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BIOTECH BONANZA: PROSPECTS FOR TEXAS

"Biotech will be to the coming century what electronics has been for the one now passing." [1]

THIS IS A bold claim to make about an industry identified as having approximately 1,300 companies, 153,000 employees and market capitalization of $97 billion.[2] The entire biotech industry is dwarfed by just one pharmaceutical behemoth like Merck, which employs 53,800 at a market capitalization of $162 billion.[3] But pharmaceutical and agrochemical giants sense biotech's potential to transform their industries and actively seek partnerships with biotech innovators. Last year, biotech firm Millennium Pharmaceuticals signed a $465 million genomics deal with Bayer and a separate deal with Monsanto worth up to $218 million.[4] Just consider what has happened in agriculture since the first genetically modified tomato went on the market in 1994. In 1999, nearly half of the total U.S. corn, soybean and cotton acreage will be planted with genetically modified crops.[5] More than 65 biotech drugs and diagnostics are on the market, with hundreds more in development. Biotech supporters sense a bonanza.

Biotech may or may not live up to predictions, but it is attracting media attention. Although most biotech companies in the news are far from the Lone Star State, recent headlines confirm biotech activity in Texas. Austin-based Introgen Therapeutics made the *Wall Street*

INSIDE

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Journal and *Business Week* short lists of biotech companies with promising cures for cancer. The *Forbes ASAP* May 1999 biotech special listed Houston's LifeCell Corp. as a major player in tissue engineering.

Before the Biotech Century begins in earnest, this article investigates biotech's presence in Texas and potential for growth.

Biotech: Innovation and Industry

Biotech is a set of innovations revolutionizing health care, food and agriculture, even manufacturing and environmental cleanup. Biotech, the applied knowledge of biology, is not new. Throughout history, the production of foods such as wine, cheese and bread and the breeding of animals and plants depended on rudimentary biotech. Twentieth century advances in scientists' understanding of molecular and cellular biology, genetics and ways the human immune system fights disease, coupled with computer technology, have enabled companies to launch revolutionary products.

Biotech: The Innovations. The ability to recombine genetic fragments and the computer-enabled deciphering of genetic code are key tools of modern biotech. A 1973 experiment to insert a gene from an African clawed toad into bacterial DNA marked the beginning of genetic engineering and eventually led to the first Food and Drug Administration approval of a genetically engineered drug: bacteria-produced human insulin. The international Human Genome Project, using sophisticated gene-sequencing computers, plans to map and sequence all human DNA by 2003. Meanwhile, Celera Genomics Corp. plans to do for biotech what Bloomberg did for financial data: develop and sell access to a comprehensive, cutting-edge database. Genetic engineering enables scientists to change what cells do, deciphering of the genetic code reveals what changes to make and access to genetic information inspires innovation.

Biotech products today blur boundaries between industrial categories. Biotech in health care harnesses the human body's own tools to fight disease through medicines, vaccines, tissue engineering and gene therapy and to detect disease through new and improved diagnostic tests. Biotech foods already engineered for higher quality and nutritional content will soon be able to deliver vaccines and hemoglobin. Biotech increases crop yields without the use of chemicals by making plants immune to herbicides and toxic only to pests—launching a second green revolution. In manufacturing, cotton grown in blue or khaki eliminates the need for chemical dyes, and microbes grow super-resilient polyester. Plants that produce biodegradable plastics and bacteria engineered to clean up toxic chemical spills are under development. And as silicon microchips approach their processing-speed limit, engineers are constructing the next generation of computer chips from DNA.

Biotech: The Industry. Because biotech's dramatic advances are relatively new, we can still distinguish companies that are using biotech to develop pharmaceutical, agricultural or industrial products from those that are not. In that respect, we can discuss biotech as an industry. Over time, competition forces all firms to adopt the best technologies. Just as most companies today use information technologies and are "high-tech," most firms in the near future could be "biotech," and discussing biotech as an industry will be less meaningful. A new industry name—life sciences—has already been proposed, but for now, we can talk about biotech.

Industry characteristics. Biotech's complex innovation process characterizes the industry. The lifeblood of biotech companies is knowledge, labor and capital capable of enduring the time-consuming, risky process of taking a product to market. (See the box, "Biotech's Innovation Process.") A new biotech drug takes about 10 years to develop, and just one drug in 10 successfully completes clinical trials.[6] Thirty biotech agriculture products currently in development will take up to six more years to reach the market.[7] Biotech companies rely on the latest scientific advances and require personnel who can interpret and apply those results. Proximity to universities is typical as companies attempt to attract biologists—

Biotech's Innovation Process

Taking a biotech innovation from discovery to market is slow and expensive. Biotech innovations rely heavily on patent protection and undergo rigorous testing by federal agencies before they can be marketed. The diagram outlines the biotech innovation process for health care, which is similar to the pharmaceutical industry's drug discovery process. Note the entire biotech process typically takes 15 years, over half of which is spent acquiring approval from the Food and Drug Administration (FDA). Biotech applications in other industries also must comply with federal regulations. The U.S. Department of Agriculture regulates biotech food and agriculture innovations, and industrial and environmental innovations are often subject to regulations of the Environmental Protection Agency.

Despite facing considerable time and expense, companies endure biotech's innovation process because of the potential for profit. Ernst & Young identifies why companies may be willing to be patient and persistent.

> "The environment in which a biotechnology product is launched is quite distinct from that of typical high-technology markets. Most products are developed upon a strongly defensible base of intellectual property, and consequently the vast majority of new products occupy highly specialized or even unique niches in the marketplace."[1]

Serving unique niches enables a company to attain a sustainable competitive advantage and thus profits. So even though patent filings and FDA approvals take time, they arguably strengthen an innovation's commercial viability.

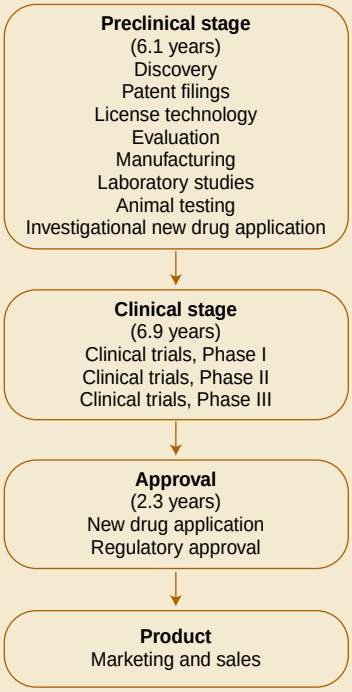
Biotech and Patent Policy. The U.S. Constitution, Article I, section 8, states that "Congress shall have power…to promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries." The Biotechnology Industry Organization advocates strong patent protection for biotech inventions:

> "Because biotech companies depend on private investments, patents are among the first and most important benchmarks of progress in developing a new biotechnology product. Patents offer limited protection against commercial use of a company's invention by a competitor. In biotechnology, patents are critical to raising capital to fund the research and development of products."[2]

Two key court cases extended patent protection to biotech innovations, but currently biotech agriculture patent protection is under fire. Patent attorney William Warren explains, "Paradoxically, biotechnology-related inventions are patentable in the United States only if obtained through a non-biological process, defined as one in which the 'hand of man' has intervened."[3] Courts established this principle in 1980 by ruling General Electric could patent a genetically engineered oil-eating bacterium. Recently the Federal Circuit Court of Appeals reversed a Patent Office decision and ruled that DNA sequences that code for particular proteins are patentable. Plant patents, however, are being challenged, as a federal appeals court has taken up the issue of plant patent legality.

Biotech and FDA Regulation. The FDA, part of the U.S. Department of Health and Human Services, pursues a single objective: consumer protection by ensuring that food, drugs, biological products and medical devices are safe. The FDA has existed since 1931, though some law enforcement functions began in 1906 under the Food and Drug Act. The FDA's Center for Biologics Evaluation and Research coordinates with the Center for Drug Evaluation and Research to approve biotech health care products. The approval process for biotech medicines is estimated to cost between $200 million and $350 million and take from seven to 12 years.[4]

Innovation Process: Biotech Health Care Applications



SOURCES: Introgen Therapeutics; Texas Healthcare and Bioscience Institute; author's research.

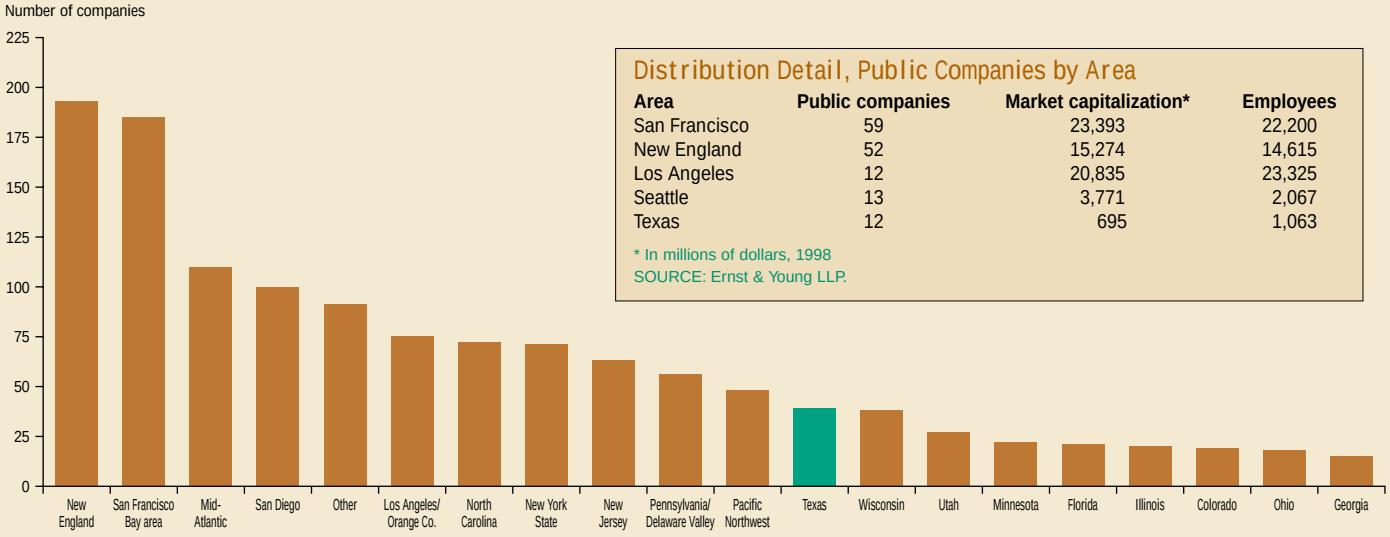
The Biotechnology Industry Organization lobbied for the 1997 FDA Modernization Act and achieved reforms liable to lop 19 months off total drug development times. Other changes include implementing fast-track approval designation to drugs for serious or life-threatening conditions and allowing one biologics license to cover both a product and a facility.

[1] Ernst & Young LLP, *13th Biotechnology Industry Annual Report*, p. 38.
[2] Biotechnology Industry Organization, *The 1998–99 BIO Editors' and Reporters' Guide to Biotechnology*, www.bio.org.
[3] William L. Warren, "Developments in Biotech Patent Law," Jones & Askew LLP.
[4] Biotechnology Industry Organization.

academics not usually involved in business. Finding investors who will wait out the product development phase is particularly challenging for biotech companies today. Many investors abandoned biotech in the mid-1990s for higher- and quicker-return tech stocks. In the meantime, biotech firms have funded themselves by tapping smaller, informed investors and licensing their technology to larger firms.[8]

Industry clusters. Biotech companies, like those in other industries, tend to cluster around essential resources, eventually attracting more such resources to the region. A cluster is not simply a geographic concentration of companies; clusters include suppliers, customers, manufacturers of complementary products and even governmental and other institutions such as universities, standards agencies and vocational training providers. Cluster growth is a self-reinforcing cycle. As a single company's success brings new suppliers or inspires cooperation with local institutions, other companies that can bene-

Chart 1
Distribution of U.S. Biotech Companies
(Public and private, mid-1998)



Distribution Detail, Public Companies by Area

Area	Public companies	Market capitalization*	Employees
San Francisco	59	23,393	22,200
New England	52	15,274	14,615
Los Angeles	12	20,835	23,325
Seattle	13	3,771	2,067
Texas	12	695	1,063

* In millions of dollars, 1998
SOURCE: Ernst & Young LLP.

SOURCE: Ernst & Young LLP.

fit from those resources are drawn to the area. Because company growth is easier in a good business environment, which itself is developed by the presence of other companies, clustering enables companies to gain competitive advantage they could not acquire in isolation.[9]

Biotech's Presence in Texas and Beyond

Traditional statistics often overlook industry clusters, and biotech's relative newness makes its industry presence even less visible to standard measures. In the following paragraphs I assess the presence of biotech companies by region and compare Texas statistics with those of other areas in the United States. I then discuss two large regional biotech clusters and the emergence of such clusters in Texas.

Biotech Companies in U.S. Regions. No database tracks all publicly traded and privately held biotech companies, but industry sources reveal the most important identities and locations of biotech companies. Ernst & Young has tracked public and private biotech companies for 13 years. Chart 1 shows the distribution of biotech companies across the United States. Table 1 lists the seven largest biotech companies. The chart and table show that not only do California and New England have the most companies, they also have the biggest companies. Texas has enough companies to register on Ernst & Young's biotech radar, but the entire Texas public biotech contingent is comparable to just one Seattle company, Immunex Corp., in terms of employees and market capitalization.

Ernst & Young's database is comprehensive but not exhaustive; yet an alter-

Table 1
Biotech Big Seven

Company	Location	R&D as percent of sales	Market capitalization (millions of dollars)	Employees	Selected products and uses
Amgen	Los Angeles	26	19,108	5,308	Procrit, red blood cell enhancement
Genentech	San Francisco	46	8,801	3,242	Humulin, manufactured insulin; hepatitis B vaccine
Biogen	Boston	34	4,912	797	Intron, cancer and viral infections
Alza Corp.	San Francisco	34	3,474	1,532	Advanced controlled dosage release for medicine
Chiron Corp.	San Francisco	32	3,312	6,842	Betaseron, multiple sclerosis
Genzyme Corp.	Boston	13	2,536	3,500	Tissue repair, cancer treatment and diagnostics
Immunex Corp.	Seattle	58	2,228	886	Treatments for cancer, immunological disorders

NOTE: Data as of November 1998. In comparison, pharmaceutical giant Merck employs 53,800 at a market capitalization of $162 billion and devotes only 7 percent of sales to research and development.
SOURCE: Ernst & Young LLP.

Table 2
Biotech Hotbed Communities in the United States

Community	Number of companies
Biotech Bay and Beach (N. and S. Calif.)	308
Pharm Country (N.Y., N.J., Conn., Pa.)	196
Genetown (Mass.)	127
BioCapital (Md., D.C., Va.)	95
Research Triangle (N.C.)	76
BioForest (Wash., Ore., Mont., Idaho)	60
BioTechxus (Texas)	45

SOURCES: Institute for Biotechnology Information; Biospace.com.

native assessment confirms those results. Biospace.com, an industry web site, identifies "hotbed communities" for biotech. The Institute for Biotechnology Information maintains a corporate directory of public and private companies by state. Combining the two sources gives a regional picture of biotech. The numbers in Table 2 differ slightly from Ernst & Young's but provide similar results. California and Massachusetts have the highest concentrations of companies, but Texas has enough to warrant identification and tracking.

Biotech Clusters in California and Massachusetts. California and Massachusetts have developed large numbers of biotech companies. These two states are home to the nation's biotech leaders because they have biotech clusters—companies surrounded by sources of innovation and supporting institutions—that can be traced to historical circumstances.

California's—and the nation's—first biotech company, Genentech, was founded in 1976 in San Francisco by venture capitalist Robert Swanson and Dr. Herbert Boyer of the University of California at San Francisco. The company's genetic engineering capabilities stemmed from recombinant DNA technology developed by Boyer and Stanford's Stanley Cohen in 1973.

Massachusetts' Genzyme Corp. initially benefited from the strength of the region's universities, medical centers and venture capital firms. Eventually, Genzyme required a manufacturing facility. Genzyme's president could have moved the company to the pharmaceuticals cluster in New Jersey and Philadelphia that already had a strong manufacturing base, but chose instead to cooperate with city contractors and develop manufacturing capability in Boston. Genzyme also has worked with the city government to improve the labor pool by offering scholarships and internships to local youth.

Biotech Clusters in Texas Cities. Texas shows signs of nascent biotech clusters. Nearly all Texas biotech companies focus on health care and concentrate in four metropolitan areas. Of the 39 public and private Texas biotech companies tracked by Ernst & Young, 18 are located in Houston, seven in Dallas, five in Austin and three in San Antonio. Table 3 details 20 Texas biotech companies.

Like companies in California and Massachusetts, Texas biotech companies benefit from proximity to educational institutions through research and technology transfer. Technology transfer occurs when a university licenses its technology or sells it outright to com-

Table 3
Texas Biotech Companies

Company	Location	Employees	Focus
Publicly traded			
Access Pharmaceuticals	Dallas	18	Cancer and canker sore therapeutics
Amarillo Bioscience	Amarillo	8	Human and animal disease therapeutics
Aronex Pharmaceuticals	Houston	91	Cancer and infectious disease therapeutics
Carrington Laboratories	Dallas	278	Custom molecular biology services
Cytoclonal Pharmaceuticals	Dallas	20	Cancer and infectious disease therapeutics
Energy Biosystems	Houston	84	Petroleum industry processes
Gamma Biologicals	Houston	134	In vitro diagnostics
GeneMedicine	Houston	109	Gene therapy for cancer
ILEX Oncology	San Antonio	180	Cancer therapeutics
LifeCell Corp.	Houston	95	Tissue engineering
Texas Biotechnology Corp.	Houston	81	Vascular disease therapeutics
Zonagen	Houston	50	Human reproductive system therapeutics
Privately held			
Ambion	Austin	100	Molecular diagnostic products
Bio-Synthesis	Dallas	70	Custom DNA synthesis
Diagnostic Systems Laboratories	Austin	100	In vitro diagnostics
Genosys Biotechnologies	Houston	165	Custom DNA synthesis
Introgen Therapeutics	Austin	60	Gene therapy for cancer
Lexicon Genetics	Houston	83	Functional genomics
Midland Certified Reagent Co.	Midland	45	Custom molecular biology services
Tanox	Houston	55	Immune system therapeutics

NOTES: This table lists public companies of all sizes and private companies with over 40 employees. GeneMedicine has merged to form Valentis; LifeCell has announced plans to move to New Jersey.

SOURCES: Ernst & Young LLP; Texas Healthcare & Bioscience Institute; Biotechnology Industry Organization.

Table 4
Texas Biotech Innovators

University	Affiliated technology transfer organization
Baylor College of Medicine, Houston	BCM Technologies
University of Texas Southwestern Medical Center, Dallas	Dallas Biomedical Corp.
University of Texas Health Science Center at Houston	Institute for Technology
University of Texas M.D. Anderson Cancer Center, Houston	Office of Technology Development
University of Texas Health Science Center at San Antonio	University–Industry Cooperative Research Center
University of Texas at Austin	Center for Technology Development and Transfer
Texas A&M University Texas Engineering Experiment Station	Technology Business Development Division

SOURCE: Texas Healthcare and Bioscience Institute.

Texas biotech companies benefit from proximity to educational institutions through research and technology transfer.

panies for commercial development.

Table 4 lists Texas institutions and their technology transfer organizations. BCM Technologies, Baylor University's technology transfer organization, has a portfolio of spinoffs including three of Texas' 12 publicly traded biotech companies. The University of Texas at San Antonio is responsible for another. Privately held Introgen Therapeutics acquired its core technologies through licensing agreements with the University of Texas M.D. Anderson Cancer Center. Technology developed by the University of North Texas Health Science Center and the University of Texas Southwestern Medical Center enabled the recent launching of ManTex Biotech, funded by Canadian incubator Genesys Venture. Of Texas biotech companies surveyed by the Texas Healthcare and Bioscience Institute, 55 percent say university ties create or help growth and 34 percent report research agreements with Texas universities.[10]

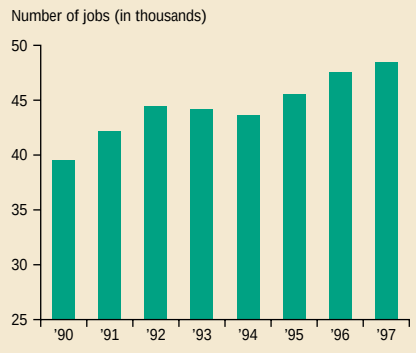
Biotech's Potential for Growth in Texas

Texas is home to some exciting biotech developments, but as an industry, biotech is still very small. For biotech to gain prominence in the Texas economy, the budding biotech clusters must grow. Clusters develop spontaneously in the right business environment, often in the presence of complementary industries. Biotech clusters grow when surrounded by the right resources; knowledge, specialized labor and capital enable companies to expand and new ventures to form. Government and institutions cannot force biotech clusters to grow, but they can remove barriers to growth.

Complementarities with Existing Industries. Biotech complements Texas' growing health care technology industry, which employed 49,000 people in 1997 (*Chart 2*). The Texas health care technology industry includes research laboratories, pharmaceutical manufacturers, and medical device and equipment manufacturers. At an annual industry employment growth rate of 3 percent from 1990 to 1997, Texas is above the national industry average of 1.7 percent.[11]

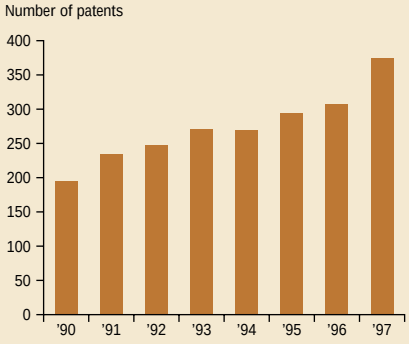
Knowledge. Biotech demands a stock of innovations, and Texas institutions supply a substantial number. The state's patent activity in health care technology suggests Texas innovations initiate in-state product development. The number of health care technology patents issued to Texas residents increased from 195 in 1990 to 375 in 1997 (*Chart 3*). Texas health care technology patents cite Texas research at nearly 3.5 times the expected rate, while California patents cite California research at 1.6

Chart 2
Texas Health Care Technology Employment



SOURCE: Texas Healthcare and Bioscience Institute.

Chart 3
Health Care Technology Patents Issued to Texas Residents



SOURCE: Texas Healthcare and Bioscience Institute.

times the expected rate.[12] Texas' health care patent activity reveals the state as an important source of university research that results in Texas patents.

Labor. Biotech requires a highly specialized labor force, and although regions can attract workers from elsewhere, a local trained workforce is important. Signs that Texas is developing its own biotech labor force include more life science graduates and new academic programs. Between 1989 and 1995, the number of life science degrees awarded in Texas increased 56 percent, from 11,306 to 17,645 (*Chart 4*). Austin Community College recently became one of six regional biotechnology centers funded by the National Science Foundation as part of Bio-Link. Like the regional centers at colleges in Madison, Wis., Portsmouth, N.H., Seattle, Baltimore and San Diego and the national center in San Francisco, Austin Community College will begin a biotech certification program in the fall of 1999, offering both one-year certification and two-year associate's degree programs.

Capital. As biotech companies across the nation feel a capital crunch, Texas companies are combining forces to attract investor attention. Texas biotech and medical/health-related companies received $80 million in venture capital in 1997—2.7 percent of the U.S. total—recovering from a drop to $11 million in 1995 (*Chart 5*).[13] In March 1999, San Mateo, Calif., biotech communications firm Russell-Welsh organized the Second Annual Texas Biomedical Investment Conference in Houston. And in May, the First Texas Life Sciences Stocks Forum was held, also in Houston.

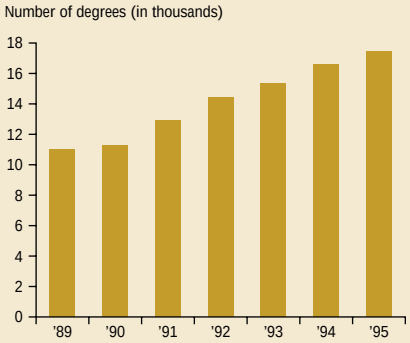
Institutional Support. Texas biotech receives support not only from its educational institutions, but also from other public and private institutions. The Texas Healthcare and Bioscience Institute is a two-year-old private consortium of biotech, medical device and pharmaceutical companies, universities and private research institutions. The institute tracks an index of the Texas health care technology industry and coordinates statewide industry initiatives and educational seminars. Cities like Houston, Fort Worth and Dallas are developing technology business incubators to address the unique needs of emerging biotech firms.

Conclusion

Although Texas biotech is still small, biotech clusters in metropolitan areas appear to be emerging in an improving business environment. Biotech complements the state's growing health care technology industry. The knowledge, labor and capital biotech needs to grow are being cultivated in Texas. Support is also developing from educational institutions, local governments and industry organizations. Whether biotech will grow clusters in Texas comparable to those in California and Massachusetts is impossible to predict, but the necessary conditions for growth are increasingly evident. Texas is a source of biotech innovations and already has a noticeable biotech presence. The biotech bonanza, whether a mother lode or just another strike, indeed has prospects for Texas.

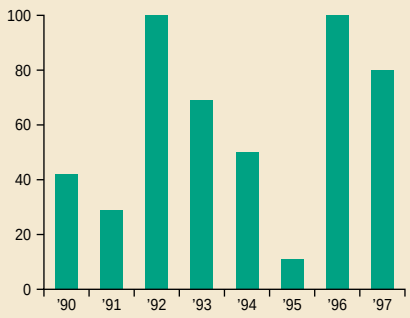
—Meredith M. Walker

Chart 4
Life Science Degrees Awarded by Texas Institutions



SOURCE: Texas Healthcare and Bioscience Institute.

Chart 5
Venture Capital Investment in Texas Biotechnology and Medical/Health-Related Companies



SOURCE: Texas Healthcare and Bioscience Institute.

Notes

Many thanks to Lori Taylor for constructive comments.

1 Michael Gruber, "Map the Genome, Hack the Genome," *Wired*, October 1997, p. 154.

2 Scott Morrison and Glen Giovannetti, "Biotech 99: Bridging the Gap," *Ernst & Young's 13th Biotechnology Industry Annual Report*, p. 4.

3 Ibid., p. 65.

4 Ibid., p. 10.

5 Steve Weinstein, "Biotech: The Third Wave," *Progressive Grocer*, April 1999, p. 22.

6 Larry Fisher, "Money Walks," *Forbes ASAP*, May 31, 1999, p. 77.

7 Biotechnology Industry Organization, *The 1998–99 BIO Editors' and Reporters' Guide to Biotechnology*, www.bio.org.

8 Larry Fisher, "Money Walks," *Forbes ASAP*, May 31, 1999, p. 77.

9 Michael Porter, "Clusters and the New Economics of Competition," *Harvard Business Review*, November/December 1998, p. 78.

10 Texas Healthcare & Bioscience Institute, *A Profile of Progress: The Texas Healthcare Technology Industry*, Spring 1998.

11 Texas Healthcare & Bioscience Institute, *Index of the 1998 Texas Healthcare Technology Industry*, p. 3.

12 Ibid., p. 12.

13 Ibid., p. 21.

The Minimum Wage Debate: Always Off Course

A Commentary by Richard B. McKenzie

POLITICAL SUPPORT IS growing in Congress for another hike in the federal minimum wage. In response to President Clinton's 1999 State of the Union message call for a minimum wage increase, bills now before Congress would raise the minimum hourly wage by $1, from $5.15 to $6.15, in two steps over the next year and a half.[1]

The proposed increase will bring, as always, reactions from both sides of the aisle. Supporters and detractors in this heated and probably unavoidable debate will earnestly restate old arguments and past claims, and again both sides will be off course in the likely employment consequences of a minimum wage increase. In considering a new round of increases, all sides need to examine how a minimum wage hike will affect labor market incentives and how conditions of employment will react to whatever Congress legislates.

The Minimum Wage in Current and Constant Dollars

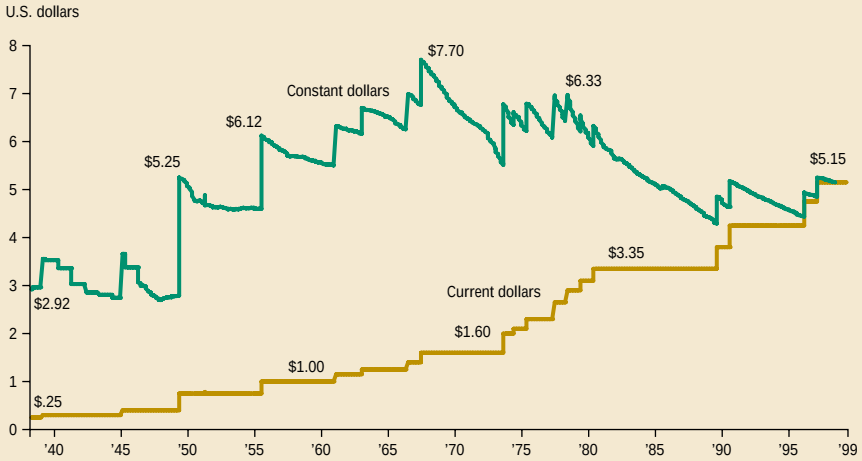
In the emerging debate, much will likely be made of how the current federal minimum wage of $5.15 an hour has no more purchasing power than the minimum wage of the early 1950s. As seen in Chart 1, the minimum wage in current dollars has risen in a series of 19 steps from 25 cents an hour in October 1938, when the first federal minimum wage took effect, to $5.15 currently. However, in constant (February 1999) dollars the hourly minimum wage rose irregularly from $2.92 in October 1938 to $7.70 in 1968, then fell irregularly to its current level of $5.15, a third less than the 1968 peak. The real value of the minimum wage in 1999 is slightly below its level of $5.25 in 1999 dollars when it was raised at the start of 1950. In recent years, the minimum wage has fallen only slightly in real terms, from $5.25 in October 1997, when the minimum wage was last raised, to $5.15.[2]

Two Sides to an Old Debate

When the next minimum wage bill reaches the floor of Congress, it is all but certain that opponents and proponents in and out of Congress will once again lock political horns, no matter what increase is proposed. Outside interests, citing studies and statistics, will stand ready to promote or denounce the legislation. On the one side, Bob Herbert, a *New York Times* columnist and minimum wage supporter, cites a study by Bernstein and Schmitt (1998) of the Economic Policy Institute, a Washington, D.C.-based think tank, that finds the last approved minimum wage hike raised the incomes of 10 million Americans. Herbert writes, "The benefits of the increase disproportionately help those working households at the bottom of the income scale. Although households in the bottom 20 percent (whose average income was $15,728 in 1996) received only 5 percent of total national income, 35 percent of the benefits from the minimum wage increase went to these workers. In this regard, the increase had the intended effect of raising the earnings and incomes of low-wage workers and their households."[3] Moreover, in the growing debate proponents like Herbert will continue to cite statistical studies that show a minimum wage hike will have no (or minimal) impact on the low-wage job count, reinforcing Bernstein and Schmitt's findings.

Herbert is convinced that such find-

Chart 1
Hourly Minimum Wage in Current and Constant (1999) Dollars
(October 1938–February 1999)



NOTES: 1938 data as of October; constant dollars based on February 1999 data.

ings should give minimum wage critics reason to eat their words. Herbert reminds his readers of comments by William A. Niskanen, chairman of the Cato Institute, former acting chairman of President Reagan's Council of Economic Advisors and an opponent of minimum wage increases, during the previous debate over increasing the minimum wage: "It is hard to explain the continued support for increasing the minimum wage by those interested in helping the working poor" (Bernstein and Schmitt 1998). Herbert and other minimum wage supporters will point anew to the empirical work of Princeton University's David Card and Alan Krueger (1994, 1995), who conclude that increases in the federal minimum wage in the early 1990s had no measurable negative effect on employment in New Jersey fast-food restaurants (and may have increased employment slightly). These same authors contend in a 1998 *Washington Post* article (Card and Krueger 1998) that more recent employment data from the Bureau of Labor Statistics corroborate their earlier findings.

Nevertheless, opponents will continue to argue that if Congress raises the cost of low-skilled labor, less than a fifth of the wage gains will go to households with incomes below the poverty level and more than half of the wage gains will go to households with more than twice the poverty income threshold (Couch 1999). They will also stress that several hundred thousand jobs are bound to be lost. Some employers will not be able to afford as many workers, and other employers can be expected to automate low-skill jobs out of existence. The opponents will back up their claims with statistics showing that some low-skilled workers will be better off (those who keep their jobs), but only because other low-skilled workers will be worse off (those who are unemployed).[4] For example, a study by the Employment Policies Institute (Macpherson 1998), another Washington, D.C.-based think tank, concludes that a $1.35 increase in the minimum wage could be expected to eliminate 7,431 jobs in the state of Washington by 2000, causing the affected workers to lose $64 million in annual income.

Both sides will again err in their assessments of the minimum wage increase because both fail to recognize that employers are a lot smarter and are pressed far more by labor market forces than the legislators think. Neither side seems to realize that Washington simply doesn't have the requisite power over markets to significantly improve worker welfare by wage decrees, no matter how well intended the legislation may be. This is why so many empirical studies show minimum wage increases have had a relatively small impact on employment. Indeed, most studies undertaken over the past three or four decades have found that a 10 percent increase in the minimum wage will lower the employment of teenagers (the group of workers most likely to be adversely affected by the minimum wage) by a surprisingly small percentage—anywhere from 0.5 percent to 3 percent.[5] Further, a tight labor market, such as currently exists in the United States, implies relatively smaller reductions in the number of lost jobs with any given percentage increase in the minimum wage.[6] When labor economists were asked to give their personal estimate of the effect on employment of a 10 percent increase in the minimum wage, they projected, on average, a decline in teen employment of 2.1 percent.[7]

When Congress forces employers to pay more in money wages, it causes them to pay less in other forms, most notably in fringe benefits.

Minimum Wage Hikes' Effect on Employment

Why have the percentage estimates of job losses been so low? The simple answer is the labor markets for low-skilled workers are highly competitive, which explains the low wages paid workers with limited skills in the first place. Many employers of low-skilled workers would love to be able to pay their workers more, but they have to face a market reality: if they pay more, then their competitors would have a cost advantage in pricing their products.

When Congress forces employers to pay more in money wages, it causes them to pay less in other forms, most notably in fringe benefits. And if there are few fringes to take away, the employers can always increase work requirements.

Why would employers curb benefits and increase work requirements? First, because they *can* do it. A minimum wage hike will attract a greater number of workers (and workers who are more productive). It will also cause some employers to question whether they can hire as many workers as they currently employ unless adjustments are made. Hence, in a tight labor market the forced wage hike strengthens the employers' bargaining position. Employers can tell prospective workers, "If you don't like it, I can hire someone else. Your replacements are lined up at my personnel office door."[8] Employers will make the adjustments for an *offensive* reason—to improve their profits (or curb losses).

Second, and perhaps more important, employers of covered workers must cut fringes and/or increase work requirements or face the threat of losing their market positions as their competitors take these same actions. Employers will make adjustments for *defensive* reasons—to prevent their market rivals from taking a portion of their markets and causing their profits to fall (or losses to mount).

Third, if employers don't cut fringes and/or increase work requirements, the value of the company's stock will suffer, opening up opportunities for investors

Competitive market pressures will force firms to do what is right by their bottom lines and *their workers. This means that when the minimum wage is raised, the value to the workers of the fringe benefits and less onerous work requirements they are forced to give up will be greater than the value of the additional money income.*

to buy the firm, change the firm's benefit/work requirements policies, improve the firm's profitability and then sell the firm at a higher market value. Employers—either the original or new owners—will make the adjustments for *financial* reasons—to maximize their firms' share values.[9]

The net effect of the adjustments in fringes and work requirements is to largely neutralize the cost impact of the minimum wage hike. For example, when the minimum wage increases by $1, the cost of labor may, on balance, rise by only 5 cents. Such an adjustment explains why Card and Krueger (1994, 1995) and more than a hundred other statistical studies have found that minimum wage hikes have caused a small, if not negligible, percentage drop in jobs even among that group of workers—teenagers working at fast-food restaurants—whose jobs are most likely to be cut.[10]

This line of argument can also help us understand why workers who retain their jobs are unlikely to be any better off. They get more money, but they also get fewer fringes and have to work harder for their pay. The covered workers who retain their jobs will be worse off—at least marginally so—because the only reason an employer intent on making as much profit as possible would offer the fringes and less onerous work requirements in the first place is that the workers valued the nonmonetary work benefits more highly than they valued the money wages they had to give up to get those benefits. And profit-maximizing employers aren't about to offer workers anything that's costly unless they get something in return, like greater output per hour or a lower wage bill.

If a firm offers costly benefits that do not lower wages or fails to offer benefits that *could* lower wages, then that firm becomes vulnerable to takeover. Some savvy investor can be expected to buy the firm, change its benefit policies and lower wages by more than other costs rise—thereby improving the firm's profitability—and then sell the firm for a higher price.

Make no mistake about it, profit-maximizing firms do not "give" fringes to their workers; they require their workers to pay for the fringes through wage-rate reductions. The wage-rate reductions can be expected because if workers value the fringes, the supply of workers will go up, forcing the money wage rate down.

It follows that competitive market pressures will force firms to do what is right by their bottom lines *and* their workers. This means that when the minimum wage is raised, the value to the workers of the fringe benefits and less onerous work requirements they are forced to give up will be greater than the value of the additional money income.

Put another way, the workers who retain their jobs are made worse off (perhaps marginally so) despite the money-wage increase. Employment in low-skill jobs may go down (albeit ever so slightly) in face of minimum wage increases not so much because the employers don't want to offer the jobs (as traditionally argued), but because not as many workers want the minimum wage jobs that are offered.[11]

Empirical Evidence

Have the expected effects been seen in empirical studies? The most compelling evidence is captured in the many studies already cited that indicate job losses from a minimum wage increase tend to be small, even within the worker groups most likely to be adversely affected. However, other studies over the past two decades have attempted to directly assess the impact of minimum wage increases on fringes and work requirements, as well as the overall value of jobs:

- Hashimoto (1982) finds that under the 1967 minimum wage hike, workers gained 32 cents per hour in money income but lost 41 cents per hour in training (a net loss of 9 cents per hour in full-income compensation).
- Leighton and Mincer (1981) conclude that minimum wage increases reduce on-the-job training and, as a result, dampen growth in the real long-run income of covered workers.
- Wessels (1987) finds that the mini-

mum wage caused retail establishments in New York to increase work requirements. In response to a minimum wage increase, only 714 of the surveyed stores cut back store hours, but 4,827 stores reduced the number of workers and/or the hours they worked. Thus, in most stores, fewer workers were given fewer hours to do the same work as before.[12]

- Research by Fleisher (1981), Alpert (1986) and Dunn (1985) shows that minimum wage increases lead to large reductions in fringe benefits and to worsening working conditions.

If the minimum wage does not cause employers to make substantial reductions in nonmoney benefits, then we would expect increases in the minimum wage to cause (1) an increase in the labor-force participation rates of covered workers (because workers would be moving up their supply-of-labor curves), (2) a reduction in the rate at which covered workers quit their jobs (because their jobs would then be more attractive) and (3) a significant increase in prices of production processes heavily dependent on covered minimum wage workers. However, Wessels (1987) finds little empirical support for such conclusions drawn from conventional theory. Indeed, in general, he finds that minimum wage increases had the exact opposite effect: (1) participation rates went down, (2) quit rates went up and (3) prices did not rise appreciably—findings consistent only with the view that minimum wage increases make workers worse off. With regard to quit rates, Wessels writes:

> I could find no industry which had a significant decrease in their quit rates. Two industries had a significant increase in their quit rates….These results are only consistent with a lower full compensation. I also found that quit rates went up more in those industries with the average lowest wages, the more full compensation is reduced. I also found that in the long run, several industries experienced a significantly large increase in the quit rate: a result only possible if minimum wages reduce full compensation.

From this perspective, the figures cited by Herbert on the added income received by 10 million workers are grossly misleading because the figures suggest the affected workers are better off, which is not likely to be the case, given their loss of fringe benefits and their increased work requirements. The fact that Card and Krueger (1994, 1995) also find no loss of jobs suggests the market may have forced nonwage adjustments on the fast-food restaurants studied.

Although economists might speculate that the job reductions have been small because the low-skilled labor market exhibits a low elasticity of demand (or low responsiveness among employers to a wage hike), such an explanation is hardly compelling. The demand elasticity for anything, including labor, is related to the number of substitutes the good (or labor) has: the greater the number of substitutes, the greater the ability of buyers (employers) to move away from the good (labor) when the price (wage rate) is raised and, hence, the greater the responsiveness of buyers (employers), or elasticity of demand.

The problem with this explanation is that no labor group has more substitutes than low-skilled (minimum wage) workers, especially now that firms have so much flexibility to automate jobs out of existence or to replace domestic workers with foreign workers by way of imports. The elasticity of demand for low-skilled labor must be relatively high; hence, the relatively small decline in the number of low-skilled workers in response to a minimum wage hike points to one central conclusion: the mandated wage hike is offset in large measure by other adjustments in the affected workers' compensation packages.

Minimum Wage Consequences Over Time

This line of argument does not lead to the conclusion that minimum wage increases of given amounts should always have the same employment effect no matter when they are legislated. Look-

No labor group has more substitutes than low-skilled (minimum wage) workers, especially now that firms have so much flexibility to automate jobs out of existence or to replace domestic workers with foreign workers by way of imports.

Legislators simply do not have as much power to manipulate markets as they think.

ing back at Chart 1, we might reason that as the real minimum wage rose between 1938 and 1968, employers did what they were pressed to do to moderate their labor cost increases: take away progressively more fringe benefits and add progressively more work requirements (compared with what they would have done). Thus, as time passed we would expect the employment effects of a given minimum wage increase to go up as 1968 approached simply because there were fewer ways for employers to adjust to the wage hike.

Conversely, as the minimum wage fell irregularly after 1968, we would expect employers to respond by gradually adding back more fringe benefits and relaxing work requirements (a trend that has likely accelerated with the increasingly tight labor market in the late 1990s). The result would be that in the 1990s employers would have had more ways to adjust to a minimum wage hike than they had in, say, the late 1960s. As a consequence, we should not be surprised that Card and Krueger (1994, 1995) find little or no employment effect in the early 1990s, whereas studies in the 1960s find larger effects.[13] Nor should we be surprised if future studies of the impact of any 1999 minimum wage increase show similarly negligible negative employment effects.

Conclusion

Congress and the president need to recognize a simple fact of modern economics: you can't fool the market as much as you imagine, at least not all the time. Legislators simply do not have as much power to manipulate markets as they think. Thus, we can anticipate that, once again, the chosen increase in the minimum wage will have minimum employment consequences for two reasons. First, Congress will choose a fairly small increase in the minimum wage because of political groups working against the bill. Second, market forces will largely neutralize the potential negative employment effects of whatever wage increase is legislated.

Notes

Richard McKenzie, author of *Getting Rich in America: 8 Simple Rules for Building a Fortune and a Satisfying Life* (HarperBusiness, 1999), is a professor in the Graduate School of Management at the University of California, Irvine. At the time this article was written, he was visiting the Research Department of the Federal Reserve Bank of Dallas.

1 The companion bills, if passed, would raise the minimum wage from $5.15 to $5.65 per hour on September 1, 1999, and to $6.15 per hour on September 1, 2000 (Fair Minimum Wage Act of 1999, 106th Cong., 1st sess., H.R. 325, S.R. 192). Another bill would delay the full $1 increase until September 1, 2001, but it would go one step further and raise the minimum wage annually by the Consumer Price Index after September 1, 2002 (Long Term Minimum Wage Adjustment Act of 1999, 106th Cong., 1st sess., H.R. 964).

2 The percentage of nonsupervisory workers covered by the federal minimum wage rose from 57 percent in 1950 to 87 percent in 1988 (the latest year of available data). This rise in coverage should have caused any increase in the minimum wage to have a progressively greater negative employment effect over the years, which is what economist Marvin Kosters finds (see Kosters 1989).

3 See Herbert (1998).

4 Several recent statistical studies on the negative employment and income impacts of state and federal minimum wage hikes can be found on the Employment Policies Institute web site, <http://www.epionline.org/research_frame.htm>.

5 For reviews of the minimum wage literature, see Brown, Gilroy and Kohen (1982) and Brown (1988). In more recent studies in the 1990s, the reported employment effects among teenagers continue to be relatively small (see Burkhauser and Wittenburg 1998).

6 These estimates of labor market responsiveness to minimum wage hikes are independent of labor market tightness. If the country's labor markets remain relatively tight over the next year or so, the number of low-skilled workers covered by the minimum wage can be expected to fall as market-determined wage rates for low-skilled workers rise past the proposed new levels for the minimum wage. (Currently, only about 4 million Americans work at the federal minimum wage.) Hence, while the percentage reduction in the number of minimum wage jobs may remain more or less in line with past studies, it stands to reason that the actual number of minimum wage jobs will fall as the number of covered workers shrinks.

7 See Fuchs, Krueger and Poterba (1998).

8 Tight labor markets, like the ones in the United States in 1999, can cause wages and fringe benefits to rise, even for low-skilled workers, and can cause the number of workers affected by any minimum wage hike to fall. However, the point that minimum wage hikes increase the relative bargaining power of employers still holds for those workers remaining at the minimum wage. Moreover, if employers have responded to their tight labor markets by increasing their workers' fringe benefits, then there will be more benefits for employers to take away when faced with a hike in the mandated money wage rate.

9 Indeed, it may be interesting to note that, at least conceptually, minimum wage workers might contemplate the prospects of buying their firms if their firms did not make compensation and work adjustments and if they, the minimum wage workers, could make the purchase. The point here is that even worker groups can see the financial benefits of adjusting fringe benefits and work requirements in light of a minimum wage increase.

10 Even the Employment Policies Institute study (Macpherson 1998), which contains estimates of employment losses that are on the high side of the expected range, shows a reduction in Washington's total employment (2.7 million workers) of less than 0.3 percent in response to a proposed 26 percent increase in the state's minimum wage. It can be noted that if Washington has the average percentage of minimum wage workers—8.8 percent—then the Macpherson study suggests that each 10 percent increase in the minimum wage

would lower the employment of covered workers by, at most, 1.2 percent.

[11] Granted, not all low-skilled workers have many fringe benefits that can be taken away, and some minimum wage workers may be working very hard. The argument that is being developed suggests that the negative employment effects of a minimum wage increase will be concentrated among this group of particularly disadvantaged workers.

[12] For more details, see Wessels (1980).

[13] The implication of the theory that a minimum wage hike will have a greater impact on employment when the minimum wage is high, compared with when it is low, has not been rigorously tested. However, it is interesting to note that through the 1950s, 1960s and early 1970s the *New York Times* staunchly supported increases in the minimum wage, mainly because the evidence on the negative employment effect was not strong. However, as the evidence mounted in the 1960s that minimum wage hikes had a negative employment effect, especially among minority teenagers, the newspaper began to shift its editorial stance. By the mid-1980s, it favored a minimum wage of "$0.00." The *New York Times* has since shifted its editorial stance back to support for minimum wage hikes, mainly because the negative employment effects have been shown to be nil in recent studies. See McKenzie (1994).

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Hey, Mr. Greenspan, Can You Spare a Dollar?

THE MEGADEVALUATIONS, banking crises and continent-jumping financial contagions of the past two years have sent policymakers searching for monetary programs to insulate their countries from such problems. In Latin America, the dollarization option is getting considerable attention. It has been the subject of debate in both Mexico and Brazil. And the president of Argentina has been pushing for dollarization there.

When a country officially dollarizes, it uses only U.S. currency. All bank accounts and loans become dollar-denominated. Countries that adopt the dollar cannot print money, so they must rely on taxes to pay their debts.

Dollarization has several benefits. It is one route to fiscal and monetary credibility because it can hold down inflation, maintain price stability and probably lower interest rates. Another benefit is that it enables a country to avoid the large exchange rate devaluations that are possible whether it has flexible or pegged rates or a currency board.

The 1990s have seen a run of collapsed exchange rate regimes (*Chart 1*). Dollarization is not an economic cure-all. But because a country that adopts the dollar cannot devalue U.S. currency, dollarization eliminates the disruptions that can occur both in anticipation of a devaluation and after one.

Devaluations are part of a broader problem—financial contagion, which occurs when one country's problems are at least temporarily transmitted to other countries, regardless of those countries' economic conditions. An example of this is the effect Russia's 1998 financial crisis had on Mexico and Argentina. Although there was little reason to consider either country a candidate for financial meltdown, interest rate increases moved through the financial systems of both. Interest rates may have become unstable because the markets factored in the likelihood of a devaluation.

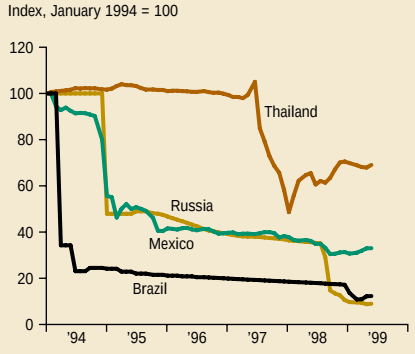
But whether a contagion is irrational or rational, investors' perceptions of policy credibility can trigger capital outflows and exchange rate crises. Investors may anticipate that governments will cheat on their commitments to stable monetary and fiscal policy, and they may fear that other investors share their suspicions. Consequently, investors often pull out en masse, triggering a sharp reduction in demand that can set off a currency crash and a sudden drop in asset prices.

Supporters of dollarization say it is one way to avoid some capital outflows—at least those that occur in anticipation of a currency crash. Dollarization ties policymakers' hands, preventing them from running up deficits that would have to be paid for with inflationary financing.

Dollarization Drawbacks

Dollarization, however, has its costs. A dollarized country cannot conduct its own monetary policy but instead has to follow the Federal Reserve Board's policies. A dollarized currency regime limits a government's ability to serve as a lender of last resort in a banking crisis.

Chart 1
Exchange Rates, 1994–Present



NOTE: 1999 data are through May.

Dollarized countries cannot create money to rescue the banking system because they can't create dollars at all.

A dollarized country also sacrifices its seigniorage, which is the profit a country makes from printing money. It costs three cents to print a $100 bill, but that bill can purchase $100 worth of goods and services. In a nondollarized economy, the central bank holds international reserves in interest-bearing instruments, such as U.S. Treasury bills. Under dollarization, a country loses the interest earned from these types of instruments.

U.S. territories such as Guam and American Samoa are dollarized, as are the Marshall Islands and Micronesia. Panama is the only Latin American country that has officially dollarized, but unofficial dollarization is common. The value of dollar bank deposits is greater than that of domestic currency deposits in Argentina, Bolivia, Peru and Uruguay.

Argentina has all but officially dollarized. In 1991, the country adopted a convertibility plan that would force the government to abandon inflationary spending and convince investors policymakers were committed to this course. Not only is the Argentine peso fixed to the dollar, but bank accounts can be converted to dollars, which can be used to make purchases. (Wages and taxes must still be paid in pesos.) Argentine President Carlos Menem has been pressing for full, official dollarization.

If additional countries opt for official dollarization, the already high foreign demand for dollars would go even higher. The United States would have to print more money but would benefit from the seigniorage.

Dollarization is not the only route to fiscal and monetary credibility, price stability and low inflation. But its supporters argue that it may be a more viable route than others.

—William C. Gruben
Sherry L. Kiser

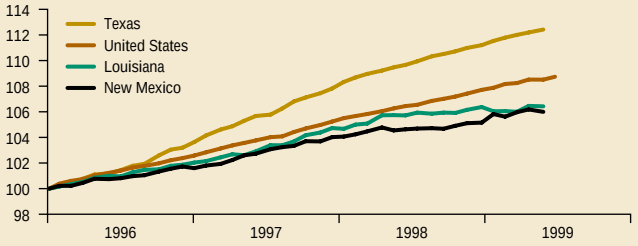
Regional Update

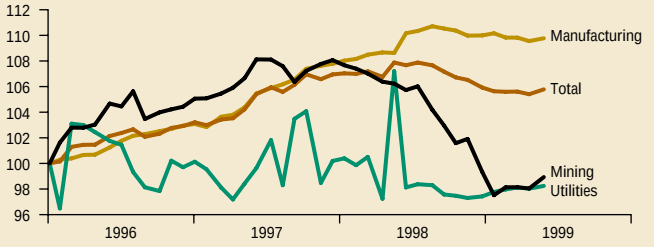
THE DISTRICT ECONOMY continues to grow, albeit at a more modest pace than a year ago. Seasonally adjusted employment rose at an annual rate of 2 percent in April and 2.5 percent in May, down from 2.9 percent in the first quarter. The service sector is still adding jobs at a strong pace, but low commodity prices continue to hurt the manufacturing and energy industries, and the region's booming construction industry is cooling.

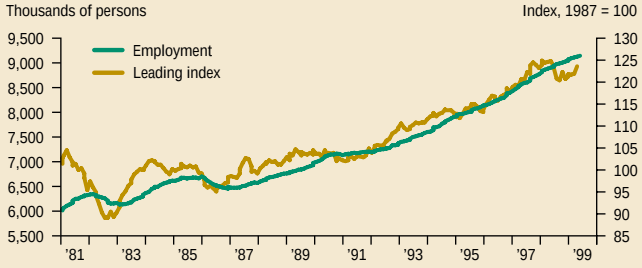
After surging in the first quarter, Texas construction contract values and housing permits came down to earth in April. Total contract values fell at an annualized rate of 24 percent, led by a steep decline in nonresidential building construction. Housing permits fell 23.5 percent. Construction employment fell at an annualized rate of 3.4 percent in May after rising at an annualized rate of 9.4 percent in the first four months of the year. Contacts in the real estate community continue to express concern about some overbuilding, however.

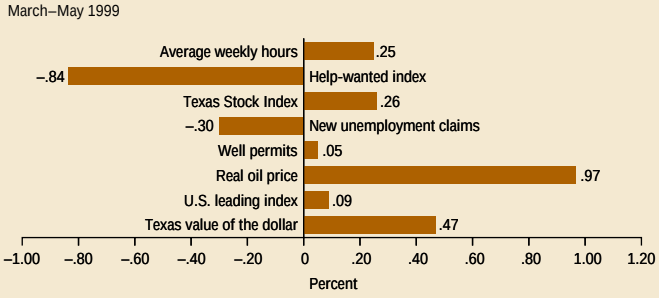
Energy activity has not increased much with higher oil prices, although there is increased optimism about the second half of this year. U.S. output is expected to rise by at least 400,000 barrels per day if oil prices remain at their current levels. Still, oil prices will come down as fast as they went up if OPEC does not hold together. Although OPEC's output agreement seems to be holding up, fiscal and supply pressures may cause a break in the agreement. The Venezuelan and Mexican economies are suffering from low oil revenues and may be compelled to revise their output cuts. On the supply side, Iraqi oil production will rise as its output ceilings are raised in the United Nations' oil-for-food program. Higher oil prices will bring increased supply from other non-OPEC producers as well, putting downward pressure on prices.

—Fiona Sigalla









Regional Economic Indicators

	Texas Leading Index	TIPI** total	Texas employment*					Total nonfarm employment*		
			Mining	Construction	Manufacturing	Government	Private service-producing	Texas	Louisiana	New Mexico
5/99	122.8	127.4	153.6	522.6	1,104.6	1,523.2	5,840.4	9,144.4	1,904.5	730.2
4/99	123.6	127.0	154.6	524.1	1,105.2	1,521.3	5,820.6	9,125.8	1,905.1	731.5
3/99	121.9	127.2	157.9	519.6	1,106.5	1,521.2	5,805.3	9,110.5	1,896.9	730.0
2/99	121.7	127.2	158.8	518.6	1,108.5	1,518.1	5,789.1	9,093.1	1,897.8	727.6
1/99	121.8	127.2	159.5	513.7	1,110.2	1,516.8	5,772.1	9,072.3	1,897.6	729.0
12/98	121.3	127.6	161.8	509.0	1,111.0	1,511.2	5,752.3	9,045.3	1,903.5	724.4
11/98	120.7	128.3	162.2	507.7	1,111.3	1,509.7	5,736.7	9,027.6	1,899.6	724.1
10/98	122.3	128.6	163.7	505.2	1,112.3	1,505.6	5,719.0	9,005.8	1,895.3	722.7
9/98	120.4	129.1	165.0	502.2	1,113.3	1,502.5	5,706.1	8,989.1	1,895.7	721.1
8/98	120.8	129.7	165.8	500.0	1,111.1	1,506.6	5,690.8	8,974.3	1,894.2	721.4
7/98	123.3	129.9	166.9	498.3	1,108.7	1,495.0	5,673.6	8,942.5	1,895.7	721.2
6/98	123.7	129.7	167.9	493.7	1,108.6	1,497.6	5,652.0	8,919.8	1,891.8	720.8

* in thousands
** Texas Industrial Production Index

Further Information on the Data

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).

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