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November 1987

In This Issue . . .

Manufacturing employment in the nation has declined since 1979, leading some to conclude that "deindustrialization" has been taking place. Other measures of manufacturing, such as output and productivity, however, suggest substantial progress in the nation's manufacturing sector. Not all regions have shared in this progress; industrial activity has shifted away from northern industrial areas to the South and West in recent years. Given these regional variations, Thomas B. Mandelbaum evaluates the performance of manufacturing in the Eighth Federal Reserve District in "Is Eighth District Manufacturing Endangered?" He uses employment data and several measures of output to compare regional with national manufacturing activity between 1972 and 1985. Mandelbaum concludes that the expansion of District manufacturing was closely similar to that of the nation as a whole during this period; the District experienced neither the severe manufacturing decline associated with the Rust Belt nor the sharp expansions of the South and West. The parallel growth of District and national manufacturing points out the similarities in industrial composition, labor productivity and unit labor costs between the two.

* * *

Many people attribute the 1987 stock market crash to a bursting speculative bubble, much like the one blamed for the 1929 crash in stock prices. The belief that speculation might cause a persistent deviation in stock prices from prices consistent with the underlying fundamentals is important. At the time of the 1929 crash, this belief spawned legislative proposals designed to curb credit for speculation, amend the National Banking and Federal Reserve Acts, impose an excise tax on stock sales and regulate the activities of stock exchanges and investment trusts. Similarly, various proposals to alter the structure of financial markets have followed the recent crash in stock prices.

G. J. Santoni examines the "speculation issue" in the second article in this *Review*, "The Great Bull Markets of 1924–29 and 1982–87: Speculative Bubbles or Economic Fundamentals?" Santoni compares a theory of stock prices based on fundamentals to one that allows for bubbles, then examines data from the 1920s and 1980s to determine which theory is supported by the evidence. He concludes that the evidence does not support the notion that speculation caused stock prices to deviate persistently from those consistent with the fundamentals.

Is Eighth District Manufacturing Endangered?

Thomas B. Mandelbaum

EMPLOYMENT in U.S. manufacturing industries has declined more than 9 percent since 1979, casting doubt about the stability of our industrial base. Other indicators of manufacturing activity, however, suggest a more favorable evaluation. Real output in manufacturing, for example, has increased 16.5 percent since 1979. This output growth, achieved with a shrinking labor input, reflects a gain in productivity per worker. Moreover, the proportion of the nation's real GNP originating in manufacturing has remained remarkably stable over the past 40 years.[1]

Despite this stability at the national level, a major shift of the location of manufacturing activity among regions has occurred. While declining in the "Rust Belt," manufacturing activity has posted solid gains in the West and the "Sun Belt."[2] Between 1947 and 1985, the share of the nation's manufactured goods produced in the Middle Atlantic and East North Central census regions dropped from 60 to 40 percent.[3] This decline was offset by an increase in the South and West from 26 percent in 1947 to 46 percent in 1985 with little change in the share contributed by New England and the West North Central states.[4]

This article compares the performance of manufacturing in the Eighth Federal Reserve District with that in the nation. Its purpose is to determine whether regional shifts of manufacturing noted elsewhere have also occurred in the Eighth District, which is not entirely in either the Sun or Rust Belts.[5]

MANUFACTURING PERFORMANCE IN THE EIGHTH DISTRICT

In this article, employment data and three measures of manufacturing output are used to evaluate manufacturing performance in the District. These three output measures are manufacturing product (MP), gross value added (GVA), and value of shipments (VS). Each indicator is described in the shaded insert on page 00. An appendix outlines the methodology used to estimate the Eighth District's MP. Several indicators of manufacturing output were used to gauge the consistency of the analysis.

Thomas B. Mandelbaum is an economist at the Federal Reserve Bank of St. Louis. Thomas A. Pollmann provided research assistance.

[1]For an analysis of the nation's manufacturing performance, see Tatom (1986a and 1986b). See Ott (1987) for a long-run perspective on structural changes of the U.S. economy.

[2]See Crandall (1986), for an analysis of regional shifts of U.S. manufacturing.

[3]This statement refers to the percentage of gross value added in manufacturing, published by the U.S. Bureau of the Census in *Census of Manufactures* and *Annual Survey of Manufactures*. Gross value added is described in the shaded box on the next page. The Middle Atlantic census region includes New Jersey, New York and Pennsylvania; the East North Central region includes Illinois, Indiana, Michigan, Ohio and Wisconsin.

[4]The New England region includes Connecticut, Massachusetts, Maine, New Hampshire, Rhode Island and Vermont; the West North Central region includes Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota and South Dakota. Except for the states in the Middle Atlantic and East North Central regions the rest of the states make up the South and the West.

[5]The Eighth Federal Reserve District includes Arkansas and parts of Illinois, Indiana, Kentucky, Mississippi, Missouri and Tennessee. Due to data limitations, however, only data from Arkansas, Kentucky, Missouri and Tennessee are used in the analysis.

Measures of District Manufacturing Output

Three measures of District manufacturing output were used in this article. Due to data limitations, the sum of data for the four states that dominate the District's economy — Arkansas, Kentucky, Missouri and Tennessee — is used to represent the District.

Manufacturing Product (MP) for the nation is the same as "GNP originating in manufacturing" in the U.S. Commerce Department's national income and product accounts (NIPA). It is conceptually similar to the economic measure of value-added. This measure is not consistently available on a state or regional basis and was estimated for the District by the author using earnings, employment, payroll and gross-value-added data. The technical appendix describes the methodology used in its construction.

The Value of Shipments (VS), published by the U.S. Bureau of the Census, is the received net selling value of products shipped from manufacturing establishments, f.o.b. plant after discounts and excluding freight charges and excise taxes. The measure includes intermediate manufactured products purchased as inputs, so that it tends to be inflated by double-counting of products made by one manufacturer and sold as inputs to another. In addition, the value of shipments reflects the costs of business services of the manufacturer, such as maintenance and repair, engineering, consulting, research and advertising. These services are assigned to service-producing sectors rather than manufacturing in the NIPA measures of manufacturing output. Since some of the intermediate inputs and business services may be purchased from other areas, a region's value of shipments may reflect production which originated in other regions.

The value of shipments also differs from the NIPA manufacturing output measure in that VS excludes the output of establishments that perform the administrative and auxiliary functions of a manufacturing enterprise, such as manufacturing headquarters.

Gross Value Added (GVA), published by the U.S. Bureau of the Census, is the value of manufacturing shipments minus the value of materials, supplies, fuel and purchased electricity used in production. The gross-value-added measure avoids the duplication in the value of shipments data resulting from the use of products of some manufacturing establishments as materials by others. But unlike the NIPA output measure, the gross-value-added data includes the value of business services and excludes the output of administrative establishments.

All measures are adjusted for inflation (1982 prices) using the nation's implicit price deflator for manufacturing. Due to data limitations, the District analysis focuses on the 1972–85 period.

Manufacturing Growth: Eighth District vs. the United States

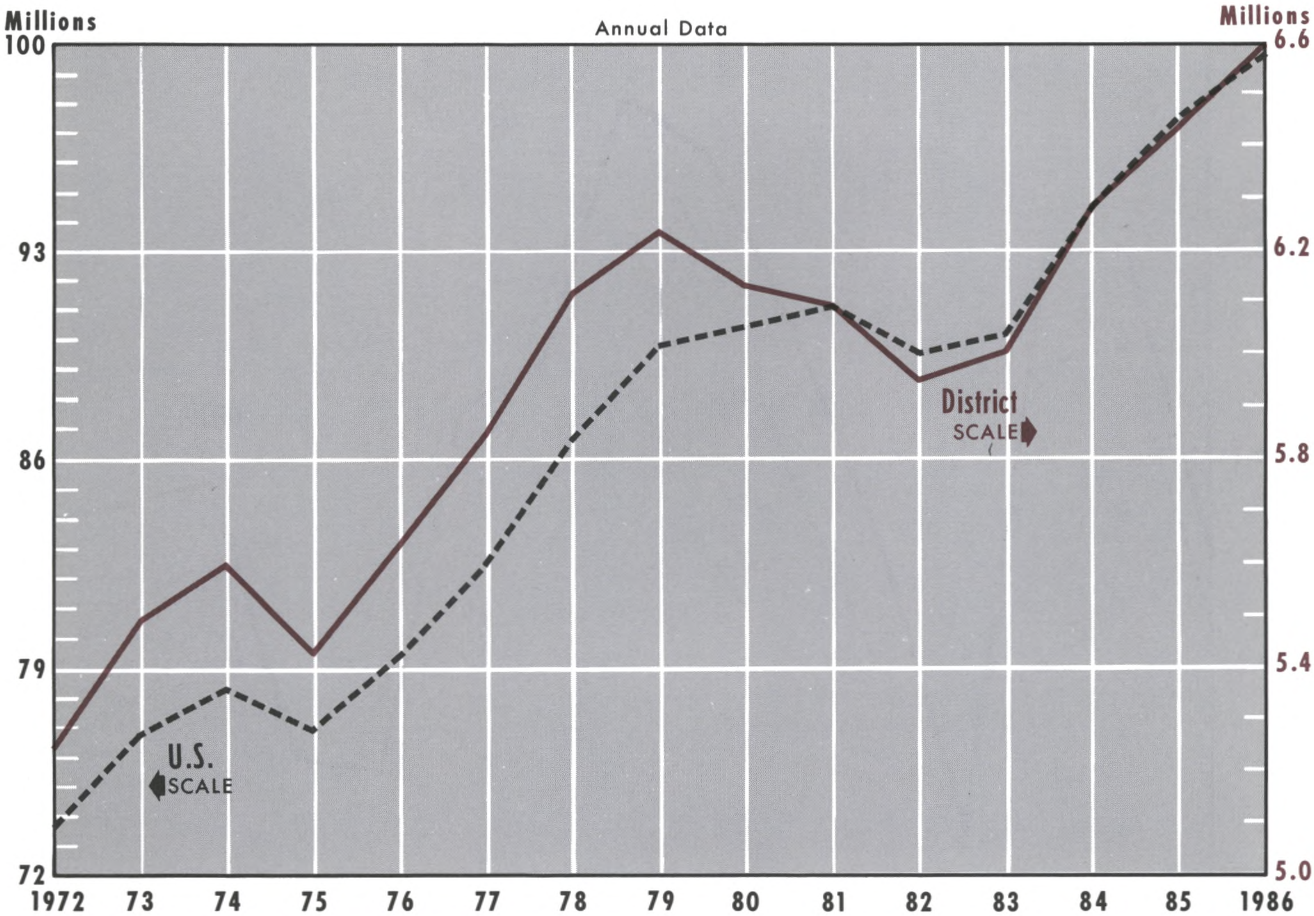
Employment Trends. Chart 1 shows that the District's total wage and salary employment, which equals about 7 percent of U.S. total employment, closely followed movements in national employment since the early 1970s. The similar growth of total employment in the region is not surprising; there is a close similarity between the industrial compositions of the regional and national work forces. The largest differences between the region's and nation's industrial structures are a slightly smaller proportion of the District economy accounted for by the services sector and a slightly larger share accounted for by manufacturing.[6] In 1986, manufacturing employed 21.4 percent of the District's wage and salary workers and 19.1 percent of the nation's.

As chart 2 shows, District manufacturing employment has also followed national trends since 1972.[7] The number of manufacturing workers peaked in 1979, then declined cyclically through 1982. In the current recovery period, manufacturing employment rebounded sharply in 1984 before resuming its decline in recent years. District manufacturing employment

[6]See Mandelbaum (1987) for a more complete discussion of the similarities of the region's and nation's employment compositions.

[7]A t-test of the average difference between District and U.S. annual growth rates of manufacturing employment, 1973–85, yields a t-statistic of −0.46, indicating the difference is not statistically significant at the .05 level. The period begins in 1973 rather than 1972, because 1972 is the first observation and this observation is used in calculating the 1973 growth rate.

Chart 1
Total Employment



in 1986 was 1.41 million, almost 8 percent below its 1979 peak level and roughly equal to its 1972 level.

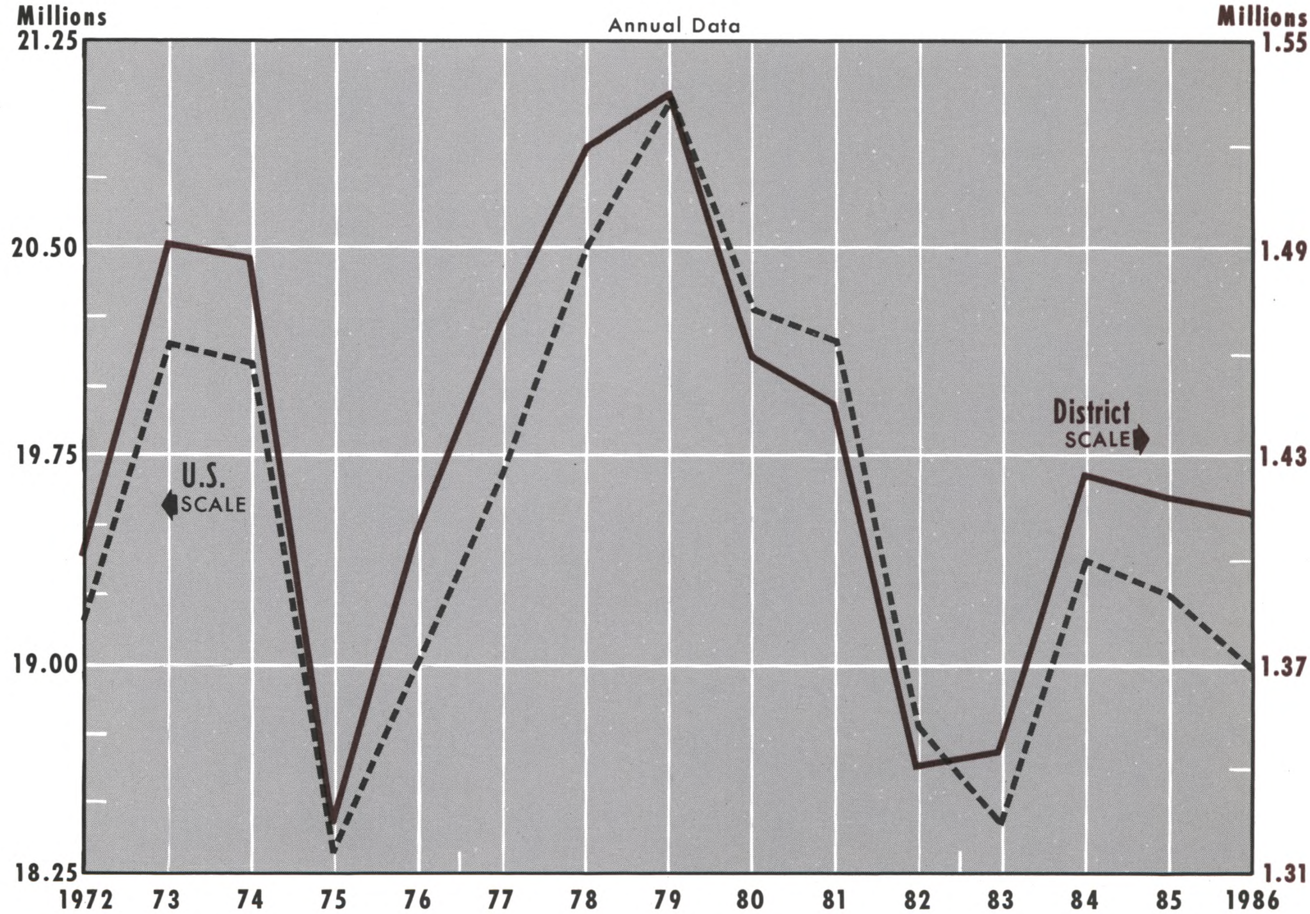
Output Growth. In contrast to employment, District manufacturing output, like that in the nation, has grown substantially. As chart 3 shows, both regional and national manufacturing output (MP) declined in recession years but increased sharply during business cycle upturns. The net result was a substantial output gain over the period.

The chart also shows that the District's manufacturing output has closely followed national trends. The first line of table 1 shows the close similarity between regional and national growth in various measures of output. The District's 2.6 percent average annual growth MP during the 1973–85 period was statistically indistinguishable from the nation's 2.9 percent pace. Regardless of the output measure used, there was little difference between annual growth rates of regional and national manufacturing output.[8]

The real value of manufacturing output in the District, as measured by MP, was $50.6 billion (1982 prices) in 1985. This represents a 7.5 percent gain between 1979 and 1985, a period in which declining employment trends intensified concerns about the health of the manufacturing sector.

[8]T-tests of the average differences between District and U.S. annual growth rates, 1973–85, of MP, GVA and VS yield t-statistics of 0.54, −0.28 and −1.59, respectively. None of these is significantly different than zero, in the statistical sense, at the .05 significance level.

Chart 2
Manufacturing Employment



Individual Industry Growth

The similarity of manufacturing output growth in the District and the United States could mask substantial differences between the regional and national growth in individual industry groups. Similar growth of total manufacturing output could result if stronger growth of some regional subsectors offset slower-than-national growth in others.

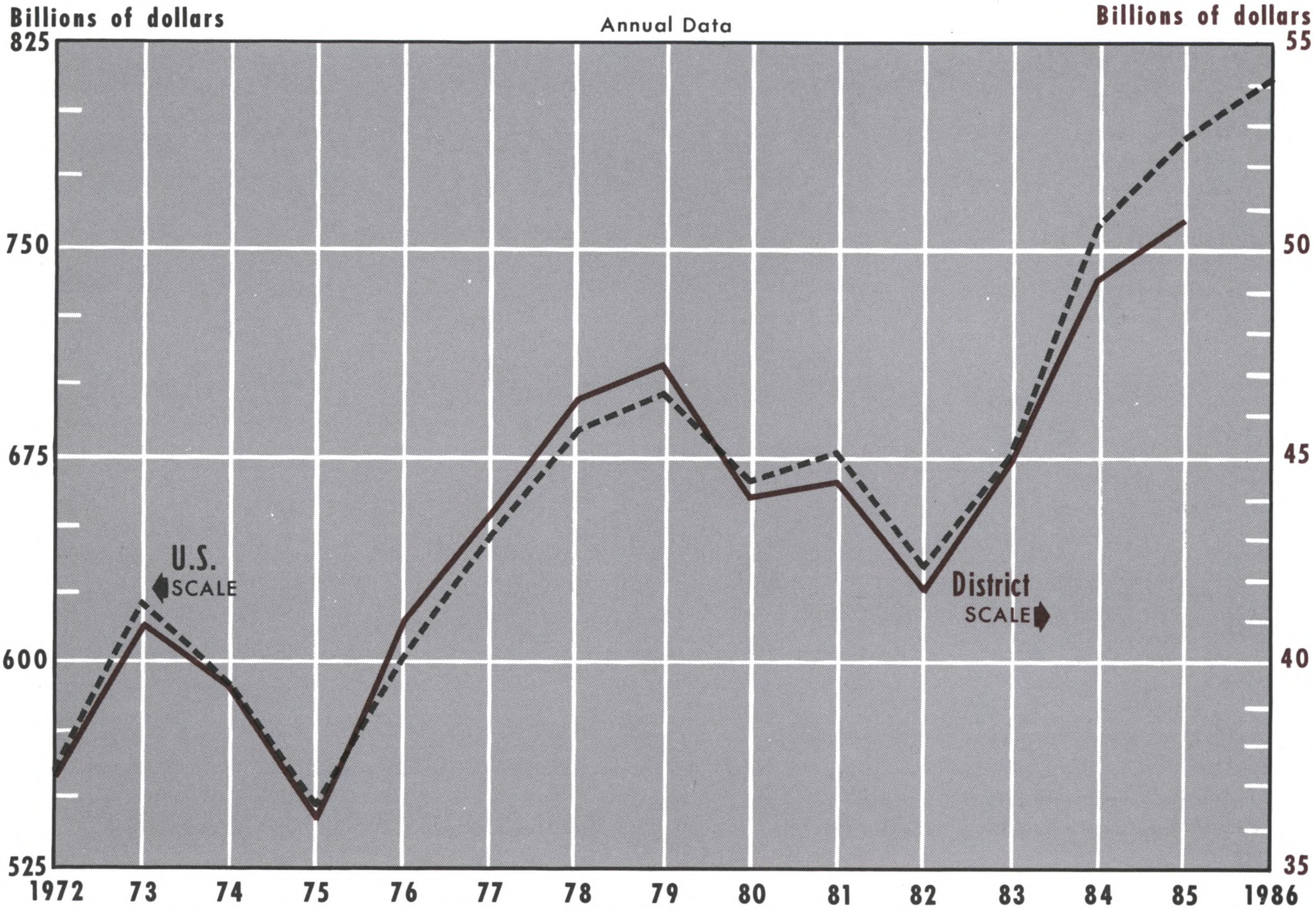
Each of the industry groups of the Eighth District manufacturing sector, however, grew at near the national pace. Although the growth rates of output for most of the District industry groups differed somewhat from the national rates (see table 1), none of the these differences is larger than would be expected due to the chance variation of the data.[9] This result holds regardless of the output measure used.

Industrial Composition

Even with identical regional and national growth rates for each industry, overall manufacturing could differ considerably if the industrial compositions of

[9]T-tests of the average differences between District and U.S. annual growth rates for each output measure for each manufacturing industry group were conducted. None of these is statistically different from zero at the .05 level of significance.

Chart 3
Real Manufacturing Output



the regional and national manufacturing sectors varied substantially. For example, if regional manufacturing were concentrated in slow-growing industries (like primary metal production), then the District's overall manufacturing growth would tend to trail the national expansion.

The diversification of regional and national manufacturing, however, has been quite similar. Chart 4 compares the percent distribution of District and U.S. manufacturing output in 1985 (as indicated by MP) among all the major industry groups. Most are of similar relative size. The sector in which the District share varied the most from the national average in 1985 was nonelectrical machinery. This sector accounted for 14.8 percent of District MP compared with 17.4 percent nationally, hardly a dramatic difference. Earlier data show that overall structural similarity between District and national manufacturing has existed at least since 1972.

Regional Productivity Gains

The increases in District manufacturing output since 1972 with little change in manufacturing employment imply an increase in labor productivity. In fact, labor productivity of District manufacturing (MP per manufacturing worker) increased at a 2.5 percent

Table 1

Average Annual Growth Rates of Real Manufacturing Output by Industry: 1973-85

	Manufacturing Product		Gross Value Added[1]		Value of Shipments[1]	
	District	U.S.	District	U.S.	District	U.S.
Total Manufacturing	2.6%	2.9%	5.3%	5.1%	6.6%	5.5%
Durable Goods						
Lumber and wood products	1.2	1.7	2.3	3.8	1.0	3.5
Furniture and fixtures	2.3	2.4	3.4	4.5	3.6	4.9
Primary metal industries	0.0	−1.7	4.8	3.0	4.8	2.6
Fabricated metal products	3.5	1.7	4.7	3.6	4.6	3.9
Machinery, except electrical	8.6	7.0	13.3	10.8	14.5	11.8
Electronic equipment	3.9	6.6	5.6	8.3	7.5	8.1
Transportation equipment	2.7	2.8	9.3	7.9	15.5	9.5
Stone, clay and glass products	1.9	1.2	1.8	3.8	2.2	4.3
Instrument and related products	6.3	5.7	N.A.	7.5	N.A.	7.8
Miscellaneous industries	3.3	2.9	5.1	2.4	3.9	2.8
Nondurable Goods						
Food and kindred products	2.3	2.1	3.1	3.1	3.3	2.8
Textile mill products	1.1	2.0	1.8	3.4	2.6	3.6
Apparel	0.9	1.4	3.0	3.3	2.5	2.8
Paper and allied products	4.1	3.0	3.8	5.1	4.5	5.5
Printing and publishing	2.9	2.4	4.6	3.1	4.8	3.3
Chemicals and allied products	1.7	3.0	5.3	5.9	6.3	7.2
Petroleum and coal products	3.8	0.2	N.A.	2.3	N.A.	7.1
Tobacco manufacturers	−3.2	−1.5	N.A.	0.2	N.A.	−1.7
Rubber and miscellaneous	5.8	4.1	6.8	7.3	7.5	8.9
Leather and leather products	−1.1	−1.1	6.5	−0.7	6.6	0.0

NOTE: N.A. indicates data not available.

[1]Data for 1979-81 are not available, so growth rates for 1979, 1980, 1981 and 1982 are excluded from the average growth rates.

compounded annual rate between 1972 and 1985. Table 2 shows slightly faster growth when labor productivity is measured by GVA per worker and VS per worker.[10]

The growth of total manufacturing output and labor productivity in the region indicate that, rather than undergoing a dramatic decline or "deindustrialization," the District's manufacturing sector — like the nation's — is expanding and becoming more productive.

Operating Ratios

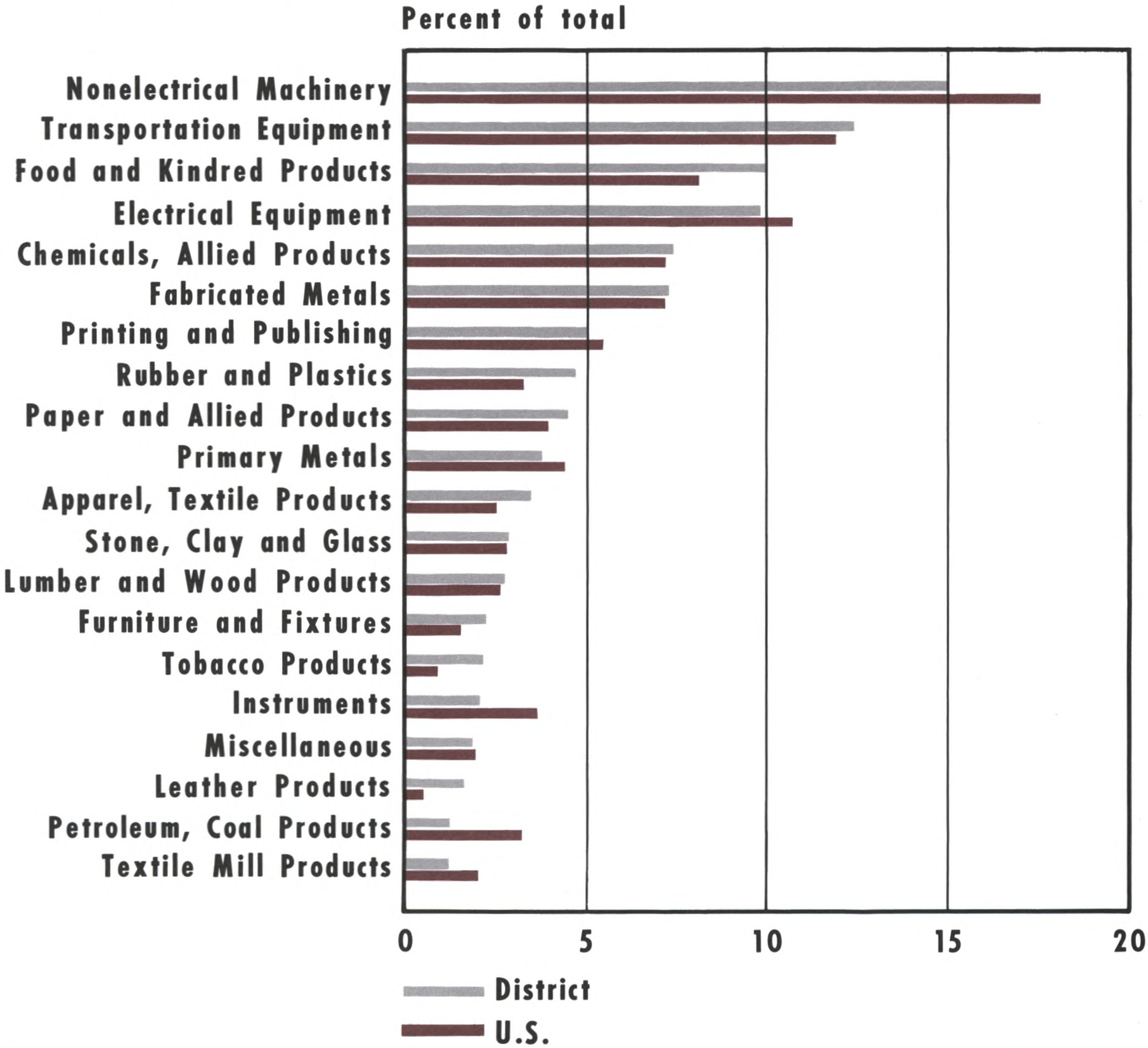
Labor productivity and unit labor costs of a region's manufacturing sector relative to the rest of the nation are related to the region's competitive position in national markets. A comparison of changes in the regional and national operating ratios reveals whether the District is keeping pace with improvements at the national level.

Table 2 compares the 1985 levels and the compounded annual growth rates of labor productivity

[10]Because no regional data for GVA and VS are available for 1979–81, it is impossible to compute average annual growth rates for those variables that are comparable to the average annual growth rates for MP. Therefore, compounded annual rates, which require only the initial and terminal years of the periods, are used to indicate average growth. In each productivity measure, the number of manufacturing workers are from the U.S. Bureau of the Census' *Annual Survey of Manufactures* and *Census of Manufactures*.

Chart 4

Composition of District and U.S. Manufacturing Output, 1985



and unit labor costs using each of the three measures of output. Unit labor costs are measured by payroll per unit of output.[11] Total District payroll per dollar of MP, measured in 1982 dollars, was $0.49, almost identical to the $0.50 national level. In addition to similar levels,

[11]The payroll data is published by the U.S. Bureau of the Census in the *Census of Manufactures* and the *Annual Survey of Manufactures*. It includes gross earnings paid to all employees, but excludes employer contributions for social insurance and payments to proprietors or partners of unincorporated establishments.

Table 2
Manufacturing Unit Labor Costs and Labor Productivity

	1985 Level		Compounded Annual Growth Rate 1972–85	
	Eighth District	U.S.	Eighth District	U.S.
Labor Productivity				
MP/worker	$ 38,400	$ 42,100	2.5%	2.8%
GVA/worker	50,800	52,600	3.0	3.0
VS/worker	124,300	119,900	3.8	3.5
Unit Labor Costs				
Payroll/MP	0.49	0.50	−2.3	−2.7
Payroll/GVA	0.37	0.40	−2.7	−2.9
Payroll/VS	0.15	0.18	−3.4	−3.4

NOTE: See text for variable definitions. Payroll and output data in constant 1982 dollars. Productivity figures are rounded to the nearest $100.

table 2 shows that the decline in District and national unit labor costs between 1972 and 1985 was also similar; unit labor costs (payroll/MP) declined at a compounded annual rate of 2.3 percent in the District, and 2.7 percent rate in the nation. Similar results are found when unit labor costs are measured by payroll/GVA or payroll/VS.

Table 2 also shows the similarity of both the level and growth of labor productivity. Whether measured by MP/worker, GVA/worker, or VS/worker, the levels and compounded annual growth rates of District and U.S. labor productivity were quite similar.

The overall resemblance in the levels and growth of these operating ratios suggest that District manufacturing is maintaining its competitive position relative to the rest of the nation.[12] This, and the fact that the competitiveness of the nation's manufacturing sector has improved relative to its major foreign competitors, suggests that District manufacturers are maintaining their competitive position in international markets as well as in domestic ones.[13]

Uneven Growth and Structural Change

The declining growth of some mature industries, especially metal production, is sometimes cited as an example of the decline of manufacturing. As table 1 shows, however, the growth of primary metal production is not typical of manufacturing as a whole. While the District's total MP expanded at a 2.6 percent pace in the 1973–85 period, the average annual growth rate of regional primary metals output was zero. Nationally, total MP grew at a 2.9 percent rate while primary metals output fell at a 1.7 percent rate. Because the sector produced less than 10 percent of regional or national MP between 1973 and 1985, however, its sluggish performance was offset by the more rapid growth in other manufacturing industry groups. For example, MP of the nonelectrical machinery and electronic equipment sectors grew at 8.6 and 3.9 percent rates in the District and at 7 and 6.6 percent rates nationally.

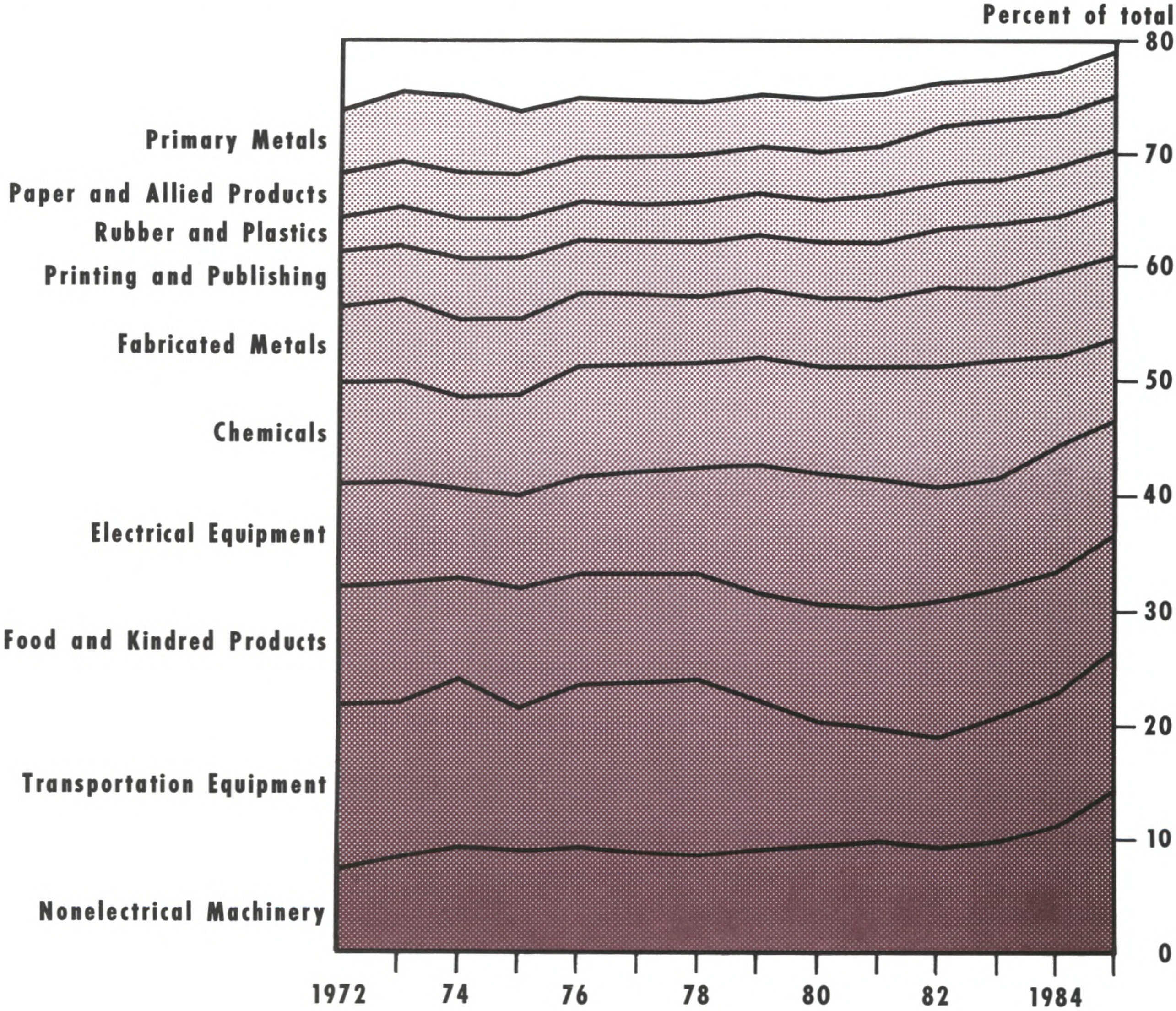
These examples and the data in table 1 point out the uneven growth among manufacturing's industry groups. Despite this diversity among the industries' growth rates, the uneven growth led to only minor changes in the industrial composition of manufacturing between 1972 and 1985. Chart 5 shows the proportion of total District MP contributed by each of the 10 largest industry groups. Although there were some changes in the components of manufacturing — for example, the rapid growth of electronic equipment output caused that industry's share to increase, while

[12] In addition to similar composition and operating ratios, District manufacturing also resembled U.S. manufacturing in the relative importance of export industries, a factor that could influence manufacturing growth. The U.S. Census Bureau's *Annual Survey of Manufactures (Origin of Exports of Manufactured Products, 1987)* reported that, in 1984, exports accounted for 5.8 percent of District manufacturing's shipments, compared with 6.7 percent nationally.

[13] See Tatom (1986a), pp. 14–15.

Chart 5

Composition of District Manufacturing Product, 1972-85



the sluggish expansion of primary metals output caused its share to shrink — overall, the composition of District manufacturing throughout this period remained relatively constant.

SUMMARY

In both the nation and the Eighth District, employment growth in the manufacturing sector has not kept pace with the rest of the economy's employment growth, leading some observers to view manufacturing as an ailing industry. Output trends, however, provide a different picture of manufacturing performance. Nationally, real manufacturing output has grown as fast as the other sectors of the economy. Labor productivity in manufacturing has grown faster than in the rest of the economy, allowing manufacturing to produce a constant proportion of national output with a declining proportion of its labor force.

Not all regions shared in the nation's manufacturing stability. Rapid growth in the South and West offset declines in northern industrial areas. In the Eighth District, however, the growth of manufacturing employment and output were quite similar to the national expansion in the 1972–85 period. This parallel growth was made possible by similarities in composition, labor productivity and unit labor costs.

Although some individual manufacturing industries contracted sharply since the early 1970s in terms of real output, others grew briskly as the composition of manufacturing evolved in response to consumer demands and comparative advantage. The overall trends point to the stability and increased productivity of the Eighth District and U.S. manufacturing sectors.

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Appendix
Computing District Manufacturing Product

Manufacturing product (MP) data computed by the U.S. Commerce Department measures that portion of the nation's real GNP originating in manufacturing. No corresponding measure is available at the state or regional level. While the value of shipments and gross value added are related measures, the shaded insert explains how they differ from MP.

To compute a measure of District manufacturing output corresponding to national MP, the methodology developed by Kendrick and Jaycox (1965) and modified by Niemi (1983) and Weber (1979) was followed. District MP is an estimate of the sum of manufacturing output in the four states that dominate the District economy — Arkansas, Kentucky, Missouri and Tennessee. MP was derived by estimating output for each of the District's 20 manufacturing industry groups and summing over all industry groups.

District MP was computed in two steps. First, preliminary estimates were calculated assuming that the ratio of output to earnings in each manufacturing industry was identical in the District and the United States. In the second step, the preliminary estimates were adjusted to correct for productivity differences between the District and the United States.

More specifically, the first step in estimating District MP is to multiply the ratio of national output to national earnings in each of the industry groups by District earnings in that industry. That is, the preliminary estimate of District output originating in industry group i, year t is:

$$(1)\ PMP_{itD} = (MP_{itUS}/E_{itUS})E_{itD}$$

where MP is real GNP originating in the nation's manufacturing industry group i, year t, E represents earnings, and the US and D subscripts symbolize the U.S. and the Eighth District, respectively. Earnings and U.S. MP data are published by the U.S. Commerce Department. Earnings include wages and salaries, other labor income and proprietory income.

The preliminary estimates resulting from equation 1 will be accurate to the extent that the ratio of MP to E in each industry group is similar in the District and the nation. This assumption has been interpreted as one of similar productivity at the regional and national levels. In the second step of computing District MP, the preliminary estimates for each industry group were adjusted by a measure of that industry's productivity in the District relative to the nation. This procedure was developed by Niemi (1983). The measure of relative productivity is the ratio of gross value added per dollar of payroll for the District to gross value added per dollar of payroll in the nation, or

$$(2)\ (GVA_{itD}/P_{itD})/(GVA_{itUS}/P_{itUS}),$$

where GVA and P are gross value added and payroll data published by the U.S. Bureau of the Census' *Annual Survey of Manufactures* and the *Census of Manufactures*. For each industry group, the relative productivity measure was multiplied by the preliminary estimates (PMP_{itD}) to compute the final estimates. Total manufacturing output is the sum of the final estimates for all industry groups.

The Great Bull Markets 1924–29 and 1982–87: Speculative Bubbles or Economic Fundamentals?

G. J. Santoni

Every so often, it seems, humankind almost en masse *has a compulsion to speculate, and it yields to that compulsion with abandon.*
— Robert T. Patterson, *The Great Boom and Panic,* p. xiii.

MANY people attribute the bull market of 1924–29 and the subsequent collapse in stock prices to a "speculative bubble."[1] According to this view, the crash was inevitable because it was only a matter of time until the bubble burst (see shaded insert on opposite page).

The same theory of stock price formation is used to describe the bull market of 1982–87. Recent discussions have characterized this bull market as the product of "unexpected insanity," subject to "trading fads and frenzies rather than economic fundamentals" and "out of control."[2] Comparisons between the 1920s and 1980s like the one summarized in chart 1 have appeared recently in the press.[3] Chart 1, which plots quarterly data on the levels of the Dow Jones Industrial Index over the two periods, shows that the behavior of stock prices in both periods is similar.[4] Both bull markets began in the second quarter of the year; each lasted 21 quarters; each hit its peak in the third quarter with the timing of the peaks separated by only a few days (September 3, 1929, and August 25, 1987); in each case, 54 days elapsed between the peak and the crash; and each crash stripped slightly more than 20 percent from the stock market averages.

The belief that speculative bubbles might cause a persistent deviation in stock prices from the price consistent with the fundamentals is important. At the time of the 1929 crash, it spawned legislative proposals that would curb credit for speculation, amend the National Banking and Federal Reserve acts, impose an excise tax on stock sales and regulate the activities of stock exchanges and investment trusts.[5] Furthermore,

G. J. Santoni is a senior economist at the Federal Reserve Bank of St. Louis. Thomas A. Pollmann provided research assistance.

[1]See the shaded insert on page and Kindleberger (1978), p. 17.

[2]"Abreast of the Market" (1987) and Jonas and Farrell (1986).

[3]See, for example, Koepp (1987), Powell (1987), Schwartz and Tsiantar (1987) and *Wall Street Journal* (1987).

[4]Scale (1982–87) = 8 x scale (1924–29).

[5]*New York Times* (October 25, 1929).

Some Popular Notions Regarding the Cause of the 1929 Crash

"Gambling in stock has become a national disease . . . Neither assets nor earnings, large as the earnings have been in many instances, warrant the market values of hundreds of stock issues. There has been an inflation (in stock prices) not free from the charge of criminality, . . . It was inevitable that a day of reckoning would come and the billions would be lost as the water and hot air were eliminated from hundreds of stock issues." Senator King, *New York Times* (October 25, 1929).

"The bull market was created by phenomenal profits in a few leading shares. Even in these shares there were not sufficient profits to justify the prices which prevailed before October 1928." Niebuhr (1930), p. 25.

"This growth (in stock prices) was matched by widespread, intense optimism which in the end deteriorated into lack of perspective and discipline. This optimism went so far in places that people began to believe that there was such a thing as 'permanent prosperity' and that economic crises could be eliminated." Roepke (1936).

"As already so often emphasized, the collapse in the stock market in the autumn of 1929 was implicit in the speculation that went before." Galbraith (1955), p. 174.

"The most common explanation of the Crash to this day is that the market was overpriced because of speculation . . ." Wanniski (1978), p. 125.

"In the end, fright may have been what turned retreat into rout. And that fright may have been partly motivated by the perception of absurdly high stock prices . . ." Schumpeter (1939), p. 876.

"Among the immediate or precipitating causes (of the crash) were the unjustifiably high prices of common stocks . . ." Patterson (1965), p. 215.

"The breakdown of 1929 was as nearly the result of willful mismanagement and violation of every principle of sound finance as such occurrence has ever been. It was the outcome of vulgar grasping for gain at the expense of the community." Willis (1930).

"It may be legitimately said that the boom and slump were caused by the alternate domination of greed and fear, and that the one was bound to resign sooner or later in favor of the other, . . ." Hodson (1933).

"Never a boom and high prosperity without an outbreak of speculation. Never such an outbreak that has not ended in a financial crisis." Snyder (1940).

"Might one still suppose that this kind of stock market crash (in 1929) was a rational mistake, a forecast error that rational people might make? This paper . . . implies that the answer is no." Shiller (1981), p. 422.

if stock price bubbles exist, economic policymakers face a difficult problem because bubbles suggest that plans to save and invest may be based on irrational criteria and subject to erratic change.[6]

The purpose of this paper is to compare the implications of a theory of stock prices based on fundamentals to one that allows for bubbles, then to examine evidence from the 1920s and the 1980s to determine which set of implications is supported by the data. The behavior of stock prices during these two periods is particularly useful in testing asset prices for the presence of speculative bubbles. The 1924–29 experience is one of the most significant bull markets in U.S. history in both its duration and rate of advance. Though not quite as dramatic, the behavior of stock prices in the 1980s has been similar. If stock price bubbles exist, these are likely places to look for them.

THE FUNDAMENTALS OF STOCK PRICES

People value common stocks for their expected return. Since investors may choose among broad categories of stock, the expected return on any particular stock must be equal to the expected return on other

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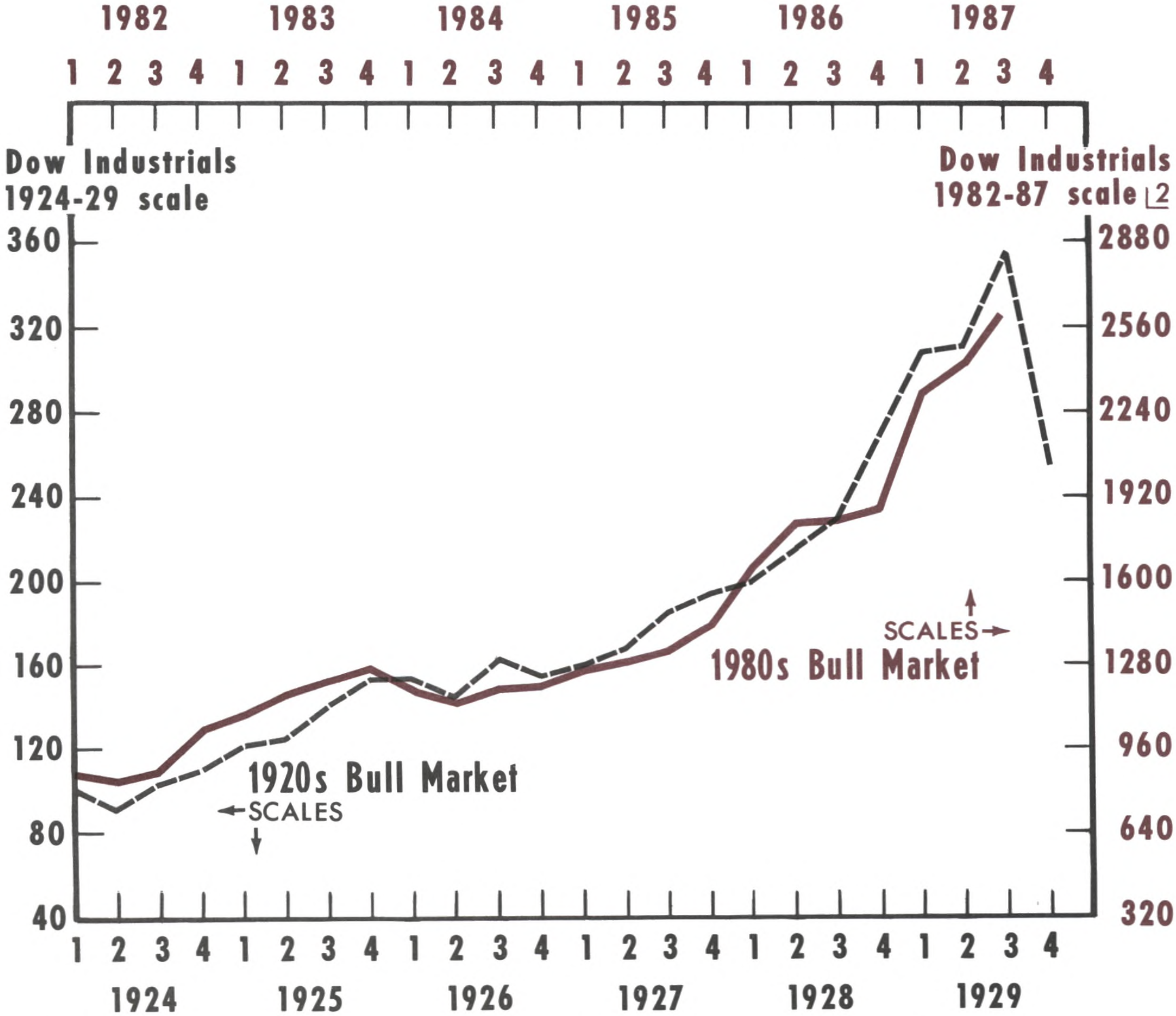
[6]Keynes (1935), p. 159. Keynes discussed erratic shifts in the investment schedule caused by changes in the "state of confidence" (pp. 153–55) and "speculation" (p. 161). He argues that a

> ". . . boom which is destined to end in a slump is caused, therefore, by the combination of a rate of interest, which in a correct state of expectation would be too high for full employment, with a misguided state of expectation which, so long as it lasts, prevents this rate of interest from being in fact deterrent. A boom is a situation in which over-optimism triumphs over a rate of interest which, in a cooler light, would be seen to be excessive" (p. 322).

See, as well, Gordon (1952), p. 378 and Varian (1979).

Chart 1

The Bull Markets of the 1920s and 1980s [1]
Dow Jones Industrial Index (Nominal Values)



1 Sources: Moore (1961), pp. 109 ,145 and Economic Report of the President. Various years.

2 Scale 1982-87 = 8× Scale 1924-29.

stocks of similar risk. For example, if a particular stock is expected to yield a relatively low return, investors will shun it causing its price to fall. This raises its expected return. The reverse holds for any stock with an expected return that is higher than other stocks of similar risk. An equilibrium exists when the expected returns are equal across equally risky stocks. Economists call this equilibrium return the required discount rate. Equation 1 calculates the expected return from holding a stock for one year assuming dividends are paid at year-end.[7]

(1) Expected Rate of Return =

$$\frac{\text{Forecast of price at year end} + \text{Forecast of dividend} - \text{Current Price}}{\text{Current Price}}$$

Equation 2 solves equation 1 for the current price by noting that the expected return is equal to the required discount rate in equilibrium.

(2) Current Price =

$$\frac{\text{Forecast of price at year-end} + \text{Forecast of dividend}}{(1 + \text{Required discount rate})}$$

The Price Depends on Forecasts of Future Outcomes

The important thing to note in equation 2 is that the current price depends on forecasts of *future* outcomes which, of course, are subject to change as new information becomes available. The price does not depend on dividends that are observed in the present as Senator King and others have implied in their comments on the behavior of stock prices during the 1920s (see shaded insert on page 17). The current price may change even though observed dividends do not and conversely.

How Far Ahead?

The discussion so far indicates that investors must forecast the price of the stock next period. What are the fundamentals for this future price? In principle, the future price depends on the stream of dividends and the required discount rate investors expect to prevail over the life of the firm. Typically this requires forecasts that extend into the distant future and suggests that the job of analyzing stock prices is formidable. It is sometimes possible to simplify the calculation, however. If dividends are expected to grow at a constant annual rate and the discount rate is constant, the calculation can be simplified as shown in equation 3.[8]

(3) Current Price =

$$\frac{\text{Forecast of dividend}}{\text{Required discount rate} - \text{Expected growth rate of dividends}}$$

The Price Fundamentals

Restating the solution for the current price as in equation 3 is particularly useful for the purposes of this paper. Equation 3 is a list of the price fundamentals: the forecast of the dividend next period, the required discount rate, and the expected (forecast) growth rate of dividends. The solution for the current price in equation 3 is called the fundamentals price. Furthermore, the equation can be used to show how relatively small changes in forecasts can account for relatively large changes in the fundamentals price. For example, suppose investors forecast a year-end dividend of $.60 per share, an annual dividend growth rate of 6 percent and the required discount rate is 8 percent. Equation 3 indicates that the fundamentals price is $30 per share [= .6/(.08 – .06)]. Now suppose that new information leads investors to lower the forecast of dividend growth to 5 percent. This is a decline of about 17 percent in expected growth [= (.01/.06)100]. The fundamentals price, however, declines to $20 [= .6/(.08 – .05)], or more than 30 percent. Notice that a large decline in price may occur even though observed dividend payments do not change. It is even possible for the price to decline when observed dividends rise.

STOCK PRICES AND MEASURES OF THE FUNDAMENTALS

Table 1 shows annual average growth rates of the Dow Jones Industrial Index in each year during the two bull markets.[9] The index rose rapidly during the

[7]See Brealey (1983), pp. 67–72, and Brealey and Meyers (1984), pp. 43–58.

[8]Brealey (1983), p. 69. The current price is defined by equation 3 only if the expected growth rate in dividends is less than the required discount rate.

[9]The data on stock prices used in this paper are daily closing levels of the Dow Jones Industrial Index. Daily closing levels of this index are available on a consistent basis from January 1915. See Pierce (1982). When possible, the statistical results obtained with this data were checked against results using daily closing levels of the Standard and Poor's Composite Index. In no case were any qualitative differences observed.

Table 1

Growth Rates in Stock Prices (annual average growth rates)[1]

Panel A: II/1924 – III/1929

Period	Dow Industrials
II/1924 – IV/1924	32.8%
IV/1924 – IV/1925	34.6
IV/1925 – IV/1926	1.5
IV/1926 – IV/1927	21.5
IV/1927 – IV/1928	32.7
IV/1928 – III/1929	37.7
Average II/1924 – III/1929[2]	25.7%

Panel B: II/1982 – III/1987

Period	Dow Industrials
II/1982 – IV/1982	40.1%
IV/1982 – IV/1983	20.9
IV/1983 – IV/1984	–4.4
IV/1984 – IV/1985	17.8
IV/1985 – IV/1986	26.8
IV/1986 – III/1987	31.5
Average II/1982 – III/1987[2]	20.0%

[1]Computed from quarterly averages of seasonally adjusted data. See Moore (1961), pp. 106–09.
[2]In computing this average, the growth rates for each period are weighted by the length of the period.

initial phases of the bull markets, slowed down considerably in 1926 and 1984, then rose rapidly through the third quarters of 1929 and 1987.

A rapid advance in stock prices is not surprising if it results from changes in the fundamentals. The investigator, however, seldom has the luxury of direct observation of the fundamentals. Instead, other variables (proxies) that are believed to provide information about the behavior of the unobserved fundamentals must be used. For example, credit market interest rates and actual dividend payments have been used to proxy the required discount rate and the expected stream of future dividends. It is important to recognize that, at best, the behavior of these (or other) proxies may give only a rough approximation of the behavior of the fundamentals and, on occasion, they may be entirely misleading. The 1920s may be an example of the latter case.

Long-term rates were roughly constant from 1924–29.[10] Data on actual per share dividends are very sketchy for this period. One estimate, however, indicates that actual dividends increased at an annual rate of about 8.8 percent from 1924–29.[11] While this is a fairly rapid rate of increase, it is far less than the growth observed in stock values. (See shaded insert on opposite page for a more precise estimate of the relationship between stock prices and these proxy variables.) When the market crashed, people like Senator King pointed to these proxy variables and claimed that stock prices before October 1929 contained "water and hot air." An alternative explanation is that the proxies give a misleading impression of the behavior of the fundamentals.

FUNDAMENTALS, FOOLS AND BUBBLES

In order to evaluate the notion that stock prices in the 1920s and 1980s were driven by psychological factors extraneous to the fundamentals, it is necessary to be clearer about the implications the alternative hypotheses have for variables that can be observed by the investigator. This paper considers three different theories that potentially explain stock prices: the efficient market hypothesis, the greater fool theory and the theory of rational bubbles.

Efficient Markets and Fundamentals

A long-standing proposition in both economics and finance is that stock prices are formed in efficient markets.[12] This means that all of the relevant information currently known about interest rates, dividends and the future prospects for firms is contained in current stock prices. Stock prices change only when new information regarding the fundamentals is obtained by someone. New information, by definition, cannot be predicted ahead of its arrival; because the news is just as likely to be good as it is to be bad, jumps in stock prices cannot be predicted in advance.

Many present-day stock market analysts are skeptical of the efficient markets hypothesis.[13] Similarly,

[10]See Friedman and Schwartz (1982), table 4.8, and Homer (1977), p. 352.

[11]See Cowles (1938), p. 389.

[12]See Brealey and Meyers (1984), pp. 266–81; Malkiel (1981), pp. 171–79; Brealey (1983), pp. 15–18; Leroy (1982) and Fama (1970).

[13]See Malkiel (1981), pp. 126–79.

The Relationship Between Growth in Stock Prices, Dividends Per Share and the Interest Rate: 1872–1930

The following regression estimate relates first differences in the natural log of the Cowles Commission index of stock prices, ΔLnP, to first differences in the natural logs of the Cowles Commission estimate of per share dividend payments, ΔLnD, and the interest rate on long-term bonds, ΔLnR. The data are annual and span the period 1872–1930. The regression estimate is intended to illustrate the results that are obtained when observed values of dividends and credit market interest rates are used to proxy expected dividends and the required discount rate.

$$\Delta LnP = .16 + .49\Delta LnD - 1.26\Delta LnR.$$
$$(.11) \quad (4.54) \quad (4.07)$$

$$Rho = .03$$
$$(.23)$$
$$RSQ = .39$$
$$SE = 10.40$$

The estimated coefficients of these proxy variables are significantly different from zero and the qualitative relationship between stock prices and these proxies is the same as that expected for their theoretical counterparts. There is a considerable amount of "noise" in the estimate, however, in the sense that variation in the proxy variables explains a relatively small amount (about 40 percent) of the variation in stock prices.

More importantly, the estimated equation performs very poorly in 1929 and 1930. For example, the percentage change in stock prices predicted by the regression estimate for 1929 is -1.24 percent. Stock prices actually rose in 1929 by 23.86 percent. The deviation of the actual from the predicted value is 25.10 percent. This deviation exceeds two standard errors of the estimate, indicating that such a large deviation is not likely to result from chance. In short, it suggests that the large increase in stock prices in 1929 was unrelated to movements in the proxy variables. In the case of 1930, the actual decline in stock prices exceeds the predicted decline by more than two standard errors. This pattern — a significantly larger percentage increase in stock prices than predicted for 1929 and a significantly larger decrease in stock prices than predicted for 1930 — appears to be consistent with the notion that a speculative bubble was responsible for a boom in prices and a crash when the bubble burst.

traders in the 1920s generally did not subscribe to it (see shaded insert on following page). But that is not important. If the behavior of stock prices is consistent with the implications of the theory, the hypothesis helps both to understand how stock markets work and to evaluate the claim that the bull markets were products of price bubbles.

If the efficient markets hypothesis is correct, past price changes contain no useful information about future price changes. With some added assumptions, this can be translated into useful empirical propositions. If the expected return to holding stock is constant and the volatility of stock prices does not change during the time period examined, the efficient market hypothesis implies that observed *changes* in stock prices should be uncorrelated and that price changes should not exhibit long sequences of successive changes that are greater or less than the median change for the sample.

The above propositions should hold even if the *level* of stock prices appears to drift upward or downward. These propositions concern the relationship between the sequence of price changes, not the average change over some specific period. Clearly, stock prices drifted upward during both bull markets; but that does not necessarily mean that price changes were correlated or that there were long runs of positive changes that exceeded the median change for these periods. Put differently, it does not necessarily mean that market participants were able to predict future changes in stock prices by observing the past.

Greater Fools

The notion that self-feeding speculative bubbles, on occasion, can drive stock prices is known as the "greater fool theory." According to this theory, people regard the fundamentals as irrelevant. Rather, they buy stock on the belief that some (bigger?) fool will buy

What Some Big Plungers Thought of Efficient Markets[1]

William C. Durant

Durant had been acquiring a large interest in American Smelters and its share price had risen from $119 to $140. One day during this period a friend burst into his office and exclaimed, "Now look here, Billy, what are you doing with Smelters? You know it's not worth $140." "Possibly not," Durant said, "but take my advice and don't sell me any more of it, because it's going much higher." The stock went to $390 on a split share basis.

Jesse Livermore

"A gambler is a man who doesn't know the market. He goes to a broker and says, 'What can I do to make a thousand dollars?' He is only an incident. The speculative investor buys or sells against future conditions on his knowledge of what has happened in the past under a similar set of conditions."

Louis W. Zimmerman

Zimmerman employed a team of experts to study the market constantly. He never purchased a stock until he received a final report from the analysts concerning the condition of the company.

Arthur W. Cutten

"Yes, I have taken my bit out of the market. Oh, quite a bit. But I would advise other men to stay away from it. If I had a son I wouldn't let him touch it with a ten-foot pole.

There are too many wrecks down there in the pit. People call them brokers. They are only part of that — the broke part."

* * *

The efficient markets hypothesis (EMH) suggests that Durant was lucky. He could not have known that the price of American Smelters would rise. Livermore's evaluation of the "gambler's" strategy vs. the "investor's" contradicts the implication of EMH that the strategy of each is just as likely to succeed (or fail). Similarly, EMH suggests that hiring teams of experts, as Zimmerman did, is not expected to result in raising the return from stock purchases above a normal return. This applies to Cutten's comment regarding brokers who, according to EMH, are expected to earn a normal return on their stock trades, not a negative return as suggested by Cutten.

[1]See Sparling (1930), various pages.

the shares from them at a higher price in the future. People maintain this belief because they think "that market values will rise — as they did yesterday or last week — and a profit can be made."[14] Once the speculation begins, stock prices continue rising because people, seeing the rise in the previous period, demand additional shares in the belief that prices will continue to rise. This pushes prices still higher.

The greater fool theory is based on the presumption that there are times when past movements in stock prices matter. According to this theory, during the "fooling" periods, there should be positive correlation in the past sequence of price changes and long runs of positive changes that exceed the median change for the sample period.

[14]Galbraith (1955), p. 23. See, as well, Malkiel (1981), pp. 31–49.

Rational Bubbles

Recently, some economists have discussed the possibility that stock prices may contain "rational" bubbles.[15] The theory of rational price bubbles is based on the belief that some asset prices (for example, stock, gold and foreign currency prices) are too variable to be justified by variation in the fundamentals.[16] (A more formal theory of price bubbles is summarized in the appendix to this paper.) Briefly, the theory says that there may be occasions when stock prices deviate from the price that is consistent with the fundamentals. The deviation is called a bubble.

[15]See Flood and Garber (1980 and 1982), Blanchard and Watson (1982), West (1986), Diba and Grossman (1985 and 1986) and the appendix to the paper.

[16]See, for example, Shiller (1981) and Mankiw, Romer and Shapiro (1985).

Bubbles must possess certain characteristics if they are to have economic significance:

Bubbles must be persistent so that a forecast of stock prices based solely on the fundamentals is biased. This means that forecast errors (actual price minus forecast price) will tend to have the same sign and not average out. The persistence of one-sided errors is important because random variation in the data generally will cause the actual price to differ from any well-constructed forecast of the price even though a bubble is not present. If bubbles were only a name used to describe random variation in the data, they would not be very interesting.

Bubbles must be explosive in the sense that they must grow at a rate that compensates the stock purchaser for the additional amount invested in the stock due to the bubble. In addition, there may be a risk premium to compensate stockholders for the additional risk that the bubble may burst.[17] This characteristic causes the price to deviate further and further from the fundamentals for as long as the bubble lasts.

Bubbles can not be negative. A negative bubble means that stock prices are less than implied by the fundamentals. The explosive characteristic of bubbles means that the prices implode with some chance that stock prices will be negative at some future date.[18] Negative stock prices, however, are impossible; they are inconsistent with the liability rules associated with common stock which limit potential losses to the extent of the initial investment.

RATIONAL BUBBLES AND STOCK PRICE BEHAVIOR

The theory of rational bubbles has implications for the behavior of stock prices that are different than the theory of efficient markets.[19] This is shown in table 2, which makes use of the fundamentals theory of stock price determination discussed above. One important assumption of this example is that, at each moment in time, investors expect dividends to grow at a constant rate over the future. To keep things simple, the example assumes that subsequent events conform to the expectations of investors (perfect foresight, an extreme version of rational expectations) and that the dividend is initially expected to be $2. The expected dividend is constant in panel A (expected growth rate is zero) but grows in panel B at an expected annual rate of 2 percent. The required discount rate is 10 percent, and a bubble of $1 occurs in period zero.

Column 3 of panel A computes the fundamentals price, P^f_t. This is simply the expected dividend, $E_t(D_{t+1}) = \$2$, (assumed constant in panel A) divided by the difference between the required discount rate, $r = .10$, and the expected growth rate in dividends, $g = 0$. The fundamentals price is $20 each period.

The fourth column computes the bubble component of the price. As discussed above, the bubble expands over time at the required discount rate, r. The observed price, P_t, is the sum of the fundamentals price and the bubble as in column 5.

Column 6 calculates the percentage changes in the price. These are positive. More importantly, the numbers in column 6 rise over time indicating that this bubble produces a time series of observed price changes that are positively correlated. The observed price does not follow a random walk. Of course, the real world is never so neat. Changes in the fundamentals — $r, g, E_t(D_{t+1})$ — may cause the observed price to change in a way that masks the bubble. If that occurs, however, it is not clear that the bubble is very important since an investor's behavior under the theory of rational bubbles depends on his ability to detect the presence of bubbles.

The example in panel B is similar to the example in panel A except that dividends are expected to grow at a 2 percent annual rate. Notice that this does not change the qualitative result with respect to the observed price changes. These rise over time and will be positively correlated. The only difference between the two examples is that the fundamentals price in panel B rises (drifts upward) over time at a constant 2 percent rate (see column 7). This results from the growth in dividends. While the fundamentals price drifts upward at a constant rate of 2 percent, the sequence of changes in the fundamentals price are uncorrelated. The fundamentals price will follow a random walk with drift.

An important thing to note is that both the greater fool theory and the theory of price bubbles discussed in this paper imply that stock prices behave similarly. Both reject the efficient markets hypothesis, which implies that stock prices follow a random walk.

[17]See Diba and Grossman (1985 and 1986), Blanchard and Watson (1982), Flood and Garber (1980), West (1986) and the appendix to this paper.

[18]See Diba and Grossman (1985 and 1986) and Blanchard and Watson (1982).

[19]See Diba and Grossman (1985) and the appendix.

Table 2

Fundamentals vs. Bubbles: An Example

Panel A: Expected growth of dividends is zero

Years	$E_t(D_{t+1})$	P_t^f	$B_t = (1+r)^t B_0$	$P_t = P_t^f + B_t$	$\%\Delta P_t$	$\%\Delta P_t^f$
0	$2.00	$20.00	$1.00	$21.00		
1	2.00	20.00	1.10	21.10	.48%	0.0%
2	2.00	20.00	1.21	21.21	.52	0.0
3	2.00	20.00	1.33	21.33	.57	0.0
4	2.00	20.00	1.46	21.46	.61	0.0
5	2.00	20.00	1.61	21.61	.70	0.0

Panel B: Expected growth of dividends is 2 percent

Years	$E_t(D_{t+1})$	P_t^f	$B_t = (1+r)^t B_0$	$P_t = P_t^f + B_t$	$\%\Delta P_t$	$\%\Delta P_t^f$
0	$2.00	$25.00	$1.00	$26.00		
1	2.04	25.50	1.10	26.60	2.31%	2.00%
2	2.08	26.01	1.21	27.22	2.33	2.00
3	2.12	26.53	1.33	27.86	2.35	2.00
4	2.17	27.06	1.46	28.52	2.37	2.00
5	2.21	27.60	1.61	29.21	2.42	2.00

Where: $E_t(D_{t+1})$ = the expected dividend next period

P_t^f = the fundamentals price in period t

B_t = the bubble in period t and B_0 is the initial bubble

r = the required discount rate

P_t = the observed price in period t

g = the expected growth rate in dividends

$$P_t = P_t^f + B_t = \frac{E_t(D_{t+1})}{r-g} + B_t$$

SOME PROBLEMS WITH BUBBLES

The notion that stock prices are influenced by bubbles is troublesome because it is not based on a well-specified theory. A complete theory of bubbles should identify the cause of bubbles in terms of some phenomenon *that can be observed separately* from bubbles themselves. On those occasions when the cause is observed, a bubble should also be observed and conversely. This allows a direct test of the theory and explains why bubbles may be observed on some occasions but not others.

In contrast, the greater fool and rational bubble theories do not suggest a cause of bubbles that can be observed separately. Rather, unusual price behavior (the bubble) is attributed to "intense optimism," "a compulsion to speculate" and "manias." These do not identify the cause of the bubble; they merely give the bubble a different name.[20]

These criticisms suggest that attributing crashes in stock prices to bursting bubbles adds nothing to our understanding of why crashes occur or how to prevent similar occurrences in the future. To illustrate,

[20]Brunner and Meltzer (1987) note that

> Some further reflections on bubbles and sunspots equilibria should make us doubt their contribution to a useful reconciliation of analysis with critical observations. The bubble term refers neither directly nor indirectly to any observable entities. It is fundamentally inconsistent with any rational exploitation of information invoked by the same analysis (p. 2).

See, as well, Singleton (1987), pp. 28–30. Sirkin (1975) and Schwartz (1981), p. 25, question the bubble hypothesis as an explanation of the 1929 crash.

Wesley Clair Mitchell (a noted student of business cycles) wrote that

> By a combination of various agencies such as public regulation of the prospectuses of new companies, legislation supported by efficient administration against fraudulent promotion, more rigid requirements on the part of stock exchanges concerning the securities admitted to official lists, more efficient agencies for giving investors information, and more conservative policy on the part of the banks toward speculative booms, we have learned to avoid certain of the rashest errors committed by earlier generations.[21]

Mitchell made this statement in 1913 in reference to the legislative and regulatory precautions instituted after the Panic of 1907. Like the crash in 1929, the 1907 crash had been attributed to a speculative bubble.

EFFICIENT MARKETS VS. PRICE BUBBLES: SOME EVIDENCE

The efficient markets hypothesis suggests that stock prices follow a random walk. The hypothesis has no implication for the drift in stock prices. Prices may be higher or lower at the end of the period being examined. Neither of these events is necessarily inconsistent with the hypothesis. Rather, the hypothesis implies that the sequence of price changes are unrelated; they behave as random variables. In contrast, the greater fool theory and the theory of rational bubbles discussed here imply that changes in stock prices are not random but are positively related. Which explanation is better supported by the evidence for the 1924–29 and 1982–87 bull markets?

To evaluate these theories, data on the level of the Dow Jones Industrial Index are used. Two periods are examined. One extends from January 3, 1928, through September 3, 1929. The second runs from January 2, 1986, through August 25, 1987. The data are first differences of the log of the Dow's daily closing level multiplied by 100 and are approximately equal to the daily percentage change in the index. Each sample contains more than 400 observations. Stock prices advanced very rapidly in these periods. If bubbles were present, they should be apparent in these data.

Were Stock Prices A Random Walk?

Table 3 presents the results of a test (called a Box-Pierce test) based on the estimated autocorrelations of percentage changes in the Dow Jones Industrial Index. This test is designed to determine whether there is significant autocorrelation in the data, that is, whether current changes in the index are related to past changes. Recall that the efficient markets hypothesis implies that past changes in stock prices are unrelated to (contain no information about) current or future changes. An empirical counterpart of this proposition is that changes in the index are not correlated. Conversely, if the hypothesis that stock prices were influenced by self-feeding bubbles is correct, percentage changes in the index should be positively correlated.

Table 3 shows test results for the two periods discussed above. None of the test statistics indicate signi-

Table 3

Autocorrelation Coefficients and Box-Pierce Statistics (first differences of logs of Dow Industrial Index)

January 3, 1928 – September 3, 1929

To lag	Autocorrelation coefficient	Box-Pierce statistic
1	.0196	.18
2	−.0325	.70
3	−.0494	1.91
6	.0200	10.41
12	.0069	16.43
18	−.0521	21.65
24	.0213	29.58

Mean of series = .128*
t-score = 2.57

January 2, 1986 – August 25, 1987

To lag	Autocorrelation coefficient	Box-Pierce statistic
1	.0553	1.28
2	−.0140	1.36
3	−.0095	1.40
6	−.0151	4.66
12	−.0076	7.86
18	−.0044	13.14
24	.0024	14.24

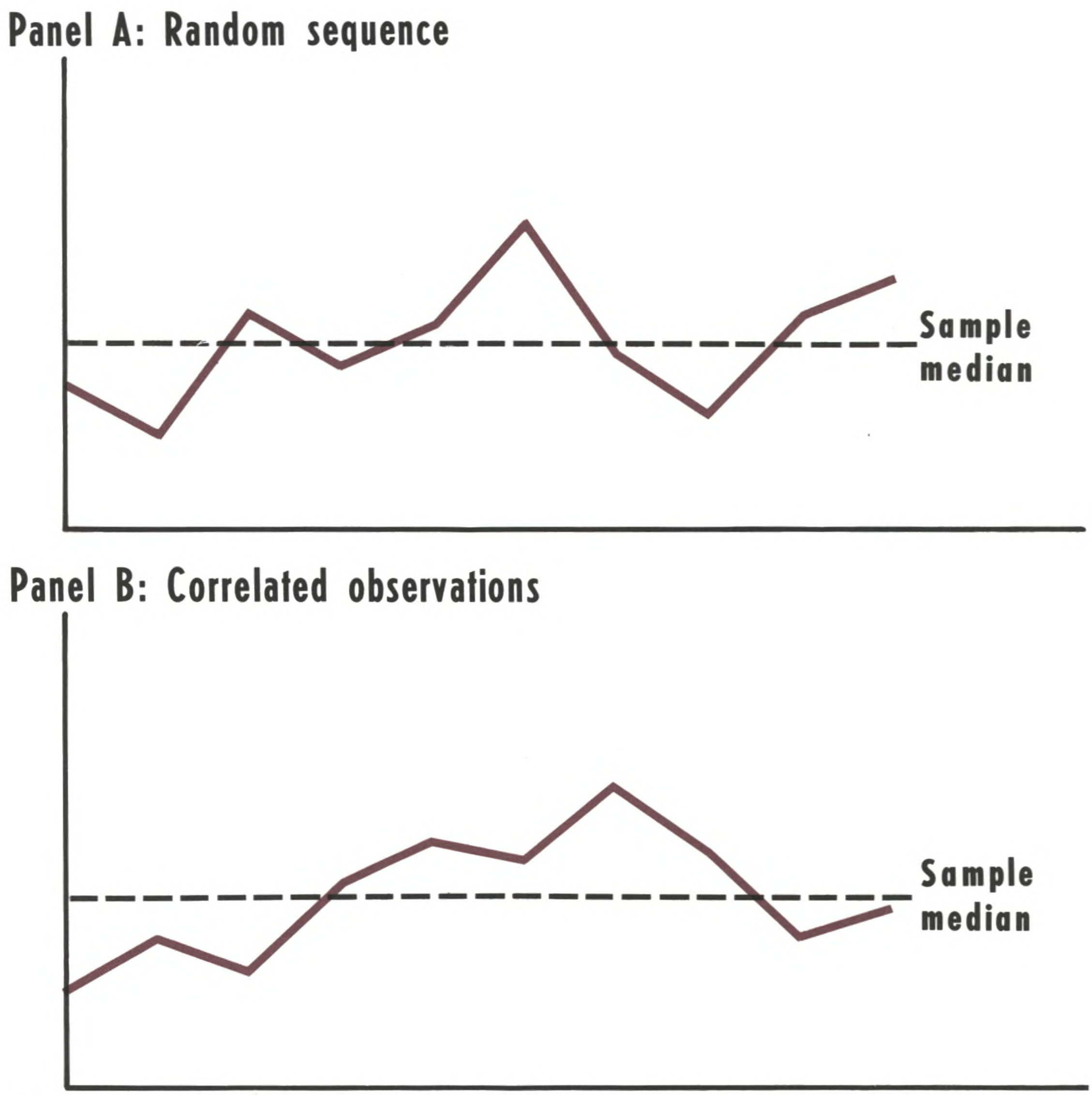
Mean of series = .136*
t-score = 2.83

*Statistically significant at the 5 percent level

[21]Mitchell (1950), p. 172.

Chart 2

An Illustration of a Random Sequence Vs. Correlated Observations[1]



[1] See Wonnacott and Wonnacott (1977), p.487.

Table 4
Runs Test

Sample period	Number of observations	Observed number of runs	Expected number of runs	Variance
Jan. 3, 1928 – Sept. 3, 1929	495	233	248.0	123.50
Jan. 2, 1986 – Aug. 25, 1987	417	220	209.0	104.00

Expected number of runs = (Number of observations + 1)/2
Variance = (Number of observations – 1)/4

ficant correlation at conventional confidence levels.[22] Stock prices followed a random walk, which is consistent with the efficient markets hypothesis.

Table 3 also shows the mean change for each period. The means are positive and significantly different from zero in a statistical sense. Today, the upward drift in stock prices during these time periods is obvious. At that time, however, the upward drift is not something that investors could have bet on with any confidence.

Runs Test

A run is the number of sequential observations that are greater or less than the sample median (the middle value of the sample). If a series of observations exhibits too few runs relative to what is expected for independent observations, the data are positively correlated or drawn from different populations.

The efficient markets hypothesis suggests that observed changes in stock prices are uncorrelated, that is, the changes are independent of one another. This means, for example, that there is no tendency for a large positive change to be followed by another large positive change. Consequently, the sequence of observed changes will move back and forth across the median change for the sample fairly frequently as shown in panel A of chart 2. If changes in stock prices are correlated as implied by the bubble hypothesis, however, a plot of the observations in the order that they appear will indicate some tracking as shown in panel B. This plot crosses the sample median infrequently. The example exhibits relatively long and, consequently, fewer runs than expected of independent observations.[23]

Table 4 presents the results of a runs test for the bull markets of the 1920s and 1980s. The third column of the table shows the number of runs observed for daily percentage changes in the Dow Jones Industrial Index during each period of rapidly increasing stock prices. Column 4 gives the number of runs expected for a series of (495 and 417) independent observations and column 5 gives the variance of this series. Since the observed number of runs is not much different than expected, the hypothesis that percentage changes in the Dow Index behaved randomly during the sample periods is not rejected by this data.

The evidence on the behavior of stock prices (as characterized by the Dow Index) is not consistent with the notion that stock prices were driven by self-feeding speculative bubbles during the 1920s and 1980s.

CONCLUSION

Many people attribute the stock market crashes of 1929 and 1987 to bursting speculative bubbles. The perception that stock prices may be driven by bubbles presents economic policymakers with an important problem because such bubbles suggest that plans to

[22]Daily data between October 22, 1929, and March 31, 1930, show significant autocorrelation at various lags. This is likely a statistical artifact produced by a substantial increase in the variance of the data at the time of the crash in October and November that appears to taper off over time. Consequently, the significant correlations do not suggest the presence of a bubble. Furthermore, stock prices were declining at this time and bubbles can not be negative.

[23]See Wonnacott and Wonnacott (1977), pp. 486–88.

save and invest may be based on irrational criteria and subject to erratic behavior.

This paper has examined data on stock prices around the time of the Coolidge and Reagan bull markets. The paper provides evidence contrary to the notion that the crashes were the result of bursting speculative bubbles. No evidence was found that changes in stock prices were autocorrelated or that the data contained long runs. Rather, the data suggest that stock prices followed a random walk. This evidence is consistent with the efficient markets hypothesis, which is based on the proposition that all relevant and ascertainable information regarding stock price fundamentals (interest rates, dividends, future prospects, etc.) is contained in current stock prices.

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Appendix
Price Bubbles

The following assumes rational investors with infinite time horizons and a complete set of markets. With these assumptions, the solution for the expected price of a share of stock next period given the information set in t, $E_t(P_{t+1} \mid w_t)$, is its price this period, P_t, plus appreciation during the period at the market rate of discount, $r_t \cdot P_t$, less the expected dividend in t+1, $E_t(X_{t+1} \mid w_t)$.[1] This relationship is summarized in equation 1.

$$(1)\ E_t(P_{t+1} \mid w_t) = P_t + r_tP_t - E_t(X_{t+1} \mid w_t)$$

The fundamentals price is the discounted present value of the expected future stream of dividends. This is shown in equation 2 for the price in period t.[2] Note that r_i is the i^{th} period interest rate.

$$(2)\ P_t = \sum_{i=1}^{\infty} \Theta_i E_t(X_{t+i} \mid w_t)$$

$$\Theta_i = 1/(1+r_i)^i < 1$$

If the expected dividend receipt is the same in each future period, $E_t(X_{t+i} \mid w_t) = E_t(X_{t+1} \mid w_t)$ for all i; and the yield curve is flat so that $r_t = r_i$ for all i, equation 2 can be rewritten in the following form.[3]

$$(3)\ P_t = E_t(X_{t+1} \mid w_t)/r_t\ .$$

Substituting (3) into (1) and collecting terms gives the solution that the expected price in period t+1 is the price in period t.

$$E_t(P_{t+1} \mid w_t) = P_t.$$

The observed price in t+1 can be expressed as the period t expectation of the price in t+1 (which, by the above argument, is equal to P_t) and a white noise error term, ϵ_{t+1}, as in equation 4.

$$(4)\ P_{t+1} = P_t + \epsilon_{t+1}$$

Equation 4 is consistent with the efficient markets solution for asset prices. It implies that prices follow a random walk.

[1]See Brealey and Meyers (1984), pp. 45–47, and Blanchard and Watson (1982), pp. 296–97.

[2]See Shiller (1981), Blanchard and Watson (1982), West (1986) and Mankiw, Romer and Shapiro (1985).

[3]The data are consistent with this assumption during the period analyzed in the shaded insert on page 21. For example, the average difference between the yield on high-grade corporate bonds and the call money rate was -30 basis points, which is not significantly different from zero (t-score = .74). Furthermore, the data are consistent with the assumption regarding expected dividends. It is not possible to reject the hypothesis that dividends per share followed a random walk. The first differences of dividends per share are a white noise process. The Box-Pierce statistics at lags 6, 12, 18 and 24 are 6.94, 12.33, 14.10 and 17.47. The dividend data are from Cowles (1938). The data are annual for the period 1871–1930.

The notion (expressed by Sen. King and others) that the Coolidge market was the product of a price bubble that eventually burst is approximated by a theory that allows share prices to deviate from the fundamentals price in period t by bubble, B_t, with probability π.[4] The average duration of the bubble is $1/(1-\pi)$ periods before it crashes. Given the assumptions regarding expected future dividends and the shape of the yield curve, a solution for the price that allows for bubbles, P'_t, is:

$$(5)\ P'_t = E_t(X_{t+1} \mid \phi_t)/r_t + B_t$$

$$B_t = \pi\Theta^{-1}B_{t-1} + U_t \text{ with probability } \pi$$

$$B_t = U_t \text{ with probability } 1-\pi$$

$$E_t(U_t \mid \phi_{t-1}) = 0.$$

Substituting (5) into (1) and collecting terms gives the solution that the expected price of a share next period is its price this period plus the appreciation in price due to the period t bubble.

$$(6)\ E_t(P'_{t+1} \mid \phi_t) = P'_{t+1} + r_tB_t$$

As long as the bubble lasts, the actual rate of return from holding the stock exceeds the market rate of discount, r. This compensates for the risk of a crash in the share price should the bubble burst.

The price in t+1 is the sum of the expected price and a white-noise error term.

$$(7)\ P'_{t+1} = E_t(P_{t+1} \mid \phi_t) + \epsilon_t = P'_t + r_tB_t + \epsilon_t$$

$$(8)\ E_t(P'_{t+1} - P'_t) = r_tB_t = r_t\pi\theta^{-1}B_{t-1} > 0$$

Notice that the expected change grows over time at rate r so the market price is expected to deviate further from the fundamentals price in each subsequent period for as long as the bubble lasts.

Furthermore, as shown below, the expected percentage change in the price is not constant.

$$(9)\ E_t[(P'_{t+1} - P'_t)/P'_t] = r_tB_t/P'_t$$

Substituting for P'_t from (5) and noting that the fundamentals price, $P^f_t = E_t(X_{t+1} \mid \phi_t)/r_t$, gives

$$(10)\ E_t[(P'_{t+1} - P'_t)/P'_t] = r_tB_t/(P^f_t + B_t) = r_t/(P^f_t/B_t - 1).$$

Since B_t grows at rate r, the percentage change in price is expected to rise over time.

In contrast to the efficient markets solution, bubbles imply that share prices do not exhibit random walk properties.

[4]See Blanchard and Watson (1982), pp. 297–98.