate growth in money and credit for the economy.'

Given the Federal funds rate objective, the SOMA's daily and weekly transactions are determined by the need to provide for those changes in the base that are consistent with the funds rate objective and to offset any changes in other F.R. accounts that would cause a change in the base that is not consistent with the objective. Changes in the base may be

[7] Outright transactions with the market are normally made through an auction in which dealers submit price bids for securities of the type and maturity the SOMA Manager plans to buy or sell. Foreign orders are executed at the "best" market prices being quoted by dealers at the time of the transaction. The distribution of RP's among dealers is determined through an auction in which dealers submit bids at various rates. The SOMA Manager accepts the bids in descending order up to the amount needed. In executing MSP agreements, the Manager requests dealers to make offerings in an auction indicating the amounts and prices at which they would resell the same securities to the System at maturity of the MSP's. The Account Manager accepts the highest prices bid.

[8] The FOMC directive to the Account Manager states that the Committee seeks to maintain the weekly average Federal funds rate at a certain level, so long as M1 and M2 appear to be growing over a 2-month period at annual rates within specified ranges. If it appears that growth rates over the 2-month period are deviating from their ranges, the SOMA Manager is instructed to modify the operational objectives for the weekly average Federal funds rate within a range specified by the Committee.

needed to encourage a change in the funds rate called for by policy objectives. However, even if policy calls for a stable funds rate, the base may fluctuate daily and weekly, due to seasonal and random shifts in the demand for reserves and currency.

To illustrate SOMA's daily and weekly activity, gross transactions in Government securities were $23.6 billion in the statement week ending December 21, 1977. (See Table 3.) The net weekly increase in security holdings was $7.7 billion, providing for a $3.4 billion rise in the base and offsetting a $4.2 billion decline in other F.R. accounts. These transactions were consistent with maintaining the daily effective Federal funds rate within a range of 6.51 and 6.57 per cent.

Transactions were conducted on each business day of the week. On Thursday, gross transactions were $7.2 billion and Federal Reserve security holdings increased $4.7 billion, providing for a $2.5 billion increase in the monetary base and offsetting a $2.3 billion decline in other F.R. accounts. (See Table 3.) The increase in securities was accomplished through outright purchases of securities, mainly from the market but also from foreign accounts, and through maturing MSP's with the market. Although MSP's with foreign accounts matured, they were offset by an increase in new MSP agreements with foreigners.

Federal Reserve holdings of securities increased again on Friday and Monday. Although the monetary base declined on Friday, the rise in securities was needed to offset a larger decline in other F.R. accounts. On Monday, the increase in other F.R. accounts supplemented open market operations in providing for an increase in the base. On both Friday and Monday, outright purchases from foreign accounts contributed part of the increase in System security holdings, but the remainder was gained through temporary transactions. On both days, MSP's with foreigners matured and new MSP agreements were entered. On Friday, 1-day RP's were made and on Monday new RP's were also entered, in part to offset maturing 1-day RP's.

On Tuesday, System security holdings were reduced slightly, as a decline in the monetary base was largely accommodated through a drop in other F.R. accounts. Changes in System security holdings were achieved mainly through early termination of RP transactions. Also, MSP sales to foreigners were slightly greater than maturing MSP's. On Wednesday, System security holdings rose to support an increase in the monetary base, which was partly facilitated by an increase in other F.R. accounts. Accommodation of foreign accounts through MSP's reduced System securities in contrast to the System's desire to increase holdings. Also, some RP's were terminated prior to maturity on Wednesday. Thus, RP agreements were entered with the market.

For the year 1977 as a whole, gross Federal Reserve open market transactions in Government securities amounted to $1,270 billion. (See Table 4.) Operations in marketable Treasury securities accounted for 98 per cent of the total. The volume of gross transactions was nearly evenly divided between transactions with foreign accounts and those with the domestic market.

Gross outright transactions were $34 billion, or less than 3 per cent of total transactions in 1977. Transactions with foreign accounts amounted to 40 per cent of all outright operations. Individual outright transactions with foreigners tended to be much smaller in size than those with the market but occurred more frequently. In 1977, outright transactions with the market were executed on only 22 days, while outright transactions with foreign accounts occurred on 85 days. In 1977, net outright purchases provided a $10.2 billion increase in System securities.

Table 3
FEDERAL RESERVE OPEN MARKET TRANSACTIONS IN U.S. GOVERNMENT SECURITIES, AND CHANGES IN THE MONETARY BASE AND OTHER ACCOUNTS
(Statement week ended December 21, 1977, billions of dollars)

	Thurs 12/15	Fri. 12/16	Mon 12/19	Tues 12/20	Wed. 12/21	Total
Total gross transactions	7.2	'4.0	4.9	2.6	4.9	23.6
Outright transactions						
With domestic market:						
Purchases	1.0	–	–	–	–	1.0
Sales	–	–	–	–	–	–
Redemptions	–	–	–	–	–	–
With foreign customers:						
Purchases	0 1	0.2	0.1	–	–	0.4
Sales	–	–	–	–	–	–
Matched sale-purchase agreements						
With domestic market:						
Purchases	3.6	–	–	–	–	3.6
Sales	–	–	–	–	–	–
With foreign customers:						
Purchases	1.2	1.2	1.3	1.1	1.2	6.1
Sales	1.2	1.3	1.1	1.2	1.3	6.2
Repurchase agreements (domestic market)						
Purchases	–	1.2	1.1	–	2.1	4.5
Sales	–	–	1 2	0 3	0 3	1.8
Net change in F.R holdings of U S. Government and Federal agency securities	4 7	1 3	0 2	– 0 4	1 7	7 7
Changes in:						
Monetary base	2.5	–0.5	0.8	– 2 7	3.4	3 4
Member bank reserves	1 7	–0 3	0 5	–3.2	3.2	1.9
Currency (outside member banks)	0.7	–0.2	0.3	0 5	0.2	1.5
Other F.R. accounts*	–2.3	–1.8	0.5	--2 3	1.7	– 4 2
Treasury deposits at F.R. Banks	–0.3	–1.2	–1.4	–1.8	–0.7,	–5.5
Federal Reserve float	–1 1	–0.9	1.6	–0 6	1 7	0 8
All other F.R. accounts	–0 9	0 2	0.4	0 1	0 7	0 5
Federal funds effective rate (per cent)	6.52	6 55	6.56	6 51	6.57	6.54

NOTE: The data shown here on the monetary base and on other F.R. accounts are not necessarily the figures that were available to the SOMA Manager on the day open market transactions occurred nor do they represent final figures for those days. Data are collected with a long time lag and may be subject to substantial revision. Details may not add to totals due to rounding.
'An Increase (decrease) in Federal Reserve assets is entered as a positive (negative) figure, while an Increase (decrease) in Federal Reserve liabilities is entered as a negative (positive) figure.

Table 4
FEDERAL RESERVE OPEN MARKET TRANSACTIONS IN U.S. GOVERNMENT SECURITIES
(Billions of dollars)

	1970	1977
Total gross transactions	122.6	1,270.2
Outright transactions, total	19.7	34.4
Treasury bills, total	18.4	23.1
Gross purchases	11.1	13.7
Gross sales	5.2	7.2
Redemptions	2.2	2.1
Net change	3.7	4.4
Other U.S. Treasury securities, total*	1.3	9.7
Gross purchases	1.3	7.2
Gross sales	–	–
Redemptions	–	2.5
Net change	1.3	4.7
Federal agency securities, total	–	1.7
Gross purchases	–	1.4
Gross sales	–	–
Redemptions	–	0.2
Net change	–	1.2
Net increase in SOMA Government security holdings due to outright transactions	**5.0**	**10.2**
Repurchase agreements, total	78.5	386.7
U.S. Treasury securities		
Gross purchases	33.9	178.7
Gross sales	33.9	180.5
Federal agency securities		
Gross purchases	5.4	13.8
Gross sales	5.4	13.6
Matched sale-purchase agreements (bills), total	24.4	849.1
Gross purchases	12.2	423.8
Gross sales	12.2	425.2
Total net changes in SOMA Government security holdings	**5.0**	**7.2**
Memo: Total gross transactions with foreign accounts included above	5.3	637.1
Outright transactions, total	5.3	13.6
Gross purchases	2.0	7.3
Gross sales	3.3	6.3
Matched sale-purchase agreements, total	–	623.5
Gross purchases	–	310.9
Gross sales	–	312.6

SOURCE: Federal Reserve Bulletin.
NOTE: Sales, redemptions, and negative figures reduce holdings of the SOMA; all other figures increase such holdings. Details may not add to totals due to rounding.
'Both gross purchases and redemptions include special certificates created when the Treasury borrows directly from the Federal Reserve, as follows: 1977, $2.5 billion.

Table 5
PERCENTAGE DISTRIBUTION OF MARKETABLE SECURITIES
November 30, 1977

	Total Outstanding	Federal Reserve Holdings
Total marketables	100.0	100.0
Final maturity:		
Within 1 year	49.1	53.5
Treasury Bills	34.4	38.6
Other Securities	14.6	14.9
1-5 years	33.8	28.6
5-10 years	10.0	10.7
Over 10 years	7.2	7.2

The System has carried out most of its outright open market transactions in short-term Treasury bills in recent years. In **1977,** transactions in bills accounted for two-thirds of total outright transactions. However, on a net basis, outright purchases of coupon securities added somewhat more to System security holdings than did net Treasury bill purchases. Increases in Federal Reserve security holdings have coincided with changes in the types of securities issued by the Treasury, and the maturity structure of the Federal Reserve's holdings of marketable securities is similar to the maturity distribution of all outstanding marketables. (See Table 5.) In recent years, the Treasury has issued a larger net amount of coupon securities than of Treasury bills as it attempted to lengthen the maturity structure of the debt. Thus, the Federal Reserve has acquired larger amounts of coupon securities. In the **1970-77** period, net coupon security acquisitions were **$24.5** billion compared with **$20.7** billion for bills.

Outright transactions by SOMA in Federal agency securities have been quite small compared to transactions in U.S. Treasury securities. In **1977,** transactions in agency securities were **$1.7** billion, about **5** per cent of total **outright** transactions.

The bulk of the System's gross transactions in Government securities in **1977** was conducted through temporary RP and MSP agreements. (See Table 4.) Gross repurchase agreements accounted for nearly one-third of total gross transactions. These transactions are largely conducted **in** Treasury securities, with only a small amount in agency **securities.** More than one-half of the RP's initiated in **1977** matured or were terminated within **1** day, and **82** per cent matured within 3 days. The remaining RP's had maturities of **4** to **7** days, and of these about one-third were made under nonterminable contracts. RP's were initiated on 88 business days in **1977.**

Matched sale-purchase transactions amounted to two-thirds of total gross open market transactions in **1977.** Gross MSP's with foreign accounts accounted for nearly three-fourths of all MSP transactions. MSP's with foreigners are normally 1-day transactions and were entered into on almost a daily basis in **1977.** MSP's with the market occurred much less frequently but were often for periods longer than **1** day.

Gross open market transactions in Government securities were substantially larger in **1977** than in **1970,** with most of the growth in temporary RP and MSP transactions rather than in outright transactions. (See Table **4.)** The greater use of MSP and RP transactions in **1977** is due in part to greater short-term fluctuations in the monetary base and especially in other F.R. accounts. The change in the Treasury's cash management policies between **1970** and **1977** was largely responsible for the greater fluctuations in other F.R. accounts. Also, prior to the change in Treasury policy, if the System needed to absorb a large volume of reserves, it could ask the Treasury to call balances at commercial banks and deposit them in Reserve Banks, thus reducing the need

for open market operations. With the change in Treasury policy, this option was lost.[9]

Another reason for the rapid growth in MSP and RP transactions is the Federal Reserve's desire to accommodate foreign customers. Prior to 1974, the System engaged only in outright transactions with foreign accounts; but since August 1974, it has entered into MSP's with foreign customers (RP's from the foreign customer's view). MSP's provide foreign customers with a convenient means for investing short-term balances of excess dollars in interest-earning assets and aid the Federal Reserve in absorbing reserves with minimum market impact. The volume of foreign transactions has increased in recent years because foreigners have accumulated large dollar balances, due to the continuing deficits in the U.S. balance of payments.

Prior to May 1977, the System carried out MSP's with foreign accounts when they coincided with System objectives. In May 1977, the Internal Revenue Service (IRS) raised the possibility that foreign central banks' earnings from RP's with the market may be taxable. The Federal Reserve then began acting as a principal for all foreign account RP transactions with the domestic market. In 1977, System MSP's with foreign accounts contributed to the need for market RP's on 47 of the 88 days that RP's were initiated.

Recent IRS rulings have clarified that foreign banks' earnings on RP's will not be subject to taxes when the Federal Reserve System acts as a principal, in the transaction. As a result, accounting procedures have changed again. Foreign MSP's appear as a SOMA transaction only when they coincide with the System's policy objectives. In other cases, the Federal Reserve Bank of New York enters into MSP's with foreigners and makes offsetting RP's with Government security dealers. These transactions do not appear on SOMA's records.

The volume of temporary open market transactions has also been influenced in recent years by the Federal Reserve's desire to keep day-to-day fluctuations in the Federal funds rate within a narrow range. In addition, the growth in the Federal funds market in the 1970's may have required that SOMA engage in larger transactions to affect the funds rate.

IMPACT OF FEDERAL RESERVE OPEN MARKET OPERATIONS ON THE GOVERNMENT SECURITIES MARKET

Federal Reserve open market operations influence the Government securities market mainly by affecting bank reserves.[10] Changes in reserves affect the availability and cost of money and credit in various credit markets, including the Government securities market. In the short run, changes in the Federal funds rate in line with Federal Reserve policy influence the Treasury bill rate and other rates on short-term Government securities. Over longer periods, both short- and long-term rates are affected by the course of monetary policy.

In addition to the impact through reserves, System transactions in Government securities may directly influence the market. However, the SOMA follows a number of policies

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9 Although under current procedures the Federal Reserve has been discouraged from requesting the Treasury to alter its deposit distribution between Federal Reserve Banks and commercial banks, the System may be able to do so under new procedures. For a description of the new Treasury cash management procedures, see Elijah Brewer, "Treasury to Invest Surplus Tax and Loan Balances," Federal Reserve Bank of Chicago *Economic Perspective*, November/December 1977.

10 At times, an important objective of the Federal Reserve in conducting open market operations has been to influence the term structure of interest rates. This policy was used mainly in the early 1960's when it was desirable to moderate downward pressures on short-term interest rates to reduce international capital flows.

designed to minimize the impact of its transactions on the market.[11] First, the Account Manager utilizes temporary RP and MSP transactions to reduce the impact of System activity on interest rates on Government securities. An outright purchase followed in a few days by an outright sale would have the same effect on reserves as an RP, and an outright sale followed by an outright purchase would have the same effect as an MSP. However, the market does not view RP's and MSP's the same as outright transactions since it does not know whether outright transactions will be reversed. When the Federal Reserve purchases securities outright, it reduces dealer inventories. If the dealers think the System may not sell securities soon, they may bid for new inventory at higher prices because they expect a smaller supply to be available. Thus, there may be greater, downward temporary pressure on interest rates when an outright purchase is used instead of an RP. Likewise, the use of outright transactions instead of MSP's may result in greater increases in interest rates.

The System can also use transactions with foreign accounts to minimize its impact on the Government securities market. Foreign purchases of securities from the Federal Reserve reduce the banking system's reserves, and foreign sales to the System increase bank reserves. Direct transactions with foreign accounts are usually undertaken when foreign orders to buy or sell coincide with System needs to alter reserves. If the System did not carry out direct operations with foreign central banks, contrasting types of transactions would need to be conducted in the domestic market. For example, if a foreign central bank wanted to sell securities at the same time the System needed to supply reserves, the Account Manager would have to ask for bids in the market for the securities of foreigners to be sold and at the same time purchase securities for the System's account. Although the market would see both types of transactions, it might place greater emphasis on the System's transactions, resulting in larger interest rate movements because of expected changes in the supply of securities.

The Federal Reserve System follows a number of other practices designed to minimize the impact of its transactions on Government security prices and yields. First, SOMA sales of Government securities have generally been limited to Treasury bills in recent years. The Treasury bill market is broad and active, whereas secondary market trading in many Federal agency and long-term Treasury issues is relatively thin. Thus, System sales of such securities tend to be unsettling to the markets and could result in large price changes. Also, if the System were to sell long-term bonds, it could pose problems for the Treasury if the amount of bonds issued to the public at rates over 4% per cent approached the legal limit. Currently the Treasury can issue up to $27 billion without regard to the interest rate ceiling, and Federal Reserve and Government account holdings are not included in this limit. The System holds one-fourth of all marketable bonds issued with coupon rates above 4¼ per cent.

Secondly, when the System purchases securities for its account, it considers the maturity as well as the prices offered. The System generally does not purchase securities that are very close to maturity, and it may be more willing to accept an issue of securities in which its holdings are relatively small. In purchasing notes and bonds and Federal

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11 The FOMC authorization for domestic open market operations limits the total change in SOMA holdings of U.S. Government and Federal agency securities to $3 billion between meetings of the FOMC. This limit was raised from $2 billion on March 18, 1974, because of the larger short-term fluctuations in reserves and factors affecting reserves.

agency securities, the System must be careful that its purchases do not overwhelm the market resulting in large price changes.

Federal Reserve security holdings are widely distributed among outstanding issues. As of November 30, 1977, the System held some portion of each of the 102 marketable notes and bonds issued by the Treasury,[12] with the percentage of individual issues held varying from less than 1 per cent to more than 70 per cent. The System also held 126 different Federal agency issues, but these holdings are limited by regulations to less than 30 per cent of any one agency security issue and less than 15 per cent of the total amount outstanding for any one agency. Federal Reserve bill holdings are also distributed among the outstanding issues.

Third, System participation in the new issues market is minimized. To avoid influencing the price or yield on new securities, SOMA does not purchase new issues for cash for its own account nor does it purchase "when-issued" securities. The System may, however, purchase new issues for cash on behalf of its foreign customers. Maturing securities in the System account are exchanged or allowed to mature without replacement. Since April 1974, the System has entered Treasury bill auctions on a noncompetitive basis, exchanging its maturing bills for new issues at the average price of accepted competitive tenders. This eliminates the risk of having to undertake outright bill purchases to maintain the same volume of security holdings and reduces the Federal Reserve's influence in determining new issue Treasury bill rates. The relative size of noncompetitive System bids and competitive bids from the public tends to remain fairly stable due to the System's distribution of bill holdings among outstanding issues. This also minimizes System influence on Treasury bill rates. Maturing notes and bonds are redeemed or exchanged at the average price of securities issued to private investors. Redemptions can be a useful option when there is a need to absorb reserves, since a redemption would have relatively little direct impact on market rates. However, redemptions of marketable Treasury securities are made infrequently and normally amount to only a few hundred million dollars at any one time. System holdings of agency issues are allowed to run off at maturity, and no new issues are purchased in the secondary market until at least 2 weeks after the issue date.

The Federal Reserve also tries to reduce its impact on market attitudes during Treasury financing operations. In much of the postwar period, the Federal Reserve adhered to a policy known as "even keel," normally meaning that from a few days before the announcement of a major Treasury security sale, the System would not alter monetary policy—i.e., change the discount rate or reserve requirements, visibly alter the Federal funds target rate, or make large outright purchases or sales of Government securities.

In recent years, the Federal Reserve has adhered less closely to even-keel policy, since debt management innovations have made Treasury financings less vulnerable to sudden variations in market interest rates. Formerly, the Treasury sold most of its notes and bonds on a subscription basis with the price and coupon rate set prior to the sale. Any sharp rise in rates before the sale would make the coupon rate appear relatively unattractive and dampen investor interest, with the risk that the Treasury would not be able to sell the desired volume of securities. In the 1970's, the Treasury has issued most notes and bonds on an auction basis, with yields and prices determined through bidding on the date of the offering. Thus, the rate and price adjust to the current

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12 This does not include 1% per cent EO notes which are held only by private investors.

market level and the risk of a financing failure is reduced.[13]

The need for the Federal Reserve to follow an even-keel policy during Treasury financings has also been reduced by the restructuring of the debt into a more regular cycle of offerings. Most financings are now moderate in size and occur on a schedule that allows investors to accumulate funds for purchasing Treasury issues. The frequency of Treasury financings in recent years makes it impractical for the System to maintain an even-keel policy during all Treasury operations. Further, even when the Federal Reserve maintained an even-keel policy, interest rate movements were sometimes large during Treasury financing periods, since rates are influenced by a number of factors other than Federal Reserve policy.

Although the System does not adhere to a strict even-keel policy, market transactions are minimized during Treasury financings. In 1977, the Federal Reserve executed outright transactions directly with the market on only 5 out of 69 days that Treasury bills were auctioned and on only two occasions when notes or bonds were auctioned. The System did enter into outright transactions in the middle of a major refunding in November 1977. MSP and RP transactions and outright transactions with foreigners were carried out on many days of Treasury security sales.

SUMMARY

Federal Reserve operations in the Government securities market developed as a result of the System's need to control changes in bank reserves and the monetary base and to influence monetary growth. The System's holdings of U.S. Treasury and Federal agency securities increased sharply in the post-World War II period and were $111 billion at the end of 1977. In the short run, Federal Reserve holdings of Government securities fluctuate to accommodate temporary or seasonal changes in the monetary base and to offset changes in other Federal Reserve accounts. These short-run fluctuations require a large volume of open market transactions. System Open Market Account transactions are conducted with foreign accounts and with domestic security dealers. Outright purchases and sales of securities provide for long-term changes in System security holdings to support bank reserves and monetary growth; while repurchase agreements and matched sale-purchase agreements are used to accomplish day-to-day changes in System security holdings and to accommodate overnight investment needs of foreign customers.

Federal Reserve open market operations

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13 Two auction techniques—the price auction and the yield auction—have frequently been utilized by the Treasury in the 1970's. While the need for an even-keel policy has been reduced under both methods, it is a less important policy when the yield auction is utilized. In a price auction, the coupon rate is set prior to the sale and the yield to maturity is adjusted to current market rates through changes in the price. A sharp rise in interest rates between the announcement of the coupon rate and the sale date results in price bids on a discount basis. If discounts become so large as to subject investors to original-issue discount tax laws, the sale may be cancelled. Alternatively, declines in interest rates result in premium prices, which when very large reduce investor participation. Since 1974, the majority of note and bond auctions have been on a yield basis, with the coupon rate determined in the auction and a par price set near the average yield. Thus, changes in interest rates do not result in large price premiums nor discounts on the issue. Under either method, rate changes between the sale date and the time that dealers distribute the securities among their customers can result in dealer profits or losses. Declines in interest rates result in higher bond prices, providing windfall profits to dealers; whereas increases in rates depress bond prices, resulting in dealer losses and a reluctance on their part to participate in future sales. Nevertheless, gradual changes in policy begun prior to the auction will not result in large profits nor losses since dealers can anticipate interest rate movements and adjust their bids accordingly.

mainly influence the Government securities market indirectly through their impact on reserves, but they also may influence the market directly. However, SOMA follows a number of policies designed to minimize the impact of its transactions on prices and yields in the market. First, the Account Manager utilizes temporary MSP and RP transactions and transactions with foreign accounts when possible, since these transactions have less impact on market rates than outright transactions with the market. Also, System sales are generally conducted in Treasury bills, where the market is broad and active. Purchases are distributed among a wide variety of issues, and System participation in the new issues market is minimized. In addition, the Federal Reserve tries to reduce its impact on market attitudes during Treasury financing operations.