Business Review

Profits Out of Thin Air

1966 Looks Even Better

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Federal Reserve Bank of Philadelphia

Profits Out of Thin Air:

. . . Extracting elements from the atmosphere is a relatively new and rapidly growing industry with widening markets, some ordinary, some extraordinary.

1966 Looks Even Better:

. . . Recent changes in the business environment have caused forecasters of economic conditions to revise substantially their expectations for 1966.

BUSINESS REVIEW is produced in the Department of Research. Donald R. Hulmes prepared the layout and artwork. Evan B. Alderfer was primarily responsible for the article "Profits Out of Thin Air" and William F. Staats and Kathryn Kalmbach for "1966 Looks Even Better." The authors will be glad to receive comments on their articles.

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PROFITS OUT OF THIN AIR

Air, thought the early Greek philosophers, was a basic element along with earth, water, and fire. They were wrong on all four counts. The first person to succeed in taking air apart was Karl Scheele. In 1772, he isolated nitrogen and oxygen. Nitrogen he called "foul air" because it would support neither combustion nor respiration. Oxygen he called "fire air" because it supported both. Two years later, Joseph Priestly, who once lived in Northumberland, Pennsylvania, independently discovered oxygen and he has been given credit for the discovery because he was the first to announce it to the world.

Nitrogen constitutes seventy-eight per cent of the volume of the atmosphere and oxygen twenty-one per cent. The remaining one per cent, in successively smaller fractions, is made up of argon, carbon dioxide, neon, helium, krypton, xenon, hydrogen, methane, and nitrous oxide.

All of these elements and substances have their own peculiar physical characteristics or personalities, so to speak, which make them useful for different industrial purposes. They are, however, great homebodies and offer terrific resistance to separation from the parental air.

This difficulty is surmounted by giving air a cryogenic treatment, that is, subjecting air to extreme cold—the coldest cold you ever heard of —so cold that air becomes a liquid. Then the various elements can be separated by a process akin to refining petroleum.

Corporate practitioners of this occult art are concerns like Linde Company, a division of Union Carbide; Air Products and Chemicals; Air Reduction; Chemetron's National Cyclinder Gas; General Dynamic's Liquid Carbonic; Big Three; Standard of New Jersey's American Cryogenics; and others.

Together they constitute what might be called atmospheric adventurers but they go under the more prosaic title of the Industrial Gases Industry. As an industry, the Census reports for 1963 a total of 460 manufacturing establishments, 10,000 employees, about half of whom are classed as production workers, and $429 million worth of shipments of gases and liquids. High purity oxygen in that year accounted for about a third of the dollar value of these shipments, and when nitrogen, hydrogen, and argon are included, the four gases together made up half the total value of products shipped.

The industry is not very large but it is growing rapidly. Its index of production in 1963 was two and one-half times that of 1958. This year's sales of gases and liquids are expected to reach $725 million.

An industry founded upon cryogenics

The industrial gases industry operates in the cold, cold world of cryogenics—a strange word with Greek roots meaning "born icy-cold." Water, as everybody knows, changes to ice at 32°F., and boils at 212°F. Other substances, in like manner, have their boiling points and freezing points. Carbon dioxide, which we exhale, when cooled to —109°F. becomes "Dry Ice"—the coldest stuff with which most of us ever came in contact.

Oxygen, when cooled way down to —297°F., becomes a liquid. Nitrogen becomes a liquid at —320, hydrogen at —423, and helium at —452, which is perilously close to absolute zero, —460°F., which is total absence of heat.

Heat is not a substance, as once believed; it is molecules in motion. In the gaseous state of any material, the molecules are in violent agitation like a riot of students running amok. In the liquid state, the molecules are restless, like an unruly class of students kicking and punching each other, and in the solid state, the molecules resemble the class put to sleep by the professor's dry lecture. End of the lesson.

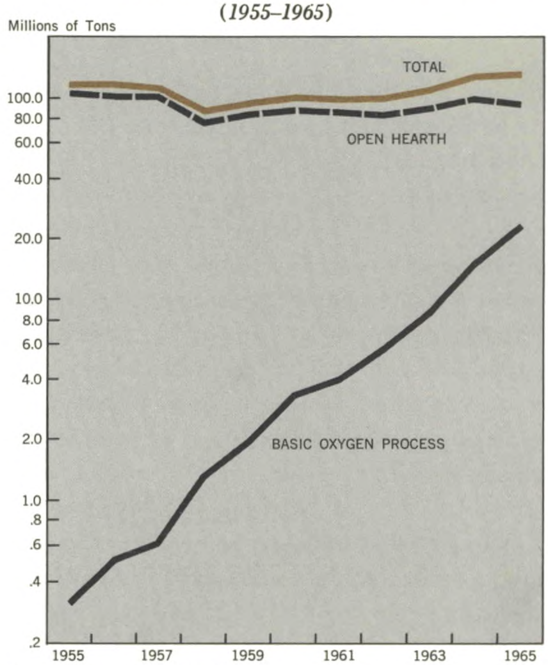
Extracting oxygen and other useful products from air is thus based upon the principle of low-temperature gas separation by liquefaction and distillation. A tour through an air separation plant affords no dramatic spectacles like those of a steel mill with its burning fires, flying sparks, and huge presses crunching great chunks of glowing metal. An air separation plant is an aggregation of refrigerating machinery, towers and tanks, valves, pipes and pumps, and varieties of instruments to tell what's going on. The raw material, air, is invisible and so are the goods in process as well as the finished products. Everything is internal. Power is a major cost in operating an air separation plant—the huge electric motors required to run the refrigeration machinery that reduces atmospheric gases to liquids eat up great gobs of kilowatts.

The markets

Oxygen has long done yeoman's service in the metal trades. Fires enriched with oxygen burn hotter, so metal fabricators use oxy-acetylene for cutting and welding. A goggled worker playing a bright blue flame at the point of the weld on a steel rail has long been a familiar scene.

Revolutionary developments in the art of steel production opened a big new market for oxygen. Prior to World War II, European steel manufacturers improved the quality, and reduced the cost of steel with the new Basic Oxygen Furnace. In the B.O.F., hot metal and scrap are charged into the furnace and by blowing a stream of oxygen into the furnace from the top with the aid of a water-cooled lance, the charge is converted into steel in a matter of minutes instead of hours as in the open-hearth process.

CHART 1
STEEL PRODUCTION IN THE UNITED STATES
(1955–1965)



Source: Iron and Steel Institute.

In the 1950's steel mills in this country began installing basic oxygen furnaces and the new process is now challenging the old workhorse open-hearth furnaces. From 1955 through 1965, basic oxygen steel production rose from less than one-half million tons to almost 23 millions while open-hearth production declined from 105 million tons to 94 million tons, and the B.O.F. seems destined to supersede open-hearth as shown in Chart 1. Oxygen is also used by the steel industry for smelting pig iron in the blast furnaces, in the electric and Bessemer steel making furnaces, and in preparing scrap iron and steel for remelting.

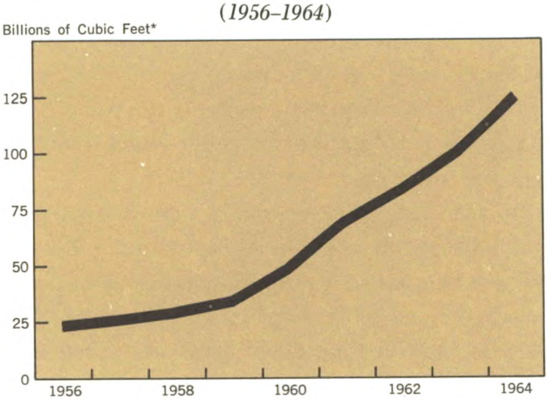
The effect of the new technology on the demand for oxygen is portrayed in Chart 2 which shows the steel industry's consumption of oxygen rising from about 25 billion cubic feet to almost 125 billion in the short span of eight years.

Moreover, the chemical industry is using oxygen in ever-growing volume and is now consuming almost as much oxygen as the steel industry. About three-fourths of the oxygen used in the chemical industry today is consumed by the producers of acetylene, methanol, and ammonia. Much of the remainder is consumed by the manufacturers of such chemicals as acetaldehyde, ethylene oxide, and hydrogen cyanide. Technically, the industrial gases industry itself is a branch of the chemical industry. The sale of products by one branch of the chemical industry to another is quite common; chemical manufacturers have long engaged in the practice of taking in each other's wash.

CHART 2

CONSUMPTION OF OXYGEN BY THE IRON AND STEEL INDUSTRY

(*1956–1964*)



Source: Iron and Steel Institute.

"Over the fence" sales

Oxygen and other major products of air separation—nitrogen, hydrogen, and argon—are delivered to customers by pipeline, in bulk liquid form (cryogenic fluid), in bulk gas form (tube trailers), and in cylinders (compressed gas). The choice depends upon the amount to be shipped and the distance.

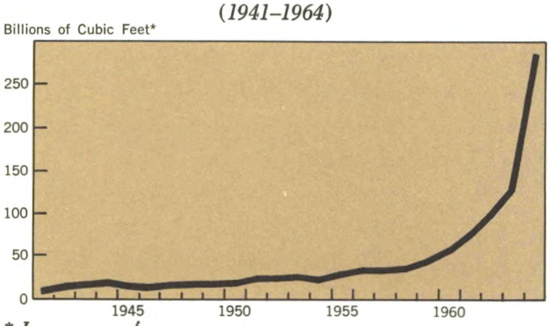
For the sale and continuous shipment of oxygen in large volume, producers have evolved what has been called "over the fence" selling. Under this arrangement, the producer of oxygen builds an air separation plant just off, or sometimes on, the premises of the consumer steel mill so that only short distance piping is required. Ownership of the plant is retained by the supplier but usually there is a "purchase of gas" agreement extending over a period of fifteen years.

Such a contractual arrangement is mutually satisfactory to both parties. The buyer is assured of a continuous supply without the expenditure of a large investment in facilities with which he is none too familiar and the seller is assured of a high operating rate extending over a period of years. The seller also provides an experienced work force to operate the plant, which in some instances is built with sufficient capacity to sell "merchant gas" to other consumers nearby. "Over the fence" selling is also growing in favor with oxygen customers in the chemical industry.

The economies of "over the fence" selling explain in part the widespread geographical dispersion of air separation plants. Air separation plants are operating in all major industrial areas of the country, which leaves comparatively few states without any. However, there is a rather heavy representation of plants, as might be expected, in the New York to Chicago axis where steel, metal, and chemical manufacturing pro-

CHART 3
UNITED STATES OXYGEN PRODUCTION—HIGH PURITY

(1941–1964)



* *In gaseous form.*
Source: United States Department of Commerce.

liferate. Note Chart 3 showing the skyrocketing of oxygen production in recent years.

Nitrogen

Nitrogen, though the most abundant of atmospheric gases, nevertheless ranks below oxygen in the amount produced cryogenically. Nitrogen can be produced more economically by other processes, but for a high-purity product consumers patronize the air separators.

An inert gas, pure nitrogen has many useful applications. It is used as a protective blanket in the manufacture of certain chemicals as ammonia, acetylene, and petrochemicals; in oil field operations to stimulate the flow of oil and gas; in the steel industry for bright annealing of stainless steel; in the food industry for the freezing and preservation of perishable foods; in animal husbandry to preserve bull semen for artificial insemination; in space exploration for flushing, precooling, and testing of rockets; and in space simulation. Production of high-purity nitrogen in 1963 came to 50 billion cubic feet.

Argon

By inserting a few extra plates in the air separation column, it is easy to extract argon which has a boiling point just slightly below that of oxygen. All traces of oxygen are then removed from the argon by burning it with hydrogen over a catalyst. Argon serves as a highly inert shield in welding metals. It is also used in electronics and in processing titanium ore to titanium metal. Production of argon, a rare gas, is measured in millions rather than billions of cubic feet. Output in 1963 was 970 million.

Cryogenic sidelines

Companies engaged in air separation usually make and sell things other than air products to enlarge the stream of income. They sell arc welding materials and accessories like electrodes, welding rods, cutting torches. Moreover, they also make for sale major mechanisms, such as low temperature liquid handling and storage systems, high vacuum pumping devices, and cryobiology refrigerators—almost anything having to do with machinery for generating torrid heat or frigid cold.

As knowledgeable experts in both extremes of outlandish temperatures, air separation concerns sell portable air separation plants for the manufacture of tonnage oxygen which suggests that they might be putting themselves out of business. But not so. They have the know-how to stay well ahead of their customers; in fact, supplying engineering services is another source of revenue.

On the fringe of absolute zero

Hydrogen and helium, as previously mentioned, are cryogenic low-lifes—they refuse to become liquid until chilled down to the very suburbs of absolute zero. Another characteristic they have in common is their scarcity in the atmosphere. It takes a mountain of air to get a mite of either hydrogen or helium. Hence, air separation plants produce neither in commercial quantities.

Hydrogen is easily obtained from natural gas and because of its lightness, hydrogen was formerly used to inflate balloons and other lighter-than-air craft. This use, however, was shortlived because of the fire hazard. Hydrogen is highly flammable and after the tragedy of the Hindenburg zeppelin, hydrogen lost favor as a lifting gas for airships.

The flammable characteristic of hydrogen, however, is turned to other uses where energy is required. The first hydrogen bomb depended upon liquid hydrogen for its operation and today hydrogen in liquid form is also used as a rocket fuel. To change hydrogen gas into a liquid, however, requires low temperature processing and that is where cryogenics comes in. Thus cryogenic technology is the basis for both super cold and super heat to produce super power.

Helium, second only to hydrogen in lightness, was discovered in the sun before it was found on the earth. It is obtained from helium-bearing natural gas which contains from one to about eight per cent helium. By a cryogenic process utilizing very low temperature and very high pressure, all the other constituent gases are squeezed and teased out of natural gas until nothing but helium is left.

The largest known helium-bearing natural gas field is found in an area extending from southwest Kansas through Oklahoma into Texas. Formerly marketed as a source of heat energy, this helium-rich natural gas, too valuable to burn, is now being processed by five Government-owned and five privately owned plants for various purposes, some ordinary, some extraordinary.

For its inert quality, helium affords a protective atmosphere in welding. For its light weight, it subs for air to inflate airplane tires. And liquid helium, which does such queer things like flowing uphill, is put to practical use in missiles and rocketry, and in atomic energy installations. The 330 million cubic feet of helium produced in 1958 was considered phenomenal; production in 1963 was over two billion.

Cryogenics unlimited

The industrial gas industry is one of the fastest growing branches of the chemical industry. One reason is its newness, its comparative youth. Another reason is its membership in the chemical industry where almost everything seems to be closely related to something else either by analysis—breaking down, as in air separation—or by synthesis—building up, as in the manufacture of plastics. For example, when ammonia synthesis gas is produced by the partial oxidation method, it is only natural to build or acquire an air separation plant which provides both the oxygen for synthesis gas manufacture and the nitrogen for ammonia manufacture.

Cryogenic technology has ever-widening applications, and in some of the most unexpected places. In addition to the numerous practical uses already mentioned, deep-down-cold is already finding application in biology to preserve blood and live tissue, in cryosurgery in the hope of relieving Parkinson's disease through bloodless brain surgery, on shipboard for freezing freshly caught fish and smelting of undersea minerals; and in electronics where intense cold works such magic in circuitry that future computers may be shrunk down to the size of a bread box. And the restoration of hamsters that had been frozen stiff raises hopes that future astronauts could survive interstellar journeys taking thousands of years. Meanwhile, earthbound uses of air products continue to grow.

Although profits are extracted from thin air, it is not to be inferred that earnings come easily. An air separation plant requires a substantial outlay of capital, obsolescence is high because of rapidly changing technology, and expanding capacity has already brought about keen competition which is reflected in declining price trends of air products. Hence, the industry's emphasis upon research and development to open up new markets.

1966 LOOKS EVEN BETTER

The semi-scientific art of forecasting business conditions is practiced by a number of bold economists in business, government and the academic community. Their work is eagerly awaited and examined by decision-makers in the economy. Although the economists make no claim of infallibility (and the record supports this), the opinions of the authoritative forecasters are respected.

Therefore, the Department of Research of the Federal Reserve Bank of Philadelphia annually compiles data on business forecasts made by a key group of economists. These forecasts are made during the last quarter—principally in December—of each year, and the Bank summary appears in January. This year rapidly changing business developments along with release of the federal budget, increased commitments in Vietnam and publication of GNP data for the final quarter of 1965, have resulted in extensive revisions of economic forecasts for 1966. Because of the recent sharp changes in expectations, it was decided to make a special survey of some of the economists to determine how much they had revised their earlier predictions. Results of the late-January survey were startling. The changes in expectations are presented in this report and summarized in Table 1.

TABLE 1
1966 ECONOMIC FORECASTS

	Estimates for 1966	
	Early*	January**
G.N.P. (billions of $)	713***	725***
Personal consumption (billions of $)	454	457
Investment (billions of $)	109	112
Inventories (billions of $)	5.5	6.4
Plant & equipment expenditures (billions of $)	57	59
Net exports (billions of $)	6.8	6.9
Government (billions of $)	146	148
Steel production (millions of tons)	121	130
Auto sales (millions of units)	9.0	9.2
Corp. profits before taxes (billions of $)	77	79
Unemployment rate (per cent)	4.3	3.9
Wholesale price index (1957–59 = 100)	104.0	105.8
Private nonfarm housing starts (millions of units)	1.50	1.49
Industrial production index (1957–59 = 100)	148	152

* Median of estimates compiled from published forecasts made during the last quarter of 1965.
** Median of estimates from special survey made in January, 1966.
*** Items do not add to total because not all respondents provided forecasts for each item.

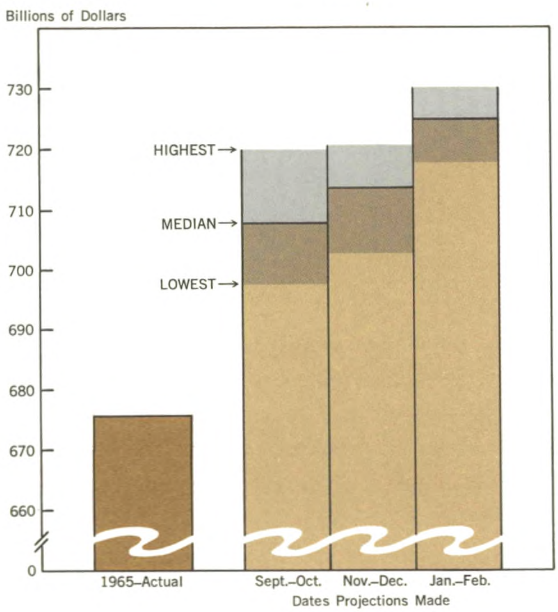
Gross National Product

Chart 1 shows the pronounced upward trend of estimates of Gross National Product during the past few months. It is evident that quite sharp revisions have been made since December. The median of early estimates of 1966 GNP was $713 billion; but the median of the recent forecasts was $725 billion—some $49 billion more than 1965 GNP. What accounts for the upward revision of GNP?

CHART 1

GROSS NATIONAL PRODUCT

Projections for 1966



Investment

Economic textbooks tell us that gross private domestic investment—spending on inventories, plant and equipment, and housing—is the most volatile component of GNP. Perhaps this is the trigger which can be counted on to propel GNP to higher levels.

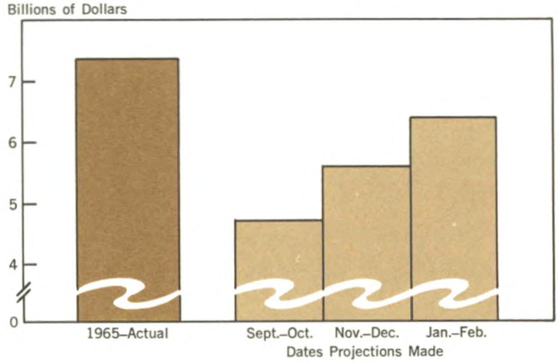
Forecasters predicted a sharp rise in business investment which accounts for one quarter of the estimated increase in GNP. Investment of $112 billion was expected in late January compared to earlier predictions of $109 billion. This 2.7 per cent upward revision of the median forecast indicates that economists got a good whiff of expansion and inventory accumulation plans of business firms. If total investment of $112 billion materializes, it would represent an increase of nearly 10 per cent over the 1965 figure.

Chart 2 shows that additions to inventories

CHART 2

CHANGE IN INVENTORIES

Median Projections for 1966



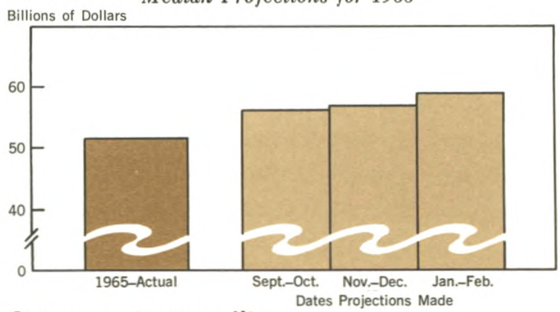
were expected to account for $6.4 billion of business investment—up over 16 per cent from the median of earlier forecasts.

The median estimate of plant and equipment expenditures was raised in January to $59 billion from $57 billion in earlier forecasts. The latest estimate for 1966 represents a vigorous 14 per cent increase over last year's figure of $51.8 billion as shown in Chart 3.

CHART 3

PLANT AND EQUIPMENT

Median Projections for 1966

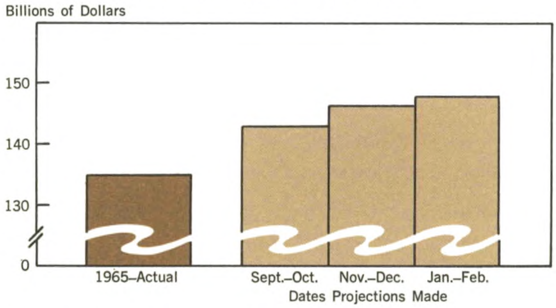


Government expenditures

A second component—government expenditures, which account for roughly one-fifth of GNP—has considerable impact in determining the expansion or contraction of total business activity. Our survey indicated that business analysts expected government spending to provide even more stimulation to the economy than they anticipated in December, largely because of the continuing escalation of military operations in Vietnam. Total government spending (Federal and state and local governments) of $148 billion was anticipated. This compares with December estimates of $146 billion and actual 1965 spending of $135 billion (see Chart 4).

CHART 4
GOVERNMENT PURCHASES OF GOODS AND SERVICES

Median Projections for 1966



Consumer expenditures

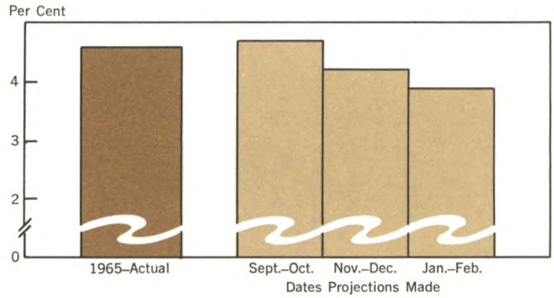
Expanded expenditures by business firms and governmental entities means that consumer incomes are increased. And consumers with bulging pockets can be counted on to satisfy some of their desires by pumping most of their income back through the economy. The more after-tax income people receive, the more they tend to spend and the higher GNP is likely to go.

Estimates for personal consumption for 1966 were raised from $454 billion in December to $457 billion at the end of January. This estimate is up significantly from $428 billion actual consumption last year.

As indicated in Chart 5, forecasters also expected the unemployment rate to average 3.9 per cent of the work force—the lowest in a decade. Reduced unemployment is not entirely a result of improved business conditions because the increasing manpower requirements of the military have absorbed some of the unemployed. Many of the draftees and enlistees would otherwise be among the marginally employed or unemployed.

CHART 5
UNEMPLOYMENT RATE

Median Projections for 1966

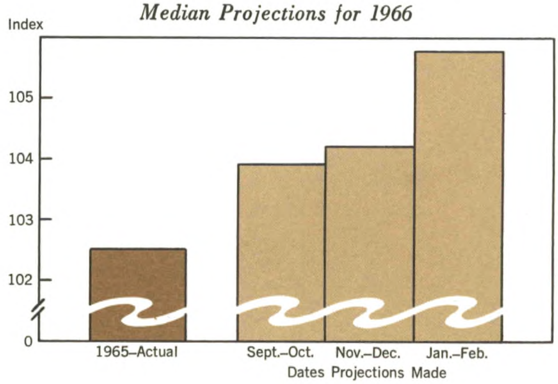


Other economic indicators

The January forecasts of 1966 steel production soared to 130 million tons from the 121 million ton estimate made in December. Similarly, forecasters recently have become more optimistic about new automobile sales which in January were estimated at 9.2 million units, including imports, for 1966.

CHART 6
WHOLESALE PRICE INDEX

Median Projections for 1966



Most of the data presented so far are expressed in current dollars. Therefore, the projected increases in GNP and other series would reflect price changes along with increases in the physical volume of goods produced. Consequently, we are interested in the forecasts of price changes so that we can isolate the "real" increases in the various data. Our January survey of forecasters indicated a growing concern over inflationary pressures. The median projected 1966 wholesale price index was raised to 105.8—up from the 104 predicted earlier and from the 102.5 average for 1965 (see Chart 6).

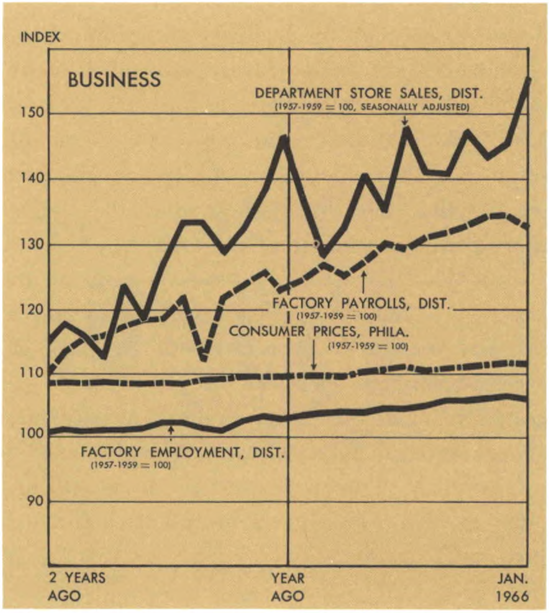
The Federal Reserve index of industrial production—a measure of output volume—was expected to reach 152. This figure is substantially higher than the 143 attained in 1965.

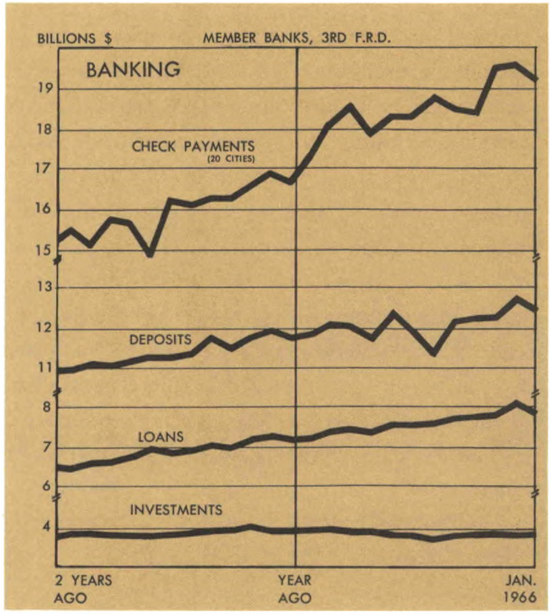
Summary

Recent changes in the business and political environment have made forecasters much more optimistic than they were toward the end of 1965. Expectations regarding 1966 economic conditions have changed markedly over the past few months. One wonders how much they might change over the course of the year.

How good have these forecasters been in the past? It is interesting that actual performance in every year in the current business expansion, except 1962, has exceeded the forecasters' expectations. Economists have almost consistently under-estimated in times such as the present. But we can judge the accuracy of these forecasts only after all of the 1966 cards are on the table and 1967 rolls around.

FOR THE RECORD...





SUMMARY

	Third Federal Reserve District		United States	
	Per cent change Jan. 1966 from		Per cent change Jan. 1966 from	
	mo. ago	year ago	mo. ago	year ago
MANUFACTURING				
Production	....	....	+ 1	+19
Electric power consumed	0	+12	....	....
Man-hours, total*	− 1	+ 6	....	....
Employment, total	0	+ 3	....	....
Wage income*	− 1	+ 8	....	....
CONSTRUCTION**	−24	+18	− 9	+ 8
COAL PRODUCTION	0	− 4	+ 1	+10
TRADE***				
Department store sales	+ 7	+ 6	....	....
BANKING (All member banks)				
Deposits	− 2	+ 6	− 2	+ 9
Loans	− 2	+10	− 2	+14
Investments	+ 1	− 1	0	+ 2
U.S. Govt. securities	+ 2	− 8	+ 1	− 5
Other	0	+10	− 1	+12
Check payments	− 2†	+15†	0	+13
PRICES				
Wholesale	....	....	0	+ 4
Consumer	0‡	+ 2‡	0	+ 2

*Production workers only
**Value of contracts
***Adjusted for seasonal variation

†20 Cities
‡Philadelphia

LOCAL CHANGES

	Factory* Employment		Factory* Payrolls		Department Store Sales†		Check Payments	
	Per cent change Jan. 1966 from		Per cent change Jan. 1966 from		Per cent change Jan. 1966 from		Per cent change Jan. 1966 from	
	mo. ago	year ago	mo. ago	year ago	mo. ago	year ago	mo. ago	year ago
Lehigh Valley	0	+ 3	0	+ 4	....	....	− 3	+13
Harrisburg	0	+ 3	0	+ 7	....	....	−10	+ 5
Lancaster	+ 1	+ 7	+ 2	+14	+ 3	+ 6	− 4	+10
Philadelphia	0	+ 4	− 1	+11	+ 7	+ 8	− 2	+15
Reading	− 4	+ 2	− 4	+ 6	+ 8	0	− 2	+17
Scranton	− 1	+ 4	− 4	+10	+ 8	+14	− 2	+10
Trenton	0	+ 1	+ 1	+ 5	+12	+14	− 2	+ 5
Wilkes-Barre	0	+ 2	− 1	+ 8	+ 2	+ 5	− 6	+11
Wilmington	− 1	+ 1	− 5	+ 1	− 2	− 4	+ 1	+26
York	− 1	+ 6	− 3	+10	+ 3	+ 3	−12	+18

*Not restricted to corporate limits of cities but covers areas of one or more counties.
†Adjusted for seasonal variation.