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ECONOMIC REVIEW

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ENERGY DEPENDENCE AND SOUTHEASTERN ECONOMIC GROWTH: AN INPUT-OUTPUT ANALYSIS

by James T. Fergus

This past winter's brush with energy shortages heightened our awareness of the central role played by energy supplies in economic growth. Recent proposals to curtail energy consumption are likely to be passed by Congress in the relatively near future (see Box 1). Suggested energy-saving measures have generally included raising the price of fuels in shortest supply (petroleum and natural gas) and providing incentives to use alternative fuels, particularly coal. How seriously *would* increased energy costs affect the Southeast?[1] Would prices of some goods and services produced in the Southeast rise relative to those provided by other regions? Would substitutes displace some of its products, dampening the region's rate of economic progress?

One cannot claim to present definitive answers to these questions because of the limited information presently available and the uncertainties surrounding key aspects of future energy developments. This analysis takes an initial step toward understanding the regional impact of energy price increases. First, the major U. S. industries which are heavy energy users are identified. Next, an examination of the relative importance of these industries in the Southeast suggests that the region may be somewhat more vulnerable to energy cost increases than the country as a whole because our region's industries are more dependent on petroleum and natural gas and less dependent on coal. A final section sketches implications for southeastern economic growth and outlines various uncertainties.

[1]The Southeast is defined as those states contained either wholly or partially within the Sixth Federal Reserve District—Alabama, Florida, Georgia, Louisiana, Mississippi, and Tennessee.

ENERGY DEPENDENCE IN MAJOR ECONOMIC SECTORS

Table 1 and Chart 1 show the pattern of energy usage by major economic sectors. The lower panel in Chart 1 pictures, for seven major sectors (industries) of the U. S. economy, the total cost of energy inputs expressed in cents per dollar of industry output. Energy costs relative to production value are greatest in the mining, excluding fuels, sector, followed by nondurable goods manufacturing and agriculture. Durable goods manufacturing and the combined transportation and trade category consume relatively less energy. The construction and services sectors have the lowest energy cost components.

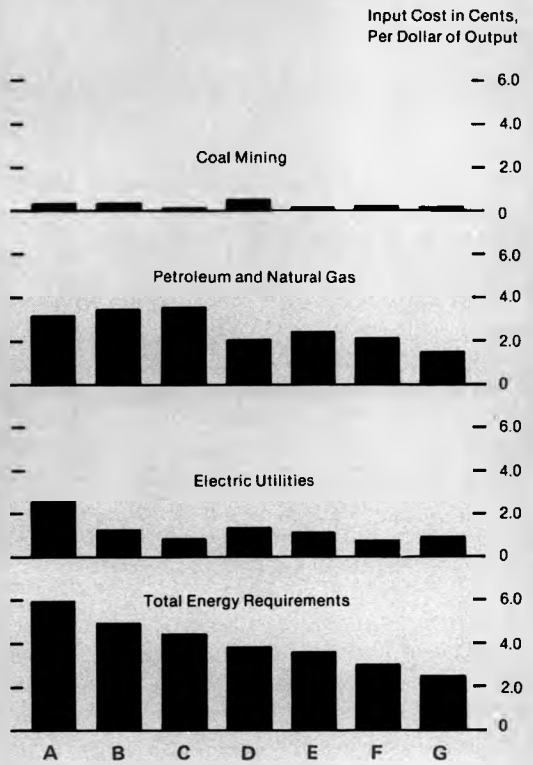
Industries' use of each of the major categories of fuels exhibits the same general pattern. Agriculture, nondurables manufacturing, and nonfuel mining are the most intensive users of petroleum and natural gas. Transportation and trade, durables manufacturing, and construction are moderate consumers of these fuels; the services sector again has the lowest cost component. The pattern differs somewhat for coal use, with durable goods manufacturing leading in consumption. Agriculture falls into the low-use category for coal inputs, accompanied by construction, transportation and trade, and services. Nondurable goods manufacturing and mining, excluding fuels, rely moderately on coal.

Electricity is consumed most vigorously by the mining sector, followed by the two manufacturing sectors and transportation and trade businesses. Services, agriculture, and construction require a relatively low volume of electricity.

In the following section, these energy input cost measures will be used to assess

CHART 1

ADJUSTED DIRECT AND INDIRECT REQUIREMENTS FOR ENERGY INPUTS, UNITED STATES, 1967



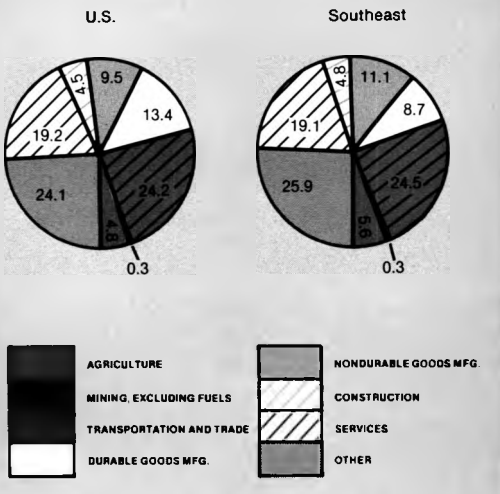
A. Mining, excluding fuels
B. Nondurable Goods Manufacturing
C. Agriculture
D. Durable Goods Manufacturing
E. Transportation and Trade
F. Construction
G. Services

SOURCE: Computed from data contained in "The input-Output Study of the U.S. Economy, 1967: Energy Model." See Technical Note for explanation of adjustment procedure.

energy dependence in southeastern states. Under ideal conditions, one would use energy input measures specific to the region under study. Regional energy measures would reflect differences from the national average in the processes and efficiency of industries in the region. However, lacking sufficiently precise, closely comparable state data, the national information has been used (see Box 2 for a description of the nature, source, and limitations of the data).

CHART 2

EMPLOYMENT SHARES OF MAJOR ECONOMIC SECTORS: U.S. AND SOUTHEAST



SOURCE: Computed from data contained in **Employment and Earnings**, U.S. Department of Labor.

REGIONAL ENERGY DEPENDENCE

Assessment of the regional impact of energy price changes requires a device which relates national energy use data to the economic structure of the region. One significant measure of an industry's importance is the share of regional employment it provides.[2] Table 2 and Chart 2 present the shares of total employment represented by the major economic sectors in the U. S. and the southeastern states. Combining information previously presented about sectoral energy requirements with the measures of their significance in each geographical area provided by these employment shares, we can form some tentative impressions of relative energy dependence.

Petroleum and Natural Gas Energy. The emerging outlines of a national energy policy suggest that users of oil and natural gas will face more rapidly rising costs.

[2]Employment is one of several standards which could be used to assess the relative importance of economic sectors. Alternative, possibly preferable, measures include value added, wage and salary payments, and physical output. Employment has been used in this study because it is a basic determinant of regional economic activity and because recent, reasonably comparable data are available by industry and geographic division.

Thus, a key factor in evaluating the potential impact of energy costs is the degree to which major industries depend on these fuels.

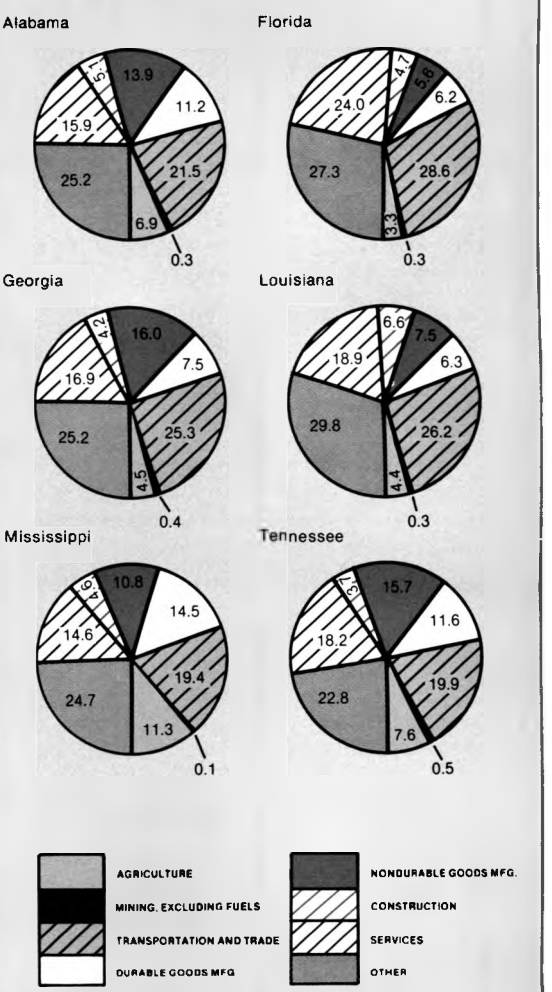
Chart 1 showed relatively high reliance on petroleum and natural gas inputs in the agricultural, nonfuel mining, and nondurable goods manufacturing sectors. There is little difference among geographic areas in mining's share of employment. But for both agriculture and nondurable goods manufacturing, the employment share in the Southeast is appreciably greater. This provides an initial hint that this region may be subject to a greater degree to energy-induced cost increases. The remaining major difference in employment shares reinforces this interpretation, since durable goods manufacturers, moderate users of petroleum and natural gas, are a much less important source of employment in the Southeast than nationally. To the extent that employment concentration in petroleum- and natural gas-intensive industries is greater in the Southeast and its share of moderate-user industries is lower, the region is more vulnerable to energy-induced cost increases.

Within the District states, Florida's position appears most advantageous at first glance (Chart 3). Its employment shares in both agriculture and nondurable goods manufacturing are the lowest of the six states, while its share is greatest in the services sector, the industry least hungry for petroleum and natural gas inputs. However, a sizable part of Florida's service business is tourism-related. Although the cost structures of these businesses may not be greatly affected by energy cost increases, the volume of their tourist business could easily be eroded by higher costs of auto and air transportation. The transportation and trade industries, which account for a relatively large proportion of Florida employment because of the importance of tourism,[3] will be affected even more directly.

Louisiana's economy, like Florida's, has important services, transportation, and trade industries, portions of which are also dependent on tourism. This state would probably experience similar effects from changing energy costs. It also has the highest concentration of employment in contract construction, another light consumer of petroleum and natural gas. Of course, Louisiana enjoys another great advantage—its position as a major energy-producing and processing state.

CHART 3

EMPLOYMENT SHARES OF MAJOR ECONOMIC SECTORS: SIX SOUTHEASTERN STATES



SOURCE: Computed from data contained in employment releases from individual state labor departments.

[3]In economic terminology, transportation is a "complementary good" to trade and services because they are consumed together like shoes and shoelaces, left and right gloves, etc

TABLE 1

ADJUSTED DIRECT AND INDIRECT REQUIREMENTS FOR ENERGY INPUTS, UNITED STATES, 1967

(input cost expressed in cents per dollar of output)

PRODUCING INDUSTRIES:	CONSUMING INDUSTRIES: Mining, Excluding Fuels	Nondurable Goods Manufacturing[1]	Agriculture	Durable Goods Manufacturing[2]	Transportation and Trade	Construction	Services
Total Petroleum and Natural Gas:							
Crude Petroleum and Natural Gas	1.1	1.4	1.6	0.7	1.0	0.9	0.6
Petroleum Refining	0.8	1.2	1.6	0.5	1.0	0.8	0.5
Gas Utilities	1.2	0.8	0.3	0.8	0.4	0.4	0.4
	3.1	3.4	3.5	2.0	2.4	2.1	1.5
Coal Mining	0.3	0.3	0.1	0.5	0.1	0.2	0.1
Electric Utilities	2.5	1.2	0.8	1.3	1.1	0.7	0.9
TOTAL ENERGY REQUIREMENTS	5.9	4.9	4.4	3.8	3.6	3.0	2.5

[1]Foods, tobacco, textiles, apparel, paper and allied products, printing and publishing, chemicals, petroleum, rubber, and leather.

[2]Ordnance, lumber and wood products, furniture and fixtures, primary metals, fabricated metal products, machinery, transportation equipment, instruments, and stone, clay, and glass.

Source: Computed from data contained in "The Input-Output Study of the U. S. Economy, 1967: Energy Model," U. S. Dept. of Commerce, Bureau of Economic Analysis, mimeo, 4 pp. See Technical Note for explanation of adjustment procedure.

TABLE 2

EMPLOYMENT SHARES OF MAJOR ECONOMIC SECTORS: U. S., SOUTHEAST, AND INDIVIDUAL STATES

(May 1977)

	(percentage of total employment, by geographic division)							
	U. S.	Southeast	Ala.	Fla.	Ga.	La.	Miss.	Tenn.
Agriculture	4.8	5.6	6.9	3.3	4.5	4.4	11.3	7.6
Mining, Excluding Fuels[1]	0.3	0.3	0.3	0.3	0.4	0.3	0.1	0.5
Transportation and Trade[2]	24.2	24.5	21.5	28.6	25.3	26.2	19.4	19.9
Durable Goods Manufacturing	13.4	8.7	11.2	6.2	7.5	6.3	14.5	11.6
Nondurable Goods Manufacturing	9.5	11.1	13.9	5.6	16.0	7.5	10.8	15.7
Construction	4.5	4.8	5.1	4.7	4.2	6.6	4.6	3.7
Services[3]	19.2	19.1	15.9	24.0	16.9	18.9	14.6	18.2
Other	24.1	25.9	25.2	27.3	25.2	29.8	24.7	22.8

Because of unavailability of data, the percentages for some employment categories do not correspond exactly to the title of the category. Exceptions in content occur in the following cases:

[1]Mining, Excluding Fuels:

Alabama - Mining, excluding only bituminous coal
Florida - Nonmetallic minerals, except fuels
Georgia and Tennessee - Includes all mining
Louisiana - Nonmetallic minerals
Mississippi - Mining, excluding oil and gas extraction

[2]Transportation and Trade:

Tennessee - Trade only; transportation is included with services

[3]Services, Including Communications, Water, and Sanitary Services:

Alabama and Louisiana - Services, communications, and public utilities
Florida, Georgia, and Mississippi - Services, communications, and electric, gas, and sanitary services
Tennessee - Includes transportation in addition to services, communications, and public utilities

Source: Computed from data contained in **Employment and Earnings** (Bureau of Labor Statistics, U. S. Department of Labor) and in employment releases from individual state labor departments.

The other four states have notably larger shares of industries which are heavily dependent on petroleum and natural gas inputs. Tennessee and Alabama have large shares of nondurable goods manufacturing employment and above-average shares of jobs in agriculture. The agricultural character of Mississippi's economy makes the state vulnerable to cost increases. A high concentration of nondurables manufacturing and a large share of tourist-related transportation and trade jobs place Georgia among the more dependent states. Furthermore, the services sector is below average in importance in each of these states.

Coal Comfort? Another likely thrust of future energy policy is encouragement of conversion from petroleum-related sources of power to alternative fuels such as coal.

BOX 1

CURRENT STATUS OF ENERGY LEGISLATION

The National Energy Act, with most of President Carter's proposed energy program intact, was passed by the House of Representatives in early August. The most important provisions affecting industrial energy costs are outlined below. Since Senate committee hearings have just begun, these programs remain subject to substantial alterations.

1. Crude Oil Prices

The controlled price of domestically produced oil sold to refiners would be increased by a tax to be applied in three steps. By 1980, the price would reach a level equal to the uncontrolled price of crude oil sold in the international market. The tax would terminate on September 30, 1981, along with the President's power to control oil prices. Income tax credits and other payments would offset the purchasing power loss which consumers would suffer as a consequence of higher energy prices.

2. Natural Gas Prices

Natural gas price regulation would continue. The ceiling price for newly discovered gas would rise from the current level of $1.46 per thousand cubic feet to $1.75 immediately. In the future, the price of natural gas would correspond to the price of the amount of domestically produced crude oil which would yield the same amount of energy. To forestall regional gas shortages, the ceiling price would apply to gas produced and sold within a state as well as to gas sold for delivery to another state. The impact of rising natural gas prices would be felt primarily by industrial users initially.

3. Coal Conversion Penalties and Incentives

New utility and industrial plants would be prohibited from burning oil or natural gas, with some exceptions based on environmental or economic considerations. Existing utilities would be required to cease burning natural gas by 1990. Plants which are now capable of burning coal could be required to use coal rather than oil or natural gas. A system of penalty taxes would be applied to industrial users of oil and natural gas beginning in 1979 and to utility companies beginning in 1983. These taxes would increase year by year to motivate conversions to coal power. Plants using small quantities of oil and gas and firms whose manufacturing process or product quality would be seriously impaired by use of other fuels could be exempt from the oil- and gas-users' tax. A company could credit expenditures for conversion to alternate fuel sources against its user taxes (disqualifying the investment for the 10-percent general investment tax credit) or it could take an additional 10-percent tax credit for investments in energy equipment. To hasten conversions, the latter option would apply only through 1982. In addition, any oil- or gas-burning boiler purchased after June 20, 1977, would no longer qualify for the regular 10-percent investment tax credit or for depreciation at an accelerated rate.

For summaries of the provisions of the National Energy Act, see **The Wall Street Journal**, August 8, 1977, p. 4, and **Congressional Quarterly Weekly Report**, Vol. 35, No. 2 (August 6, 1977), pp. 1624-1625.

Since the costs of coal-burning processes seem likely to fall relative to oil and natural gas, an effort to assess potential price effects must consider the reliance on coal energy by major sectors.[4]

A lower price for coal relative to petroleum-related fuels would favor areas where coal-using industries are concentrated. We can be fairly sure that coal-burning facilities are concentrated in the older manufacturing centers of the Northeast and Midwest. The "new" centers in the South, Southwest, and West grew in the postwar period of inexpensive, readily available, efficiently burning natural gas. Therefore, the change in relative energy cost in favor of coal will probably penalize manufacturers in these regions and

[4] This analysis does not include the influence of fuels used to generate electricity, which is derived from a variety of primary energy sources. Relative to the U. S., the Southeast derives a much *higher* share of its electric power from coal and a much *lower* proportion from natural gas. The shares of electricity supplied by oil and nuclear power are about the same regionally as nationally, while the national percentage of hydroelectric power is significantly greater. On balance, smaller cost increases in electric power are likely to be experienced in the Southeast than in the nation as a whole. See Table VI, pp. 18-19, in **1977 Annual Electric Power Survey,** published by the Edison Electric Institute.

BOX 2

A KEY TO THE ENERGY-DEPENDENCE RIDDLE

Input-Output Data. How does one spot a heavily energy-dependent industry? "Input-output" studies provide a key to this problem in the form of a detailed "shopping list" for each major sector of the economy. These data indicate the "ingredients" required for each sector's production, including the value of key raw materials obtained from other industries, labor compensation, profits, and taxes. One variety of input-output data shows the value in cents of each input directly consumed to produce one dollar's value of output for each industry.[1] A second variety of "shopping list" shows the value in cents of the direct input requirements *plus* the indirect requirements generated by a one-dollar increase in output for each industry. The industry energy requirements presented in Table 1 and Chart 1 of the accompanying article are based on such input-output data.

Recency and Other Reservations About the Data. Although the input-output information seems well suited for an investigation of energy dependence, it has been used with some reservations. First, the data are not very current. The most recently published data are for the 1971 calendar year.[2] Furthermore, even older data have been used for this study. A special tabulation of the 1967 input-outpu data is available, which offers two majo advantages: First, it provides greater deta for energy-producing industries; second, reduces the degree of detail for nonenerg industries by aggregating them into majo economic sectors.[3]

Use of ten-year-old data creates som risks, of course. Changes in technology prices, demand patterns, and product mi may have significantly altered the patter of industrial input use since 1967.

A second reservation concerns th representativeness of the data. The input output numbers discussed below are broa averages which apply to the entire Unite States. However, conditions within pa ticular regions, states, industries, and firm may cause input-output patterns to diffe sharply from these average values. On would expect fairly wide variations be tween areas in industry composition and i the efficiency of particular firms. But i the absence of sufficiently precise stat and regional data, the national informatio supplies a useful indication of sectora energy dependence. In discussing thes numbers, we do not wish to imply tha they are typical of all areas.[4]

[1] For a useful description of input-output data, see "The Input-Output Structure of the U. S. Economy, 1967," **Survey of Current Business,** Vol. 54, No. 2 (February 1974), pp. 24-56.

[2] Paula C. Young and Philip M. Ritz, "Input-Output Table of the U. S. Economy, 1971" (Bureau of Economic Analysis Staff Paper No. 28), U. S. Department of Commerce, March 1977.

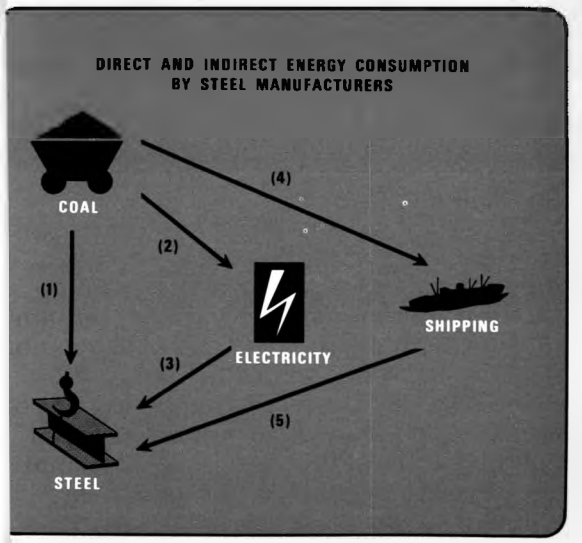
[3] "The Input-Output Study of the U. S. Economy, 1967: Energy Model," U. S. Department of Commerce, Bureau of Economic Analysis, mimeo, 4 pp.

[4] Although input-output studies have been prepared for some states, most do not provide a sufficiently detailed breakdown of energy usage to permit the type o analysis pursued in this study. Also, studies for particular states are usually not comparable. See William A. Schaffer, Eugene A. Laurent, and Ernest M. Sutter, **Using the Georgia Economic Model,** Atlanta, Georgia, Georgia Institute of Technology, 1972.

enhance the competitive positions of the coal-burning facilities of the Northeast and Midwest. However, use of national data on industry coal requirements tends to obscure these regional differences.

As Chart 1 indicated, coal is used most intensively in the durable goods manufacturing sector. But the share of employment provided by durable goods producers is significantly *lower* in the Southeast. Industries which use coal to a moderate degree include mining and nondurable goods manufacturing. As noted previously, mining's employment shares vary little, either between the Southeast and the nation or among the southeastern states. Nondurables is a sector of concentrated employment in the Southeast; but this industry's moderate use of coal only serves to soften somewhat the disadvantage of its heavy reliance on petroleum-related energy.

Relatively heavy concentrations of coal-using industries slightly improve the position of some southeastern states. Tennessee and Alabama, heavily dependent



Adjustment to Eliminate Understatement r Overstatement. The input-output data hat appear in Table 1 and Chart 1 have een adjusted to avoid understating or verstating energy requirements. The steel dustry provides a convenient example of he need for such adjustments.

Steel production processes use large uantities of both coal and electricity. mitting other energy sources for the moent, how would one properly represent the eel industry's energy dependence? One ould sum the values of the direct reuirements for coal and electricity (1 and 3 the diagram). Although the value of coal sed to generate electricity (2) is included in he value of the electricity used in steelmakg (3), this procedure would result in a serious underestimate of energy consumption, since coal is also used to produce numerous other "ingredients" for steelmaking. These inputs are represented in the diagram by shipping, which is assumed to be coal-powered. Measuring the energy dependence of steel manufacturing by summing only its *direct* energy inputs would omit the energy content of these nonenergy inputs (4).

Then, why not add together the direct *and indirect* requirements for energy inputs? This approach would *overstate* energy dependence because of double counting. In the preceding diagram, steel manufacturers' direct and indirect consumption of coal (1, 2, and 4) would be included. But the value of coal used to generate electricity (2) would be counted a second time as part of the value of the electricity input directly consumed in steel production (3).

The direct and indirect input coefficients (cents per dollar of output produced) for each major energy source have been modified to eliminate this source of overstatement. In simple terms, the modification employed here takes the sum of input flows (1) and (4) as the measure of coal input dependency and classifies segment (3) as the measure of dependence on electricity.[5] That is, the value of energy used to produce energy is measured in its *final* form as a *direct* input.

[5]For a more detailed explanation of the adjustment method used, please consult the technical note at the conclusion of this article

on petroleum-related inputs, also have greater-than-average employment shares in durable goods and nondurable goods manufacturing. Mississippi, the District state with the largest durable goods job concentration, should benefit to some extent from any shift of energy prices in favor of coal.

Despite the potential benefits to coal users, the present role of coal inputs is minor compared to that of petroleum and natural gas energy sources. In the manufacture of durable goods, the value of the coal used to generate one dollar of output is one quarter of the cost of petroleum and natural gas required. For the other industries, it amounts to only one-tenth or less. Unless the mix of fuel consumption is altered markedly, coal price incentives will cushion the impact of increasing energy costs only slightly.

IMPLICATIONS FOR SOUTHEASTERN GROWTH

Although producers throughout the nation will face increasing energy costs, incipient changes in energy prices and use patterns will probably have a stronger impact in the Southeast than in the nation as a whole. Heavy use of petroleum and natural gas will be discouraged, but southeastern industries are more dependent on these fuels than are their national counterparts. Fuel consumption will be shifted to nonpetroleum sources, especially coal; and with the exception of

TECHNICAL NOTE

As shown in the example in Box 2, the problem of double counting arises when energy sector A uses inputs from energy sector B, resulting in an overlap of direct consumption of sector A's product with indirect consumption of sector B's product. The key to identifying these areas of duplication is Table T-1, which gives the direct and indirect energy input requirements of the five energy-producing sectors.

The procedure used in this study to adjust for double counting began by summing the coefficients for the inputs provided by the other four energy sectors to the particular sector under consideration (calculating a total for each column of Table T-1). Thus, adding the requirements of the coal mining industry from the crude petroleum and natural gas, petroleum refining, electrical utility, and gas utility industries provided a sum for coal mining. This sum indicates the relative importance of other energy inputs, directly and indirectly required, in the production of coal. Note that this fraction, about 6 percent in the case of coal mining, measures the extent to which another sector's *direct* consumption of coal would overlap the *indirect* consumption (via direct use of coal) of the other four forms of energy. That is, for each $1 of coal supplied to coal-consuming industries, approximately 6 cents would be counted again as energy inputs obtained indirectly by those industries from other energy-producing sectors.

The adjustment required to correct this overlap is to reduce the value of coal inputs by about 6 percent. The exact factor is obtained by subtracting the sum of the energy input coefficients to the coa industry from 1.0 (see Table T-1). In this case, about 94 percent of the value of coa inputs supplied to other industries is *not* counted within other energy sector input coefficients. In each of the remaining columns of the table, an identical procedure is followed to obtain the adjustment factors shown on the bottom lin of the table.

This explains how the adjustment facto were derived; but how were they applied? For each of the five energy sectors, the original requirement coefficient for each input (shown in Table T-2) was multiplied by the adjustment factor for that input (a given in Table T-1). The resulting adjusted direct and indirect input requirements are presented in Table 1 of the article. Thus, for coal mining inputs, the agricultural sector's coefficient was changed from .00125 to .00117 (= .9373 x .00125) and th durable goods manufacturing sector's coefficient was altered from .00549 to .00515 (= .9373 x .00549), etc.

electrical power generation, coal-burning facilities are relatively scarce in the Southeast.

As their production costs begin to increase, relatively heavy users of petroleum and natural gas will face an unappealing choice. They can attempt to absorb rising energy costs by controlling other costs, increasing prices, or sacrificing net income. Or they can undertake major capital investment programs to convert to alternative fuels, primarily coal. But tax incentives for coal conversion would only partly offset the additional financing costs incurred. Such investments would absorb capital that could be invested in new or expanded facilities. Producers faced with conversion may find that their ability to enter new markets, offer new or improved products, and increase production efficiency via investment is hampered, at least temporarily. For some small-scale producers, coal conversion may be so costly as to be unprofitable and difficult to finance. Without the conversion option, higher prices of fuels presently used could force them to curtail operations.

Thus, a number of uncertainties cloud a definitive conclusion concerning the effects of energy costs on the outlook for southeastern economic growth. The most certain aspect of the outlook is that considerable turbulence is in store before adjustments to the new realities of energy supplies and prices are completed. ■

TABLE T-1
ENERGY SECTORS: DIRECT AND INDIRECT INPUT REQUIREMENTS, 1967

	CONSUMING INDUSTRIES: Coal Mining	Crude Petroleum and Natural Gas	Petroleum Refining	Electrical Utilities	Gas Utilities
PRODUCING INDUSTRIES:					
Coal Mining	–	.00124	.00162	.06684	.00110
Crude Petroleum and Natural Gas	.00960	–	.49695	.02111	.28325
Petroleum Refining	.01800	.00654	–	.02104	.00435
Electrical Utilities	.03062	.01264	.01476	–	.00818
Gas Utilities	.00448	.00719	.02234	.06191	–
Sum of Energy Input Coefficients	.06270	.02761	.53567	.17090	.29688
1.0 - (Sum of Energy Input Coefficients)	.93730	.97239	.46433	.82910	.70312

Source: "The Input-Output Study of the U. S. Economy, 1967: Energy Model" and computations.

TABLE T-2
DIRECT AND INDIRECT REQUIREMENTS PER DOLLAR OF DELIVERY TO FINAL DEMAND

	CONSUMING INDUSTRIES: Agriculture	Mining, Excluding Fuels	Construction	Durable Goods Manufacturing	Nondurable Goods Manufacturing	Transportation and Trade	Services
PRODUCING INDUSTRIES:							
Coal Mining	.00125	.00365	.00215	.00549	.00305	.00114	.00127
Crude Petroleum and Natural Gas	.01678	.01127	.00945	.00687	.01423	.01069	.00627
Petroleum Refining	.03440	.01722	.01809	.01019	.02578	.02048	.01010
Electric Utilities	.00940	.03022	.00845	.01509	.01506	.01335	.01077
Gas Utilities	.00448	.01772	.00557	.01136	.01080	.00573	.00536

Source: "The Input-Output Study of the U. S. Economy, 1967: Energy Model."

EXPANSION OF MIAMI EDGE ACT CORPORATIONS

by Donald E. Baer

In 1919, Senator Walter Edge successfully sponsored a Federal Reserve Act amendment which permitted banks, singly or jointly, to establish international banking subsidiaries outside their home states. The resulting "Edge Act corporations" were confined to international activity and required to show a minimum capitalization of $2 million.[1] For 40 years, the provision was virtually unused. Since 1960, however, the number of Edge Act corporations has expanded rapidly as U. S. banks have become increasingly involved in international finance. By June 1977, 113 Edge Act corporations were operating in U. S. cities.

The Edge Act expansion came in two distinct stages. In the first stage, banks and bank holding companies, prohibited from investing directly in foreign banks and corporations, established "investment Edges" to accomplish the same result indirectly. These Edges were generally located in the same city as the headquarters of the parent bank. Subsequent amendments in 1966 and 1970 to the Federal Reserve and Bank Holding Company Acts, however, eliminated some of the major advantages of these investment-oriented Edge Act corporations by allowing bank holding companies to invest in foreign companies under guidelines similar to those governing Edges and further permitting national banks' investment in foreign banks.

The second stage of Edge Act corporation development has been concentrated on "banking" Edges, where a parent bank (or banks) establishes international banking facilities in regional financial centers outside the parent's home state.[2] By June 1977, there were 62 of these Edges, 10 of which are in Miami. The Miami Edges have all been established since 1969 by parent banks in California, Georgia, Illinois, Massachusetts, and New York (see Table 1), placing Miami second only to New York City in the number of away-from-headquarters Edge Act corporations (see Appendix).

TABLE 1
MIAMI EDGE ACT CORPORATIONS
(as of August 1977)

	Commenced Business
• Citizens and Southern International Bank	3-24-69
• Bank of America International of Florida	3-8-71
• Citibank Interamerica	5-3-71
• Irving Interamerican Bank	8-2-71
• Wells Fargo Interamerican Bank	8-16-71
• Bank of Boston International of Miami	5-15-72
• Chase Bank International (Miami)	10-19-72
• Bankers Trust International (Miami) Corporation	8-19-74
• Northern Trust Interamerican Bank	9-16-74
• Morgan Guaranty International Bank of Miami	2-15-77

Latin America and the Miami Edge Corporations. Latin American linkages have drawn the Edge corporations to Miami. Its bilingual population, relative proximity to Latin America, and heavy South and Central American visitor traffic make it an attractive and convenient site for the Latin American operations of large U. S. banks. Indeed, nearly all of the foreign loans and deposits of Miami Edges involve Latin America or the Caribbean.

Historically, much of Latin American international financial transactions has been handled directly by the largest U. S. banks, particularly those in New York. Now Miami banks provide not only traditional servicing of deposits but also trade and medium-term financing. Interbank competition and increased financial sophistication of international clients are stimulating Miami's development into a full-service, specialized Latin American banking center.

[1] A previous study on Edge Act corporations in the Southeast was published in the Federal Reserve Bank of Atlanta's September 1974 **Monthly Review**.

[2] "Banking" Edges are defined as subsidiaries whose aggregate demand deposits and acceptance liabilities exceed capital and surplus.

All Miami Edge corporations operate as subsidiaries of their parent bank, with activities in Miami dependent on their parents' network of international offices. Where the parent bank maintains a substantial number of branches in Latin America, Miami Edge activities are necessarily coordinated with those branches and with the Latin American headquarters of the parent bank. For some banks, the Miami Edge serves as the Latin American headquarters itself. Other Miami Edges deal only with clients in specific countries, sharing Latin American responsibilities with other Edge cities with Latin American links (e.g., Houston, Los Angeles, and New Orleans).

Edge Act Corporation Regulations[3] and Effect on Activity. By law, Edge Act corporation activities are confined to servicing the international financing requirements of U. S.-based customers and accounts of foreigners. The Edges may offer demand and time deposits to foreigners but not passbook savings accounts.

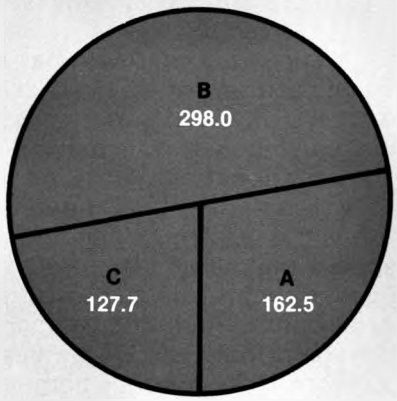
Edge deposits are subject to reserve requirements no less than those prevailing for Federal Reserve System member banks. The reserve requirement on aggregate Edge deposits, however, can never be less than 10 percent. This reserve requirement is not a severe constraint in the case of demand deposits. Due to their size, their parent banks are subject to higher than 10-percent marginal requirement rates on demand deposits (see Table 2). Some of the Edge demand deposits may actually represent accounts previously held at the parent bank and now subject to lower marginal reserve requirements at the Edge. Time deposits, however, are also subject to the minimum 10-percent reserve requirement. Since Federal Reserve member bank reserve requirements on time deposits vary from 1 to 6 percent (see Table 2), the Edge Act corporations' cost of maintaining time deposits surpasses that of commercial banks. This is important to Miami because time deposits represented nearly half of Miami's 1976 Edge total liabilities and capital.

[3]Edge Act corporations are regulated by Section 25(a) of the Federal Reserve Act and by the Federal Reserve System's Regulation K

TOTAL LIABILITIES, RESERVES, AND CAPITAL ACCOUNTS, MIAMI EDGE ACT CORPORATIONS

December 1976

(Mil.$)



A. Demand Deposits Due to Other than Directly Related Institutions
B. Time and Savings Deposits Due or Issued to Other than Directly Related Institutions
C. Other Liabilities, Reserves, and Capital Accounts

As with national banks, banking Edges cannot lend more than a tenth of their capital and surplus to one borrower. Since most Miami Edges were established with close to the $2-million minimum capitalization, their initial loan limit was approximately $200,000. This limitation has played an important part in shaping the character of the Edges. Some large loans are arranged by a Miami Edge, with participations by the head office or other subsidiaries. Many Edges, however, direct larger credit requests immediately to head offices, particularly large-scale public sector credits. Likewise, few Edges purchase participations from nonrelated institutions; however, they do join subsidiaries or branches of their parent institutions in some participations. The capital and reserves of the Miami Edges are expanding as they receive new capital infusions from parent banks and plow back earnings into reserves. This growing financial base gives the Edges greater independence and enables them to make larger individual loans.

Growth of Miami Edge Corporation Liabilities. Both the number of Miami Edge

Act corporations and the level of Miami Edge financial activity have expanded rapidly in recent years. Growth of liabilities was greatest in 1974, when liabilities, reserves, and capital grew more than 70 percent. Even the more modest 25-percent 1976 growth was striking (see Table 3).

Edge Act corporation growth has increased competition for foreign accounts within Miami's financial community; local banks have also benefited from the rising level of international activity. One index of Miami's commercial bank international expansion is the growth of demand and time deposits maintained by foreign banks, foreign governments, official institutions, and central banks. Such deposits increased some 85 percent between December 1973 and December 1976. Miami's commercial banks in mid-1976 maintained nearly twice the volume of foreign deposits of the Edge corporations and approximately equal amounts of foreign loans and foreign trade financing activity.

Uses of Miami Edge Act Funds. The Miami Edge Act corporations have consistently accepted more deposits than could be placed locally. Deposits and loans to parent or other related institutions have constituted from a quarter to a third of Miami Edge asset portfolios since 1973. In June 1977, about 17 percent of Miami Edge Act assets were deposits and loans to directly related institutions in the U. S., with another 12 percent allocated to directly related institutions abroad (see Table 4).

Still, an increasing proportion of the Miami Edge assets has been committed to loans abroad; the share had reached 40 percent by June 1977. The bulk of these foreign loans is made to firms and individuals, although loans to nonrelated foreign banks and foreign public institutions have also expanded in relative significance. Loans to U. S.-based entities have declined in importance; in June 1977, such loans represented less than 10 percent of Edge assets. Miami Edges have found trade financing opportunities in Florida and the Southeast but generally have placed greater emphasis on foreign loans.

Conclusion. Edge Act corporations are increasingly performing as international banking rather than international investment entities; each Miami Edge has a banking Edge perspective. The character of the Edge Act corporations is shaped by Edge Act regulations as well as by the local environment. Regulations necessarily limit activity to international finance. Reserve requirements and loan limitations tied to capital accounts also affect the

TABLE 2
FEDERAL RESERVE SYSTEM
MEMBER BANK RESERVE REQUIREMENTS[1]
(percent of deposits)

Type of Deposit and Deposit Interval (million $)	Requirements in Effect June 30, 1977	
	Percent	Effective Date
Net Demand:[2]		
0-2	7	12/30/76
2-10	9½	12/30/76
10-100	1¾	12/30/76
100-400	12¾	12/30/76
Over 400	16¼	12/30/76
Time:[2,3]		
Savings	3	3/16/67
Other Time:		
0-5, maturing in		
30-179 days	3	3/16/67
180 days to 4 years	[4]2½	1/8/76
4 years or more	[4]1	10/30/75
Over 5, maturing in		
30-179 days	6	12/12/74
180 days to 4 years	[4]2½	1/8/76
4 years or more	[4]1	10/30/75

[1]For changes in reserve requirements beginning 1963, see Board's **Annual Statistical Digest, 1971-1975,** and for prior changes, see Board's **Annual Report for 1976,** Table 13.

[2](a) Requirement schedules are graduated, and each deposit interval applies to that part of the deposits of each bank. Demand deposits subject to reserve requirements are gross demand deposits minus cash items in process of collection and demand balances due from domestic banks.
(b) The Federal Reserve Act specifies different ranges of requirements for reserve city banks and for other banks. Reserve cities are designated under a criterion adopted effective November 9, 1972, by which a bank having net demand deposits of more than $400 million is considered to have the character of business of a reserve city bank. The presence of the head office of such a bank constitutes designation of that place as a reserve city. Cities in which there are Federal Reserve Banks or Branches are also reserve cities. Any banks having net demand deposits of $400 million or less are considered to have the character of business of banks outside of reserve cities and are permitted to maintain reserves at ratios set for banks not in reserve cities. For details, see the Board's Regulation D.
(c) Member banks are required under the Board's Regulation M to maintain reserves against foreign branch deposits computed on the basis of net balances due from domestic offices to their foreign branches and against foreign branch loans to U. S. residents. Loans aggregating $100,000 or less to any U. S. resident are excluded from computations, as are total loans of a bank to U. S. residents if not exceeding $1 million. Regulation D imposes a similar reserve requirement on borrowings from foreign banks by domestic offices of a member bank. A reserve of 4 percent is required for each of these classifications.

[3]Negotiable Orders of Withdrawal (NOW) accounts and time deposits such as Christmas and vacation club accounts are subject to the same requirements as savings deposits.

[4]The average of reserves on savings and other time deposits must be at least 3 percent, the minimum specified by law.

Note: Required reserves must be held in the form of deposits with Federal Reserve Banks or vault cash.
Source: **Federal Reserve Bulletin,** July 1977.

character of Edge operations. The Miami Latin American linkages--both locational and demographic--have been prime inducements for Edge Act corporations' operations in the city. The rapid growth of international finance in Miami, shown by Edge Act corporations and commercial banks alike, is increasingly giving the city the character of a specialized Latin American banking center. ■

TABLE 3
MIAMI EDGE ACT CORPORATION LIABILITIES AND CAPITAL
SELECTED ACCOUNTS
(million $)

	December 1973	December 1974	December 1975	December 1976	June 1977
Foreign Individuals, Partnerships, and Corporation Demand Deposits	24.5	35.8	55.2	76.8	95.8
Foreign Individuals, Partnerships, and Corporation Time Deposits	71.9	165.7	212.3	285.6	288.1
Other Liabilities	76.8	99.7	152.8	166.2	159.0
Capital Accounts (Stock, Surplus, and Undivided Profits)	28.7	47.8	52.2	59.5	88.3
Total Liabilities and Capital	201.9	349.0	472.5	588.1	631.2
Annual Growth Rate, Total Liabilities and Capital Accounts (Percent)		72.9	35.4	24.5	7.3*

*Semiannual

TABLE 4
MIAMI EDGE ACT ASSETS
(percent distribution)

Foreign Loans Other than to Directly Related Institutions	December 1973	December 1974	December 1975	December 1976	June 1977
a. To Foreign Banks	4.1	4.4	4.8	5.8	6.2
b. To Foreign Governments, Central Banks, and International Monetary Institutions	1.6	2.0	1.8	2.1	2.3
c. Other Loans Other than to Directly Related Institutions	26.2	30.1	30.1	29.1	31.8
d. Sum of Foreign Loans Other than to Directly Related Institutions	31.9	36.5	36.7	37.0	40.3
U. S. Loans Other than to Directly Related Institutions	13.5	12.0	11.1	7.5	9.2
Customers' Liabilities on Acceptances Outstanding	1.7	12.8	5.6	7.9	8.4
Deposits Due from and Loans to Directly Related Institutions					
a. In Foreign Countries	12.7	12.4	15.0	13.5	11.8
b. In U. S.	13.1	14.9	18.8	20.2	17.1
c. Sum of Deposits from and Loans to Directly Related Institutions	25.8	27.3	33.8	33.7	28.9
Other Assets (Includes Reserve Requirements)	27.1	11.4	12.8	13.9	13.2
Total Assets	100.0	100.0	100.0	100.0	100.0

EDGES BY CITY
CORPORATIONS LOCATED OUTSIDE HEADQUARTERS CITY (as of June 1977)

CHICAGO	HOUSTON	LOS ANGELES	MIAMI	NEW YORK	SAN FRANCISCO	OTHER
				Allied Bank International		
Bank of America International of Chicago	Bank of America International of Texas		Bank of America International of Florida	Bank of America	*	
				Bank of California International		
Bankers Trust International (Midwest)	Bankers Trust International (Southwest)	Bankers Trust International (Pacific)	Bankers Trust International (Miami)	*		
				Central Cleveland International Bank		
Chase Bank International Chicago	Chase Bank International Houston	Chase Bank International Los Angeles	Chase Bank International Miami	*		
Chemical Bank International of Chicago				*	Chemical Bank International of San Francisco	
Citibank International Chicago	Citibank International Houston	Citibank International Los Angeles	Citibank Interamerica	*	Citibank International San Francisco	Citibank Overseas Investment Corporation (Wilmington)
			Citizens and Southern International Bank			Citizens and Southern International Bank of New Orleans
				Connecticut Bank International		
*	Continental Bank International (Texas)	Continental Bank International (Pacific)		Continental Bank International		
Crocker Mid-America International Bank				Crocker International Bank	*	
				Fidelity International Bank		
		Bank of Boston International of Los Angeles	Bank of Boston International of Miami	Bank of Boston International		
*		First Chicago International Los Angeles		First Chicago International Banking Corporation	First Chicago International San Francisco	
				First Wisconsin International Bank New York		
				Girard International Bank		
*				Harris Bank International Corporation		

* Headquarters City

CHICAGO	HOUSTON	LOS ANGELES	MIAMI	NEW YORK	SAN FRANCISCO	OTHER
		Irving Trust Company International Pacific	Irving Interamerican Bank	*		
		Manufacturers Hanover Bank (Los Angeles)		*		
				Marine Midland International Corporation		
				Mellon Bank International		
	Morgan Guaranty International Bank of Houston		Morgan Guaranty International Bank of Miami	*	Morgan Guaranty International Bank of San Francisco	
				North Carolina National Bank (NCNB) International Banking Corporation		
			Northern Trust International Bank	Northern Trust International Banking Corporation		
				Philadelphia International Bank		
		Rainier International Bank Los Angeles		Rainier International Bank New York		
		*		Security Pacific International Bank		
				State Street Bank of Boston International		
				United California Bank International		
						United Virginia Bank International (Norfolk)
				Wachovia International Banking Corporation (New York)		
			Wells Fargo Interamerican Bank	Wells Fargo Bank International	*	
6	6	9	10	24	4	3

* Headquarters City

(SUM TOTAL BY CITY)

SIXTH DISTRICT BANKING NOTES

Bank Earnings Recover Slightly in 1976

Sixth District member banks took a small step toward a recovery in earnings last year. According to their operating ratios, returns on equity capital advanced to 6.8 percent from 6.3 percent in 1975. Despite the improvement, the earnings rate remained significantly below the 10 percent experienced in the early part of the Seventies.

The earnings advance resulted from expenses rising more slowly than revenues. The ratio of total operating income to total assets actually declined from 7.59 percent to 7.46 percent. But expenses charged against that income dropped even further, from 7.05 percent to 6.84 percent of total assets.

The relative decline in operating income reflected lower rates of return on earning assets. Member banks sharply increased holdings of U. S. Treasury securities, investments that earn much less than loans, to 14 percent of total assets from 9.3 percent in the previous year. At the same time, the interest return on these investments averaged 6.73 percent, down from 7.1 percent in 1975. Because of the shift toward government securities, such interest income comprised nearly 13 percent of total operating income, compared to a 9-percent share in the year before.

Lagging loan demand pulled loan income down from 64.2 percent of operating income to 62.2 percent last year. A reduction in the proportion of earning assets accounted for by lending outweighed a slightly higher rate of return on loans. The importance of total loans diminished despite sustained increases in real estate and consumer loans; commercial and industrial loans continued weak until late in the year.

Operating expenses consumed a smaller proportion of total operating income last year. Reduced interest costs for borrowed money and lower interest payments on deposits contributed to the savings. Average interest paid on time and savings deposits dropped as banks experienced inflows of lower cost funds. This helped to counter the increased expense of additional interest-bearing deposits. Provisions for loan losses, while still high, were smaller last year. Wage and salary expenses, the second largest bank expense, remained unchanged as a percent of total operating income.

There continues to be considerable variation in earnings among banks in the different Sixth District states. While member banks in the District part of Louisiana still lead the Sixth District in earnings performance, their earnings declined slightly last year. Banks in Alabama, Georgia, and the Sixth District portions of Mississippi and Tennessee posted a moderate earnings gain. However, Florida's member banks had below-average earnings of 3.5 percent, a bit less than in the previous year.

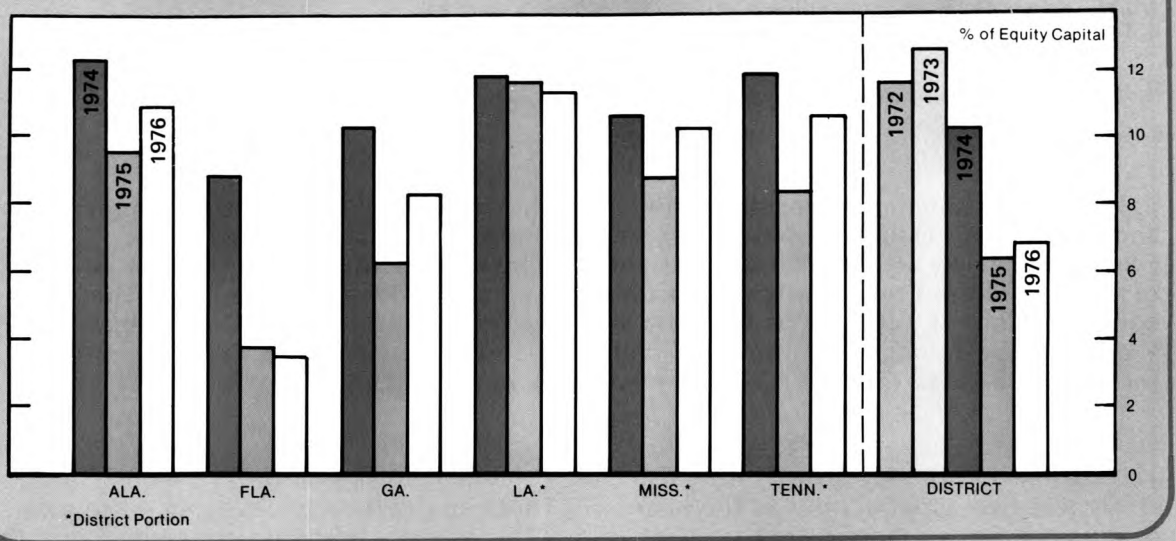
Poor performance by Florida's member banks reflects in part the large number of very small member banks in that state. Smaller banks have tended to earn lower rates of return than medium- and large-sized banks. While the smaller District banks had slightly higher operating income/asset ratios, they also spent significantly more for employees' salaries, occupancy of their facilities, and "all other" operating expenses. Many of these types of expenses are relatively fixed and indivisible, and the larger banks can spread them over a larger asset base. Nearly 50 percent of the Sixth District member banks with assets of less than $10 million failed to generate sufficient income to meet all of their expenses last year. In contrast, less than 15 percent of banks with total assets of $10 million to $50 million earned less than they spent.

Member banks apparently have turned the corner on earnings and, according to preliminary reports for the first half of 1977, are on the way back toward the higher returns of previous years. Sharply improved earnings, however, will depend on banks' ability to expand their most profitable activity, lending, while reducing provisions for loan losses.

John M. Godfrey

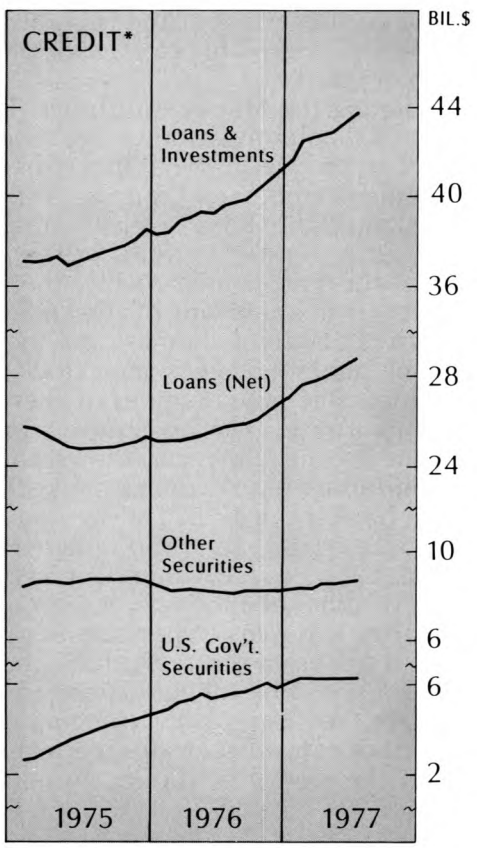
Note. Data based on "1976 Operating Ratios, Sixth District Member Banks" now available upon request.

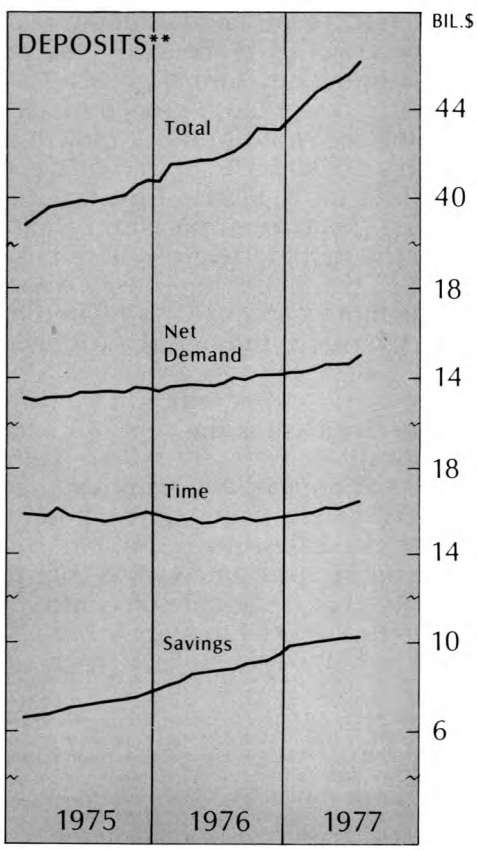
Income After Taxes



*District Portion

Banking Statistics





LATEST MONTH PLOTTED: JULY

NOTE: Seas. adj. figures covering District member banks

*Figures are for the last Wednesday of each month

**Daily average figures

COMPONENT RATIO ESTIMATION OF THE MONEY MULTIPLIER

by Stuart G. Hoffman

This article summarizes a staff analysis that may interest those in the economics and banking professions as well as others. It is more technical than the typical Economic Review article. The analysis and conclusions are those of the author. Studies of this kind do not necessarily reflect the views of the Federal Reserve Bank. The complete study is available as part of a series of Federal Reserve Bank of Atlanta Working Papers. Single copies of this and other studies are available upon request to the Research Department, Federal Reserve Bank of Atlanta, Atlanta, Georgia 30303.

The notion that money growth significantly influences economic activity is the heart of much recent economic doctrine. Accordingly, the Federal Reserve System selects monetary aggregate growth ranges consistent with the goals of price stability, low unemployment, and sustained real economic growth. The Federal Reserve's emphasis on money supply growth necessitates research on procedures for controlling the rate of money growth.

The "multiplier-base" framework is one approach to the analysis of money stock behavior.[1] This framework is so called because the money stock is viewed as a multiple of the "monetary base." Specifically, the money stock (M) is related to the monetary base (B) through the following identity:

$$M = mB$$

The monetary base is the sum of member bank deposits at Federal Reserve Banks, member and nonmember bank vault cash, cash in the hands of the nonbank public, and a reserve adjustment.[2] An important assumption in this framework is that the Federal Reserve is capable of controlling the magnitude of the monetary base. The "money multiplier" (m) is the link connecting the base to the stock of money. This study is primarily concerned with the predictability of the money multiplier. The assumption of a controllable monetary base, combined with a predictable money multiplier, suggests that the Federal Reserve should be able to control the money stock.

Predicting the Money Multiplier. To help explain the determination of the money multiplier, the Definitional-Behavioral technique is employed.[3] Starting with the above "multiplier-base" identity, the multiplier is defined in terms of ten component ratios which specify the influences of the behavior of the U. S. Treasury, commercial banks, and the nonbank public on the money stock (see Appendix). The actual values of these component ratios can be computed at any moment in time. However, the essence of the "multiplier-base" framework is that the public, banks, and U. S. Treasury have a desired value for each ratio under their control. Each desired value depends on the values of other economic, institutional, and policy variables. When actual ratio values differ from desired values, the sectors respond by taking actions to eliminate the discrepancy, bringing the ratios back toward their desired levels.

After the money multiplier formulas

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[1]See, for instance, Karl Brunner and Allan Meltzer, "Some Further Investigations of Demand and Supply Functions of Money," **Journal of Finance**, May 1964, pp. 240-283, and Albert E. Burger, **The Money Supply Process**, Belmont, California, Wadsworth Publishing Company, 1971. It is important to point out that the Federal Reserve does not use the "multiplier-base" approach to controlling money at this time.

[2]The reserve adjustment accounts for reserve requirement ratio changes and shifts in deposits between classes and sizes of banks over time. This paper was completed prior to the recent change in the method by which the reserve adjustment magnitude is computed. See Albert E. Burger and Robert H. Rasche, "Revision of the Monetary Base," **Review**, Federal Reserve Bank of St. Louis, July 1977.

[3]Albert Burger, Lionel Kalish, III, and Christopher Babb, "Money Stock Control and Its Implications for Monetary Policy," Reprint No. 72 from the **Review**, Federal Reserve Bank of St. Louis, October 1971, p. 8.

have been developed (see Appendix), the Definitional-Behavioral technique requires specifying the structural relationship between each component ratio and its causal determinants. Each behavioral equation is then estimated with regression analysis using monthly, seasonally unadjusted data from January 1969 to December 1975.[4] (This sample period encompasses most of the period since the September 1968 Amendment to Regulation D of the Federal Reserve Act, which instituted lagged reserve accounting.) A post-sample "forecast" of values of each component ratio for the first nine months of 1976 was constructed using the estimated reduced form regression coefficients, the actual post-sample values of the explanatory variables, and the predicted values of the lagged ratio.

The final step in the Definitional-Behavioral method is to substitute the predicted values for each component ratio from its estimated reduced form equation into the money multiplier formulas (equations (1) and (2) in the Appendix) to calculate the predicted values for the multipliers associated with the narrowly and broadly defined money stocks.[5] Summary results of this final calculation for the sample and post-sample periods are presented in Table 1. Comparing predicted with actual multipliers shows that the model's predictive accuracy in the sample period is comparable for the narrow and broad money multipliers (m_1 and m_2, respectively). The in-sample average monthly prediction error equals 0.37 percent for both multipliers, which is nearly equal to their respective average quarterly prediction errors. The model consistently overpredicts each multiplier before mid-1971 and consistently underestimates them thereafter. This result implies that monthly misses do not cumulate nor do they offset one another. Still, the annualized prediction error for any month would be greater than the annualized error for any quarter.[6]

TABLE 1
SUMMARY STATISTICS FOR THE MULTIPLIER PREDICTION ERRORS[1]

Period	$(m_1^d - \hat{m}_1)/m_1^d$ (percent)	$(m_2^d - \hat{m}_2)/m_2^d$ (percent)
SAMPLE (Monthly)		
ME	0.37	0.37
MAE	0.71	0.74
RMSE	0.78	0.79
SAMPLE (Quarterly)		
ME	0.38	0.37
MAE	0.69	0.70
RMSE	0.69	0.72
POST-SAMPLE (Monthly)		
ME	0.58	1.69
MAE	0.58	1.69
RMSE	0.39	0.41

ME = Mean (Average) Error
MAE = Mean (Average) Absolute Error
RMSE = Root Mean Square Error

[1] m_1^d and m_2^d denote the actual values of the narrow and broad money stocks, respectively, divided by the nonborrowed monetary base. $\hat{m}_1$ and $\hat{m}_2$ denote the predicted values of the multipliers calculated from Appendix equations (1) and (2), respectively, using the predicted values for each component ratio.

In the post-sample period, the average monthly prediction errors for the narrow and broad money multipliers are 0.58 and 1.69 percent, respectively (see Table 1). For the narrow multiplier, the error is only slightly higher than the in-sample prediction error. However, the broad multiplier estimation error is nearly five times as great as the comparable in-sample average error. The model performs much less satisfactorily for the broad than the narrow money multiplier in tracking post-sample movements because the broad multiplier is more sensitive to the public's holdings of time and savings deposits relative to demand deposits (t1)--a ratio that was relatively difficult to predict in the post-sample period.

The Federal Reserve would be interested in estimating the money multiplier because it is the connecting link between the money stock and the presumed controllable nonborrowed monetary base. The

[4] The specification and empirical estimation of the behavioral equation for each component ratio are not discussed in this summary article. A thorough discussion of this important step in the Definitional-Behavioral method can be found in Sections II and III of the Working Paper.

[5] The narrow money stock, M_1, equals currency and demand deposits held by the nonbank public. The broad money stock, M_2, equals M_1 plus time and savings deposits other than large negotiable certificates of deposit (CDs) held by the public.

[6] For example, the narrow multiplier's monthly mean absolute error of 0.71 percent equals an annualized error of 8.5 percent while the quarterly mean absolute error of 0.69 percent equals an annualized error of only 2.8 percent.

FIGURE 1

ACTUAL AND PREDICTED VALUES FOR THE NARROW MONEY STOCK

(January 1969-September 1976)

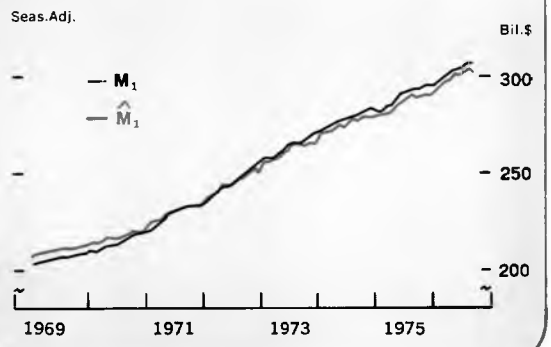
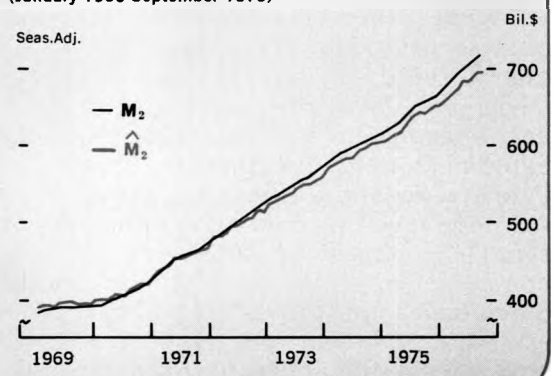


FIGURE 2

ACTUAL AND PREDICTED VALUES FOR THE BROAD MONEY STOCK

(January 1969-September 1976)



ability of the Federal Reserve to control movements in M_1 and M_2 is related to the accuracy of the money multiplier predictions. Multiplying the predicted multipliers by the actual nonborrowed monetary base produces predicted values for the narrow and broad money stocks ($\hat{M}_1$ and $\hat{M}_2$, respectively). These predicted values can be compared to the actual values of each money stock, with the difference between the two measuring the dollar prediction error. These results are graphed in Figures 1 and 2 and summarized in Table 2.[7] The predicted values of the seasonally adjusted narrow and broad money stocks deviate from their actual values by $1.1 billion and $2.4 billion, respectively, on both a monthly and quarterly average basis for the 1969-75 period. In the post-sample period, the average monthly M_1 and M_2 prediction errors rise to $1.8 billion and $11.7 billion, respectively.[8] The big increase in the average M_2 error reflects the large post-sample (under)prediction error for the broad money multiplier.

Multiplier Interest Rate Elasticity. The main issue in this study is the feasibility of money stock control by the Federal Reserve, given its ability to determine the magnitude of the nonborrowed monetary base through open market operations. In conducting an open market purchase, the Federal Reserve induces the commercial banks and the nonbank public to sell U. S. Government securities in exchange for reserves or demand deposits, respectively, by bidding up the price of the securities (or forcing down the yield). In an open market sale, the Federal Reserve prompts just the opposite exchange by forcing down the price of the securities (or forcing up the yield).

In this analysis, the market yield on three-month U. S. Treasury bills (TBR) is used as a proxy for the many different yields on government securities of varying maturities. Estimation of the behavioral equations for the multiplier component ratios revealed that certain ratios were significantly related to the Treasury bill rate.[9] Thus, open market operations, undertaken to control the magnitude of the nonborrowed monetary base, necessarily involve changes in the bill rate. Those changes, in turn, alter the values of the related ratios and, thus, the values of the money multipliers. Are these interest

[7]Note that the table and figures compare the actual and predicted values for the *seasonally adjusted* money stocks. The predicted seasonally adjusted values were computed in the following manner. The predicted seasonally unadjusted money stock (the predicted seasonally unadjusted multiplier times the actual seasonally unadjusted nonborrowed monetary base) was multiplied by the implicit seasonal factor for that month. This seasonal factor was computed by dividing actual seasonally adjusted money stock by its actual seasonally unadjusted value.

[8]The average *percentage* error between the actual and predicted money stock is, of course, equal to the average percentage error between the actual and predicted money multiplier in both periods.

[9]Specifically, the h, k, t1, t2, e, and b ratios were found to be significantly related to the three-month Treasury bill rate.

TABLE 2
SUMMARY STATISTICS FOR THE MONEY STOCK PREDICTION ERRORS
(billion $)

Period	$M_1 - \hat{M}_1$	$M_2 - \hat{M}_2$
SAMPLE (Monthly)		
ME	1.1	2.4
MAE	1.8	3.9
RMSE	2.0	4.0
SAMPLE (Quarterly)		
ME	1.1	2.4
MAE	1.8	3.7
RMSE	1.8	3.7
POST-SAMPLE (Monthly)		
ME	1.8	11.7
MAE	1.8	11.7
RMSE	1.2	3.0

ME = Mean (Average) Error
MAE = Mean (Average) Absolute Error
RMSE = Root Mean Square Error

rate-induced changes in the money multipliers large enough to offset the effects of Federal Reserve policy on the monetary aggregates?

To answer this question, the interest rate elasticity[10] of each multiplier was calculated over the sample period using the money multiplier formulas and the behavioral equation specified for each component ratio. Likewise, the elasticity of each money multiplier with respect to the Federal Reserve Discount Rate (DISC) was calculated. These results are summarized in Tables 3 and 4.[11] The *impact* elasticity measures the immediate or *initial* response of each multiplier to a change in the Treasury bill or discount rate. The *long-run* elasticity measures the full or *complete* response of each multiplier after all subsequent adjustments have taken place. The results confirm the hypothesis that the narrow money multiplier is positively related to the bill rate and inversely related to the discount rate, although the multiplier's response to movements in either rate is small.[12] In both the January 1969-April 1973 and May 1973-December 1975 subperiods,[13] the narrow multiplier's impact interest elasticity is very low and even its long-run response to changes in the bill rate is very inelastic. Likewise, for the full sample period, the narrow multiplier's initial and long-run responses to changes in the discount rate are slight.

In contrast to the narrow multiplier, the broad multiplier's long-run interest rate elasticity is negative, although also very small. A *rise* in the bill rate ultimately

TABLE 3
IMPACT AND LONG-RUN INTEREST RATE ELASTICITIES OF THE MONEY MULTIPLIERS[1]

Period	Impact*	Long-Run*
Jan. 1969 - April 1973		
$E(m_1, TBR)$	0.016	0.055
$E(m_2, TBR)$	0.005	-0.018
May 1973 - Dec. 1975		
$E(m_1, TBR)$	0.014	0.034
$E(m_2, TBR)$	0.003	-0.051

[1]The elasticity coefficient of the narrow money multiplier (m_1) with respect to the Treasury Bill Rate (TBR), denoted by $E(m_1, TBR)$, is defined as the *percent* change in m_1 divided by the *percent* change in TBR. The larger the elasticity coefficient the greater the response of the multiplier to a given change in the bill rate.

*Valued at sample means

TABLE 4
IMPACT AND LONG-RUN DISCOUNT RATE ELASTICITIES OF THE MONEY MULTIPLIERS[1]

Period	Impact*	Long-Run*
Jan. 1969 - Dec. 1975		
$E(m_1, DISC)$	-0.016	-0.059
$E(m_2, DISC)$	-0.017	-0.061

[1]The elasticity coefficient of the narrow money multiplier (m_1) with respect to the Federal Reserve Discount Rate (DISC), denoted by $E(m_1, DISC)$, is defined as the *percent* change in m_1 divided by the *percent* change in DISC. The larger the elasticity coefficient the greater the response of the multiplier to a given change in the discount rate.

*Valued at sample means

[10]Elasticity measures the degree to which one variable (multiplier) responds to a change in another variable (bill rate).

[11]For a detailed description of the calculation of the money multipliers' interest and discount rate elasticities, see Section V and Appendix II of the Working Paper.

[12]The low interest and discount rate elasticities for the narrow money multiplier found in this study are consistent with the results of previous empirical studies of the money supply process. For a summary of the results of these other studies, see Table 7 of the Working Paper.

[13]The May 1973 suspension of the Regulation Q ceiling rate on 90-day, large negotiable CDs caused a shift in each multiplier's responsiveness to bill rate changes. Therefore, each multiplier's interest rate elasticity was calulated separately for the subperiod prior to ceiling suspension (January 1969-April1973) and the subperiod after the suspension (May 1973-December 1975).

causes a significant reduction in the public's ratio of time and savings to demand deposits (t1), which leads to a small *decline* in the broad money multiplier. This inverse relationship tends to reinforce the impact of changes in the monetary base on M_2. However, the impact interest elasticity of the broad multiplier in both subperiods is slightly positive. For the total sample period, the broad multiplier's impact and long-run discount rate elasticities are nearly equal to the comparable discount rate elasticities of the narrow multiplier. That is, discount rate movements have similar minor impacts on each multiplier.

These results confirm very low interest and discount rate elasticities for the money multipliers, implying that feedback effects on m_1 and m_2 via changes in the bill rate induced by open market operations will be quite small. Therefore, the use of open market operations by the Federal Reserve to determine the magnitude of the nonborrowed monetary base in an attempt to control M_1 and M_2 will not induce large offsetting changes in the money multipliers. ■

APPENDIX

The narrow money multiplier (m_1) linking the nonborrowed monetary base with the narrow money stock, M_1 (currency and demand deposits held by the nonbank public), is approximated by the following formula:

$$(1)\ m_1 = \frac{1 + k}{\bar{r}^d\,(h+dg) + \bar{r}^t n\,(t1+t2) + (e-b)[h+dg+n\,(t1+t2)] + ck},$$

where h, n, and g are the fractions of total private demand deposits, time and savings deposits, and U.S. Government demand deposits, respectively, held in member banks; k, t1, t2, and d are the ratios of public currency holdings, consumer time and savings deposits, large negotiable CDs, and U.S. Government demand deposits, respectively, to the demand deposit component of the money stock; e and b are the ratios of member bank excess reserves and Federal Reserve Bank borrowings, respectively, to total member bank liabilities subject to reserve requirements; and c is the ratio of currency outside *member* banks to public currency holdings. $\bar{r}^d$ and $\bar{r}^t$ are the average reserve requirement ratios against demand and time and savings deposits, respectively. They are held constant at their August 1954 levels, since the reserve adjustment magnitude included in the nonborrowed base presumably captures changes in reserve requirement ratios.

The general form of equation (1) is

$m_1 = f(\bar{r}^d, \bar{r}^t, h, n, g, d, k, t1, t2, e, b, c)$,

where

$\begin{bmatrix} d \\ g \end{bmatrix}$ = component ratios determined by the behavior of the U. S. Treasury,

$\begin{bmatrix} e \\ b \\ c \end{bmatrix}$ = component ratios determined by the behavior of commercial banks, and

$\begin{bmatrix} h \\ n \\ k \\ t1 \\ t2 \end{bmatrix}$ = component ratios determined by the behavior of the nonbank public.

The broad money multiplier (m_2) linking the nonborrowed monetary base with the broad money stock, M_2 (M_1 plus time and savings deposits less large negotiable CDs held by the nonbank public), is approximated by the following formula:

$$(2)\ m_2 = \frac{1 + k + t1}{\bar{r}^d\,(h+dg) + \bar{r}^t n\,(t1+t2) + (e-b)\,[h+dg+n\,(t1+t2)] + ck},$$

where all component ratios are defined above.