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Economic upheaval in the Midwest

George Cloos and Philip Cummins

The Midwestern heartland, with the Seventh Federal Reserve District at its center, has entered its sixth year of adversity. Economic recovery in this region in 1983 was concentrated in the motor vehicle industry and certain smaller sectors such as household appliances. The gap in the region's economic performance relative to the rest of the nation, a gap that began to open in 1979, widened further in 1983.

Signs point to a broader improvement in the Midwest in 1984. Further gains are expected in motor vehicles and there are glimmerings of revival in the region's badly depressed capital goods industries. Suppliers to the farm sector are almost certain to rebound from their worst slump since the 1930s.

In general, confidence is firming. However, the best-case scenario for 1984 will still leave the Midwest economy far below its high-water mark of the late 1970s. The restructuring of what has been labeled the "Rust Belt," with its ailing "smokestack" industries, will require years of painful adjustment.

This article examines the causes of the current plight of the Midwest, and considers the policies, public and private, that could point the way to a return to economic health.

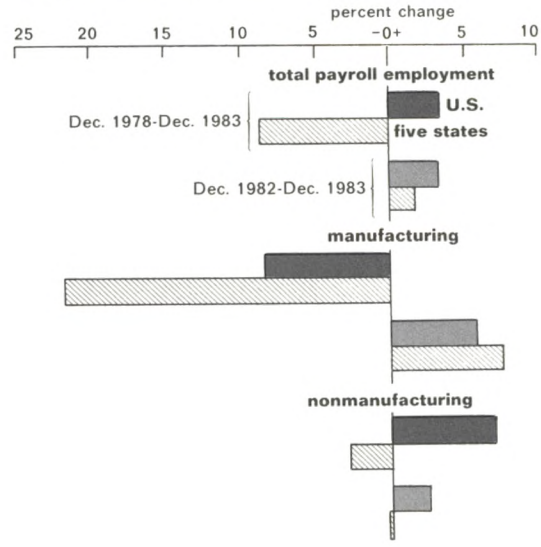
Hard times—1979-84

Prior to 1979, economic conditions in the Midwest were basically sound and prosperous. Business recessions since World War II hit the region with varying intensity, but output and employment always recovered lost ground and reached new highs in subsequent expansions. Business and consumer confidence remained unshaken in the expectation that good times would return.

Although trouble had been brewing for years, the present problems of the Midwest were touched off by the huge increases in petroleum prices associated with the Iranian oil embargo, and the soaring interest rates of 1979, that sent the booming motor vehicle industry into a sharp decline. The region's important machinery and equipment industries were badly mauled in the 1981-82 recession. Steel output dropped below 50 percent of capacity. Setbacks to industry were reinforced by a three-year recession in the Cornbelt, the nation's largest area of productive farmland, which covers major portions of Indiana, Illinois, and Iowa.

In December 1983, nonfarm payroll employment nationally was 3.5 percent above the year-earlier level, while the increase was 2 percent for the five-state area. However, compared to December 1978, U.S. employment was up 3 percent while the five-state area was *down* 8 percent. Manufacturing employment in December was 6 percent above last year nationally, and up 8 percent in the five-state area, which was helped by a 13 percent rise in Michigan. Compared to December 1978, manufacturing employment was

District employment remains well below prosperous levels



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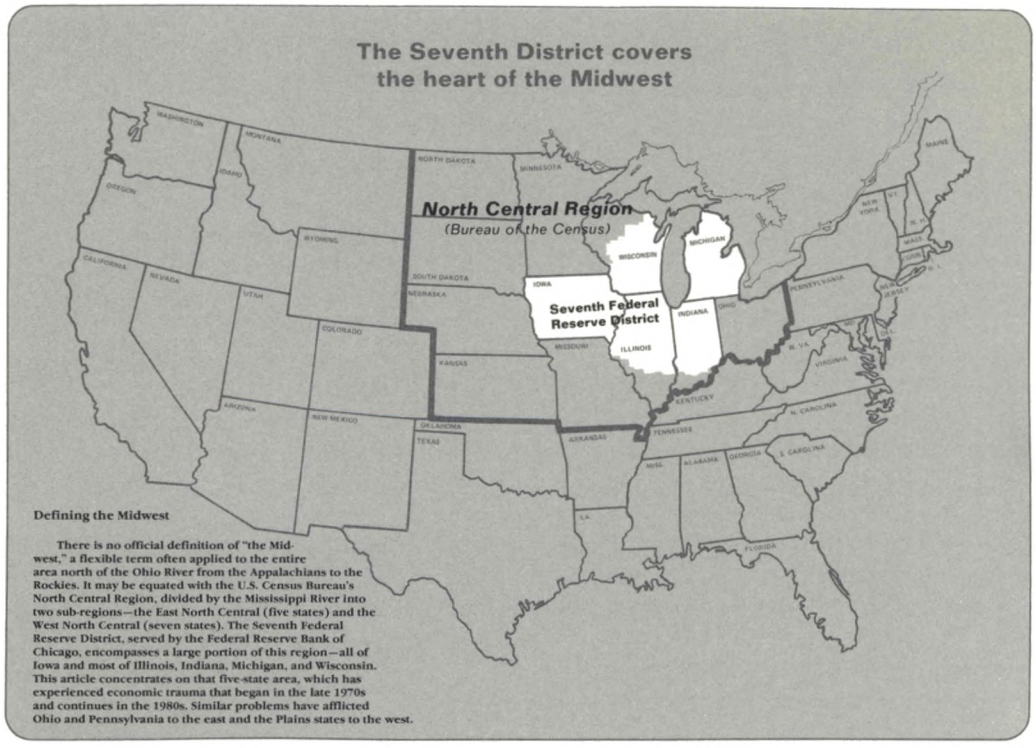


Defining the Midwest

There is no official definition of "the Midwest," a flexible term often applied to the entire area north of the Ohio River from the Appalachians to the Rockies. It may be equated with the U.S. Census Bureau's North Central Region, divided by the Mississippi River into two sub-regions—the East North Central (five states) and the West North Central (seven states). The Seventh Federal Reserve District, served by the Federal Reserve Bank of Chicago, encompasses a large portion of this region—all of Iowa and most of Illinois, Indiana, Michigan, and Wisconsin. This article concentrates on that five-state area, which has experienced economic trauma that began in the late 1970s and continues in the 1980s. Similar problems have afflicted Ohio and Pennsylvania to the east and the Plains states to the west.

still down 8 percent nationally and down 22 percent in the five-state area. Manufacturing employment was 23 percent less than in 1978 for Illinois, Indiana, and Michigan, despite the motor state's recovery in the previous 12 months.

Five years of weak job markets in the goods producing industries of the Midwest have reverberated in other sectors—services and construction. State and local governments, which continued to add staff even in recession years prior to the 1970s, have been forced by financial stringencies to freeze hirings or reduce staff. The cumulative effect of hard times has taken a toll of public confidence, causing investment decisions of businesses and individuals to be postponed or cancelled, thereby intensifying the problems. Population growth has slowed and many once-prosperous communities have reported net outmigration.

Results: Higher unemployment in the Midwest...

In much of the 1960s and 1970s unemployment was less of a problem in the industrial states of the Midwest than in the nation generally. In 1969, for example, at the end of a nine-year upswing in general activity, there were significant labor shortages in some of the region's major industrial centers.

In 1978, the jobless rate averaged 6.1 percent nationally. In the five-state area the rate averaged 5.9 percent, ranging from 4 percent in Iowa to 6.9 percent in Michigan. In 1982, the worst year for unemployment since 1940, the rate for the U.S. averaged 9.7 percent. But in the five-state area it was 12.2 percent, with Michigan at 15.5 percent.

During 1983, job markets improved steadily. By December, the national jobless rate was down to 8.2 percent. The five-state average was 9.8 percent, with Michigan at 11.6 percent. In contrast to the national situation, most of the decline in unemployment in the Midwest in 1983 resulted from net withdrawals from the labor force rather than increased employment. Jobs in the region remained relatively scarce. Knowledge that a company was adding workers often produced mob scenes with eager applicants far exceeding the number of openings.

Despite sharp decline in unemployment in 1983, District rates remain high

...and a halt in population growth

The five-state area's population has been growing less rapidly than in the nation for several decades. Until recently, however, the difference was modest. In 1930, the area had 17.1 percent of the nation's population. By 1970, this ratio had dropped to 16 percent. In the 1970s the drop accelerated. By 1980 the five states had only 14.9 percent of the nation's population, and by 1982 14.6 percent.

From 1960 to 1970, the U.S. population rose 13.4 percent while population in the five states rose 10.8 percent. In 1970-80, growth was 11.4 percent for the U.S., and 4.2 percent for the five states. From 1980 to 1982 U.S. population rose 2.2 percent, while the five-state area *declined* by 0.3 percent. Indiana, Iowa, and Michigan lost population in 1980-82. The reduction or reversal of population growth reflects, in large part, migration of job seekers to the South and West.

Until 1960, the number of people taking residence in the five-state area from outside exceeded the number that departed. Only Iowa had reported net outmigration, because of the decline of the farm population. Net outmigration from the five-state area reached 200,000 in the 1960s, and 840,000 in the 1970s, when only Wisconsin reported a small plus.

The latest available data for the 1980-82 period shows net outmigration from the five-state area of 650,000, more than 70 percent of the number in the previous *decade*. Michigan, which attracted many newcomers in the 1940s and 1950s, led the other states in outmigration in 1980-82, losing more than 300,000 persons. The bulk of those leaving headed for Texas, Florida, and California—areas of rapid growth.

Population loss is associated with reduced job opportunities in virtually all fields. Fewer people means less need for all consumer goods and services, including housing. Fewer workers are required to supply these needs when popula-

Decline in Midwest's share of U.S. population accelerated in 1970s

	United States	Five States	Illinois	Indiana	Iowa	Michigan	Wisconsin
				(percent of United States)			
1960	100.0	16.3	5.6	2.6	1.5	4.4	2.2
1970	100.0	16.0	5.5	2.6	1.4	4.4	2.2
1980	100.0	14.9	5.0	2.4	1.3	4.1	2.1
1982	100.0	14.6	4.9	2.4	1.3	3.9	2.1
				(percent change)			
1960 to 1970	+13.4	+10.8	+10.2	+11.4	+2.5	+13.5	+11.8
1970 to 1980	+11.4	+ 4.2	+ 2.8	+ 5.7	+3.1	+ 4.3	+ 6.5
1980 to 1982	+ 2.2	- 0.3	+ 0.2	- 0.4	-0.3	- 1.7	+ 1.3
				(millions)			
1982	231.5	33.7	11.4	5.5	2.9	9.1	4.8

tion declines or grows at a slower pace.

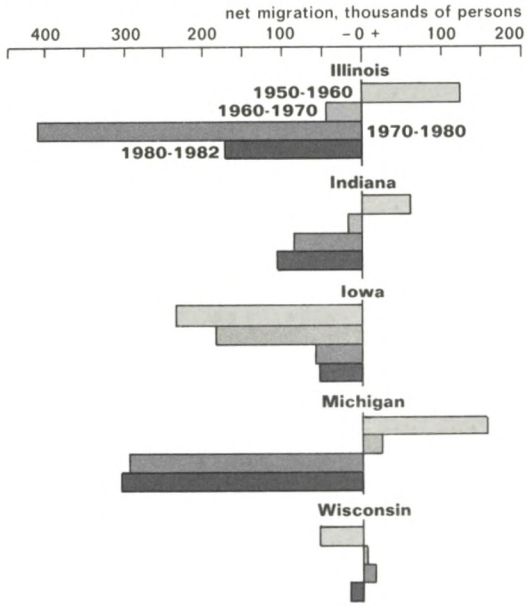
Population data clearly depict the decline of the great cities of the Midwest. Most large central cities have been losing population for about 25 years, while suburban areas have continued to grow. And in the 1970s even some metropolitan areas, including Detroit and Milwaukee, lost population as growth in the suburbs failed to match the exodus from the city.

Between 1970 and 1980, the population of the city of Detroit declined 21 percent. Chicago and Milwaukee each lost 11 percent of its people, Indianapolis and Des Moines 5 percent. Jobs in the core cities have declined faster than population. Unemployment rates there are exceptionally high.

Even as cities have been losing population, their racial mix has been changing rapidly. By 1980, 63 percent of Detroit's residents were black and 2 percent Hispanic. Chicago was 40 percent black and 14 percent Hispanic.

Blacks and Hispanics have increased in the big cities, both through net inmigration and high birth rates. These populations tend to be less well equipped with academic and job skills than the whites they replace. Pressure on employers to provide affirmative action programs based on the cities' population mix may have adversely affected the total number of jobs available.

Midwest population trends reflect outmigration



A troubled sector: durables

In the late 1800s and early 1900s, the Midwest increasingly turned from agriculture to the production of durable manufactured goods. Detroit and other Michigan cities became centers of motor vehicle manufacturing. The steel producers of south Chicago and northern Indiana started the expansion that would eventually seize the lead in steel production from Pittsburgh. Chicago continued to expand its place as the region's financial, trading, and financial hub. Milwaukee became prominent in heavy machinery. Other centers emphasized farm equipment, machine tools, construction equipment, freight cars, engines and other components. In large part the economic problems of the Midwest since the late 1970s reflect the declines in output and sales of such industries.

In 1978, when business activity in the Midwest was still robust, the five-state area accounted for 15.7 percent of the nation's nonfarm payroll employment, somewhat more than its 15 percent share of the population. These states accounted for 19.3 percent of the nation's employment in manufacturing, and 23.4 percent in durable goods manufacturing. Within durable goods, they accounted for 31 percent of employment in steel, 55 percent in engines and turbines, 56 percent in farm machinery, 35 percent in construction machinery, 35 percent in metalworking machinery, and 54 percent in motor vehicles. The five states accounted for a very high proportion of the nation's employment—ranging up to 70-80 percent—in farm tractors, heavy earthmoving equipment, industrial cranes, diesel engines, recreational vehicles, and outboard motors.

In December 1982, at the low point of the recession, total U.S. payroll employment was only about 1 percent below the 1979 average. Employment in durable goods manufacturing, however, was 17 percent less than in 1979 and average work weeks were sharply lower. Employ-

Midwest takes a big share of jobs in durable goods manufacturing

	United States	Five States	Illinois	Indiana	Iowa	Michigan	Wisconsin
	(percent of United States, 1978)						
Total nonfarm payroll employment	100.0	15.7	5.5	2.6	1.3	4.1	2.2
Manufacturing	100.0	19.3	6.1	3.6	1.2	5.6	2.8
Durable goods	100.0	23.4	6.8	4.7	1.3	7.6	3.0
Primary iron and steel	100.0	31.1	8.7	10.7	0.4	8.7	2.5
Engines and turbines	100.0	54.9	15.8	9.0	0.8	9.8	19.5
Farm machinery	100.0	55.6	21.0	3.1	16.0	4.3	11.1
Construction and related machinery	100.0	34.5	17.6	1.6	5.7	4.1	5.4
Metalworking machinery	100.0	35.0	10.2	3.5	0.3	17.8	3.2
Motor vehicles and equipment	100.0	53.7	2.8	6.9	0.9	39.8	3.4

ment in motor vehicles was down 36 percent; steel, 45 percent; farm equipment, 40 percent; construction equipment, 36 percent; metalworking, 22 percent; and railroad equipment, 38 percent.

In many Midwestern localities the situation was worse than the data above suggest. Plants closed for months on end, only to reopen with minimal staff. Others closed permanently and operations were abandoned or shifted to new, up-to-date plants in the South or abroad where labor costs were much lower.

Causes—complex and varied

The factors that have combined to produce the present relative decline in the Midwest are varied in nature and in severity. Some are economic, some political, and some social. Some factors are long-term results of "natural" economic evolution, such as the aging of the Midwest's heavy industrial plant. Others, such as the high interest rates of recent years, may be only temporary dislocations. If the causes differ in kind and degree, so do the potential remedies. While some problems may best be left to the economic market place for solution, including adjustments by management and labor, others may call for close regional cooperation on the political front, or sensitive intervention in social areas by government agencies.

A high wage area

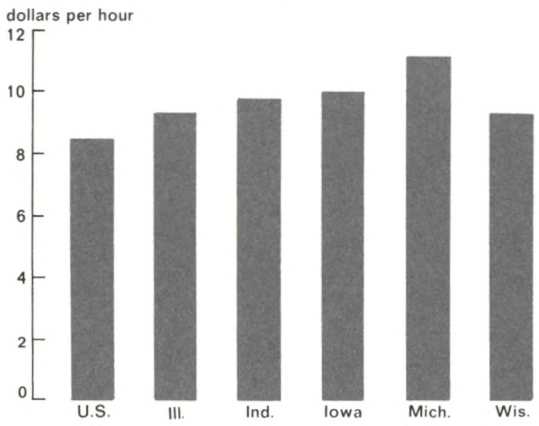
Until the successful CIO organization drives of the late 1930s (aided by the National Labor Relations Act of 1935) the great durable goods industries of the Midwest were largely nonunion. Most prominent among the new "industrial unions," as opposed to the AFL's craft unions for specific trades, were the United Automobile Workers (UAW) and the United Steelworkers (USW). The UAW eventually organized the farm and construction equipment factories, and has often set the pace for demands of other unions.

Successive industrial union contracts from 1946 through 1980, sometimes agreed to after

Motor vehicles, machinery, and other durables dominate Midwest manufacturing

	United States	Five States	Illinois	Indiana	Iowa	Michigan	Wisconsin
	(percent of manufacturing employment, 1978)						
Manufacturing	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Durable goods	59.8	72.3	66.9	77.0	62.4	80.4	65.7
Primary iron and steel	3.9	6.2	5.6	11.5	1.2	6.0	3.6
Engines and turbines	0.7	1.9	1.7	1.6	0.4	1.1	4.6
Farm machinery	0.8	2.3	2.7	0.7	10.4	0.6	3.2
Construction and related machinery	1.9	3.4	5.5	0.8	8.8	1.4	3.7
Metalworking machinery	1.7	3.0	2.8	1.6	0.4	5.3	2.0
Motor vehicles and equipment	4.8	13.3	2.2	9.1	3.6	33.7	5.9

Earnings of District factory workers far exceed U.S. average



extended work stoppages, brought substantial increases in wages and benefits, and changes in "work rules" desired by organized labor. In addition to annual, "basic" wage increases, contracts called for cost-of-living increases and generous benefit packages—vacations, pensions, medical and dental insurance, workers' compensation, and supplementary unemployment insurance. Important benefits also were provided for retired workers. As a result, total compensation rates in these industries tended to outrun compensation per hour in other industries by a widening margin.

Despite concessions in the past year, total cost per hour of employed production workers in the major unionized durable goods industries including steel and autos is $20-24 per hour ($40,000 to $50,000 per year), almost double the average for manufacturing workers in the U.S. and several times foreign labor costs. Nonunion compensation in highly organized states such as Michigan also tends to be higher than in the nation generally.

Average wage rates in the five-state area have exceeded the national average for many years. Wages typically are highest in Michigan, where average hourly earnings of all production workers in manufacturing in 1982 were one-third higher than for the nation. Average wage rates in other District states exceeded the national average by 10 percent to 18 percent.

Labor costs per hour in the Japanese auto industry, high by world standards, are said to be about $12 per hour. In addition, labor productivity is higher than in the U.S., in part because of strict worker discipline, absence of strikes, and low absenteeism. Compensation elsewhere in the Far East and in Mexico and other parts of Latin America is generally much lower than in Japan.

Productivity lags

High labor compensation need not lead to high prices or low profits if output per hour, or labor productivity, is also high. Throughout much of the postwar era, labor productivity in nonfarm business nationally rose more than 2 percent a year on average. In 1977-82, however, there was no rise in productivity on balance. In 1983, productivity rose 3 percent and a further gain is probable in 1984. After severe cutbacks in both blue-collar and white-collar staffing, including many middle managers, Midwest employers are limiting increases in hiring. Some positions eliminated during the recession will not be refilled, and productivity, presumably, will gain as a result.

In some Midwest industries, productivity has been limited by labor problems. Strikes, absenteeism, and restrictive work rules regarding job assignments, overtime, and discipline have lowered labor efficiency.

Another factor inhibiting labor productivity in the Midwest is the aging of important facilities. Existing plants here are generally among the nation's older plants. These factories compete with more modern plants in other regions or abroad which incorporate more advanced technology. In recent years, some producers have shifted production to newer plants in the South that originally had supplemented output of older facilities in the North.

The greater age of the Midwestern industrial plant has another adverse effect. Regulations controlling industrial emissions—air, water, and solid wastes—have had a large impact on the Midwest. Emission controls can be incorporated at lower cost in newly constructed facilities. Deadlines for meeting emission standards im-

posed on older plants may sometimes be satisfied most easily by closing the plants. Often closings have been the answer, especially for foundries. Such decisions have been encouraged by the income tax code. Many Midwest plants, once locally owned, have been acquired by conglomerates whose owners may benefit from tax write-offs when older facilities are shut down.

Foreign competition grows

In the past several years, Midwest producers of durable goods have encountered increasingly severe foreign competition. Imports have taken a growing share of domestic markets while their exports have declined.

Last year, imports accounted for 20 percent of U.S. steel consumption, 30 percent of passenger car sales, 40 percent of machine tool sales, and almost all small farm tractor sales. In addition, a growing share of equipment components are imported. Exports of equipment, steel, and autos have dropped—to a trickle in some cases. Construction machinery producers, some of whom used to export over half of their output, reported a drop in foreign sales of almost 70 percent from 1981 to 1983, largely because of a near-collapse in world markets, but also because of increased foreign competition.

The reasons for adverse trends in the durables trade balance are several. Foreign producers have narrowed or eliminated the technological leads formerly enjoyed by U.S. companies. In part, this has reflected investments of U.S. companies abroad and licensing of U.S. patents and processes. In some cases, e.g., small cars, American consumers have preferred imports to domestic models. Quality of some U.S. goods has been compared unfavorably with imports. Then there is the matter of price. Costs of production are lower abroad than in the U.S., mainly because of lower labor costs.

In recent years the increase in the value of the dollar has been an important factor in the relative prices of U.S. and foreign goods. This development enables foreigners to sell more cheaply here while it raises prices of U.S. goods abroad. Since 1980 the "trade weighted dollar" has risen 50 percent relative to other industrialized countries.

U.S. producers have complained that foreign competitors have been aided by governments that subsidize exports, and impose barriers on imports. Subsidies can take many forms, including low cost financing. In addition, value added taxes, common abroad, are refunded on exported items.

Interest rates hit hard

Most of the durable goods produced in the Midwest, both for business and consumers, involve relatively large outlays, which often require the use of credit. When credit is costly and lenders are cautious, sales of durables will be affected adversely. Purchases of most machinery and equipment, and most big-ticket consumer goods such as autos, appliances, RVs, and boats, are postponable. In depressed times outlays on such items typically decline more than total spending. Businesses have less need for equipment when they are operating below capacity. Consumers may choose to make do with what they have, or do without. In recent years the slump in the durables industries has been reinforced by the highest interest rates in modern times.

In 1980-82, yields on high-grade corporate bonds averaged 13.3 percent and the prime business loan rate averaged 16.4 percent. In 1976-78, when the Midwest was relatively prosperous, high-grade bonds averaged 8.4 percent and the prime rate averaged 7.6 percent. Although high relative to the early 1960s when both the bond rate and the prime rate were at about 4.5 percent, the rates of 1976-78 were not too high to prevent expanding use of credit for purchases.

Interest rates on consumer installment loans historically have been higher than rates on business loans because of the additional costs of administration and servicing. A decade ago effective annual rates on new car loans were around 11-12 percent and other consumer loan rates ranged to more than 20 percent. In recent years of tight money, rates on consumer loans rose to new highs, pricing some borrowers out of the market. Moreover, usury ceilings in various states prevented rates from rising to competitive

levels and caused some lenders to halt new loan applications. Even apart from usury problems, financial conditions of recent years have caused some banks and finance companies to de-emphasize or completely withdraw from "retail" (consumer) lending.

Energy prices and the Midwest

Despite declines since the 1981 peak, world crude oil prices are about 10 times the level of 1972, with OPEC still keeping a lid on output. Prices of other fuels, such as natural gas and coal, also have increased sharply. By comparison, the general price level has only slightly more than doubled since 1972. Soaring energy costs have had profound effects on national economies throughout the world.

Nowhere in the U.S. has the impact been more adverse than in the Midwest. The most direct effect has been on the motor vehicle industry. Customers initially curtailed purchases of cars and trucks, especially the larger, more powerful U.S. models. Imports of small Japanese cars and trucks rose rapidly, until growth was limited by quotas and taxes. Sales of motor homes, other recreational vehicles, and outboard motors, a substantial proportion of which are made in the Midwest, also suffered precipitous declines. Demand for capital equipment made here was curtailed because of the severe recession, which resulted partly from the large increases in energy prices, and because of the massive shift of investment funds to energy exploration and development. The equipment needed for such work is produced and serviced mainly in the oil and gas producing areas in the South and West.

Higher energy prices, coupled with some unusually severe winters here, encouraged the growth of industry and population in warmer climates. Overall, per capita energy usage is not much different in the Midwest than in the nation. However, space heating requirements are much greater here than in warmer areas. This is offset, in part, by lesser use of energy for air conditioning. On average, per capita *residential* energy use in the five-state area exceeded the national average by 16 percent in 1981.

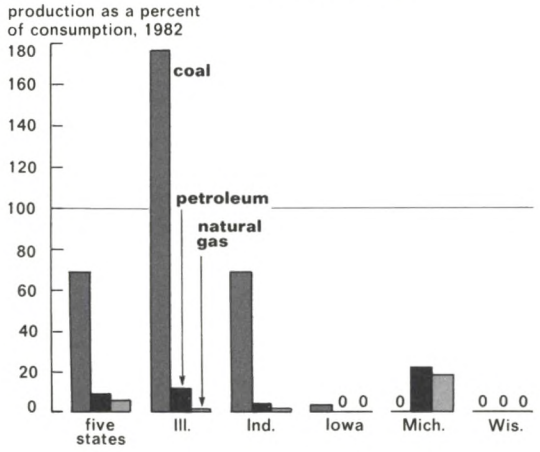
The price of fuel in the Midwest includes not only the cost at the production site, or at U.S. ports, but also transportation charges to this region. Costs to District users are further raised by severance taxes levied by energy-producing states. In some major oil, gas and coal exporting states, severance taxes in 1981 accounted for 20 percent to 50 percent of total tax revenue.

A very large share of the energy consumed in the five-state area is imported from other regions or abroad. Some oil is produced in Illinois, Indiana, and Michigan, but only a small fraction of their consumption. Iowa and Wisconsin produce none at all. Taken as a group, the five-states produce only 10 percent as much oil as they consume.

Some natural gas is produced in Michigan, but less than 20 percent of its consumption. Taken together, the five states produce only 5 percent of the natural gas they consume.

The Midwest fares somewhat better in coal production than in gas or oil. Coal reserves underground in Illinois account for 14 percent of the U.S. total, but coal mined in the state accounts for only 6 percent of U.S. output. Illinois coal is high in sulfur, and many utilities are required to burn low sulfur coal which is commonly supplied by mines in the Rocky Mountain states. Indiana also produces a substantial amount of coal, about 3 percent of the U.S. total. Production of coal in Iowa is small, and none is pro-

Midwest must import costly energy



duced in Michigan and Wisconsin. As a group, the five states produce about 70 percent as much coal as they consume.

Federal outlays low here

The five Seventh District states contribute a much higher proportion of the federal government's revenues than they receive in federal disbursements. This is especially true in the case of national defense spending. This disparity tends to reinforce other factors adversely affecting economic activity in the region.

The five states generate about 15 percent of the nation's personal income. Their contribution to federal revenues is probably similar. These states receive a much smaller share of federal outlays disbursed in the United States—only 10.7 percent of the total and only 5.1 percent of the outlays for defense. (These data exclude interest paid and certain other items not allocable by state.)

Midwest states do not share equitably in federal spending

	Federal outlays, fiscal year 1982			
	Total	Defense	Total	Defense
	(billions)		*(percent)*	
United States	$603.6	$178.8	100.0	100.0
Illinois	22.4	2.8	3.7	1.5
Indiana	10.1	2.6	1.7	1.4
Iowa	5.2	.5	.9	.3
Michigan	18.0	2.2	3.0	1.2
Wisconsin	8.9	1.1	1.5	0.6
Five States	64.5	9.1	10.7	5.1

	Per capita federal outlays			
	Relative to U.S. average		State rank	
	Total	Defense	Total	Defense
	(percent)			
United States	100	100		
Illinois	75	31	46	44
Indiana	71	62	49	34
Iowa	69	22	50	49
Michigan	76	31	45	45
Wisconsin	72	30	48	47
Five States	73	35		

SOURCE: Federal Expenditures by State for Fiscal Year 1982, Bureau of Census.

The relatively low participation of the District in federal outlays stands out dramatically in comparisons with other states on a per capita basis. The five states have five of the six bottom slots among the 50 states in per capita total federal spending and four of the lowest seven positions in defense spending. Indiana ranks highest in the District in defense, but is still only 34th in the nation. The District's role both as prime contractor and as supplier of raw materials and semifinished parts to the rapidly expanding production of military equipment remains relatively small.

State and local governments

Until the late 1970s, state and local government employment in the District had tended to offset periodic declines in private employment, rising even in recession years. In the past few years, state and local governments throughout the District have been grappling with serious financial problems. Revenue shortfalls have reflected both the recession's effect on tax revenues and cutbacks of federal aid. Meanwhile, requirements for social programs and welfare outlays have increased.

State and local governments in the Midwest are dealing with their financial problems by (1) curtailing programs (often reducing employment), and (2) raising taxes. While these steps are necessary to achieve financial solvency, they exert a dampening effect on economic activity.

Farm economy still weak

In some periods in the past when durable goods manufacturing was curtailed, the farm economy of the District was relatively prosperous. In the past three years, declining farm income has coincided with and reinforced the contraction in manufacturing. Many smaller communities are dependent on sales of equipment, supplies, and services to farmers.

Data on agriculturally related employment

are sparse, rendering precise characterizations of the situation difficult. Yet, there is no doubt that rural communities and the industries serving agriculture have suffered extensively in the economic downturn of recent years. There are signs that the farm sector is beginning to recover. But any recovery in agriculturally related employment, in the Midwest and nationwide, is likely to be slow.

Acreage removed from production under government programs in 1983 was about 16 percent of the area planted to principal crops in 1982—the largest such removal ever. The decline in acreage helped to place the farm sector on a stronger financial footing. But industries that furnish inputs and services to farms experienced weak sales in 1983. Sales of seeds, fuels, fertilizer, and pesticides declined 10 to 15 percent, and purchases of grain storage facilities were reduced. Unit sales of farm equipment, down 50 percent from the levels of the late 1970s, remained at very depressed levels. In 1984, the replanting of most of the acreage idled last year will reverse these trends but many firms supplying the farm sector will remain under considerable stress.

Government aids for industries

The shift of industry to the South and West has not merely reflected advantages of climate. Right-to-work laws that hamper organizational efforts of unions also are factors. In addition, powerful incentives are offered to induce businesses to locate new facilities in these states.

Some state and local aids to business are noncontroversial. These include informational services on local resources, labor, transportation, and utilities. Training of potential workers in courses tailored to the needs of particular companies also meets with little criticism. However, the use of financial subsidies can lead to destructive competition among the states and municipalities. Some states and municipalities offer property tax exemptions on new facilities which place additional burdens on other taxpayers, including other businesses. Some offer free land, below-market-rate loans, and aid for construction of access roads or utility extensions. The widespread use of tax-free industrial revenue bonds has inflated the volume of municipal offerings and raised borrowing costs for all state and local governments.

The *Commercial Club Project*

The "City that works" looks for work

In mid-1983, the Federal Reserve Bank of Chicago joined with the Commercial Club of Chicago, a long-established group of business leaders, in a project to create an economic plan for the Chicago metropolitan area. The plan is envisioned as a strategic road map for the Chicago area over the next twenty years, with an emphasis on retaining, creating, and attracting jobs.

As part of this effort, the Chicago Fed is developing a data base of economic information on the metropolitan area. Employment figures and trends, comparative data for other metropolitan areas, and other economic data are being collected and analyzed. The bank will maintain and update the data for the future.

Preparation of the economic plan involves analysis of the Chicago area's strengths and weaknesses and the identification of economic pitfalls and opportunities. Representatives of industry, labor, government, and education are working on industrial sector and individual issue "resource committees" covering such areas as manufacturing, agribusiness, transportation, emerging businesses, research and education, and changing job skills. Resource committees will report to the project's "Road Map" committee.

The recommendations of the resource committees will serve as the basis for detailed proposals to better Chicago's economic and employment position. Some ideas being considered include establishment of public-private partnerships to give technical assistance to small and emerging businesses; tax, zoning, and regulatory changes to encourage retention of business; closer cooperation between the business and education communities to provide appropriate technical support for new enterprises as well as career training for new and displaced workers; and promotional campaigns to improve the Chicagoland image as one of the world's great metropolitan centers. Final project recommendations are scheduled to be completed by August 1984.

The business environment issue

Business groups complain of "unfavorable business climates" in the industrial states of the Midwest. Costs of unemployment insurance and workers' compensation are relatively high in this region, especially in Illinois and Michigan. These costs reflect both the size of payments and the ease of establishing claims. Other complaints involve high costs of waste disposal, large medical insurance premiums, excessive taxes on business, burdensome state pollution controls, restrictions on cutoffs of utility services, and laws affecting hiring and personnel practices.

In 1983, Alexander Grant and Co. published its fourth study of general manufacturing business climates in the 48 contiguous states. States were assigned over-all rankings for 1982. Florida, Texas, and North Carolina took the top three spots. Indiana was 29, Iowa 35, Wisconsin 36, Illinois 42, and Michigan 48. Among the factors considered:

- Costs of fuel and electricity. Costs in the Great Lakes states were 41 percent greater than in the South Central Region, and 4 percent more than the national average.
- Wage costs. Michigan had the highest wage costs of any state. The average for the Great Lakes states was 40 percent higher than for the Southeastern states, and 18 percent above the national average.
- Unionization. In the Great Lakes states 31 percent of nonfarm workers were organized, compared to less than 10 percent in the Carolinas.
- Taxes. Total taxes in the Great Lakes states on individuals and businesses, relative to incomes, was about equal to the national average, but higher than in the Southeastern states.

Business financial stress

Some large District companies that were in excellent financial condition a decade ago have been operating under severe stress in recent years. Their problems usually are a result of several factors—sales falling below expectations, intense competition, rising costs of labor and other inputs, and heavy debts incurred at high interest rates. Some of these firms are operating under special agreements with creditors who could force them into bankruptcy under contractual agreements.

Many hard-pressed firms, especially in the auto industry, have substantially improved their financial positions in the past year and further gains are expected in 1984. However, erosion of executive morale and confidence over the past several years will not be corrected in a year or two. Until financial strength is solidly reestablished and the general economy is clearly in a new growth trend, business caution will restrain commitments for capital spending, inventory investment, and hirings.

The outlook—a warming trend

The Midwest retains the assets that supported growth and prosperity in the past. These include central location, productive farmland, good transportation, ready access to materials and markets, ample fresh water, and a well-educated work force under vigorous management. The economy of the region should improve significantly in 1984 with gains in output of motor vehicles, capital goods, and agricultural supplies. However, a number of steps to correct the problems and inequities that have contributed to the post-1978 malaise must be taken if full economic health is to be regained. Some progress was made in 1983, but much remains to be done. Management, labor, and government have vital roles to play.

Many of the factories closed in recent years will never reopen. Probably, durable goods will never be as large a factor in the region's economy as in the past. But service industries, including scientific research, law, consulting, finance, communications, and futures trading are growing. The continued expansion of office space, especially in Chicago, largely reflects the rise of services. An atmosphere conducive to further growth of these sectors should be maintained. In particular, tax initiatives that might drive such businesses elsewhere should be avoided.

But manufacturing will continue to provide more jobs in the Midwest than will these sophisticated service industries. Its vitality will depend

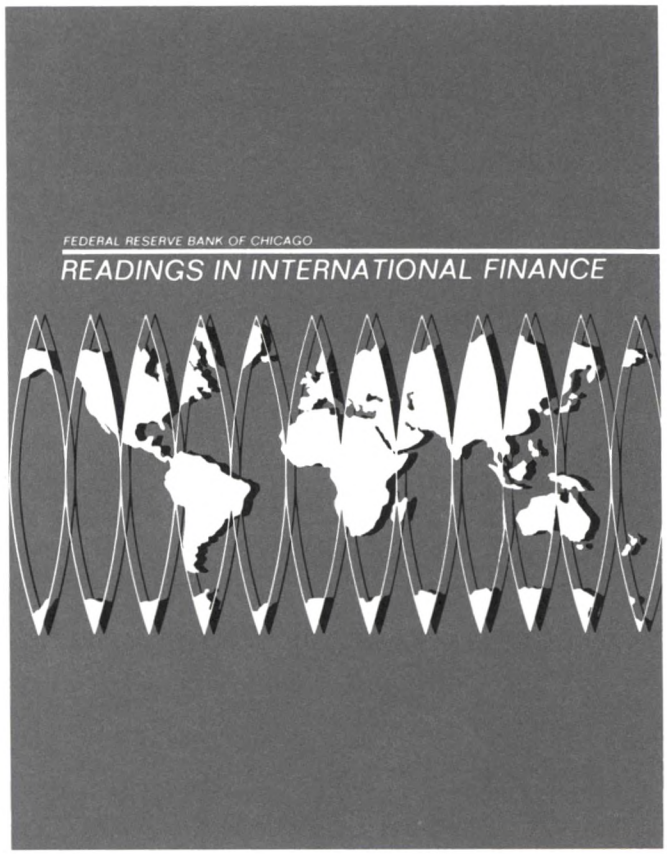
on efficient, low-cost operations. Labor-management agreements to bring worker compensation more in line with competition and to reduce or eliminate counter-productive work rules are essential. In reaching agreements, long, destructive strikes should be avoided.

State and local governments are aware that the "economic climate" of the region is widely viewed as unfavorable to business. Excessively burdensome business taxes, programs for workers' and unemployment compensation, and regulatory policies should be adjusted to "level the playing field" with other regions.

The federal government should take various measures to aid the Midwest. This does not mean special financial help as has been directed, at times, toward Appalachia, and other depressed regions. Rather, the gross inequity of the underdistribution of federal outlays in this region should be ameliorated. Other measures could include action against (1) high severance taxes that force Midwest residents to finance governments in fuel producing states; (2) sales of tax writeoffs that encourage closings of older plants; and (3) subsidies and other unfair practices of foreign governments that encourage their exports and discourage our exports.

The federal government responds to pressure from many groups according to the size of their constituencies. The Midwest states have common problems that require national attention. An organization of state governments of the region, presenting a united front, and cooperation among District congressional delegations could provide effective instruments for constructive change.

The whole nation is adjusting to new economic realities and relationships. That the adjustment should affect most deeply the established industrial base of the Midwest was inevitable. Minimizing the pains of change and maximizing the benefits will require application of the Midwestern traits that created the achievements of decades past: competitive spirit, adaptability, intelligence, technical proficiency, and hard work.



Readings in International Finance, recently published by the Federal Reserve Bank of Chicago, explores major issues and trends in international trade and finance. The 301-page paperback book brings together articles from various Federal Reserve publications dealing with such topics as the balance of payments, the International Monetary System, the Eurodollar market, foreign exchange markets, and international business.

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Measuring and managing interest rate risk: A primer

George G. Kaufman

Losses from unexpected changes in interest rates have become an increasing problem at depository institutions over the past decade, as interest rates have become more volatile and have climbed to unprecedented levels. Such losses occur when unexpected increases in interest rates decrease the market value of an institution's assets more quickly than the market value of its liabilities—deposits and other borrowed funds. This differential change in market values occurs if the institution's assets are less *interest sensitive* than its deposits, that is, if the earnings rate on assets adjusts more slowly to market changes in interest rates than does the payout—the coupon or contract rate—on deposits. Under the same balance sheet condition, the institution experiences a gain when interest rates decline unexpectedly.

The more quickly an asset or liability adjusts to market rate changes, the more interest sensitive it is said to be. Institutions expose themselves to interest rate risk whenever the interest sensitivity of the two sides of their balance sheet is not equal.

The problems of interest rate risk are well-known, but accurate measurement of risk exposure is not easy. And, without such measurements, reliable management of this risk is not possible. This article describes a new technique for measuring in one number or factor the degree of risk exposure an institution assumes, and develops simple hypothetical examples to demonstrate the implications of various interest rate changes for depository institutions. The article also discusses alternative strategies for managing or controlling interest rate risk and the pros and cons of the new technique relative to more commonly used procedures.

George G. Kaufman, professor of finance and economics at Loyola University of Chicago, is a consultant to the Federal Reserve Bank of Chicago. Professor G. O. Bierwag of the University of Arizona assisted in the development of the numerical examples. Much of this article borrows from earlier joint work with him and Alden Toevs. The author also benefited from earlier presentations at the Federal Reserve Banks of San Francisco and St. Louis and the Federal Home Loan Bank of San Francisco.

A hypothetical bank balance sheet

The implications of interest rate changes may be analyzed most easily with a simplified bank balance sheet. The same principles apply to more complex and realistic situations. Here, we describe an institution that has only three types of assets:

1. Cash reserves (C)
2. 2½-year business loans, amortized monthly (BL), and
3. 30-year mortgage loans, amortized monthly (ML).

It also has only two types of deposits (P):

1. 1-year single payment certificate of deposit (CD1) and
2. 5-year single payment certificate of deposit (CD5).

These deposits make no coupon payments and may not be redeemed before maturity. The remaining item on the right side of the balance sheet is net worth or capital (K). The balance sheet shown in Figure 1 describes an institution with total footings of $1,000. All accounts are valued at market. Cash is $100; business loans are $400; mortgage loans are $500; one-year CDs are $600; and five-year CDs are $300. The bank's capital is valued at $100, and its capital-to-asset ratio is 10 percent.

For the sake of simplicity, interest rates are assumed to be the same for all terms to maturity for all securities and deposits of a given default

risk class. That is, the yield curve is assumed to be flat. All interest rates are compounded monthly. All payments are to be made on schedule; there are no assumed defaults, prepayments, or early deposit withdrawals. The interest rate on all business loans is initially assumed to be 13 percent and on all deposits, 11 percent. Cash reserves are assumed not to bear interest initially. The projected net income of the bank for the year may be computed by multiplying the market value of each account by the appropriate interest yield. This is shown in the summary income statement in Figure 1.[1] The bank's initial net income (NI) projected for the year is 1.8 percent on assets. This income will be realized if interest rates do not change during the year. The expected return on capital is 18 percent.

If interest rates change, they are assumed to change by equal percentage points (basis points) for all securities. After a change in interest rates, all bank accounts are marked to their new market (present) values—the price for which the accounts could be sold, if necessary. The balance sheet is designed so that accounts are not equally sensitive to interest rate changes.

Figure 1

Initial conditions

Balance sheet

Assets	Dollars*	D (yrs.)†	Liabilities	Dollars*	D (yrs.)†
Cash	100	0	CD (1 yr.)	600	1.0
BL (2½ yr.)	400	1.25	CD (5 yr.)	300	5.0
ML (30 yr.)	500	7.0	Net worth (K)	100	5.5
Total	1,000	4.0	Total	1,000	2.65

Deposit duration

$$D_P = \frac{600\ (1) \times 300\ (5)}{900} = 2.33 \text{ years}$$

Projected annual income statement for year

	Interest yield	Market value ÷ total assets	Interest ÷ total assets (percent)	
Revenues				
Cash	0	.1	0	
Loans	13	.9	11.7	11.7
Expenses				
Deposits	11	.9	9.9	9.9
Net income				1.8

Summary accounts

K = $100
K/A = 10%
NI = 1.8%

*All accounts are valued at market (present value).
†Approximate, using Equations 2 and 4.

Interest rates increase by 200 basis points

Now let interest rates increase 200 basis points across the board. This reduces the market value of all accounts. The new balance sheet and income statements are shown in Figure 2. It is obvious that the accounts do not change by equal amounts. Longer-term accounts decline more in value than shorter-term accounts. For example, the market value of the business loan declines from $400 to $390, while that of the longer-term mortgage loan declines from $500 to $437. Total assets decline to $927. Likewise, the market value of the one-year CD declines from $600 to $589, the five-year CD from $300 to $272, and total deposits from $900 to $861. The value of capital, which is the difference between the value of total assets and deposits, declines 34 percent from $100 to only $66. Capital as a ratio of total assets declines from 10 percent to 7.1 percent. The increase in interest rates also decreases the projected annual net income by increasing the interest cost of deposits more than the revenue from assets, even though cash is now assumed to yield a small interest return. This occurs because deposits now account for proportionately more of total footings than before, so that interest expense has increased in relative importance. The projected net income declines to 1.5 percent of total assets from 1.8 percent. It is evident that the increase in interest rates has harmed the institution.

An equal decrease in interest rates of 200 basis points would have opposite effects. As can be seen from Figure 3, the values of all bank accounts except cash increase. Capital increases

[1]This definition of net income reflects economic income. All gains and losses due to changes in interest rates are recognized immediately. In practice, banks do not use this accounting system and do not recognize these gains and losses unless securities are sold before maturity. Nevertheless, economic income provides the most meaningful picture of a bank's income condition.

to $147, the capital to asset ratio to 13.5 percent, and net projected income to 2.0 percent of total assets. The institution is better off than it was before.

Duration analysis

Changes in a bank's financial position due to interest-rate changes can be looked at with the help of *duration analysis*. Duration is a measure of the average life of a security. In its simplest form, it is computed by multiplying the length of time to each scheduled payment by the ratio of the present value of that payment to the total present value or price of the security and summing, or

$$D = \frac{\sum_{t=1}^{l} t \cdot PVF_t}{\sum_{t=1}^{l} PVF_t} \qquad (1)$$

where:

D = duration
t = length of time (number of months, years, etc.) to the date of payment
PVF_t = present value of the payment (F) made at (t), or $F_t/(1+i)^t$
$\sum_{t=1}^{l}$ = summation from the first to the last payment (l).

This measure of duration is referred to as Macauley's Duration, and is named after Frederick Macauley, who first computed it in 1938 in his seminal study of the history of interest rates in the United States. Duration is a single number that is measured in units of time, e.g., months or years. For securities that make only one payment at maturity, duration is equal to maturity; for all other securities, it is shorter than term to maturity. Duration effectively converts a coupon security into its zero coupon (single payment or bullet) equivalent. For coupon bonds, for example, duration is equal to the term to maturity of an equivalent zero coupon bond that makes the same total payments and yields the same interest rate. The properties of duration have been described elsewhere.[2] Most importantly for our purposes, at first approximation, duration relates changes in interest rates and percentage changes in bond prices linearly as follows:

$$\frac{\Delta S}{S} = -D\frac{\Delta i}{(1+i)} \approx -D\Delta i \qquad (2)$$

where:

S = price of a security
i = yield to maturity
Δ = change from previous value.

Figure 2

Assume interest rate increase of 200 basis points

Balance sheet

	Dollars*			Dollars*	
Assets	Actual	Approx'd.	Liabilities	Actual	Approx'd.
Cash	100	100	CD (1 yr.)	589	588
BL (2½ yr.)	390	390	CD (5 yr.)	272	270
ML (30 yr.)	437	430	Net worth (K)	66	62
Total	927	920	Total	927	920

Projected annual income statement for year

	Interest yield	Market value ÷ total assets	Interest ÷ total assets (percent)	
Revenues				
Cash	2	.11	0.2	
Loans	15	.89	13.4	13.6
Expenses				
Deposits	13	.93	12.1	12.1
Net income				1.5

Summary accounts

K = $66
K/A = 7.1%
NI = 1.5%

*All accounts are valued at market (present value).

[2] G. O. Bierwag, George G. Kaufman, and Alden Toevs, "Duration: Its Development and Use in Bond Portfolio Management," *Financial Analysts Journal*, July/August 1983 and "Management Strategies for Savings and Loan Associations to Reduce Interest Rate Risk," *New Sources of Capital for the Savings and Loan Industry: Conference Proceedings* (Federal Home Loan Bank of San Francisco), December 1979. A more technical analysis appears in George G. Kaufman, G. O. Bierwag, and Alden Toevs, eds., *Innovations in Bond Portfolio Management: Duration Analysis and Immunization*, Greenwich, Conn.; JAI Press, 1983 and in Gabriel A. Hawawini, ed., *Bond Duration and Immunization*, New York; Garland Publishing, 1982.

Figure 3

Assume interest rate decrease of 200 basis points

Balance sheet

	Dollars*			Dollars*	
Assets	Actual	Approx'd.	Liabilities	Actual	Approx'd.
Cash	100	100	CD (1 yr.)	612	612
BL (2½ yr.)	410	410	CD (5 yr.)	331	330
ML (30 yr.)	580	570	Net worth (K)	147	138
Total	1,090	1,080	Total	1,090	1,080

Projected annual income statement

	Interest yield	Market value ÷ total assets	Interest ÷ total assets (percent)	
Revenues				
Cash	-2	.09	-0.2	
Loans	11	.91	10.0	9.8
Expenses				
Deposits	9	.87	7.8	7.8
Net income				2.0

Summary accounts

K = $147

K/A = 13.5%

NI = 2.0%

*All accounts are valued at market (present value).

Equation 2 is more accurate the smaller are the interest rate changes.

Now we can readily see why the value of each account changed when interest rates increased. All we need to do is compute the duration for each account by Equation 1 and multiply by the 200 basis point increase in interest rates. The duration of each account is shown in Figure 1. (For ease of following the analysis, the durations shown are rounded.) As was noted earlier, the duration of securities that generate periodic flows before maturity is less than their term to maturity. Thus, the initial duration of the 30-year monthly amortized mortgage yielding 13 percent is only seven years (7.14 years precisely). The durations of the single payment CDs are equal to their maturities. Because the bank will generate a constant stream of earnings as shown in the projected income statements unless interest rates change, the return on capital is projected to be constant. Thus, the duration of capital is the same as the duration of a fixed-coupon perpetual bond (consol) and approximates 1/i. The initial return on capital is $18 per $100 or 18 percent, and its initial duration is approximately 5½ years.[3] The longer are the durations, the proportionately greater will be the price change predicted by Equation 2 for a given change in interest rates. Note also that: 1) duration, unlike maturity, has a linear relationship with price sensitivity and 2) the longer the duration of a security, the smaller is its interest sensitivity as defined at the beginning of this article.

The change in the market value of each account predicted by Equation 2 is shown in Figure 4. Changes in interest rates of 200 basis points are large relative to the capabilities of Equation 2. As a result, the predictions are only rough approximations and will be less accurate with longer durations. In actuality, changes of 200 basis points are unlikely to occur all at one time. In addition, the predictions are distorted because rounded rather than precise values of duration are used. The approximate changes in

Figure 4

Using duration to measure risk exposure for individual accounts

Approximate changes in the market value of balance sheet accounts for 200 basis point *increase* in interest rates (see equation 2):

BL: -1.25 (+200) = - 2.5%, (-$10)

ML: -7.0 (+200) = -14.0%, (-$70)

1 yr. CD: -1.0 (+200) = - 2.0%, (-$12)

5 yr. CD: -5.0 (+200) = -10.0%, (-$30)

K: -5.5 (+200) = -11.0%, (-$11)*

TA: -4.0 (+200) = - 8.0%, (-$80)

TL: -2.65 (200) = - 5.3%, (-$53)*

*Price effect (PE) only. But there is also an income effect (IE) = $(TA_{PE} - TL_{PE}) = (80-53) = \$27$

Thus, total effect = PE + IE = :

TL: -53 + (-27) = -$80

K: -11 + (-27) = -$38

[3]If the bank's earnings are expected to increase, duration would be greater than the consol value, as can be seen from Equation 1. If earnings are expected to decrease, duration will be shorter. Although capital has no maturity date, its duration is not constant. It changes when interest rates change.

values will approach the actual changes in value as the assumed interest rate changes decrease in size and the precise values of duration are used. Nevertheless, for all the accounts except capital and total liabilities, the computed dollar changes are reasonably close to the actual changes between Figures 1 and 2. For example, the actual decline in the market value of the 5-year CD is $28 (from $300 to $272) and the approximated decline is $30 (from $300 to $270). To the extent that changes in prices reflect the degree of interest rate risk assumed, duration represents a good first-approximation measure of risk because it is proportional to the price change. For example, the price of the five-year CD will change five times as much for a given change in interest rates as the price of the one-year CD. This makes it five times as risky, which is reflected in a duration five times as great.

For capital and total liabilities, the computed declines are substantially smaller than the actual declines. This occurs because the approximated market value of the assets declines by $80 when interest rates increase by 200 basis points, while the sum of deposits and capital declines by only $53 (42 + 11), or $27 less. The additional $27 loss must be charged against capital. When this is done, the approximated value of capital declines by $38, directly by $11, as shown in Figure 4, and indirectly by $27, from the additional loss in assets. (The actual value of capital declines by $34.) The sharp decline reflects the combined effects of the 200 basis-point increase in the discount rate on capital from 18 to 20 percent and the decline in projected earnings on capital from 18 to 15 percent. Now also the approximated market value of total liabilities declines by $80 (53 + 27), the same amount as the decline in assets, and the two sides of the balance sheet balance. Thus, as formulated, Equation 2 cannot be used directly for approximating changes in the value of capital.

With a small adjustment, however, durations can be used to measure the overall interest rate exposure of the institution. As is evident from analyzing the changes in the balance sheet and income statement above, the increase in interest rates did not affect every account equally. It is thus necessary to specify precisely what account is most important to the institution. The selection of such a target account whose value is to be controlled and the assumption of a particular degree of risk exposure in that account is the function of the bank's senior management. In this article, we will focus on only two accounts: 1) the nominal value of capital and 2) the capital-to-asset ratio.[4] The first is most likely of primary concern to the shareholders of the bank and the second, to bank examiners. While the interest rate sensitivity or risk of individual accounts is related to the duration of the account, the interest rate risk of a target account is related to the difference, or gap, between the average duration of the assets of the institution and the average duration of the deposits. The duration gap measures for the two accounts discussed above are:

$$\begin{aligned} &\text{K:} \quad (D_A - wD_P) \\ &\text{K/A:} \quad (D_A - D_P) \end{aligned} \qquad (3)$$

where:

D_A = average duration of assets
D_P = average duration of deposits
w = a weight defined as $P/P+K = P/A$

The proofs for these relationships are derived in the Appendix.

The average durations for the measure of duration given in Equation 1 are obtained by weighting the durations for the individual securities by their relative market values. Substituting into Equation 3 the appropriate values of duration from Figure 1, yields the values of the duration gap for each account. These are shown in Figure 5. Note that the duration gaps differ for the two accounts, reinforcing the need for the

[4]It is also possible to use net income as a target account and to develop appropriate measures of duration gap. The duration gap measure for economic income is complex and has been derived by G. O. Bierwag. It is available from the author upon request (George Kaufman, Research Department, Federal Reserve Bank of Chicago, Box 834, Chicago IL 60690). A duration gap measure for net income using current bank accounting practices has been derived in Alden Toevs, "Gap Management; Managing Interest Rate Risk in Banks and Thrifts," *Economic Review* (Federal Reserve Bank of San Francisco), Spring 1983.

Figure 5

Using duration gap to measure interest rate risk exposure for target accounts

Duration gap formulas:

K : $(D_A - wD_P) = 4.0 - .9\,(2.3) = 1.9$ years

K/A: $(D_A - D_P) = 4.0 - 2.3 = 1.7$ years

where $w = (P/A)$

Approximate changes in market values for 200 basis point increase in interest rates (see equation 4):

K : $-1.9\,(+200) = \$-38$

K/A: $-1.7\,(+200)\,(0.9) = -3.1\%$

Formulas for immunization (IRR = 0):

K : $D_A = wD_P$

K/A: $D_A = D_P$

bank to identify a primary target account. The gap is 1.9 years for capital and 1.7 years for the capital-to-asset ratio.

The estimated impact of interest rate changes on the target accounts can be obtained by substituting the relevant duration gap into Equation 2, as follows:

For capital:

$$\frac{\Delta K}{A} = -(D_A - wD_P)\Delta i$$
$$= -(4 - .9 \times 2.3)\,\Delta i$$
$$= -1.9\Delta i$$

or

$$\frac{\Delta K}{K} = -(D_A - wD_P)\left(\frac{A}{K}\right)\Delta i$$
$$= -(1.9)\,(10)\,\Delta i$$
$$= -19\Delta i \qquad (4)$$

For capital-asset ratio:

$$\Delta\left(\frac{K}{A}\right) = -(D_A - D_P)\left(\frac{1-K}{A}\right)\Delta i$$
$$= -(4 - 2.3)\,(.9)\,\Delta i$$
$$= -1.5\,\Delta i$$

Multiplying each duration gap by the 200-basis-point increase in interest rates yields the decrease in the value of the respective account as a percent of total footings. Capital now decreases by 3.8 percent of total assets, or the full $38, a combination of the $11 price effect and the $27 income effect (See Figure 4).

The above examples clearly demonstrate that the actual changes in the market value of the balance sheet accounts attributed to interest rate changes are proportional to the duration of the accounts. Accurate measures of duration yield close approximations of these actual changes.

The institution can change its degree of interest rate exposure to any extent it wishes by changing the composition of its balance sheet in such a way as to obtain the desired duration gap for its target account. The greater the duration gap, the greater is the institution's risk exposure for a particular target account; and conversely, the smaller the gap, the smaller its exposure. Moreover, the relationship is linear. For example, if in the above example the duration gap for capital were twice as large, say 3.8 years, then the value of capital would decline twice as much, or $76 for a 200-basis-point increase in interest rates.

An institution can also eliminate its risk exposure to zero by setting its target account duration gap to zero. This can be seen by using a value of zero in Equation 4. The bank is then said to be "immunized," and unexpected interest rate changes will not change the market value of the target account. The decision on how much interest rate risk exposure to assume and the strategy of how to achieve this is referred to as interest rate risk management and is discussed in the next section.

Before introducing risk management, it is useful to emphasize a number of points:

1. If the institution does not specify a target account, it cannot measure its interest rate risk exposure accurately.

2. Interest rate exposure is directly related to the absolute size of the duration gap for the target account; the greater the gap, the greater the risk exposure.

3. Interest rate exposure can be removed or immunized in a target account by setting the appropriate duration gap to zero.

4. If the market value of total assets changes more or less with changes in the price level, maintaining a constant capital-to-asset ratio (immunizing) maintains a constant real value of capital.

5. Although the bank balance sheet used in our examples includes only securities traded on the cash market, duration analysis applies equally well to securities traded on the futures and options markets. The durations of these securities can be computed and included in the appropriate duration gap measure to measure the overall interest rate exposure of the bank.

Managing interest rate risk

Like any private business firm, a depository institution attempts to maximize its profits. However, profit maximization presumes a desired level of risk exposure. Expected profit and risk are directly related. The greater the risk of loss assumed, the greater must be the expected profit required to compensate for the higher likelihood of loss, and, conversely, the smaller the risk exposure assumed, the smaller can the expected profit be. The desired risk-return tradeoff for an institution is determined by its senior management and may be expected to differ from bank to bank. Interest rate risk is only one type of risk a bank assumes. It generally also assumes credit quality risk, liquidity risk, foreign exchange rate risk, and so on. Thus, managing interest rate risk is part of overall risk management.

To manage any risk accurately, a bank must predict the probability of possible outcomes of undertaking the risky activity. To manage interest rate risk, it is necessary to predict, at minimum, the direction of interest rate changes. The effect of an interest rate change will differ depending on whether the bank has a positive gap (the duration of assets is greater than the duration of the appropriately weighted deposits) or a negative gap in the relevant target account. As may be seen in Equation 2, decline in interest rates will increase the nominal value of a bank's capital account if its capital duration gap is positive and decrease the value if its gap is negative. An increase in interest rates will have the opposite effect, decreasing the nominal value of the capital account if the duration gap is positive and increasing it if it is negative. The greater the gap, the greater will be the gain or loss. Thus, the bank must determine both the direction and the size of its gap on the basis of its predicted interest rates. Correct predictions will increase capital and incorrect predictions will decrease capital. A bank may pursue two interest rate risk strategies; a passive (immunization) strategy or an active strategy.

Immunization. For whatever reasons, a depository institution may wish to maintain a constant nominal value of its target account regardless of changes in interest rates and immunize its interest rate risk exposure. This is a complete hedging strategy. It should be noted that banks generate profits if they assume interest rate risk and manage it correctly, and that this income may be reduced or lost altogether when it decides to immunize. On the other hand, by immunizing the bank also decreases its chances of suffering losses if the risk is mismanaged. As discussed earlier, to immunize fully the bank needs to set the appropriate duration gap to zero.

Assume that the bank chooses the nominal value of capital as its target account and wishes to immunize its current market value. In our example in Figure 1, the initial value of capital is $100. To immunize capital, the bank needs to restructure its balance sheet so that from Equation 3:

$$D_A - wD_P = 0 \qquad (5)$$

Initially $D_A = 4$ years, $D_P = 2.3$ years and $P/A = .9$. This yields a duration gap of $4 - .9\,(2.3) = 1.9$ years. The bank is not immunized. It can reduce the gap to zero either by shortening the duration of its assets by 1.9 years to 2.1 years or by length-

ening the duration of its deposits to 4.4 years so that .9 (4.4) = 4 years. It can do so either on the cash or the futures market. We will assume that the bank prefers to lengthen its deposits on the cash market. It can do so by reducing the dollar volume of its one-year CDs from $600 to $125 and increasing the volume of its five-year CDs from $300 to $775. As is shown in Figure 6, this increases the duration of the deposits from 2.3 to 4.4 years and satisfies Equation 5.

Now let interest rates increase 200 basis points as before. (For the sake of ease in tracing the mechanics, the examples are created using the approximate duration values rather than the precise duration values. Thus, the bank will not be perfectly immunized in actuality). Except for capital, which remains at $100, the approximated market value of each account declines. Because the composition of assets was not changed, the decline in their market value is the same as in Figure 2. The composition of the deposits was changed, however, by reducing the proportion of shorter-term deposits. As a result, the decline in the value of total deposits is greater than before. Capital remains unchanged because the decline in the market value of the deposits is now exactly equal to the decline in the market value of the assets. Although capital remained unchanged, the values of the other two summary accounts did not. The capital-to-asset ratio increased to 10.8 percent, and net income increased to 2.0 percent of assets. Thus, immunization of the capital account does not imply immunization of other accounts. As shown in Figure 6, the gap for the capital-to-asset ratio is -0.44 when the gap for capital account is 0.

Because, as can be seen from Equation 1, the change in interest rates changes the duration of all securities, Equation 5 is no longer satisfied after the change in rates. Thus, the bank is no longer immunized and must restructure its balance sheet so that it is immunized against the next interest rate change. Moreover, as may also be seen from Equation 1, the durations of securities decline, even if there is no interest rate change, just from the passage of time. To remain immunized, the bank must continually restructure its balance sheet to offset this duration "drift". For larger institutions that buy or sell Fed

Figure 6

Immunize K and set DGAP = 0 years when $D_A = 4$ and $D_P = 2.3$

Strategy: Set $D_A - (P/A)D_P = 0$

Currently: $D_A = 4$, $(P/A)\,D_P = 2.1$ years

$DGAP_K = 4 - 2.1 = 1.9$ years

Can satisfy by:

1. By shortening TA to $D_A = 2.1$ years
2. Lengthening P to $D_P = 4.4$ years [$(P/A)D_P = .9\,(4.4) = 4.0$)]

Can act on:

1. Spot market
2. Futures market

Assume *lengthening* P on *cash* market by changing mix:

Assets	Dollars*	D (yrs.)†	Liabilities	Dollars*	D (yrs.)†
Cash	100	0	CD (1 yr.)	125	1
BL (2½ yr.)	400	1.25	CD (5 yr.)	775	5
ML (30 yr.)	500	7.0	Net worth	100	5.5
Total	1,000	4.0	Total	1,000	2.65

Deposit duration

$$D_P = \frac{125\,(1) \times 775\,(5)}{900} = 4.44 \text{ years}$$

If interest rates increase by 200 basis points:

	Dollars*			Dollars*	
Assets	Actual	Approx'd.	Liabilities	Actual	Approx'd.
Cash	100	100	CD (1 yr.)	123	122
BL (2½ yr.)	390	390	CD (5 yr.)	704	698
ML (30 yr.)	437	430	Net worth	100	100
Total	927	920	Total	927	920

*All accounts are valued at market (present value).

†Approximate.

Projected annual income statement

	Interest yield	Market value ÷ total assets	Interest ÷ total assets (percent)	
Revenues				
Cash	2	.11	0.2	
Loans	15	.89	13.4	13.6
Expenses				
Deposits	13	.89	11.6	11.6
Net income				2.0

Summary accounts

K = $100

K/A = 10.8%

NI = 2.0%

Analysis (duration gap)

K : 4 - .9 (4.44) = 0 yrs.

K/A: 4 - 4.44 = - .44 yrs.

funds daily in the normal course of their business, this is not a problem. It is more of a problem for smaller institutions.

It is important to note that even though an immunized institution as a whole does not assume interest rate risk, the durations of the individual securities on the bank's balance sheets need not be matched, and the institution may still engage in interest rate intermediation in individual accounts. In our example, the bank has 30-year mortgages financed in part by one-year deposits. The reduction in overall risk exposure is achieved through diversification across individual securities with different durations. A portfolio of a given average duration can be structured from an almost infinite number of individual securities with different durations.

Active management. Many banks do not wish to eliminate interest rate risk altogether, but prefer to manage it. Because accepting risk exposure assumes that the bank will suffer losses if interest rates change in the wrong direction, the decision to accept such exposure presupposes that the bank is willing to predict interest rates and believes it can do so successfully. (If it is not, it is better off to immunize and to assume no risk for the same expected return.) Indeed, to determine the desired direction and magnitude of the duration gap, it is necessary, at minimum, for the bank to forecast the direction in which interest rates will change. If rates are predicted to increase, the gap should be negative, so that the average duration of the assets is shorter than that of the weighted deposits. This would make the bank behave as if it were a net liability, whose value declines as interest rates rise. The bank will benefit from an interest rate rise. On the other hand, if rates are predicted to decline, the institution would be better off if the gap were positive. Then the bank behaves like a net asset, whose value increases as interest rates decline.

Assume the bank predicts that interest rates will decline. It will restructure its portfolio to obtain a positive duration gap. The precise value of the gap it chooses depends on its risk-return preferences. The larger the gap, the higher the potential return but the higher also the risk of loss. The decision as to the precise risk-return matrix to assume and thus the value of the gap to achieve is generally made by the bank's top management in consultation with the Asset and Liability Management Committee. Assume that the bank predicts that interest rates will decline in the next period and prefers to accept risk in the value of its capital consistent with a value of a positive duration gap of 1 year so that:

$$D_A - wD_p = 1 \qquad (6)$$

It can achieve this value in our example either by shortening the duration of its assets from 4 to 3.1 years or by lengthening the duration of its deposits from 2.3 to 3.3 years. (We again use the approximate durations.) For every 100 basis points interest rates decline, the bank's capital value will rise by $10 (100 basis points × 1 year gap = 1% of total assets).

In Figure 7, the bank lengthens the duration of its deposits on the cash market to 3.3 years by reducing the dollar amount of one-year CDs from $500 to $375 and increasing the dollar amount of five-year CDs from $300 to $525. Now, contrary to the bank's expectations, let interest rates increase by 200 basis points rather than decrease. The bank is worse off. Assets again decline to $927 as before, but the market value of capital declines by $17 to $83. The bank has lost its bet on interest rates and has paid the price. At the same time, its capital-to-asset ratio declines to 9.0 percent and its net income remains basically unchanged. Each of these changes is easily predictable using duration analysis and assuming alternative interest rate scenarios. As was noted earlier, to win with an active policy, the bank must both predict interest rates and be right. As before, the interest rate increase changes the durations of the accounts differently and thus the value of the duration gap. To maintain a gap of 1 year, or any other target amount, the bank must restructure its balance sheet accordingly.

The changes in the values of the different summary accounts for a 200-basis-point increase in interest rates for alternative value of the duration gap in terms of capital are summarized in Figure 8. The changes may even be in different directions. For example, if the duration gap for capital is set at 0.5 years, the market value of capital will decline by about $10 when interest

Figure 7

Set DGAP for K = 1 year when D_A = 4 and D_P = 2.3

Strategy: Set $D_A - (P/A) D_P = 1$ year

Currently: $D_A = 4$, $(P/A) D_P = 2.1$ years

$DGAP_K = 1.9$ years

Can satisfy by:

1. Shortening TA to $D_A = 3.1$ years
2. Lengthening P to $D_P = 3.3$ years [$(P/A)D_P = 3.3$ and $.9D_P = 3$]

Can act on:

1. Spot market
2. Futures market

Assume *lengthening* P on *cash* market by changing mix:

Assets	Dollars*	D (yrs.)†	Liabilities	Dollars*	D (yrs.)†
Cash	100	0	CD (1 yr.)	375	1
BL (2½ yr.)	400	1.25	CD (5 yr.)	525	5
ML (30 yr.)	500	7.0	Net worth	100	5.5
Total	1,000	4.0	Total	1,000	3.5

Deposit duration

$$D_P = \frac{375\ (1) \times 525\ (5)}{900} = 3.33 \text{ years}$$

If interest rates increase by 200 basis points:

	Dollars*			Dollars*	
Assets	Actual	Approx'd.	Liabilities	Actual	Approx'd.
Cash	100	100	CD (1 yr.)	368	367
BL (2½ yr.)	390	390	CD (5 yr.)	476	473
ML (30 yr.)	437	430	Net worth	83	80
Total	927	920	Total	927	920

Projected annual income statement

	Interest yield	Market value — total assets	Interest — total assets (percent)	
Revenues				
Cash	2	.11	0.2	
Loans	15	.89	13.4	13.6
Expenses				
Deposits	13	.91	11.8	11.8
Net income				1.8

Summary accounts

K = $83

K/A = 9.0%

NI = 1.8%

Analysis (duration gap)

K : 4 - 3 = 1 yr.

K/A: 4 - 3.3 = 0.7 yr.

*All accounts are valued at market (present value).

†Approximate.

Figure 8

Changes in summary accounts for alternative duration gaps targeting capital account when interest rates increase by 200 basis points

GAP (years)	Approximate changes in summary accounts*		
	K	(K/A)	NI
1.9	$-38	-3.1%	-0.2%
1.0	-20	-1.2	0.0
0.5	-10	-0.2	+0.1
0	0	+0.8	+0.2

*Using Equation 4.

rates increase by 200 basis points, the capital-to-asset ratio declines somewhat by 0.2 percentage points, and net income increases by .08 percentage points.

Practical problems with applying duration gap analysis

Although theoretically appealing, duration gap analysis has some practical problems that have limited its use to date. Duration gap analysis imposes strenuous data demands. It requires complete data on each account (security) or, at minimum, each homogeneous group of accounts on the bank's balance sheet, including not only information on contract (coupon) interest rate and maturity but also on when a variable rate account (security) can be repriced (its contract rate changed) before maturity and any constraints on the amount by which it can be repriced. In addition, data on prepayment and other call provisions; due-on-sale, early deposit withdrawal, and other put provisions; and any other options that are included and the conditions for when and how they may be exercised are required. This information requires full access to the bank's account origination files. The less information on individual accounts that is available, the less reliable will be the computed duration gaps.

Variable rate contracts and contracts that contain option provisions have effective maturities that are shorter than their nominal maturities. For example, if a 10-year variable rate bond can be repriced at $100 at the beginning of every year, its price behavior resembles that of a one-year bond rather than a 10-year bond. Likewise, a 10-year bond with a call option permitting the

borrower to buy back (prepay) the bond at no more than a maximum price will behave like a shorter term bond when interest rates decrease so that the probabilities of a call are sufficiently high. The computation of durations for cash flows that involve either repricing or the exercise of option provisions requires forecasts of interest rates to determine when the cash flow pattern will be changed and by how much. The best forecasts to use for this purpose are the rate forecasts that are implicit in the term structure of interest rates at the time.[5]

A number of types of bank deposit accounts, such as demand deposits, savings, NOWs, SNOWs, and MMDAs, do not have specific maturity dates. Depositors may redeem these accounts at any time at par value. The accounts effectively have a put option exercisable by the holder on the bank at any time. What are the durations of such deposit accounts?

On the one hand, it may be argued that these are one-day accounts. If market rates of interest increase and the bank does not raise its deposit rates accordingly, either in cash or in services, the depositor may withdraw the funds. This is particularly likely in a world of increasing deregulation in which institutions across the street are able and likely to compete by offering market rates. The deposits may be effectively viewed as variable rate accounts that are repriced at par every day. Unlike our earlier examples, their market value will never decline below par value as interest rates rise. Their durations would be one day. This treatment makes it difficult for a bank to structure its balance sheet to produce zero or even small positive or negative duration gaps.

On the other hand, in the old world of regulation and deposit rate ceilings and to some extent even today, all deposits are not equally interest sensitive. If a bank's deposit rates lag increases in market rates, all deposits will not leave the bank immediately. "Core" deposits will remain for some time and flow out only slowly. It may be possible to assign accurate probabilities to the timing of the net outflows, depending on the difference between the market and deposit rates. From this it is possible to compute the effective decline in the market value of the remaining deposit accounts by assuming them to be equivalent to certificates of deposits with maturity dates equal to the predicted outflow dates. Their durations would also be equivalent and thus would be longer than one day. If interest rates increase, it is then possible to value these deposits at less than their par value.

However, the correct duration to assign these deposits cannot be determined arbitrarily by the desirability of the assumptions. Rather, the actual price behavior of the accounts when interest rates change must be used. Otherwise the interest rate sensitivity of the bank is misgauged. The correct duration awaits additional research. (To the extent that interest rate deregulation has increased the availability of deposit accounts without specific maturity dates, it may have made it more difficult for banks to structure small positive or negative duration gaps and to decrease their interest rate exposure.)

Because the value of a security's duration is determined by the interest rate, changes in interest rates change its duration and may force a restructuring of the portfolio in order to maintain the desired duration gap. Moreover, even if interest rates did not change, periodic restructuring is necessary in a dynamic framework because the durations of coupon securities do not decline or age at the same rate as does time. They generally decline more slowly, although at times duration can increase as time passes. Thus, the durations of the two sides of the balance sheet are unlikely to change equally over time and continual updating or restructuring of the balance sheet is required. Restructuring, of course, is costly. But most depository institutions operate, at least in the Fed funds market, daily, so that restructuring at the margin should not be much of a burden.

In effect, every day is a new day for managing the gap. Although there may be long duration accounts on the balance sheet, the relevant time horizon for asset and liability management is only to the next restructuring date. Only in this

[5]For example, if the current interest rate on one-year fixed rate bonds is 10 percent and on two-year bonds is 11 percent, the implied rate on a one-year bond for delivery next year is approximately 12 percent.

interval is the interest rate exposure of the institution uncertain. The disposition of cash flows beyond this interval is of no immediate concern for ongoing institutions. Through time, long duration accounts become shorter duration accounts and maturing accounts are, at maturity, either removed from the balance sheet or rolled over into the same or other accounts, whose durations are then included in the gap measure. At any moment, only an account's interest sensitivity matters.

We have made a number of simplifying assumptions in the analysis. One of these was to assume that the yield curve is flat and that when interest rates change, they all change by the same amount. This is highly unlikely. But the duration measure defined in Equation 1 is dependent on it. Different and more complex assumptions about the shape of the yield curve and changes in interest rates yield different and more complex measures of duration. If the actual process that governs interest rate changes, referred to as the stochastic process, were known, the correct duration formula could be used. But this process is not known with certainty. The theory, however, assumes that the correct duration measure is used. Moreover, securities of different default risk classes may be subject to different stochastic processes. Thus, the bank is likely to use an incorrect measure of duration and this introduces a source of error.[6]

In addition, the theory applies strictly only to securities that are free of the risk of default. Yet, many bank accounts, particularly on the asset side, have default risk. This introduces additional inaccuracies into the computation of the correct duration measure. Lastly, the analysis abstracts from transactions costs and taxes. Introduction of these complicates the analysis further.

Advantages of duration gap analysis

Despite these disadvantages, duration gap analysis has substantial advantages over alternative techniques for measuring interest rate risk exposure accurately. The most widely used alternative measure technique involves classifying all asset and liability accounts by their terms to maturity or to first permissible repricing, whichever comes first.[7] The accounts are grouped in a number of maturity-period "buckets;" e.g., one day, one to three months, three to 12 months, one to five years and so on. Net balances, or maturity gaps in dollars, are computed for each bucket. The larger are the net balances in the shorter maturity buckets, the more interest sensitive and less price sensitive the institution.

Duration analysis considers the timing of coupon and other intermediate cash flows as well as the timing of the final payment at maturity. This is particularly important for mortgages and other amortized loans for which the intermediate flows are significantly larger than the final payment. Yet the maturity bucket approach classifies such accounts only by the date of the final payment or of the first permissible repricing.

For practical purposes, the number of maturity categories must be limited. What should be the maturity cutoffs for each bucket? Should the shortest-term bucket include accounts maturing or eligible for repricing in 1-30 days, 1-60 days, or 1-90 days? The same question applies to the other bucket categories. Changing the limits of the buckets can give a different picture of a bank's interest rate sensitivity. Figure 9, which groups the accounts in the balance sheets shown in Figure 1 and 6 in a number of alternative ways, illustrates this problem.

The more limited the number, the wider the category. But the wider the category, the less accurate is the informational content of each category. For example, a category of 6 to 12 months is frequently used, e.g., on the new Federal Reserve call report. This category would encompass 182-day securities as well as 364 day securities. If these were zero coupon single payment instruments so that the terms to their maturities were equal to their durations, Equation 2 indicates that the price sensitivity of the

[6]The nature of this risk is discussed in G. O. Bierwag, George G. Kaufman, and Alden Toevs, "Bond Portfolio Immunization and Stochastic Process Risk," *Journal of Bank Research*, Winter 1983.

[7]Alden L. Toevs, *op. cit.*; Barrett F. Binder and Thomas W. F. Lindquist, *Asset/Liability and Funds Management at U.S. Commercial Banks*, Rolling Meadows, IL.; Bank Administration Institute, 1982.

Figure 9

Alternative maturity gap measures

Maturity bucket	Assets	Liabilities	Gap	Assets	Liabilities	Gap	Assets	Liabilities	Gap	Assets	Liabilities	Gap
					(dollars)							
A. Balance sheet from figure 1												
0-3 mos.	100	0	+100									
3-6 mos.	0	0	0	100	600	-500	100	600	-500	500	600	-100
6 mos.-1 yr.	0	600	-600									
1-2½ yrs.	400	0	+400	400	0	+400	400	300	+100			
2½-5 yrs.	0	300	-300	0	300	-300						
5-10 yrs.	0	0	0	0	0	0	500	100	+400	500	400	+100
>10 yrs.	500	100	+400	500	100	+400						
Total	1,000	1,000	0	1,000	1,000	0	1,000	1,000	0	1,000	1,000	0
B. Balance sheet from figure 6												
0-3 mos.	100	0	+100									
3-6 mos.	0	0	0	100	125	- 25	100	125	- 25			
6 mos.-1 yr.	0	125	-125							500	125	+375
1-2½ yrs.	400	0	+400	400	0	+400	400	775	-375			
2½-5 yrs.	0	775	-775	0	775	-775						
5-10 yrs.	0	0	0	0	0	0	500	100	+400	500	875	-375
>10 yrs.	500	100	+400	500	100	+400						
Total	1,000	1,000	0	1,000	1,000	0	1,000	1,000	0	1,000	1,000	0

364 day security to a given interest rate change is exactly twice that of the shorter security. Thus, if the 182 day security was the only security on the asset side of the balance sheet and the 364 day security the only security on the liability side, the maturity bucket would indicate no gap and no interest sensitivity. Yet the bank's liability side would in fact be twice as price sensitive as the asset side. In reality, there will be larger numbers of securities with different maturities in all the buckets so that the average maturity in each is unlikely to be at one extreme of the maturity range. Nevertheless, accuracy is sacrificed.

As noted, the maturity gap analysis yields a number of gap values equal to the number of maturity categories used. These individual gaps cannot be simply summed. The overall degree of risk exposure is thus difficult to summarize. It is not readily observable, for example, from any of the alternative maturity gap groupings in Figure 9B that the balance sheet is one that immunizes the dollar value of capital. The gap in any one bucket, even the shortest one, is unlikely to be representative of the overall interest rate sensitivity of the institution. The impact of the value of the gap in the shortest term bucket can be more than offset by the value of the gap in the next shortest bucket, so that the longest gaps can be in the same direction as the shortest gaps. More importantly, measured this way, the risk exposure is difficult to manage. A different strategy is required for each bucket. To immunize, for example, cash flows must be matched in each bucket. This involves considerable management and transactions costs. It is reasonable to assume that some of the bucket gaps are internally offsetting and that the use of external transactions to achieve the same objective is inefficient. In contrast, duration analysis yields a single number and only a single gap to manage. Any internal cancelling is already accounted for.

Maturity bucket gaps must generally be managed with securities in the same maturity category; e.g., a gap in the 6 to 12 month bucket can be changed most easily by buying or selling other securities in this maturity range. This constrains management. The larger the number of buckets used to gain greater accuracy, the more constrained is management. On the other hand, duration gaps can be managed with a very wide range of maturities. For example, as was seen earlier, the duration of a 30-year amortized fixed rate mortgage when interest rates are 13 percent is nearly equivalent to that of a seven-year zero coupon bond. Moreover, even durations on individual securities on the two sides of the balance sheet need not be equal or different by the size of the gap as long as the average durations of all

securities are. The desired target gap value may be achieved by diversifying among individual securities of different but offsetting durations. Thus, bank management has an almost unlimited choice of maturities and can continue to provide a range of interest rate intermediation services to its customers within a given degree of net interest rate risk exposure to the institution. Even if the bank wishes to immunize itself, it may still engage in a wide range of interest rate intermediation for individual securities; it does not have to match cash flows in each maturity bucket. That is, a bank can simultaneously engage in macro immunization and micro interest rate intermediation and continue to accommodate its customers, who have a wide range of maturity preferences, with an equally wide range of products.

Lastly and perhaps most importantly, the strenuous data demands made by duration analysis are not any more severe than those that alternative systems, including maturity gap analysis, would impose if they were to be equally accurate. All measuring techniques must forecast interest rates to know when repricing will occur and options will be exercised. The relative simplicity claimed for some alternative systems cannot be obtained by sweeping such problems under the rug. Only a complete and thorough cost-benefit analysis can differentiate among the alternative techniques. Simplicity and reduced cost is likely to be achieved only at the cost of reduced accuracy. And, because once a computerized information system is in place it is costly to change, banks should plan their systems for asset and liability management models of the future. Duration-based models are in a relatively early stage of development and require further refinement. They appear, however, a most promising tool for accurate asset and liability management.

Summary

Interest rate risk continues to be a problem of increasing importance to many depository institutions. In order to manage this risk correctly, it is first necessary to measure it accurately. This article has discusssed how the recently developed technique of duration analysis can be applied to this problem. Duration gap is both an accurate measure of an institution's interest rate risk exposure and, because it is a single number, a simple concept to manage. But its application is complex, and the data required is costly. However, most of these complexities and costs also apply to alternative measures of interest rate risk, if they are to be equally accurate, including maturity gap analysis. Banks and other depository institutions should consider the use of duration analysis to measure and manage their interest rate exposure reliably and to maximize their long-run profits.

Appendix

Approximate proofs of duration gap measures*

Assume:

1) In market values: $A = P + K$ and $\Delta A = \Delta P + \Delta K$

2) All interest rates for same default risk class securities are the same and all changes in interest rates are equal.

1. Target account K

Let $K = 0$ (immunize)

Then from above assumptions: $\Delta A = \Delta P.$

Recall the basic equation: $\frac{\Delta A}{A} = -D_A \Delta i$

or $\Delta A = -D_A \Delta iA.$

Thus as $\Delta i_A = \Delta i_P$ $D_A A = D_P P$

or $D_A = (P/A)D_P$
$= wD_P.$

It follows that DGAP is: $(D_A - wD_P)$

2. Target account: K/A

Let $K/A = 0$ (immunize)

Define $K/A = c$

so $K = cA.$

Then from above assumptions:

$A = P + cA$

$\Delta A = \Delta P + c \Delta A$

$A(1 - c) = P$

And $\Delta A(1 - c) = \Delta P$

Using the basic equation with $\Delta i_A = \Delta i_P$:

$D_A A(1 - c) = D_P P$

or $D_A = D_P.$

It follows that DGAP is: $(D_A - D_P)$

*More detailed proofs are found in F.M. Redington, "Review of the Principle of Like-Office Valuations," *Journal of the Institute of Actuaries*, 1952, pp. 286-340 (reprinted in Gabriel Hawawini, ed., *Bond Duration and Immunization*, New York: Garland Publishing Co., 1982, pp. 286-340); Myron A. Grove, "On 'Duration' and the Optimal Maturity Structure on the Balance Sheet," *The Bell Journal of Economics*, Autumn 1974, pp. 698-709; and the references cited in footnote 2.

Economic events of 1983—a chronology

Jan 1 Social Security tax base rises from $32,400 to $35,700. Tax rate unchanged at 6.7%. (Base rises to $37,800 on Jan 1, 1984, and tax on employers rises to 7%.)

Jan 3 Dow Jones industrial stock average closes at 1027, low for the year. (See Nov 29.)

Jan 4 Eastman Kodak offers incentives for employees to retire early or resign.

Jan 5 Super NOW Accounts offered to public.

Jan 6 ICC ends 48-year restriction on railroads operating truck lines.

Jan 7 Administration estimates real GNP growth at 1.4% in 1983. (See Mar 25.)

Jan 10 IMF approves $3.8 billion loan to Mexico as part of "debt rescue" package. (IMF loans to other debt problem nations followed.)

Jan 11 President Reagan announces "Payment-In-Kind" (PIK) program to use surplus grains to compensate farmers who reduce 1983 crop acreage. (See Mar 22.)

— Legislation validates agricultural export contracts for up to 270 days after imposition of an embargo.

Jan 12 Commerce Dept. survey indicates capital spending by U.S. business will decline for second consecutive year, unprecedented since World War II.

Jan 17 J.L. Hudson closes big downtown Detroit store.

Jan 18 Housing starts reported at 1.06 million in 1982, lowest since 1946.

— USDA announces subsidized sale of wheat flour to Egypt.

Jan 20 China says it will import less U.S. grain because U.S. tightened import restrictions on textiles from China.

— Romania announces stretchout in debt payments.

Jan 24 IMF approves $2.2 billion loan to Argentina.

Jan 26 GHR Energy Corp. files under Chapter 11, one of the largest filings ever.

Jan 31 Independent truckers strike over higher user taxes in new transportation bill. (Strike ends Feb 10.)

— Treasury forecasts deficit at $208 billion for fiscal 1983, $189 billion for fiscal 1984.

Feb 3 Congressional Budget Office (CBO) estimates real GNP growth at 2.1% in 1983, price deflator to rise 4.6%.

Feb 6 Purchasing managers report outlook "definitely brighter," best in 19 months.

Feb 10 Business Council says "recession is over."

Feb 12 Japan agrees to restrict auto exports to U.S. to 1.68 million units for third year, beginning Apr 1. (See Nov 1.)

Feb 14 FDIC closes United American Bank of Knoxville, TN.

— GM and Toyota announce joint venture to produce subcompact cars in U.S.

Feb 15 GATT reports world trade volume declined 2% in 1982, first postwar decline.

Feb 16 Federal Reserve Chairman Volcker announces monetary growth targets for 1983: M1, 4-8%; M2, 7-10%; M3, 6½-9½%. (See Jul 20.)

Feb 18 United Kingdom cuts North Sea oil price from $33.50 to $30.50 per barrel. (Price cuts by other oil exporters follow.)

Feb 28 Prime rate reduced from 11 to 10.5%, lowest in over 4 years, and low for 1983.

— Supreme Court declines to review split-up plan for AT&T.

— IMF approves $5.4 billion loan to Brazil.

Mar 1 United Steelworkers vote to accept pay cuts.

Mar 14 OPEC nations agree on first official crude oil price cut in 23 years, from $34 to $29 per barrel, and new output quotas.

Mar 21 Finance ministers of European Monetary System announce realignment of currencies.

Mar 22 Enrollment reports for PIK and related programs indicate withdrawal of 82 million acres from crop production in 1983, much more than had been expected.

Mar 25 Administration raises forecast of real GNP growth in 1983 to 2.9%.

Mar 31 Reserve requirements on 2½ to 3½ year nonpersonal time deposits eliminated. (See Apr 1.)

Apr 1 Interest rate ceilings on 2½ to 3½ year time deposits removed, following DIDC phaseout schedule.

— Federal gasoline tax rises 5 cents to 9 cents per gallon.

Apr 4 Baldwin-United fails to make debt payment.

Apr 6 Federal law becomes effective permitting larger and tandem truck trailers on major highways.

Apr 20 Preliminary estimate shows real GNP up in the first quarter. (Later data show recession trough in fourth quarter 1982.)

Apr 21 Federal appeals court rules that banks may be criminally liable if they misrepresent variable lending rates tied to prime rate.

Apr 22 Wilson Foods Corp., largest pork processor, files under Chapter 11 and then cuts worker compensation sharply despite union protests. (Continental Airlines followed suit in Sep.)

Apr 25 Caterpillar workers return to work ending 206-day strike.

May 4 Yield on 20-year Treasury bonds (constant maturity index) falls to 10.39%, low for the year. (See Aug 8.)

May 9 FDIC reports problem bank list totals a record 470.

— FHA/VA mortgage rate ceiling reduced from 12 to 11½%, lowest since Aug 1980, and low for 1983. (See Aug 1.)

May 16 Commission of European Communities approves loan of 4 billion European Currency Units (ECUs) to France to finance payments deficit.

May 25 Congress approves rise in debt ceiling from $1,290 billion to $1,389 billion. (See Nov 18.)

May 31 Chicago-area building trade unions approve wage freeze, first time in many years.

— Washington Public Power Supply System (WPPSS) fails to pay $15.6 million interest due on $2.25 billion of bonds. (Default declared Jul 26.)

Jun 13 Comptroller of Currency and Federal Reserve Board announce new minimum capital guidelines for multinational banking organizations.

Jun 18 Paul Volcker reappointed as Federal Reserve Chairman when term expires Aug. 5. (Confirmed by Senate Jul 27.)

Jun 27 Supreme Court upholds California unitary business tax.

Jul 1 Personal income tax rates cut 10%, as provided in 1981 act.

Jul 6 Supreme Court rules that pension payments cannot be based on sex of pensioners.

Jul 15 Rising prices trigger release of corn held in 3-year reserve.

— Federal Reserve reports that FOMC moved to increase restraint on reserves slightly at May 24 meeting.

Jul 20 Chairman Volcker announces revised 5-9% "monitoring" growth range for M1. Ranges for M2 and M3 retained. (See Feb 16.)

Jul 28 U.S. and U.S.S.R. announce new 5-year agreement boosting minimum U.S.S.R. purchases of U.S. corn and wheat by 50%.

Aug 1 FHA/VA ceiling rate raised from 12½ to 13½%, high for year. (See May 9.)

Aug 5 Wayne County, MI, workers begin 4-day week to cut budget deficit.

Aug 7 AT&T strike idles 700,000. (Agreement reached Aug 28.)

Aug 8 Prime rate rises from 10.5 to 11% at major banks.

— Yield on 20-year Treasury bonds rises to 12.27%, high for year. (See May 4.)

Aug 9 First Chicago Corp. agrees to buy American National Bank from Walter E. Heller International.

Aug 11 Initial USDA reports indicate drought will sharply reduce crop yields. (See Nov 10.)

Aug 12 Chrysler completes repayment of $1.2 billion in government guaranteed loans.

Aug 18 Poland and bankers reschedule $2.6 billion loan payments.

Aug 19 CBO predicts deficits of $140-$200 billion for several years ahead.

Aug 20 Reagan lifts ban on sale of pipeline equipment to Russia.

Aug 31 Reagan proposes 3.5% pay raise for federal workers, effective Jan 1, 1984.

— South Korean Airlines Boeing 747 shot down by Russian interceptor, 269 dead.

Sep 1 Most steel producers raise prices of sheet and strip 7%, reflecting strong demand.

Sep 5 Chrysler and UAW agree on contract providing sizable wage increases.

Sep 7 City of Chicago debt rating reduced by S&P for "chronic financial stress."

Sep 8 Government survey shows upward revisions in business capital spending plans.

Sep 9 Yugoslavia and banks agree to debt restructuring.

Sep 15 Menachem Begin resigns as Israeli prime minister.

Sep 24 Continental Airlines files under Chapter 11. (Strike by aircrews begins Oct. 1.)

Sep 26 Baldwin-United Corp., insurance giant, files under Chapter 11.

— Walter E. Heller International directors approve dissolution.

Sep 28 LTV Corp. and Republic Steel agree to merger that would create second largest U.S. steel producer.

Sep 30 DIDC announces phasedown schedule for minimum deposit requirements on MMDAs, Super NOWs, and 7- to 31-day time deposits.

Oct 1 Federal deficit in fiscal 1983 was a record $195 billion, up from $111 billion in fiscal 1982.

— Interest rate ceilings and minimum deposit requirements removed on time deposits over 31 days. Minimum maturity on time deposits reduced from 14 to 7 days.

Oct 4 Sante Fe and Southern Pacific railroads agree to merge.

Oct 5 Bank of Montreal agrees to buy Harris Bankcorp.

— Domestic auto sales reported 10% above last year in Sep, although held back by low inventories.

Oct 6 Reserve requirements eliminated on 1½- to 2½-year nonpersonal time deposits.

Oct 9 James G. Watt resigns as Secretary of the Interior.

Oct 14 First National Bank of Midland, TX, closed by FDIC.

Oct 16 Philippine government announces plan to defer debt payments.

Oct 20 Government reports real growth at 8% in third quarter, following 10% growth in second quarter, faster than expected.

Oct 23 Bomb blast at U.S. Marine barracks in Beirut kills over 200 Marines.

Oct 25 U.S. Marines land on Grenada.

Oct 26 Senate votes to halt construction of Clinch River breeder reactor.

Nov 1 FHA/VA ceiling rate reduced from 13 to 12.5%.

— Japanese raise auto export quota to U.S. from 1.68 million to 1.85 million for 12 months starting April 1, 1984.

Nov 2 Rath Packing Co. (employee owned) of Waterloo, IA, files under Chapter 11.

Nov 4 Greyhound bus drivers strike over company plan to cut compensation 17%.

Nov 6 Germany's IBH Holding AG, construction equipment combine, files for bankruptcy. (Terex Corp., U.S. subsidiary, follows suit.)

Nov 10 Revised USDA estimates show that drought and acreage cuts resulted in production declines of 51% for corn, 31% for soybeans, and 37% for cotton.

Nov 18 Congress approves rise in federal debt ceiling to $1,490 billion. (See May 25.)

Nov 21 Trading begins in shares of new AT&T and seven regional companies on "when issued" basis.

Nov 22 Congress authorizes $8.4 billion U.S. participation in IMF quota increase.

Nov 29 Dow Jones industrial stock average closes at 1287, alltime high. (See Jan 3.)

— Foreign trade deficit hit a record $9 billion in Oct. Total for 1983 is expected to exceed $70 billion, more than double 1982 record.

— Legislation lowers milk support price and institutes payments to farmers who reduce milk production.

Dec 1 Ceiling rate on FHA insured loans eliminated, ceiling on VA loans retained.

Dec 2 Unemployment rate in Nov. reported at 8.4%, down from 10.8% in Dec. 1982.

Dec 8 Eastern Airlines and union agree to wage and work rule concession.

Dec 15 FHLBB clears purchase of First Federal S&L of Chicago by Citicorp.

Dec 20 Australian press magnate signs agreement to purchase Chicago Sun-Times.

— Greyhound strike ends as union agrees to large cut in compensation.

Dec 22 FTC tentatively approves GM-Toyota joint venture.

— Administration projects 4.5% real GNP growth, 5% inflation, in year to fourth quarter 1984.

Dec 23 Increase in consumer price index reported at 3.2% in year ended in Nov, indicating fourth year of slower inflation.

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