

Southwest Economy

The Euro Cash Changeover

At midnight on Dec. 31, 2001, for the first time in history, a currency that had not been debased through inflation had its legal tender status revoked. From its introduction in 1948, the German mark was one of the world's strongest currencies and was viewed as one of the great achievements of the postwar Bonn Republic. Its replacement by the euro signifies a major milestone in European integration. On Jan. 27, the mark was joined by the Dutch guilder, and on Feb. 9 the Irish punt disappeared into history. The French franc became a thing of the past on Feb. 17, and at midnight on Feb. 28 all of the legacy currencies of the 12-nation euro area ceased to be legal tender. The euro is now the only legal tender in most of Western Europe.

The introduction of euro banknotes and coins, which began on Jan. 1 of this year, was a great success. The predictions of long lines at retail outlets and railway stations were not borne out, and the European public has embraced the new currency with an enthusiasm that surprised even its most ardent supporters. There were glitches, but they were few. The cash changeover, far from marking the beginning of the end of economic and monetary union (EMU) as some had expected, simply marks the end of the beginning.

(Continued on page 2)



The Economic Impact of Biotechnology

It's as daunting a task today to divine how biotechnology will affect future economic activity as it might have been for economists in the 18th, 19th and 20th centuries to forecast how the steam engine, electricity and the microchip would influence and eventually transform the world economy. With the assistance of mind-boggling inventions, humankind's bucolic existence has morphed into a world that our agrarian ancestors would scarcely recognize. Biotechnology may change our world as much.¹

Even though the bioscience industry has been around for 25 years and the gargantuan task of mapping the human genome is complete, it's still not clear to what extent life science technology will affect our economy. Some observers have already labeled this the "Biological Century," betting that advances in the life sciences will yield changes more momentous than those of electricity and computers. Such predictions may be overinflated, but bio-

(Continued on page 6)

INSIDE:

*New Economy,
New Recession?*

*Venezuela Addresses
Economic Stress*

In 1950, when French Foreign Minister Robert Schuman proposed the first steps toward greater integration between Germany and France, he noted that

“Europe will not be made all at once, or according to a single plan. It will be built through concrete achievements which first create a *de facto* solidarity.”

These achievements were modest at first: sharing of sovereignty over coal and steel (the raw materials of industrial-age warfare) and later the creation of a common market. Over the years the integrationists’ ambitions have grown, and so have their achievements: the creation of a single market for goods, labor and capital; the transformation of the European Economic Community into the European Union (EU) of today; expansion from six to 15 members; and now the completion of economic and monetary union. In fewer than five years we may see the EU expand to 25 members, and before the end of the decade the euro may well be the only currency used in all of Europe and may even have made tentative steps into Asia. The completion *par excellence* and one that fundamentally alters the character of the European Union.

The Scale of the Task

The euro has been around for slightly more than three years. During that time, it has not had a physical form, existing only as a unit of account, while the notes and coins of the legacy currencies continued to circulate as the medium of exchange. A three-year transition between the launch of EMU and the introduction of the notes and coins, though not specified in the Maastricht Treaty governing monetary union, was deemed necessary in part to allow sufficient time for production of the new currency. Approximately 15 billion euro banknotes (with a face value of about €635 billion) had to be produced to replace the legacy currencies’ banknotes. Likewise, some 50 billion euro coins (with a face value of about €15.75 billion) had to be minted to be ready for the Jan. 1 launch date.

Once production was nearly complete, there remained the formidable logistical challenge of distributing the

notes and coins to financial institutions and other businesses across the euro area to facilitate a smooth transition. In addition, the payments infrastructure (the 200,000 ATMs, the 3.5 million-plus vending machines and so on) had to be recalibrated to dispense and accept the new currency.

As large as these tasks were, they probably didn’t require three years. Production of the euro banknotes began in 1999 and peaked at more than one billion notes per month in summer and fall of 2001. Coin production began even earlier, in mid-1998. A more important reason for the three-year transition was to allow businesses and consumers time to familiarize themselves with the new currency before being forced to use it in all transactions.

Characteristics of the Notes and Coins

The denominational structure of the euro follows a standard 1-2-5 (or binary-decimal) pattern, with denominations of 1 cent, 2 cent and 5 cent, 10 cent, 20 cent and 50 cent, and so on up to 500 euro. The highest denomination coin is the €2 coin, and the lowest denomination note is the €5 note. Notice that the definitional denomination, €1, is a coin. The coins all have a common European side, and the reverse side features national designs. Unlike the banknotes, which are issued by the European Central Bank (ECB) via

the national central banks, the euro coins are issued by the national treasuries of the participating countries, subject to the ECB’s approval. Coins issued by national governments will be legal tender throughout the euro area.

In contrast, euro banknotes don’t have any distinguishing national features, apart from a letter code at the beginning of the serial number to denote where the note was printed. The front features windows and gateways from different architectural styles (symbolizing openness), while the reverse side features bridges (signifying cooperation). (See the box titled “The Euro Banknotes.”)

The general public’s uptake of the euro notes and coins proceeded somewhat quicker than expected. Banknotes had been distributed (or “frontloaded”) to financial institutions throughout the euro area as early as last September, and financial institutions in turn distributed (or “sub-frontloaded”) banknotes and coins to the retail sector and other cash businesses in the last months of 2001. Starter kits of euro coins were distributed to the general public in mid-December, and at midnight on Dec. 31, ATMs across the euro area started disbursing euro banknotes.

Of the 200,000 or so ATMs in the euro area, more than 80 percent had been converted to issue euro on Jan. 1; by Jan. 3, the proportion was 97 percent (*Chart 1*). About half the coin-operated

Chart 1

Uptake of the Euro

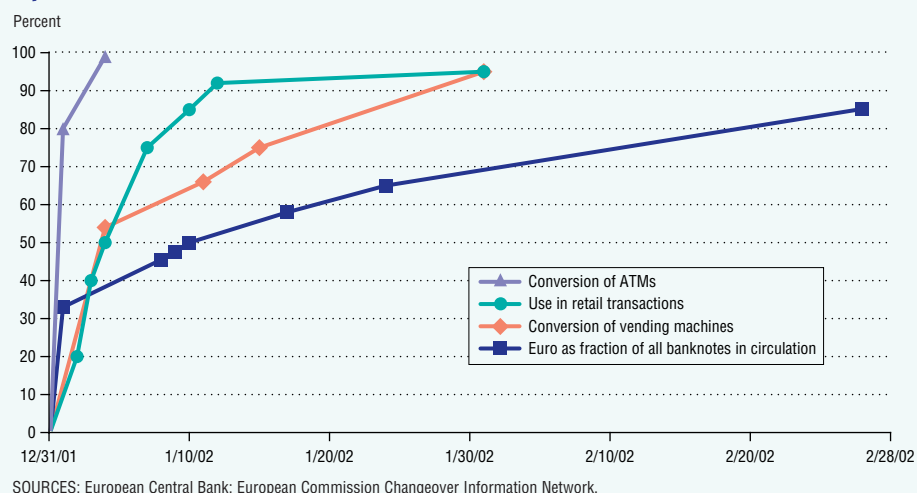


Table 1

Key Dates in the Withdrawal of Legacy Currencies

	End of legal tender	Exchange at banks after end of legal tender	Redemption at central bank after end of legal tender
Austria	Feb. 28, 2002	To be decided individually by banks after Feb. 28, 2002	Indefinitely
Belgium	Feb. 28, 2002	Dec. 31, 2002	Notes: Indefinitely Coins: End of 2004
Finland	Feb. 28, 2002	To be decided individually by banks	Feb. 29, 2012
France	Feb. 17, 2002	June 30, 2002	Notes: Feb. 17, 2012 Coins: Feb. 17, 2005
Germany	Dec. 31, 2001	At least until Feb. 28, 2002	Indefinitely
Greece	Feb. 28, 2002	Positive (to be decided individually by banks)	Notes: March 1, 2012 Coins: March 1, 2004
Ireland	Feb. 9, 2002	For a period not yet specified	Indefinitely
Italy	Feb. 28, 2002	Banks to decide in February 2002	March 1, 2012
Luxembourg	Feb. 28, 2002	June 30, 2002	Notes: Indefinitely Coins: End of 2004
Netherlands	Jan. 27, 2002	Dec. 31, 2002	Notes: Jan. 1, 2032 Coins: Jan. 1, 2007
Portugal	Feb. 28, 2002	June 30, 2002	Notes: Dec. 30, 2022 Coins: Dec. 30, 2002
Spain	Feb. 28, 2002	June 30, 2002	Indefinitely

vending machines in the euro area had been converted to accept euro on Jan. 4, and by the end of January the proportion was close to 95 percent. The euro was being used in more than half of all retail transactions after only three business days and exceeded the 90 percent mark by Jan. 12. The euro replacement ratio, which is the ratio of euro banknotes in circulation to the total of euro and national banknotes in circulation, hit 50 percent on Jan. 10 and was 65 percent on Jan. 25. By the end of February, national banknotes made up less than 15 percent of the stock of notes in circulation. Some may never be exchanged for euro because they have been lost or destroyed or will be kept as souvenirs or collector's items.

Although all of the legacy currencies ceased to be legal tender at the end of February, the currencies can still be

redeemed for euro at commercial and national central banks. However, only four countries (Austria, Germany, Ireland and Spain) will redeem national coins and banknotes indefinitely. Belgium and Luxembourg will redeem old banknotes indefinitely but will stop redeeming coins at the end of 2004. The Netherlands will redeem notes until 2032 but will cease redeeming coins in 2007. The other countries have set various cutoff dates for redemption of notes, with the soonest being 10 years from now. Table 1 gives the complete details.

Was the Cash Changeover Inflationary?

A common fear among European consumers was that businesses would take advantage of the cash changeover to raise prices surreptitiously. And the most recent data on inflation in the euro area suggest

there may be something to this. Euro area inflation in January was 2.7 percent, up from 2 percent in December.

Usually when a new currency is introduced, the conversion rate makes the new currency some convenient decimal multiple of the old currency. The last time such a reform was undertaken in Europe was in France in 1960, when the old franc was replaced by the new "heavy" franc at a rate of 1 new franc to 100 old francs. When the introduction of a new currency simply entails dropping a few zeros, shoppers can easily compare prices in the old and new currencies.

However, the irrevocable exchange rates between the euro and most of the legacy national currencies are far from being simple multiples. One euro is equal to 1.95583 German marks, 6.55957 French francs, 0.787564 Irish punts and so on (*Table 2*); hence consumers' fear that retailers would round prices up. There is anecdotal evidence that the price of a pint of Guinness in Dublin is now €3.15, instead of the €3.11 it should be if converted at the fixed exchange rate. However, the cost of a one-way subway ticket from the Frankfurt airport to downtown Frankfurt is now €3.10, instead of the €3.12 it would have cost if the old fare were converted at the fixed exchange rate.

Standard economic theory tells us that this kind of currency reform should not lead to any significant change in the price level, up or down. For every example of a price rounded up, there is sure to be a

Table 2

The Irrevocable Exchange Rates

1 euro =	13.7603 Austrian schilling
	40.3399 Belgian franc
	2.20371 Dutch guilder
	5.94573 Finnish markka
	6.55957 French franc
	1.95583 German mark
	340.750 Greek drachma
	0.787564 Irish punt
	1,936.27 Italian lira
	40.3399 Luxembourg franc
	200.482 Portuguese escudo
	166.386 Spanish peseta

The Euro Banknotes



€5 note
Size: 120 x 62 mm (4.75 x 2.4 in.)
Architectural period: Classical

€10 note
Size: 127 x 67 mm (5 x 2.6 in.)
Architectural period: Romanesque



€20 note
Size: 133 x 72 mm (5.2 x 2.8 in.)
Architectural period: Gothic

€50 note
Size: 140 x 77 mm (5.5 x 3 in.)
Architectural period: Renaissance



€100 note
Size: 147 x 82 mm (5.8 x 3.2 in.)
Architectural period: Baroque and rococo

€200 note
Size: 153 x 82 mm (6 x 3.2 in.)
Architectural period: 19th century iron and glass



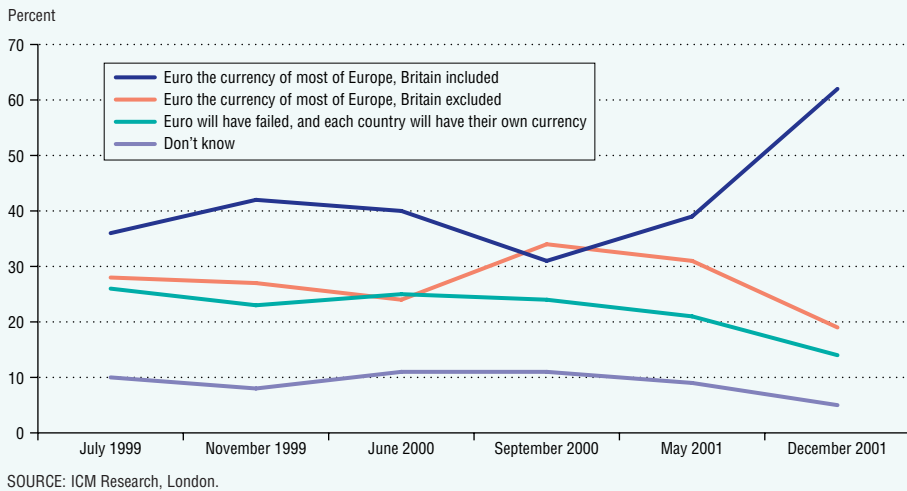
€500 note
Size: 160 x 82 mm (6.3 x 3.2 in.)
Architectural period: 20th century modern

SOURCE: European Central Bank.

Chart 2

UK Voters' Assessment of the Euro's Prospects Over the Next 10 Years

Question: Leaving aside how you would vote, in 10 years' time which of the following is most likely?



less well-publicized example of a price rounded down. The January increase in inflation is in line with what would have been expected on the basis of existing seasonal patterns, recent price behavior and an increase in fuel costs in January. Furthermore, inflation in the United Kingdom (UK), which does not participate in the euro, accelerated by a comparable amount, from 0.9 percent in December to 1.6 percent in January. Inflation in Sweden, another nonparticipant, increased from 1.6 percent to 2.9 percent.

And Now?

Going forward, the completion of the cash changeover raises many important questions. One of the biggest is: How soon will the countries that are currently members of the EU but not members of EMU (the so-called pre-ins) adopt the single currency? Of the 15 current EU members, only three—the UK, Sweden and Denmark—do not participate in the single currency. Of the three, the UK is in many ways the most important, from both a European and U.S. perspective.

The single currency has been a divisive issue in British politics for more than a decade. Hostility to EMU on the part of the UK and Denmark was significant enough that both negotiated

opt-out clauses to the treaty governing monetary union. However, many members of the UK's current Labor government, including Prime Minister Tony Blair, are enthusiastic about taking the UK into EMU, possibly soon. Europhiles are hoping the process of "euro creep" will lower resistance to the single currency and generate consent through familiarity. Many leading UK retailers have announced that they will accept euro, and some components of the payments infrastructure (vending machines, for example) will be calibrated to take euro. Furthermore, many large multinational businesses operating in the UK are requiring that their suppliers invoice them in euro.

And there is some evidence the electorate is slowly acknowledging that the UK will probably be a member of the euro area eventually. Last December nearly two-thirds of British voters polled agreed with the statement that the euro was likely to be the currency of most of Europe, Britain included, within the next 10 years (*Chart 2*). Opinion polls taken since the cash changeover confirm that public sentiment is becoming less hostile.

Concluding Observations

There is an apocryphal story that when the initial negotiations for the European Economic Community were taking

place, the British delegate made the confident assertion, "Gentlemen, you are trying to negotiate something you will never be able to negotiate. But if negotiated, it will not be ratified. And if ratified, it will not work." At a session on the euro at the American Economic Association's recent meetings, a senior ECB official took some delight in reminding his audience of this remark and of the similar sentiments expressed by many North Americans that EMU would never get off the ground.

The successful introduction of the euro notes and coins completes the transition to economic and monetary union. The fact that the euro now has a physical form will make it more real to the average citizen and may begin to foster the European identity that was among the goals of the currency's architects. With the euro now the only coin of the realm in most of the EU, monetary union will be just that much more difficult to reverse, not that there is any provision for exit in the governing treaty. The success of the cash changeover may prompt the pre-ins to join EMU sooner rather than later.

—Mark A. Wynne

Wynne is an assistant vice president and senior economist in the Research Department of the Federal Reserve Bank of Dallas.

The Economic Impact of Biotechnology

(Continued from front page)

technology has the potential to greatly affect the economy.

Two types of economic effects are already appearing in the nascent industry. By analogy, they resemble the *direct* splash of a stone tossed into a still pond and the *indirect* rippling that follows. Direct impacts from biotechnology include such obvious pluses as research and development (R&D) spending, sophisticated jobs and tax revenues. Biotech companies have already sprouted up in many parts of the country (*Chart 1*). Less visible are the indirect effects, which include improvements in quality of life and living standards stemming from faster labor productivity growth, better health products and services, and a cleaner environment.

Landmark discoveries and novel inventions have marked biotechnology's early history. These advances, propelled by public funding and market incentives, have increased interest and sustained research activity. The current marketplace is characterized by intense competition but also by cooperation among public and private stakeholders. However the industry and supporting science play out, the advent of biotechnology could profoundly affect our lives.

What Transforms Market Economies?

Historically, the combination of groundbreaking discoveries and subsequent commercialization has preceded periods of prolonged economic expansion. For example, the Industrial Revolution in Great Britain was launched by a confluence of new technologies with commercial potential, such as the steam engine. Later, the internal combustion engine and electric power revolutionized America. More recently, William Shockley's transistor and Jack Kilby's microchip laid the foundation for the Information Age. All these eras of discovery and applied research were followed by strong economic growth.

Benchmark discoveries and innovations such as steam power, electricity and the microchip always garner the most attention. But it's usually not until the technology is harnessed and products are mass produced that we see economic consequences.

Similarly for biotechnology, completion of the human genome map—while transcendent in scientific importance—will remain of little use commercially until the information can be used to

combat human disease. Scientists are making significant headway, but as recently as 2001, one report said the genome sequencing has not yet “materially affect[ed] the speed of development of any given product.”² All this is not to understate the gains in biotechnology in recent years but to point out that it will take time before products are conceived and economies materially affected.

The Splash (Direct Impact)

Karl Ereky, a Hungarian engineer, first coined the word biotechnology in 1919. At the time, the term referred to all lines of work involved in creating products from raw materials with the aid of living organisms. Today, the Biotechnology Industry Organization (BIO) defines biotechnology as “the use of cellular and molecular processes to solve problems or make products.”

In May 2000, BIO commissioned Ernst & Young to determine the aggregate impact firms involved in biotechnology have on the U.S. economy. The study looked at information from firms whose primary business operations fell under five Standard Industrial Classification codes. While some components of biotech activity are not included in this definition, the report gives an idea of the direct impact biotechnology is having on the economy.³

The study reveals impressive growth for the industry. The life science industry

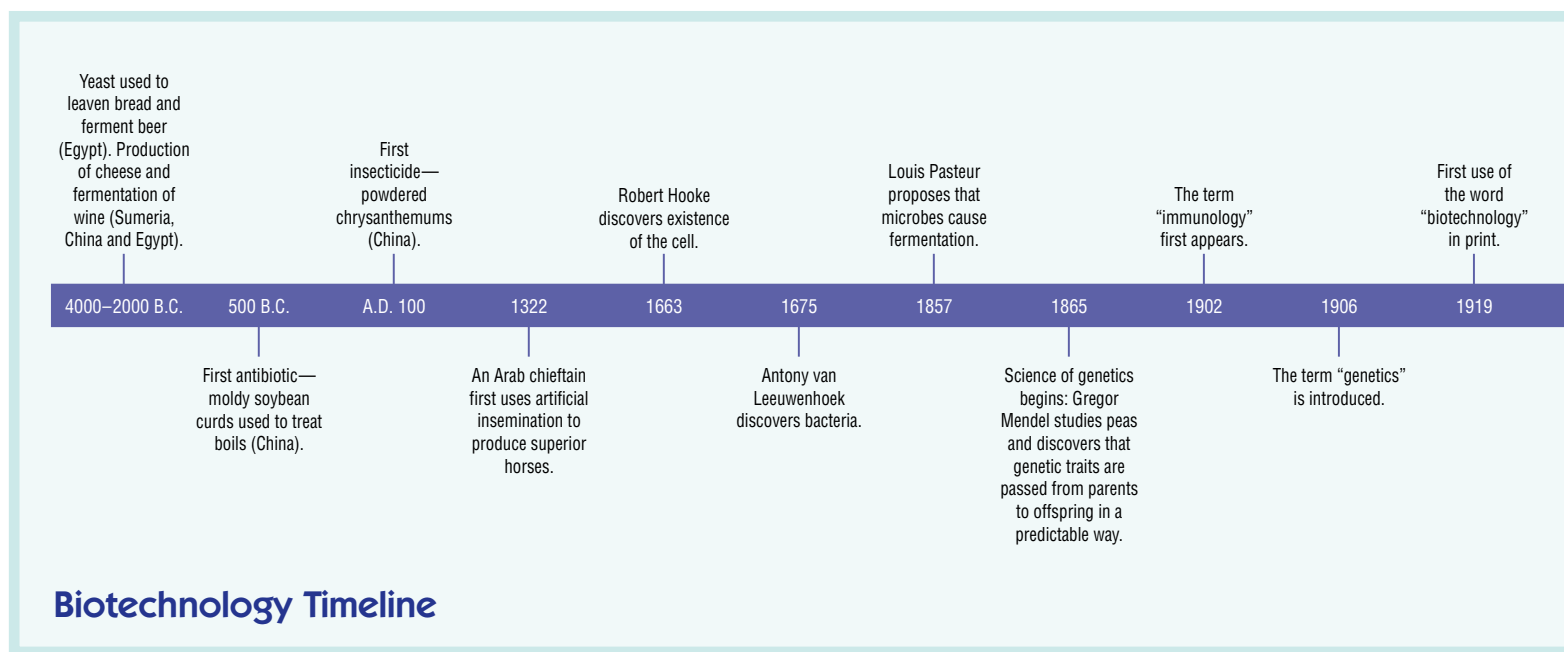
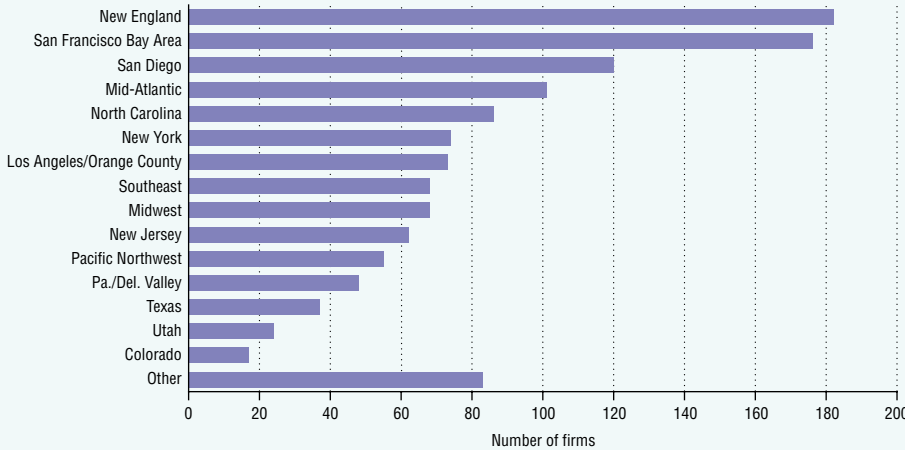


Chart 1

Private and Public Biotech Companies by Region



SOURCE: Ernst & Young, *Biotechnology Industry Report: Convergence, 2000*.

more than doubled revenue from \$8 billion in 1993 to \$20.2 billion in 1999. R&D spending was \$11 billion in 1999, not counting monies spent by colleges, universities and nonprofits. Total tax collections reached nearly \$10 billion. Federal taxes accounted for \$6.8 billion of the total and state and local taxes for the remainder.

Completion of the human genome and promises of new medicines sent biotech share prices skyward in 1999 and 2000. Since then, sparse profits and the realization that investment returns to

biotechnology are going to take some time have kept overall stock prices subdued (*Chart 2*). Profitability in the four largest biotech firms has instilled recent confidence in the sector, but the majority of firms have yet to show a profit.

Biotech activity should continue to expand. Overall health care and prescription drug expenditures have increased steadily in recent years. For example, health care expenditures as a percentage of GDP have grown from 8.8 percent in 1980 to 13 percent in 2000. Prescription drug expenditures have been climbing

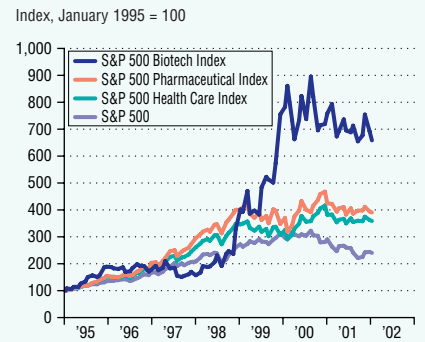
steadily since 1994 (*Chart 3*). The aging of baby boomers will only augment such trends. Recognizing the growth potential in the industry, 41 states, including Texas, New Mexico and Louisiana, are currently pursuing economic initiatives to foster growth in their emerging biotechnology sectors. (See the box titled “BioTexas.”)

The Ripples (Indirect Impact)

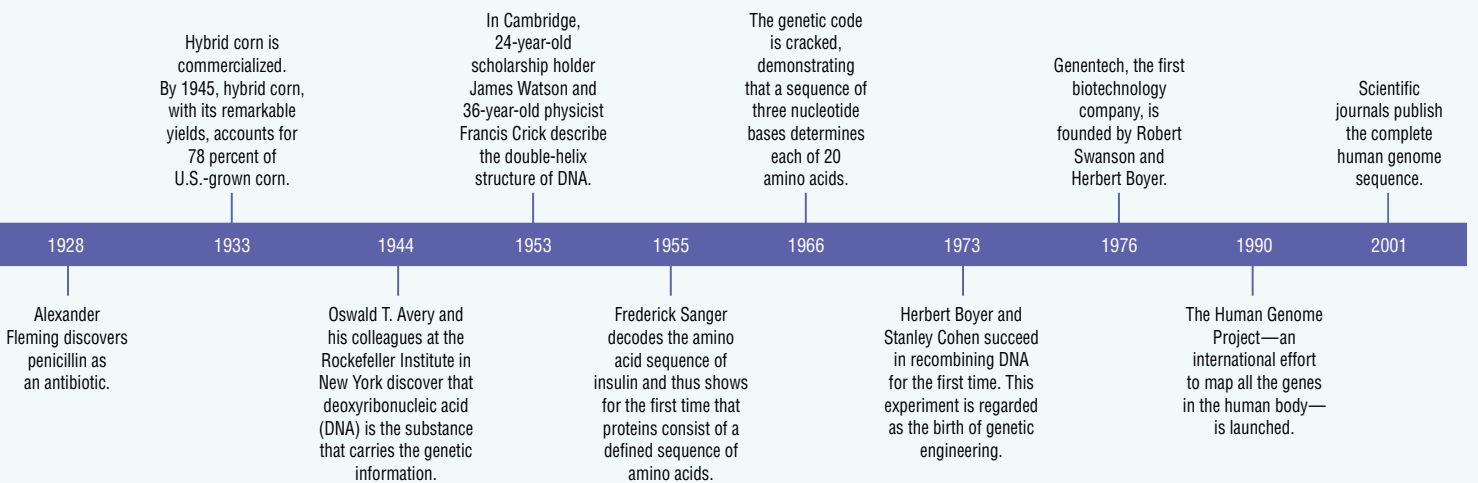
Still a relative newcomer to the economy, biotechnology is already having a positive indirect influence on economic activity. Ernst & Young estimates that biotechnology has an employment multiplier of 2.9. In other words, each job

Chart 2

Health Care Indexes, 1995–2002



SOURCE: Bloomberg.



SOURCES: Biotechnology Industry Organization; Schering AG, Germany; Genentech Inc.

BioTexas

The Texas life science industry is still in a fledgling stage. In recent years, the industry has garnered considerable interest among investors, politicians, consultants and community developers but remained relatively small. The Texas Healthcare and Bioscience Institute (THBI) reported that the Texas life science industry employed 50,650 people in 1999, only 0.5 percent of statewide employment. Life science jobs in the state have continued to grow, however, increasing at an annualized rate of 1.4 percent between 1997 and 1999.¹

Dallas, Houston, Austin and San Antonio are the life science strongholds, making up two-thirds of the total industry employment. Even though it is small, the industry is already having a positive effect on local economies. Compensation for those working in the industry is relatively high; life science employees earn an average of \$48,623, considerably higher than the state average of \$34,936.

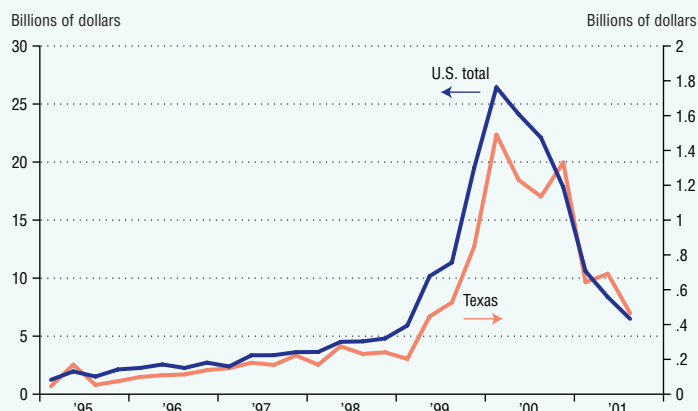
Growth in the life science industry is unequivocally tied to the rate of intellectual property generation and commercialization. Life science intellectual property in Texas is growing quickly but still lags the powerhouses of California, New York, Massachusetts, New Jersey and Pennsylvania. THBI reports that life science patents issued to Texas residents increased 54 percent from 1997 to 1999, reaching a record 577 in 1999. Novel intellectual property will continue to increase as individuals are trained in the life sciences. State institutions of higher learning awarded 17,894 life science degrees in 1997.

Grants, endowments and investments enable researchers to discover new life science technologies and bring them to market. Texas ranked third nationwide in 1999 in university dollars earmarked for life science research and development. In all, just over \$1 billion was spent, an 18.1 percent increase over 1995. Most of the funding went to Baylor College of Medicine, Texas A&M University and University of Texas Southwestern Medical Center at Dallas.²

Texas researchers are beginning to bring biotechnology-related ideas to market. According to THBI, income from Texas intellectual property increased from \$4.2 million to \$25.6 million between 1993 and 1999. Although still small, it represents more than a 500 percent increase. Such returns reinforce the incentive to produce biotech research that can be commercialized.

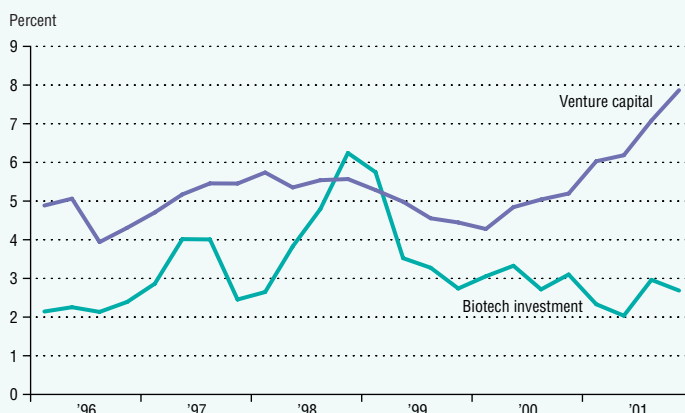
The state government is committing vast resources to the Texas biotechnology cause. The 2001 Legislature appropriated \$800 million for science, engineering, research and commercialization activities. Various research parks that include facilities for life science companies will benefit from the Legislature's commitment. These facilities include BioHouston, the Texas Research Park in San Antonio, the Woodlands Research Forest and the Harrington Regional Medical Center in Amarillo.

Chart B1
Texas Venture Capital Financing Moves with Overall U.S. Venture Investment



SOURCES: PriceWaterhouseCoopers MoneyTree/Venture One surveys through 2001:3; authors' calculations.

Chart B2
Texas Share of Total U.S. Venture Capital Investment Rises, While Biotech Investment Share Remains Low



NOTES: Four-quarter moving averages. Biotech includes biopharmaceuticals, medical devices and medical information systems.

SOURCES: PriceWaterhouseCoopers MoneyTree/Venture One surveys through 2001:3; authors' calculations.

Within the biotech sector and across all industries, the pace of venture capital investment in Texas is dominated by national fluctuations related to changing conditions in U.S. financial markets. Last year, venture capital investment in Texas fell sharply, in line with the national decline (*Chart B1*), much of which paralleled the fall in the Nasdaq stock index.³

Abstracting from these general movements, Texas' share of U.S. biotech venture investment has varied within a low range of 2 to 3 percent in recent years, even though Texas' share of overall venture capital investment has risen to about 7 percent, roughly the state's share of the U.S. population. This disparity, depicted in *Chart B2*, reflects that venture capital investment in other high-tech industries and in non-health care services in Texas has outstripped growth elsewhere in the United States, while Texas' venture investments in health care and biotech have lagged the national pace.⁴

These differences likely stem from factors affecting the state's regional comparative advantage across industries. Nevertheless, like the vast majority of states, Texas' shares of U.S. venture capital investment across industries is also held down by the disproportionately high concentration of venture investment in California (44 percent of the U.S. total in 2001:4) and, to a lesser extent, in New England and New York.

Texas life science firms could flourish if three key challenges are surmounted. First, strong local scientific and academic norms must permit the rapid translation of academic results into competitive enterprises. Second, researchers and stakeholders need good access to capital. And third, favorable royalty schemes between the researcher and universities must protect incentive structures for scientists wishing to take their intelligence to market.

Notes

¹ THBI 2001 Index, Texas Healthcare and Bioscience Institute, 2001.

² State Government Initiatives in Biotechnology 2001, September 2001. Report prepared for the Biotechnology Industry Organization by the Technology Partnership Practice, Battelle Memorial Institute and State Science and Technology Institute.

³ For details on venture capital, see, "The Venture Capital Revolution," by Paul Gompers and Josh Lerner, in *State Government Initiatives in Biotechnology 2001*, pp. 145-68, and "How Does the Stock Market Affect the Economy?" by John V. Duca, in Federal Reserve Bank of Dallas *Southwest Economy*, September/October 2001.

⁴ The charts use data from the PriceWaterhouseCoopers Money Tree/Venture One survey through 2001:3. This survey, which was revamped in 2001:4, is now called the PriceWaterhouseCoopers/Venture Economics/National Venture Capital Association MoneyTree Survey.

created in biotech generates an additional 2.9 jobs, resulting from biotech firms' purchases and consumer spending of biotech employees. With the multiplier effect, biotech's total impact on employment comes in at more than 437,000 jobs.

Ernst & Young gives biotech a 2.3 revenue multiplier, increasing the total impact on revenues from biotechnology to \$46.5 billion. The personal income multiplier is estimated to be 2, which results in a \$28.8 billion total impact on personal income from the industry.

Biotechnology's contributions to medicine and health care are growing rapidly, promising to increase human longevity and healthiness. To the extent that biotechnology results in new treatments for old ailments, people will become more productive over their lifetimes.

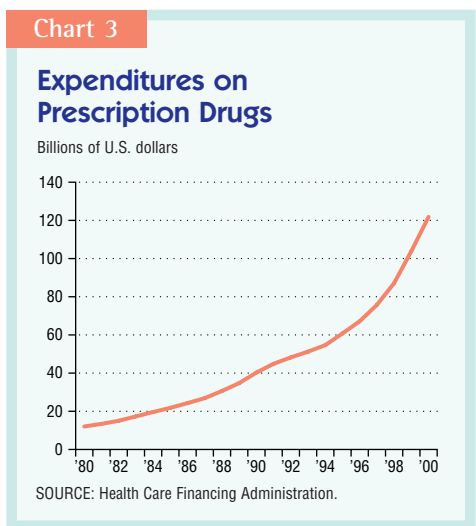
In addition, improved strains in agricultural crops have helped increase yields for many years. Research and development of more-productive and disease-resistant crops have enabled output per farmer to increase steadily. Improvements in quality of life will continue as scientists further harness biological processes to clean up hazardous waste and contaminated areas. Environmental remediation is growing fast as a result of increased public demand for a cleaner, safer and more natural living space.

Structure of the Bioscience Industry: Form Follows Function

The structure of the bioscience industry is in flux. Advances in biotech science have led to an evolution of the industrial structure: from the domination of large-scale firms to the entry of many small, innovative start-ups to alliances between the large and small for a more efficient way of doing business.

Stanley Cohen and Herbert Boyer's transfer of DNA from one organism to another in 1973 was a major milestone in biotech, leading to an explosion of new research and production mechanisms and a change in the industry's organization. This advance in genetic science propelled the industry along two different paths, according to Henderson, Orsenigo and Pisano (1999).

One path employed genetic science as a process technology, that is, using the methods of Cohen and Boyer to mass produce proteins as therapeutic agents.



Genetic engineering required competency in the new techniques and a different type of R&D effort by firms. Before genetic engineering, a small number of proteins could be manufactured either from natural sources or by organic chemical methods. Genetic engineering made it possible to produce large quantities of proteins, opening a completely new area for drug research. Henderson, Orsenigo and Pisano argue that this process technology was the force behind the first large-scale entry into the biotech industry since the early post-World War II period. Zucker, Darby and Brewer (1998) also note that the number of firms using biotechnology "grew from nonexistent to over 700 in less than two decades, transforming the nature of the pharmaceutical industry."

The second path employed biotechnology techniques as a research tool for discovering and manufacturing conventional, "small molecule" drugs.⁴ This trend reinforced the dominance of the large pharmaceutical firms, which were able to leverage their competency in chemical R&D processes to build off the knowledge already codified in the academic literature.

The academic research done in universities in the 1970s and 1980s spawned many small, innovation-rich start-up companies, beginning with Genentech, formed by Boyer and Robert Swanson in 1976. The 1990s brought much merger activity as large biotech companies purchased innovative start-ups.⁵ Often, the mergers occurred because the target R&D firms,

while rich in talent, were poor in capital and resources to commercialize products. These start-ups needed the distribution and production processes of larger firms to take their products to market. Conversely, larger firms needed new ideas but often found it more economical to acquire brain-rich start-ups than to expend scarce resources for cutting-edge in-house research. Moreover, by buying an established firm, a larger firm was able to mitigate the uncertainty inherent in R&D efforts.

Public and Private Collaboration

Much basic biotech research has been publicly funded and conducted at universities because the research is a public good and has positive spillovers. (See the box titled "Biotech: A Public Good?") The National Institutes of Health (NIH) funds the majority of biotech research in the United States. The NIH budget in 2001 was \$20.5 billion, or roughly twice the size of private spending on biotech R&D in 1999 (the most current year for which we have data). About 82 percent of the NIH budget is for grants and contracts that support research and training in universities. Another 10 percent goes toward in-house research. Henderson, Orsenigo and Pisano report that NIH spending on basic research has had a significant effect on the productivity of the large firms that received funds.

Studies suggest that the public-good

SCIENCE & CENTS

Exploring the Economics of Biotechnology

Join economists, venture capitalists and scientists at a conference to explore the economic impact of biotechnology, including:

- The promise of productivity gains
- Patents, property rights and other legal issues
- New technology in the 21st century
- Venture capital and public funding
- Where biotech firms locate and why

April 19, 2002 • 8 a.m. to 4 p.m.
Federal Reserve Bank of Dallas

For more information, go to www.dallasfed.org and click on "Events."

Biotech: A Public Good?

Public funding through government agencies and universities has been a major factor in the history of biotech research. Such funding is an efficient way to advance biotech research, which, like all basic research, has certain public-good characteristics and positive spillover effects.

Public goods are those in which consumption is nonrival and nonexcludable or where exclusion is very costly. For example, the outcome of a biotech experiment can be considered a public good. When the experiment's outcome is published, it becomes hard to exclude people from seeing the results (nonexcludability). And, an individual knowing the results (consuming the good) does not compete with another's ability to consume (nonrival in consumption). In fact, the additional cost of another person knowing the results is nil.¹

The nonexcludability characteristic also gives rise to what is called a free-rider problem. Consumers of the good have no incentive to pay when they know they can get the good for free. Because of the non-excludable nature of biotech "goods," firms have no economic motivation to advance the research. For this reason, most public goods (such as basic research, national defense and so forth) are paid through taxes.

Moreover, if a good has positive spillover effects, benefits accrue to people other than those paying for the good. Private production of the good then would be less than optimal because it would not take account of the spillover benefits accruing to consumers who did not specifically buy and pay for the good.

Possibly recognizing the public-good qualities of basic biotech research, the Morrill Acts of 1862 and 1890 were passed in response to the growing demand for agricultural and technical education. The beneficiaries of the Morrill Acts were institutions designated as land-grant universities, the first publicly supported venues for biotech research. The acts provided these institutions with federal land grants and monies. A key component of the system was the Agricultural Experiment Stations, which promoted agricultural research.

The majority of public funds for biomedical research now flows through the National Institutes of Health (NIH). NIH first emerged in 1887 as the Laboratory of Hygiene in Stapleton, N.Y. This one-room lab was initially set up to find cures for infectious diseases such as cholera, typhoid fever and smallpox. In 1930 the lab was expanded, reorganized and renamed the National Institute of Health. In 1948, the lab widened its scope, and four institutes were created to support research on cardiovascular disease, mental illness, infectious diseases, and experimental biology and medicine. These days, the goal of NIH is to acquire new knowledge to help prevent, detect, diagnose and treat diseases and disability.

Because there is quite a bit of learning by doing in biotech research, Zucker, Darby and Armstrong (2001) argue, some biotech innovations are excludable. The excludability arises from the complexity or tacitness of the information necessary to practice the innovation. This information is held by a small number of star scientists and hence does not disseminate as quickly. However, the authors do suggest that publicly funded research greatly benefits the biotech industry. Public funding of biotech research can be justified insofar as it continues to display public-good qualities.

Note

¹ This is in contrast to a private good, such as food, where one person's consumption leaves less for others and it is relatively cheap to prevent others from consuming it.

aspects of biotech research make it costly to work through the market and that mergers and acquisitions are one way of internalizing these costs. Gaisford et al. (2001) posit that restructuring activity can be motivated by institutional failure or weak patent protection and incomplete contracts. Disputes between biotech companies over the control of patent and contractual rights to key technologies have landed many of them in court. Vertical integration solves some of these contractual problems and helps firms protect the returns on their innovations.

Mergers and acquisitions also allow companies to take better advantage of their relative strengths. Life science firms generally have different comparative advantages in producing knowledge, whether it be codified (designs, formulas,

patents), tacit (learning-by-doing) or distributed (only valuable if used in conjunction with others). Because transferring knowledge between independent firms through the market is difficult, firms vertically integrate to make such transfers more efficient.⁶

In addition to corporate restructuring has been the rise of strategic alliances among firms. Such partnering allows two or more firms to combine forces without bearing the cost of merging or coordinating a joint venture. Alliances have been important for biotech innovation because established firms find it difficult to keep abreast of all the industry's technological advances, according to Filson and Morales (2001). Their study shows that firms in a strategic alliance purchase some of their R&D partner's equity, thus gaining

shareholder influence to better monitor the R&D firm and to allay some of the investment's uncertainty. Some recent examples are collaborations between Nanogen and Hitachi; Affymetrix and Perlegen; OSI Pharmaceuticals, Genentech and Roche; Bayer and CuraGen; and Abbott Laboratories and Millennium Pharmaceuticals.⁷

Zucker, Darby and Armstrong (2001) show that basic university science is integral to the successful commercialization of scientific discoveries. Star scientists provide the intellectual capital that defines the firm's core technology and largely determines the company's success. The researchers also show that collaboration between academic and corporate scientists has a significant effect on a wide range of firm performance measures. For example, for an average firm, Zucker, Darby and Armstrong (1998) find that five articles coauthored by academic stars and the firm's scientists imply about five more products in development, 3.5 products on the market and 860 more employees.

According to Zucker, Darby and Brewer (1998), the location of top scientists also predicts where new technology firms will locate. The bioscience industry's growth and location from 1975 to 1990 was dependent on the growth and location of intellectual capital. Intellectual capital flourished around the great universities (the authors cite 20), but the existence of outstanding scientists played a role over and above the presence of universities and government research funding. Local venture capital also was important to the industry's growth.

The evolution of the bioscience industry provides insights into how states, all now vying for a piece of the biotech pie, can focus their efforts. The recipe for success seems to start with strong academic institutions and laboratories with a good research base. These institutions will provide the groundbreaking research and draw top scientists to the region. Another ingredient is an institutional structure that will aid technology transfer or commercialization of innovations arising from the research and that will foster start-up companies. In the long run, firms will go where the research and start-ups are percolating.

(Continued on back page)

New Economy, New Recession?

The National Bureau of Economic Research (NBER) confirmed in November 2001 what many had long suspected—that the U.S. economy was in recession and had been since March 2001. Thus ended an economic expansion that had begun in March 1991, the longest in the NBER chronology that dates to the mid-1800s. During this expansion, many economists and policy analysts talked about a “New Economy” characterized by a higher sustained level of productivity growth brought on by new networking and information-sharing technologies.

What does the New Economy’s new recession look like? This article examines the 2001 recession by comparing it with previous recessions and investigating whether an added degree of resilience and flexibility is evident in the economy. The downturn appears to have been relatively mild and to have been tempered by the productive use of information technologies. Paradoxically, the information technology sector itself was hit exceptionally hard.

What Is a Recession?

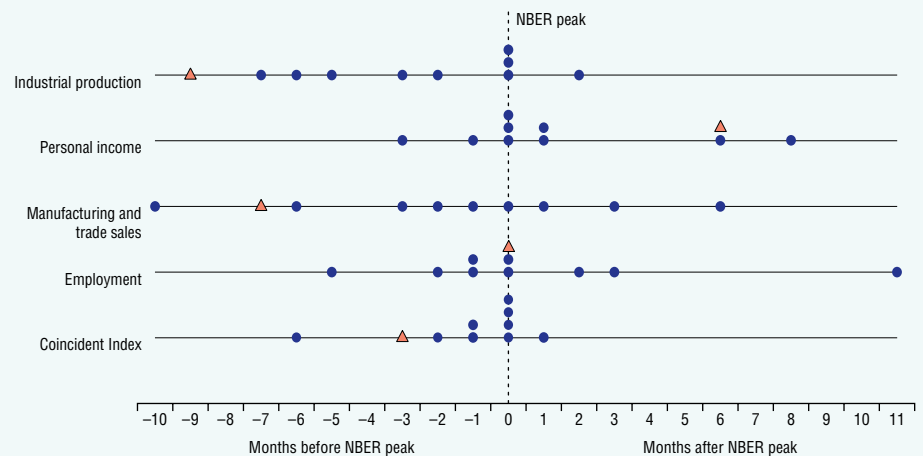
The NBER’s Business Cycle Dating Committee is the official arbiter of the dates that mark the onset of expansions and contractions in U.S. economic activity—business-cycle troughs and peaks. The NBER does not employ the media’s rule of thumb that a recession occurs when gross domestic product (GDP) falls for at least two consecutive quarters. Rather it defines a recession as “a significant decline in activity spread across the economy, lasting more than a few months, visible in industrial production, employment, real income and wholesale-retail sales.” This definition makes it clear that the depth, breadth and duration of a downturn are key to determining whether it will be classified as a recession.

Anatomy of a Recession

Chart 1 shows the timing of the cyclical peaks in the NBER’s four coincident indicators and the Conference

Chart 1

“Coincident” Indicators Don’t Always Move Together



SOURCES: Victor Zarnowitz (2002), “The Coincident Indicators in the Current Slowdown and Recession,” *Business Cycle Indicators*, The Conference Board, vol. 7, no. 1 (January), pp. 3–4; authors’ calculations.

Board’s composite Coincident Index (which is an average of the NBER indicators) relative to the official business-cycle peaks designated by the NBER. A dot to the left of 0 means the indicator peaked before the NBER peak, and a dot to the right of 0 means the indicator peaked after the NBER peak. Each triangle distinguishes the indicator’s most recent cyclical peak. The data cover the period from 1948 through 2001.

The chart illustrates that peaks in

particular indicators often don’t correspond well with the NBER’s business-cycle peak, with discrepancies as large as 11 months. The Coincident Index matches the NBER peaks most closely but not perfectly. Clearly, the dating of business-cycle peaks involves a good deal of judgment, and there is room for reasonable people to disagree.

Because the indicators peak and trough at different times, Table 1 examines the length and depth of the de-

Table 1

Length and Depth of Declines in the NBER Indicators and Coincident Index

	Length of decline (months)			Depth of decline (percent)		
	Most recent recession	Past recessions Mean	Past recessions Range	Most recent recession	Past recessions Mean	Past recessions Range
Industrial production	18	13	6–17	7.1	9.5	4.6–14.9
Personal income	1	8	2–17	.8	2.5	1.0–5.7
Manufacturing and trade sales	13	14	5–23	4.1	8.0	5.1–12.9
Employment	10	12	4–20	1.1	2.9	1.4–5.2
Coincident Index	11	11	6–16	1.0	3.2	2.0–5.9

SOURCES: Federal Reserve Board; Bureau of Labor Statistics; Bureau of Economic Analysis; The Conference Board.

The evidence suggests that the most recent recession was unusually mild.

clines in each indicator relative to its own cyclical peak. For instance, industrial production fell by 7.1 percent from its most recent cyclical peak. Its 18-month contraction was the longest in the post-World War II period. Yet, the decline was smaller than the average 9.5 percent drop and, indeed, was one of the shallowest on record. For the other series, the table shows their declines were shorter in duration than average, and in each case the slide was less than *all* of the previous decreases.

In summary, the evidence suggests that the most recent recession was unusually mild. As we shall see, this result is consistent with a broader trend toward smaller fluctuations in output growth in recent years.

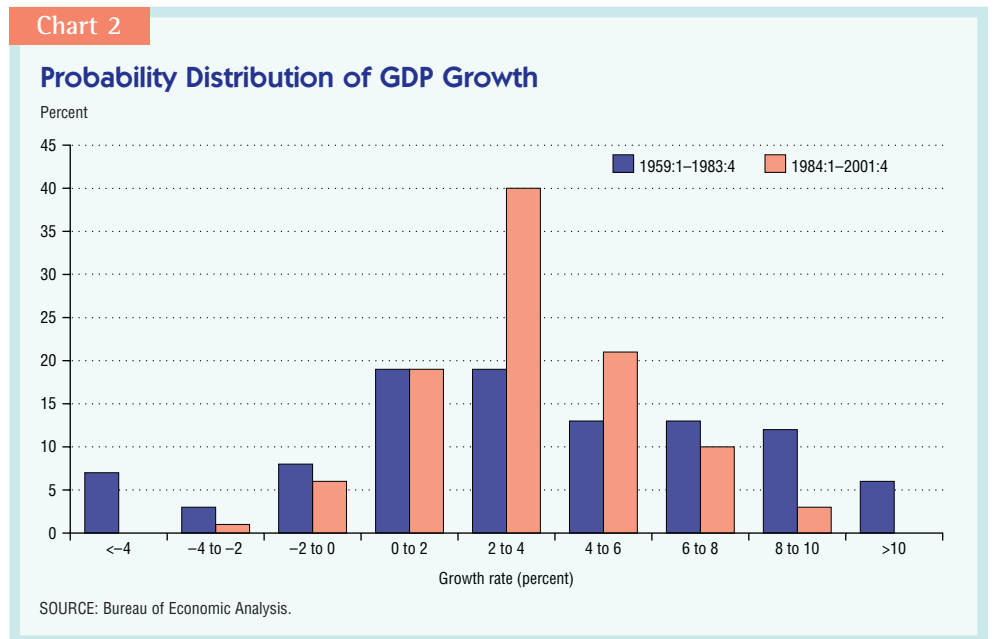
A More Stable Economy

Chart 2 shows the distribution of quarterly GDP (annualized) growth over two different periods: 1959–1983 and 1984–2001. The mean GDP growth rate differs little between the periods—it is 3.6 percent during the early period and 3.2 percent during the latter period—but the standard deviation of growth falls almost in half, from 4.5 percentage points to 2.3 percentage points.¹ In particular, extreme movements in output—growth rates below –4 percent and above +10 percent—are much less likely today than 20 or 30 years ago. Obviously, declines

in GDP are also less likely than before. GDP declined in 18 percent of the quarters prior to 1984 but in only 7 percent of the quarters since then.

Understanding why output growth has become more stable will help us understand why recessions have become less frequent and less severe. We start by identifying the components of GDP responsible for the economy’s greater stability. Besides yielding clues to underlying economic causes of the economy’s improved performance, this exercise will help us determine in what respects the most recent economic slowdown has been unusual.

The impact of volatility in a particular sector on GDP volatility depends on two factors. It depends, first, on how large the sector is relative to the economy as a whole. Variation in the demand for cars is more important for GDP volatility than is variation in the demand for rubber bathtub stoppers. Second, the impact depends on the correlation between that sector’s (size-weighted) growth rate and growth in GDP. A sector that is strong when the rest of the economy is weak (whose growth is negatively correlated with GDP growth) tends to smooth out fluctuations in the aggregate economy. The more variable the growth is in this sector, the better. On the other hand, volatility within a sector whose growth is *positively* correlated with growth in the rest of the economy is destabilizing.



More generally, a sector's contribution to GDP growth variability equals the variability in that sector's size-weighted growth rate multiplied by the correlation coefficient between sector growth and GDP growth.²

Columns 1 and 2 in Table 2 show different sectors' contributions to the variability of GDP growth during the pre-1984 and post-1983 periods, respectively. Columns 3 and 4 compare these contributions across time periods. For example, consumption growth—because of reduced volatility and lower correlation with GDP growth—has subtracted 0.82 percentage points from the standard deviation of GDP growth, which is 37 percent of the total decline in GDP growth volatility. Similarly, the investment sector accounts for 1.47 percentage points, or 67 percent, of the decline in GDP growth variability. Growth in government purchases has had little net effect on GDP growth volatility. Net exports' size-weighted growth rate has become both less variable and less strongly correlated with GDP growth, which is destabilizing since net exports tend to move opposite to GDP. So, net exports have actually *added* 0.11 percentage points to the variability of GDP growth. Globalization has not—so far at least—helped insulate U.S. production from swings in domestic demand.

Sources of Stability

Three spending categories stand out as major contributors to the economy's greater stability since 1984: inventory investment, consumer durables and residential investment. Together, these three sectors account for 83 percent of the total reduction in GDP growth variability, with 41 percent coming from inventory investment alone. Having isolated these three components of GDP that appear most responsible for the economy's greater stability, we now put forward some (admittedly speculative) ideas about the underlying causes. As we discuss below, it appears that financial deregulation and tighter inventory control contributed a great deal to the economy's increased stability. However, other explanations that are not mutually exclusive are possible as well, such as better monetary policy and smaller food and energy supply shocks.³

Table 2

Why Is the Economy More Stable?

Contributions to GDP growth variability before and after 1984

Sector	Contribution to variability of GDP growth		Change in variability contribution	Percent of fall in GDP growth variability accounted for
	1959:1–1983:4	1984:1–2001:4		
Consumption	1.51	.68	-.82	37
Durables	.83	.29	-.54	25
Nondurables	.41	.23	-.18	8
Services	.26	.16	-.10	5
Investment	3.02	1.55	-1.47	67
Nonresidential fixed	.70	.49	-.21	10
Residential	.58	.21	-.37	17
Inventory	1.74	.85	-.89	41
Government	.22	.19	-.03	1
Net exports	-.27	-.16	.11	-5
Total	4.47	2.28	-2.21	100
(standard deviation of GDP growth, percentage points)				

NOTE: Numbers may not total due to rounding.

Residential Construction. The contribution of residential investment to the economy's increased stability arises almost entirely from its reduced variability rather than from any change in its correlation with GDP growth. This reduced variability likely results from the elimination of bank deposit interest-rate ceilings (which helps stabilize the supply of funds available for home loans), from the increased availability of variable-rate mortgages (which makes housing more affordable when interest rates on fixed-rate mortgages are high) and from technical advances in construction.

Consumer Durables. The contribution to economic stability from the consumer durables sector at least partly reflects wider access to consumer credit (through credit cards and home-equity loans, for example), allowing households to better maintain their spending on big-ticket items in the face of short-term income fluctuations. In turn, expanded access to consumer credit (especially unsecured credit) is partly due to the improved information-storage and information-processing technologies available to financial institutions. Finally, the steadier funding available to financial institutions since the elimination of deposit interest-rate ceilings (Regulation Q) may help maintain consumer loan availability

over the business cycle just as it helps stabilize mortgage lending.

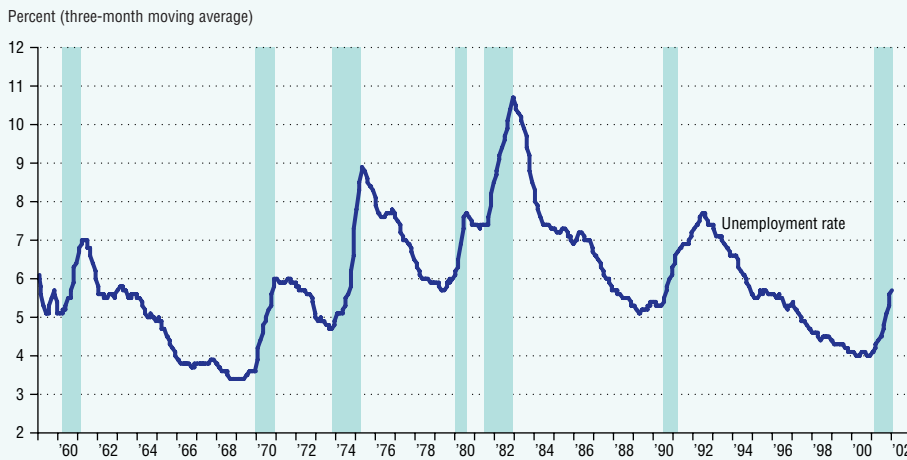
Inventory. What of inventory investment? New Economy technologies have provided tremendous opportunities to streamline industry supply chains and reduce reliance on inventory buffers. Moreover, decisionmakers at all points along the supply chain can use real-time information systems to quickly limit imbalances between demand and production. The inventory-to-shipments ratio for all manufacturing industries has fallen from an average 1.74 in the 1959–83 period to 1.54 in the 1984–2001 period. Moreover, the ratio, which averaged 1.80 during the past six NBER-defined recessions, was only 1.33 in January 2002.

Unfortunately, cause and effect are difficult to disentangle. Is inventory investment growth more stable because of new technologies and improved practices, or has an economy that is more stable for other reasons (such as monetary policy or good luck) simply made it easier to forecast future sales? Is consumer durables growth more stable because of a better-functioning consumer credit market or because a more stable economy smooths growth in household incomes, reducing the need for occasional sharp cutbacks in purchases of big-ticket items?

Chart 3

Slow Growth as Evidenced by a Rising Unemployment Rate

Slowdowns start earlier and sometimes last longer than NBER recessions.



NOTE: Bars indicate NBER-defined recessions.
SOURCE: Bureau of Labor Statistics.

How Does the Current Slowdown Measure Up?

We began this article by comparing the timing, depth and duration of absolute cyclical declines in the NBER's monthly indicators. The mainstream academic approach to business-cycle analysis focuses, instead, on *fluctuations around trend growth*. It looks at periods during which the economy is growing at substantially less than its trend rate. These growth slowdowns correspond more closely to the public's perception of bad economic times than do NBER recessions, because periods of below-trend growth are also typically periods of rising un-

employment. Indeed, a simple way to identify growth slowdowns is to look for periods of sustained increase in the unemployment rate.

As shown in Chart 3, the practical difference between a growth slowdown and an outright NBER-style recession is one of timing. Every NBER recession is associated with a substantial rise in the unemployment rate, and every substantial rise in the unemployment rate is associated with an NBER recession. But the unemployment rate often begins rising before NBER peaks and sometimes (most notably in 1991–92) continues to rise after NBER troughs.⁴

Using the unemployment rate to identify periods of below-trend growth, Table 3 compares the recent slowdown with past slowdowns. For GDP and its major components, the table gives (1) the average contribution to GDP growth from 1959:1 through 2001:4, (2) the mean and range of contributions to GDP growth during the first four quarters of the six prior slowdowns, and (3) the contribution to GDP growth during the first four quarters of the most recent slowdown (2000:4 through 2001:4). For example, the first column of the table shows that GDP rose 3.4 percent per year, on average, over the past 43 years; that it declined by an average of 1.3 percent during the first year of cyclical slowdowns (with a range from -2.9 to 0.2 percent); and that during the first year of the most recent slowdown, GDP rose by 0.4 percent—above the upper end of the historical range. This last finding is consistent with evidence that GDP growth fluctuations have generally diminished.

The second column of Table 3 shows that consumption's contribution to GDP growth (2.1 percentage points) was exceptionally large during the most recent slowdown. Much of the credit goes to consumer durables purchases, which rose at a strong 1.1 percent clip. Zero-interest auto financing in the fourth quarter of 2001—made possible by a highly expansionary monetary policy—was behind much of this strength, but consumer durables purchases were above year-earlier levels even in the third quarter of 2001, before auto-purchase incen-

Table 3

How Does the Current Slowdown Measure Up?

Comparing contributions to GDP growth in the current and past six cyclical growth slowdowns (percent per year)

	Consumption				Investment				Government	Net exports
	GDP	Total	Durables	Nondurables and services	Total	Nonresidential fixed	Residential	Inventory		
1959:1–2001:4	3.4	2.3	.5	1.9	.7	.6	.1	0	.5	-.1
Mean of past six slowdowns	-1.3	.1	-.6	.7	-2.3	-.4	-1.0	-.9	.4	.6
(range)	(.2, -2.9)	(1.4, -1.0)	(-.1, -1.0)	(1.6, 0)	(-.9, -3.3)	(.1, -.9)	(-.6, -1.6)	(-.2, -2.4)	(1.0, -.7)	(2.1, -.9)
2001 growth slowdown	.4 H	2.1 H	1.1 H	1.1	-2.6	-1.2 L	.1 H	-1.5	.9	0

NOTES: An "H" or "L" after an entry indicates that it is unusually high or low relative to past slowdowns. For a quarter to qualify as the start of a cyclical growth slowdown, the average unemployment rate in that quarter must be within 0.1 percentage points of the cyclical low rate. Among the quarters satisfying this criterion, the one showing the slowest subsequent four-quarter GDP growth was selected. By these criteria, cyclical slowdowns began in 1960:1, 1969:2, 1973:4, 1979:2, 1981:3, 1990:1 and 2000:4. These calculations are based on GDP data revised on Feb. 28, 2002. The GDP data will be revised again on March 28, 2002, and in subsequent annual and benchmark revisions.

tives kicked in to provide an end-of-year boost. Recall that the greater stability of household spending growth, particularly spending on durable goods, was also an important result from Table 2.

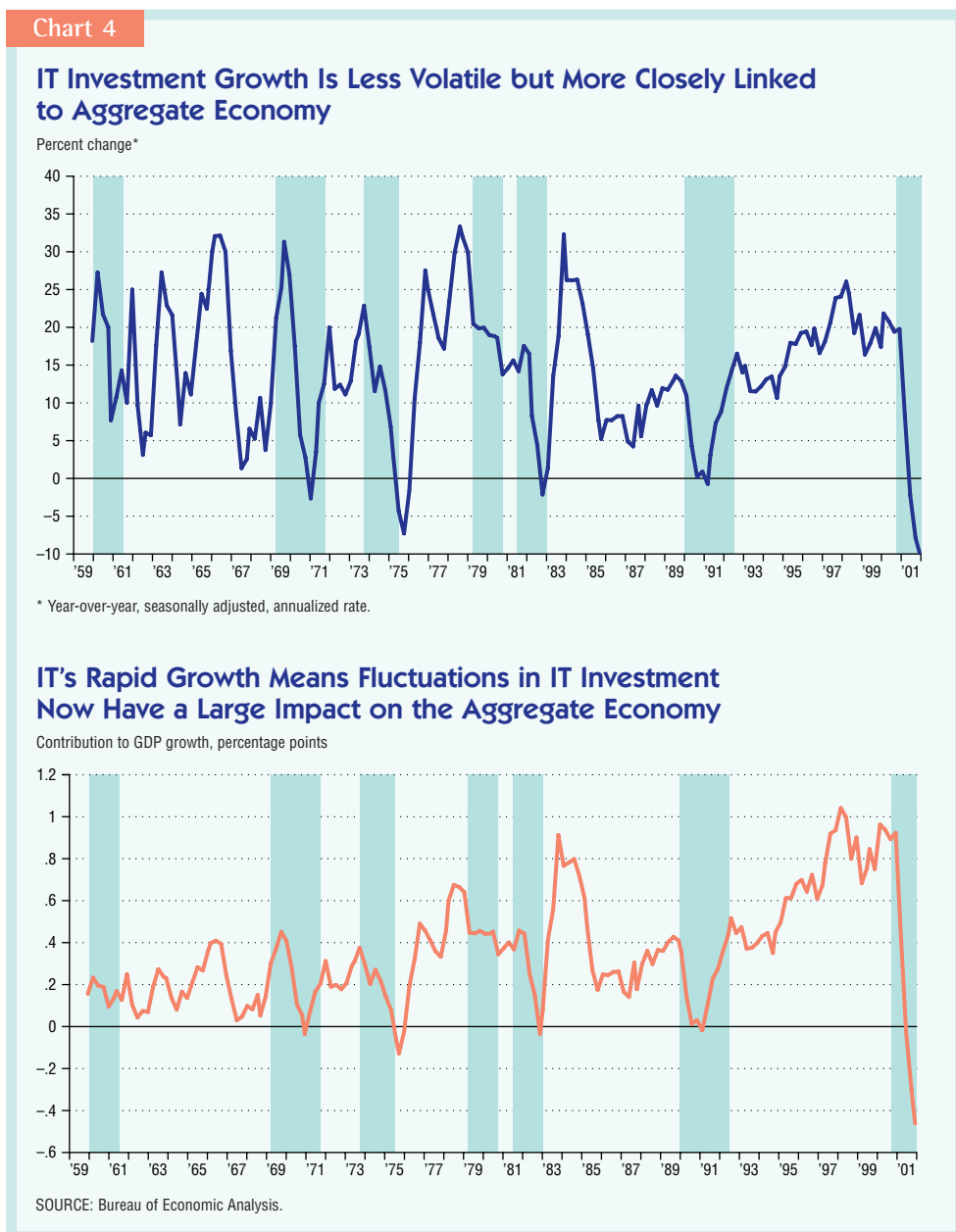
The growth contribution of government expenditures was somewhat above average during the recent slowdown, and that of net exports somewhat below average. Both of these series, however, were within the range of past experience.⁵

The behavior of gross private domestic investment during the recent slowdown was also not unusual, but a closer look reveals important variations across subsectors. Much like consumer durables purchases, residential investment made a positive contribution to GDP growth during the current slowdown, instead of its usual negative contribution. On the other hand, nonresidential fixed investment behaved much worse than might have been expected. The sector's growth contribution dropped off precipitously as the slowdown took hold, subtracting 1.2 percentage points from GDP growth during 2001. The behavior of inventory investment—although within the range of past experience—was disappointing given the trend toward tighter inventory controls.

In summary, the shortfall in GDP growth during 2001 was smaller than average, thanks partly to unusual strength in consumer durables expenditures and residential investment. Inventory investment, government expenditures and net exports behaved about as they have during past slowdowns. The biggest single contributor to the recent slowdown was an unusual collapse in nonresidential fixed investment spending. The following section focuses on the role information technology played in this collapse.

Impact of IT Investment

Investment in information technology (IT, which includes information-processing equipment and software) has grown relative to the rest of the economy, rising from 0.8 percent of GDP in 1959 to just under 3 percent in 1983 and to nearly 5 percent in 2000. This growth means that a swing in IT investment will have a six-times-larger impact on GDP growth today than in 1959, all else constant. But not all else is constant. As IT devices have become more fully integrated into



a wider cross section of industries, fluctuations in IT investment have become more highly correlated with fluctuations in the overall economy. Declines in IT investment not only carry more weight than before, but also are more likely to come at inopportune times.

Chart 4 illustrates these points and also sheds light on the role IT investment played during the most recent slowdown. The top panel shows IT investment's unadjusted growth rate from 1960 through 2001, with shaded regions denoting the slowdowns. Note how volatile IT investment growth is. The good news is that there appears to be some reduction in volatility since 1984. The bad news is that

periods of sluggish IT investment growth now coincide more closely with periods of sluggish GDP growth. Statistical analysis confirms these impressions.⁶

Prior to the most recent slowdown, IT investment growth was higher than average but well within the historical range. However, the falloff in growth during 2001 was exceptionally sharp.

The bottom panel of Chart 4 clarifies IT investment's impact on economic stability and the most recent slowdown by looking at the growth rate of IT investment weighted by the size of IT investment in GDP. This size-weighted growth rate shows the same increase in correlation with the aggregate economy

The severe IT downturn indicates that IT's stabilizing influence has been indirect, through applications that have increased the resilience of non-IT-producing sectors of the economy.

as the unadjusted growth rate but doesn't display any reduction in volatility. Consequently, there is no ambiguity: Far from contributing to the increased stability of GDP growth since 1984, IT investment has tended to make GDP growth *less* stable.⁷

In the most recent slowdown, the plot shows that IT investment added an exceptionally large 0.9 percentage points to GDP growth during 2000 only to subtract 0.5 percentage points from GDP growth during 2001. This 1.4-percentage-point swing in IT's growth contribution from one year to the next accounts for over half of the concomitant slowdown in GDP growth.

That the IT sector was unusually hard hit during the recent economic slowdown does not necessarily mean that the IT collapse *caused* the slowdown or that the slowdown would be less severe if firms still used 1970s-vintage technology. If anything, the manner in which the slowdown spread across the economy casts doubt on a causal role. In particular, the IT collapse was preceded by declines in manufacturing output, which were, in turn, preceded by a sharp slowing of growth in retail sales and a buildup of inventories.⁸ The severe IT downturn indicates that IT's stabilizing influence has been indirect, through applications that have increased the resilience of non-IT-producing sectors of the economy.

Concluding Remarks

The evidence demonstrates that the U.S. economy has become more stable. The relative mildness of the most recent recession illustrates this broader trend. The IT sector has not been an important direct contributor to the economy's improved cyclical performance. However, the fact that much of the economy's increased stability has originated in the inventory investment and consumer durables sectors suggests that the widespread application of new information technologies to inventory control and consumer lending has played a role in reducing the economy's fluctuations. Financial deregulation's contribution has also been important—especially in reducing fluctuations in the residential construction and consumer durables sectors.

A continuation of the strong trend productivity growth of the late 1990s will

help protect the economy from outright declines in output—and, so, from NBER-defined recessions—but not from periods of rising unemployment associated with slowdowns. In this sense, the cyclical implications of one key element of the New Economy—faster productivity growth—are limited. Fortunately, as we have seen, there is more to the New Economy than faster productivity growth.

—Evan F. Koenig
Thomas F. Siems
Mark A. Wynne

Koenig is vice president and senior economist, Siems is a senior economist and policy advisor and Wynne is an assistant vice president and senior economist in the Research Department of the Federal Reserve Bank of Dallas.

Notes

¹ The reduction in volatility is statistically significant, and its timing can be determined quite precisely. Margaret M. McConnell and Gabriel Perez-Quiros document the 1984:1 break date and examine the variance of different GDP components in "Output Fluctuations in the United States: What Has Changed Since the Early 1980s?" *American Economic Review* 90 (December), 2000, pp. 1464–76.

² Let ΔY denote annualized growth in real GDP and ΔX_i denote the contribution to GDP growth made by sector i (so that $\Delta Y = \sum_i \Delta X_i$). In the text, this contribution is called the size-weighted growth rate. Then $\sigma_Y = \sum_i \rho_i \sigma_i$, where σ_Y denotes the standard deviation of ΔY , ρ_i denotes the correlation between ΔY and ΔX_i , and σ_i denotes the standard deviation of ΔX_i . Under the Commerce Department's chain-weight methodology, $\Delta X_i = v_i \Delta Y_i$ where v_i is the share of sector i in nominal GDP and ΔY_i is the real growth rate in sector i . The first and second columns of Table 2 report $\rho_i \sigma_i$ for each of two time periods.

³ The variability of the relative price of food and energy has declined by about 20 percent since 1983. The case for monetary policy's stabilizing role is less straightforward (see McConnell and Perez-Quiros 2000, pp. 1474–75).

⁴ Most recently, the unemployment rate troughed at 4.0 percent in 2000:4 and was 5.6 percent in 2001:4. However, the unemployment rate had already risen to 4.8 percent in 2001:3, prior to the September 11 terrorist attacks. Increases of that magnitude have always been associated with NBER recessions.

⁵ Net exports have been a drag on U.S. GDP growth during the downturn because our trading partners' economies are weak. Industrial production during this recession declined an average 3.8 percent in the G7 nations outside the United States, compared with an average increase of 1.5 percent in the previous nine U.S. recessions.

⁶ The standard deviation of quarterly IT investment growth fell from 15.8 percentage points to 10.9 percentage points, while its correlation with GDP growth rose from 0.10 to 0.28.

⁷ The standard deviation of size-adjusted IT investment growth rose from 0.28 percentage points to 0.42 percentage points, while its correlation with GDP growth rose from 0.10 to 0.31. So, its contribution to GDP growth volatility rose from 0.03 percentage points to 0.13 percentage points. See Note 2.

⁸ Of course, temporal and causal orderings need not coincide. Moreover, it may well be that a reassessment of risks and growth prospects in the IT sector played an important role in spreading weakness that originated elsewhere in the economy.

Venezuela Addresses Economic Stress

Venezuela, the fourth-largest oil producer in the world, has lately found itself in the midst of rising fiscal deficits, international capital outflows and devaluation. Oil accounts for about one-third of Venezuela's gross domestic product, 50 percent of its tax revenue and 80 percent of its exports. After reascending from 1998 lows, oil prices have weakened significantly from a March 2000 peak in the mid-\$30s. Softer oil prices, together with production cutbacks, have slowed Venezuela's economic growth.

In recent months, exchange-rate pressures created by concerns over expansive fiscal policy—together with national strikes and other signs of problems in consensus building—motivated the central bank to tighten monetary policy and increase the targeted depreciation of the nominal exchange rate. When these efforts to stanch the outflow of the central bank's foreign currency reserves were met only with more dollar outflows, Venezuela allowed its currency, the bolivar, to float. The exchange rate moved from 795.50 bolivars per dollar on Feb. 12 to 998.49 the following day.

Countries have historically used devaluation to stem foreign currency reserve outflows and to make fiscal adjustments when they could not otherwise resolve disparities between income and outgo. But Venezuela is perhaps more proactive than many countries in its use of devaluation for fiscal balance.

Exchange-Rate Fluctuations

Increases in oil prices in the late 1990s seem to have energized Venezuela's disposition to spend, but the subsequent oil price declines did not have the opposite effect. Indeed, while Venezuela's central government had targeted a 3 percent deficit in 2001, the actual deficit averaged 4 percent, up from just 1.7 percent in 2000. Even though Venezuela had the third highest GDP growth

among Latin America's eight largest economies, it also had the third largest fiscal deficit (*Chart 1*).

The Venezuelan government had been showing signs of difficulty in preserving its exchange-rate regime for some time. In recent years, the bolivar has been allowed to fluctuate within a target band. When the exchange rate moved toward the preestablished barrier on either the weak or the strong side of the band, the government was committed to intervene by selling more dollars at the weak side and buying more on the strong side.

The progress of the bolivar within its band has not always been smooth, and special exchange-rate adjustments have been made from time to time. When the exchange-rate band was established in July 1996, the bolivar was allowed to fluctuate 7.5 percent in either direction from a central parity, which was allowed to move in accordance with an annual inflation target. In January 2001, the band itself was moved to make the central parity rate consistent with the prevailing exchange rate. Because the exchange rate

had been pushing persistently on the weak side of the band, the government simply moved the band 7.5 percent so as to position the existing exchange rate in the middle of the band instead of on the edge. The government then targeted the annual depreciation rate at 7 percent.

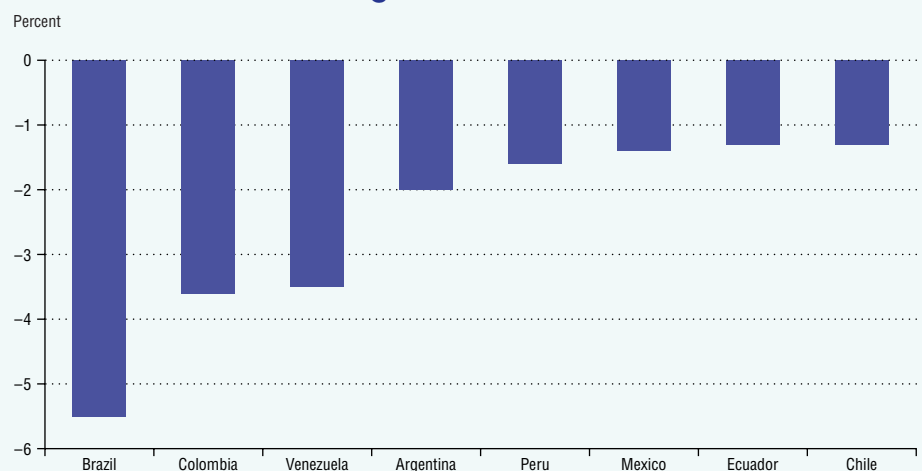
In the face of this weakened commitment, however, more pressures ensued. On Jan. 2, 2002, the government increased the targeted nominal depreciation to 10 percent. When foreign reserves continued to flow out of the country, the government announced on Feb. 12 that the exchange rate would float. The following day, however, this commitment was relaxed. Venezuela began using dollars to purchase bolivars to prevent a serious exchange-rate crash.

Oil for Dollars

The chief source of dollars in Venezuela has historically been the government-owned oil company, *Petróleos de Venezuela Sociedad Anónima*. This institution is required to turn all its earnings, which are in dollars, over to Venezuela's central bank. In the wake of the devalu-

Chart 1

Fiscal Balance as a Percentage of GDP: 2001



Accumulating a debt burden denominated chiefly in the local currency offers motivation for devaluation that would not exist if all debt were denominated in a foreign currency.

ation, the central bank has allocated a preannounced quantity of dollars to a daily auction.

The combination of capital outflows, failure to achieve political consensus and a relatively tight monetary policy has caused Venezuela to have some of Latin America's highest interest rates. The problem has not simply been exchange-rate risk. Chart 2 shows Emerging Market Bond Index spreads for eight Latin American countries. Because these spreads represent dollar-denominated government indebtedness for each country, they reflect market perceptions of types of risk other than those from losses due to devaluation.

Investors have perceived some legal changes as increasing the risk of investing in Venezuela. A new hydrocarbons law raises the royalties private firms must pay the government from 16.6 percent to 30 percent. Venezuelan land law now allows the government to evaluate private land use and to seize and reallocate the lands if they are adjudged underutilized.

A striking detail of the Venezuelan devaluation is how much less extreme the financial ratios, which one typically associates with predevaluation stresses, were than in most cases. Current account deficits preceded the great majority of exchange-rate devaluations in the last decade, but Venezuela was running a current account surplus before its Feb. 13 devaluation. Ratios of external debt to

exports were greater than 4:1 in the recent Argentine crisis, almost that high in Brazil just before its 1999 exchange-rate crash and greater than 2:1 in Mexico before its December 1994 crash. In Venezuela, however, the ratio of external debt to exports was 1.25:1. The ratio of debt to GDP was also markedly lower in Venezuela than was typical of precrisis countries in the 1990s.

The relatively mild values for these economic stress measures before devaluation suggest that Venezuela's motivations for devaluation differ from those of most countries. In this context, it is interesting to note that in 2001, net internal financing in Venezuela was about three times as high as external financing. This is to say that about three-fourths of Venezuela's 2001 deficit was financed in bolivars rather than in dollars or other foreign currency.

Motivation for Devaluation

Accumulating a debt burden denominated chiefly in the local currency offers motivation for devaluation that would not exist if all debt were denominated in a foreign currency. An important detail about the Venezuelan economy is that oil is priced worldwide in dollars, so a very large portion of Venezuela's total income is denominated in dollars. Devaluation means that the dollar value of such income stays the same, but the dollar value of domestic expenses falls, and so does the dollar value of bolivar-denominated debt.

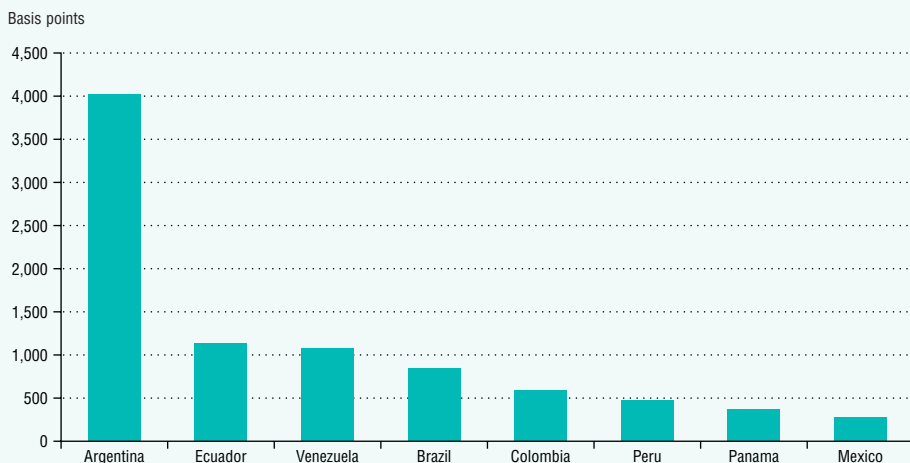
Some analysts argue that if the bolivar reaches 1,200 per dollar, the Venezuelan budget will be balanced under current circumstances. The bolivar was at less than 800 per dollar before the devaluation but now exceeds 1,000. The country is more than halfway there.

— William C. Gruben
Sherry L. Kiser

Gruben is vice president and Kiser is an associate economist in the Research Department of the Federal Reserve Bank of Dallas.

Chart 2

Interest Rate Spreads of Latin American Bonds over U.S. Treasuries



SOURCE: J.P. Morgan, Emerging Markets Bond Index.

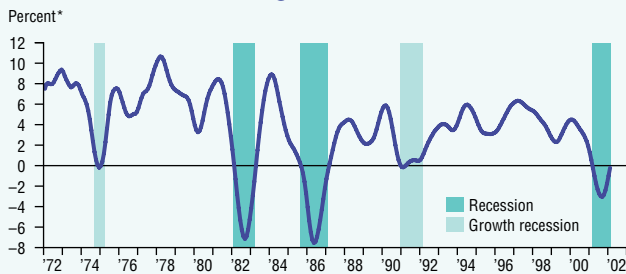
Ten years of economic expansion came to an end in 2001. Economic activity in Texas slowed throughout 2000 and turned negative in the spring of 2001, dragged down by the national and Mexican recessions and by the shock of September 11.

It may be too soon to feel confident that the recession is over. However, signs are increasingly positive. The U.S. economy's unexpected strength raises the prospects for a quick recovery, both in Texas and in Mexico. The Texas Leading Index has been climbing for the past four months, led by sharp increases in the U.S. leading index, the Texas Stock Index and average weekly hours worked in Texas manufacturing and by a decline in initial unemployment claims in Texas. After declining for most of 2001, private nonfarm employment in Texas surged in January. Despite falling back slightly in February, the private sector has added 23,000 jobs since the start of the year.

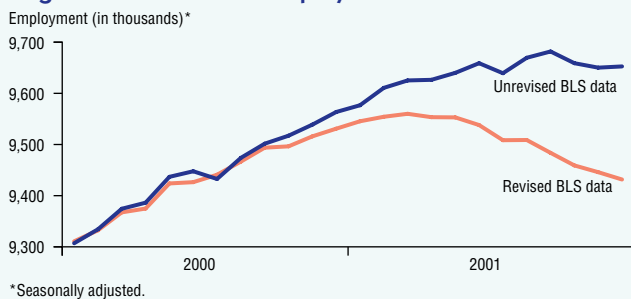
These numbers paint a very different picture of the Texas economy than was presented in the last issue of *Southwest Economy*. The Bureau of Labor Statistics (BLS) has just revised (in some cases substantially) all of the state-level employment data from second quarter 2000 forward. The difference between the unrevised and the revised data for December 2001 exceeds 2 percent of employment in five states—North Carolina, South Carolina, Washington, Florida and Texas. Where we once thought that Texas employment grew 1 percent in 2001, we now know it shrank 1 percent. After the revisions, the BLS lopped 215,000 jobs out of the Texas employment estimate for December 2001. The Texas revisions were proportionately most extreme in the wholesale trade and temporary employment industries.

—Lori L. Taylor

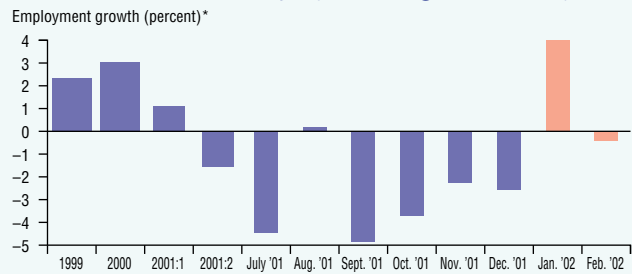
Texas Coincident Index Signals Recession



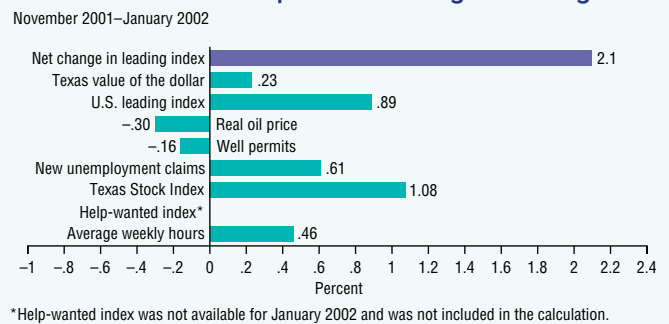
Large Revisions to Texas Employment Data



Texas Private Nonfarm Employment Surged in January



Net Contributions of Components to Change in Leading Index



Regional Economic Indicators

	TEXAS LEADING INDEX*		TEXAS EMPLOYMENT*				TOTAL NONFARM EMPLOYMENT*			
	Texas Leading Index	TIPI† total	Mining	Construction	Manufacturing	Government	Private service-producing	Texas	Louisiana	New Mexico
2/02	—	—	161.4	559.2	1,018.4	1,607.0	6,118.3	9,464.3	—	—
1/02	115.4	126.7	161.7	561.1	1,024.8	1,603.4	6,112.3	9,463.3	1,920.3	762.2
12/01	114.2	125.6	161.9	559.7	1,024.5	1,597.2	6,088.3	9,431.6	1,925.5	758.3
11/01	114.3	126.9	162.7	559.4	1,027.9	1,594.4	6,101.5	9,445.9	1,925.7	758.1
10/01	113.0	127.7	163.0	559.0	1,033.1	1,592.7	6,111.3	9,459.1	1,926.7	758.5
9/01	114.4	129.8	163.7	561.4	1,038.9	1,592.4	6,127.3	9,483.7	1,924.0	756.3
8/01	119.5	130.6	164.5	564.0	1,047.6	1,584.3	6,148.4	9,508.8	1,928.2	756.3
7/01	118.4	131.5	164.1	561.7	1,053.0	1,584.9	6,144.7	9,508.4	1,925.4	756.4
6/01	118.9	131.5	164.2	565.6	1,063.0	1,584.2	6,161.0	9,538.0	1,927.0	757.5
5/01	119.8	131.0	162.7	567.8	1,070.1	1,578.8	6,173.6	9,553.0	1,927.6	757.3
4/01	118.8	131.0	161.3	567.5	1,075.3	1,576.6	6,172.7	9,553.4	1,927.4	755.9
3/01	120.1	131.1	158.4	570.8	1,081.4	1,574.6	6,174.8	9,560.0	1,924.6	757.7

* In thousands. † Texas Industrial Production Index.

For more information on employment data, see "Reassessing Texas Employment Growth" (*Southwest Economy*, July/August 1993). For TIPI, see "The Texas Industrial Production Index" (Dallas Fed *Economic Review*, November 1989). For the Texas Leading Index and its components, see "The Texas Index of Leading Indicators: A Revision and Further Evaluation" (Dallas Fed *Economic Review*, July 1990). Online economic data and articles are available on the Dallas Fed's Internet web site, www.dallasfed.org.

Economic Impact of Biotechnology

(Continued from page 10)

Conclusion

Life science as a formal industry has only been around for a quarter century, but using living organisms to advance human life quality has transpired for thousands of years. Public funding has expedited growth in the life sciences and catalyzed private interest in the sector. Like the gains from trade among countries, trading among private and public entities has been key to industry growth in recent years. In particular, universities, labs and incubators laden with ideas and brainpower have collaborated with industry leaders whose deep pockets have enabled them to produce, market and sell new life science products. While it is too early to tell what the overall impact of biotech will be, the industry's effect on the economy is already noticeable and growing fast.

—John Thompson
Mine K. Yücel
John V. Duca

Thompson is an associate economist, Yücel is an assistant vice president and Duca is a vice president and senior economist in the Research Department of the Federal Reserve Bank of Dallas.

Notes

¹ The terms life science technology and biotechnology are used interchangeably in this article.

² See Ernst & Young (2001), p. 5.

³ Standard Industrial Classification codes included in the definition are 2833, 2834, 2835, 2836 and 8731. See Ernst & Young (2000).

⁴ See Henderson, Orsenigo and Pisano (1999), p. 283.

⁵ For example, Monsanto bought Calgene and Agracetus, Dow Chemical acquired Mycogen and Dupont bought Pioneer Hi-Bred. More recently, about 12 acquisitions took place from 2000 to mid-2001.

⁶ See Gaisford et al. (2001), p. 178.

⁷ See Ernst & Young (2001), p. 58.

References

Ernst & Young (2000), *The Economic Contributions of the Biotechnology Industry to the U.S. Economy*, report prepared for the Biotechnology Industry Organization, May.

——— (2001), *Focus on Fundamentals: The Biotechnology Report*, 15th Annual Review, October.

Filson, Darren, and Rosa Morales (2001), "Equity Links and Information Acquisition in Biotechnology Alliances," Economics Working Paper no. 2001:24, Claremont Colleges (Claremont, Calif., August).

Gaisford, James D., Jill E. Hobbs, William A. Kerr, Nicholas Perdikis and Marni D. Plunkett (2001), *The Economics of Biotechnology* (Cheltenham, UK: Edward Elgar).

Henderson, Rebecca, Luigi Orsenigo and Gary Pisano (1999), "The Pharmaceutical Industry and the Revolution in Molecular Biology: Interactions among Scientific, Institutional and Organizational Change," in *Sources of Industrial Leadership*, ed. David C. Mowery and Richard R. Nelson (New York: Cambridge University Press), 267–311.

Zucker, Lynne G., Michael R. Darby and Jeff S. Armstrong (1998), "Geographically Localized Knowledge: Spillovers or Markets?" *Economic Inquiry* 36 (January): 65–86.

——— (2001), "Commercializing Knowledge: University Science, Knowledge Capture, and Firm Performance in Biotechnology," NBER Working Paper Series, no. 8499 (Cambridge, Mass.: National Bureau of Economic Research, October).

Zucker, Lynne G., Michael R. Darby and Marilyn B. Brewer (1998), "Intellectual Human Capital and the Birth of U.S. Biotechnology Enterprises," *American Economic Review* 88 (March): 290–306.

Southwest Economy



Southwest Economy is published six times annually by the Federal Reserve Bank of Dallas. The views expressed are those of the authors and should not be attributed to the Federal Reserve Bank of Dallas or the Federal Reserve System.

Articles may be reprinted on the condition that the source is credited and a copy is provided to the Research Department of the Federal Reserve Bank of Dallas.

Southwest Economy is available free of charge by writing the Public Affairs Department, Federal Reserve Bank of Dallas, P.O. Box 655906, Dallas, TX 75265-5906, or by telephoning (214) 922-5254.

This publication is available on the Internet at www.dallased.org.

Robert D. McTeer, Jr.
President and Chief Executive Officer

Helen E. Holcomb
First Vice President and Chief Operating Officer

Harvey Rosenblum
Senior Vice President and Director of Research

Robert D. Hankins
Senior Vice President, Banking Supervision

W. Michael Cox
Senior Vice President and Chief Economist

Executive Editor
Harvey Rosenblum

Editors
Stephen P. A. Brown
William C. Gruben
Alan D. Viard

Publications Director
Kay Champagne

Associate Editors
Jennifer Aflierbach
Monica Reeves

Art Director
Gene Autry

Design & Production
Laura J. Bell

Federal Reserve Bank of Dallas
P.O. Box 655906
Dallas, TX 75265-5906

ADDRESS SERVICE REQUESTED

PRSR STD
U.S. POSTAGE
PAID
DALLAS, TEXAS
PERMIT NO. 151