So, what do the economics of biotech industry location and the political economy of why badly run countries remain badly run have to do with each other? Nothing, except the fact that Milken Institute scholars are interested in both subjects. Check out their latest and greatest musings on the topics.

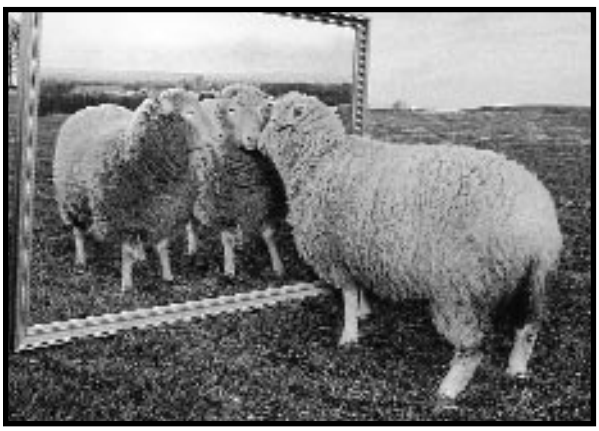
Biotechnology and Bioscience

BY ROSS DEVOL

The biotechnology and bioscience industries are on the cusp of significant breakthroughs in decoding genetic structures, understanding cellular processes, aiding diagnosis of a wide array of diseases, and creating treatments for diseases. The timing of these advances is especially fortuitous for the baby boom generation, which is rapidly approaching the high-risk age for cancer, cardiovascular diseases and brain disorders such as Alzheimer's and Parkinson's.

Seniors, who represent 15 percent of the population today, already purchase one-third of all prescription medications dispensed in the United States and will account for 30 percent of the population in a decade. Even more dramatic aging patterns are transforming Japan and Western Europe, feeding an explosion in the world's elderly. The total over-65 population will expand from about 550 million today to over one billion in 2020. The major biotech and pharmaceuticals firms recognize the potential returns that these changing demographics imply, and are investing in research accordingly.

Biotechnology and bioscience thus have the potential to mean to the first half of the 21st century what information technology meant to the second half of the 20th. Indeed, we are likely to see a fusing of information technology and biotechnology/bioscience into a powerful economic force. The computer is being applied to decipher and manage the vast genetic information that will play a major role in the global economy. Of course, there is growing resistance to bioengineered foods and animals. This is an ongoing battle that might slow, but certainly cannot block,



STEPHEN FERRY/REMI BENALI/LIFE MAGAZINE/DIGITALLY ASSEMBLED PHOTO BY STEVE WALKOWIAK/LIAISON AGENCY

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significant advancements by the army of researchers engaged in the industry.

A BRIEF DEFINITION AND HISTORY

To analyze the biotechnology and bioscience industries, one must first define them. Bioscience is the broader term, incorporating biotechnology and other life science industries, commercialization in the private sector and development of related medical devices, instruments and software. Biotechnology concerns the processes through which living organisms are modified to create products with industrial applications.

The concepts are not new. Humans learned long ago that they could selectively breed livestock, transform sugars into alcohol and convert milk into cheese. During World War II, factory-produced penicillin reduced deaths from infectious diseases and lessened human suffering. But the modern biotechnology industry dates from the seminal research of biologists James Watson and Francis Crick, who in 1953 mapped the chemical structure of the DNA molecule. Over the next 20 years, biologists developed the molecular tools that would allow isolation, replication and alteration of DNA.

The true biotechnology age, however, began in 1973, when Stanley Cohen of Stanford and Herbert Boyer of the University of California at San Francisco collaborated to combine DNA from different life forms to give birth to the first recombinant DNA organism. Just three years later, Boyer and venture capitalist Robert Swanson founded Genentech, which became a pioneer in developing and marketing products, unveiling its first product based on recombinant DNA technology in 1977. An important milestone for the industry was the 1980 Supreme Court decision that genetically altered life forms could be patented. That pulled investment capital into the industry and spurred rapid growth.

The next major biotechnology era was initiated in 1990 with the Human Genome Project, a research effort designed to map life from its smallest building blocks. Although international in scope, it has largely been staffed by Americans. Indeed, in many respects, this is the most ambitious project that Washington has undertaken since the space program of the 1960's. The project seeks to map and sequence the three billion base pairs of human DNA and to identify the approximately 100,000 genes that comprise the human genome, at a cost of about $13 billion. Thanks to rapid advances in computer technology, the process should be completed by the end of 2001 rather than the original scheduled completion date of 2005.

CURRENT INDUSTRY STATUS

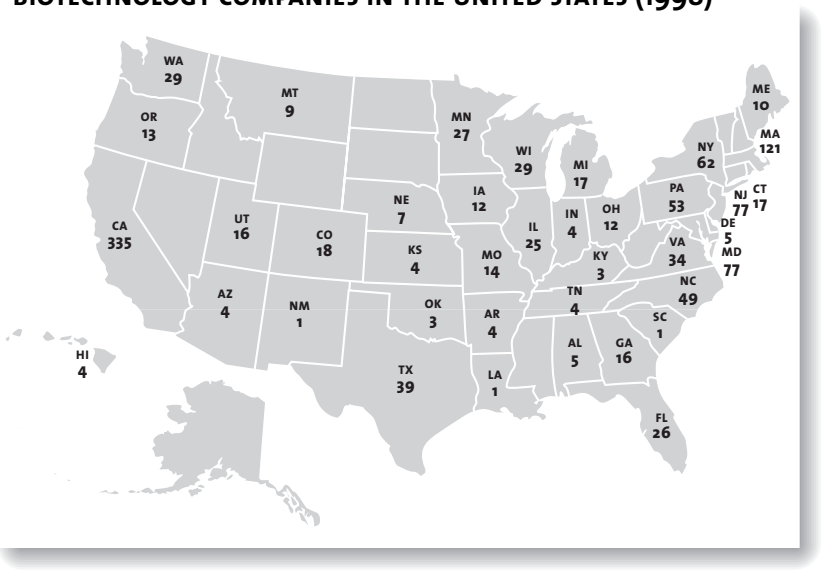
More than 80 biotechnology drugs and vaccines have been approved by the Food and Drug Administration. They include Immunex's Enbrel for rheumatoid arthritis, Biogen's Avonex for multiple sclerosis, Centocor's ReoPro for heart attack and stroke, and Amgen's Epogen red-blood-cell stimulant. There are more than 350 biotechnology drugs and vaccines undergoing human clinical trials and hundreds more in earlier stages of development. Some 1,300 firms in the United States are in the biotech business. Most are small: two-thirds employ fewer than 135 people and only one-fifth are publicly owned.

Biotechnology has given us less expensive and more accurate tests for a wide array of diseases, as well as consumer diagnostics such as home pregnancy test kits. And while they face a political backlash, genetically engineered seeds, crops and biopesticides are

increasing agricultural productivity. Biotech products are reducing the cost of water purification and hazardous waste disposal. Even crime-solving is benefiting from cheaper, faster and more accurate DNA testing.

One of the hottest areas attracting new talent is bioinformatics, the application of information technology to genetics and molecular biology. Mapping the human genome is the first step; the real action will be in scouring the data for small genetic variations using computers and sophisticated new software. Human clinical trials may become less critical as software simulates biochemical reactions within the body.

BIOTECHNOLOGY COMPANIES IN THE UNITED STATES (1998)



Better drugs involve more complex molecules that pose greater difficulty in getting to where they will do the most good. We can envision development of a range of innovative means of improved drug delivery (everything from ultrasound and electricity to micro-machine implants). A wristwatch may even monitor blood sugar in diabetics, and deliver small, continuous doses of insulin.

CLUSTERS' POSITIONING FOR FUTURE GROWTH

Although discoveries in biotechnology/bioscience will benefit the entire human race, there is a different kind of race under way – one to determine where the new industries will cluster. The economic consequences will likely be immense. For the biotechnology industry is among the most research-intensive sectors in the economy, seeding its future discoveries by investing more than half its revenues – some $10 billion – in 1998. The top five biotech firms invested an average of $120,000 per employee on research and development, while the leading pharmaceuticals firms spent $30,000 per employee. Thus, the pool of high-paying, equity-owning knowledge workers that those industries will attract, and the supplier infrastructure that develops around them, promise significant wealth creation for the winning regions.

This new cluster race has many regional entries around the United States. San Francisco and the Bay Area, Los Angeles, Orange County, and San Diego are generally listed among the leading aspirants. Other regions in the running include Boston, the Research Triangle area of North Carolina, Austin, and central New Jersey.

Even though biotech is a young industry, an increasing number of firms are reaching maturity. The factors that determine where biotechnology and bioscience firms are spawned, in contrast to where they grow into

adulthood, would seem to be quite different. Indeed, making this distinction is critical when evaluating the attractions of competing biotechnology/bioscience clusters.

Biotechnology is research-intensive, with a long payback period for return on investment. And it is no coincidence that biotechnology and bioscience firms are heavily concentrated in regions with top research centers. By the same token, it is no secret that venture capitalists don't like to fly. So financing generally comes from nearby.

Early financing is critical for young "gazelle" firms, because sophisticated research facilities are very expensive. High-end scientists are critical, but gazelles also need a deep pool of management and operational talent. And quality of life matters a lot in attracting the gold-collar workers those firms require.

BIOTECH LOCATION FACTORS (Rank of Top Regions*)

	RESOURCE INFRASTRUCTURE**	OPERATIONAL SUSTAINABILITY***
Austin, TX	8	2
Bay Area, CA	3	5
Boston, MA	1	6
Los Angeles/ Orange County, CA	5	7
Princeton, NJ	7	4
Research Triangle Park, NC	6	1
San Diego, CA	4	3
San Francisco, CA	2	8

* Regions ranked based on mean factor score 1 to 8, 1 being highest and 8 being lowest.

** Resource Infrastructure factors include: Quality of Local Research, Accessibility to Financing, Quality of Labor Pool, Quality of Life, and Infrastructure.

***Operational Sustainability factors include: Availability of Land for Research and Clinical Trials, Availability of Land for Manufacturing, Tax Incentives, Operating Costs, Permitting Process, Health and Environmental Regulations, and Animal Testing Regulations.

Source: A.T. Kearney Inc.

Mature biotechnology firms focus more on clinical testing and production and less on research. That causes them to adjust their thinking on the optimal location. High-tech manufacturing depends on land availability and the ease of getting building and operating permits for the factories. But biotech clusters are usually in high-growth regions, where production costs are high. Moreover, local support for the animal-based testing some of those firms perform may not be forthcoming in areas that hardly lack job opportunities.

A recent study by management consulting firm A.T. Kearney sheds some light on what matters in site selection. Kearney polled senior executives at some 40 biotechnology, pharmaceuticals and medical-device companies, asking them to rate 8 regions on 12 site-selection criteria. As shown in the accompanying tables, the 12 factors were aggregated into two major categories: "resource infrastructure" – the people and institutions needed to conduct business – and operational sustainability.

The study found that young firms weigh resource infrastructure heavily, while maturing companies look to the nuts-and-bolts issues of production. And the results suggest that the regions with an edge will be those that do well in both broad criteria.

Boston appeals to young companies, ranking first in four out of the five resource infrastructure components. San Francisco is second and the rest of the Bay Area is third.

In addition to its world-class research institutions and a highly skilled labor pool, biotech firms in Boston face a friendly government. Massachusetts' program for technology transfer is among the best in helping academics commercialize their research. Massachusetts has also been at the forefront in creating extensive public venture-capital funds for early-stage financing. Boston also

achieves high scores on business assistance and mentoring of its fledgling firms through its biotechnology incubators.

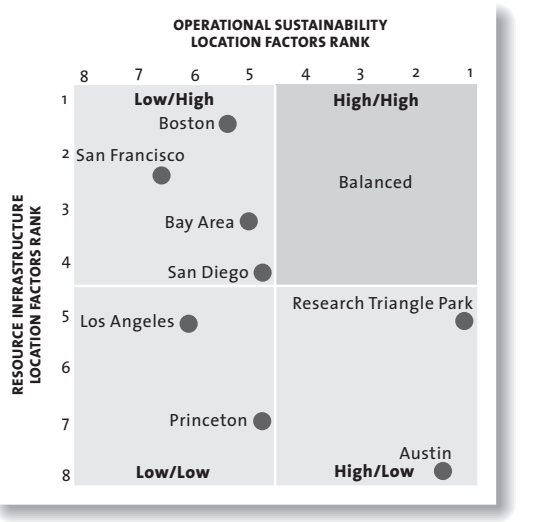
The Research Triangle area of North Carolina is most attractive to maturing firms, scoring highest in five out of the seven criteria for sustaining operations. Cheap land, combined with business-friendly zoning and assistance with infrastructure, make it relatively easy to launch manufacturing operations. North Carolina has zoned three times more land for manufacturing than for lab space. At the other extreme, San Francisco has zoned more than eight times as much land for lab space as for bio manufacturing.

North Carolina has also offered tax incentives to decrease production costs and provided state funding for training a biotechnology manufacturing labor force. Austin ranks second on operational sustainability, scoring first on public policy toward animal research and speed in granting licensing and building permits. San Diego is a strong third on operational sustainability. Boston slips to sixth place in that category, and San Francisco is eighth.

San Diego achieves the best balance between factors important to young and maturing companies, although no region provides the balance that the industry desires. Boston, San Francisco and the Bay Area appeal to young companies, but don't suit maturing ones. The Research Triangle and Austin have the opposite problem.

Why does balance matter so much? If you develop young firms, but lose them when they mature, some other region gets the wealth. On the other hand, if you excel only in biotechnology manufacturing, you will not attract the highly skilled and highly compensated scientists and researchers who provide a large multiplier impact on a regional economy.

BIOTECHNOLOGY REGIONS ARE UNBALANCED



Hilton Root Explains It All to You

BY HENRI LEPAGE

THIS INTERVIEW OF HILTON ROOT, the acting director of global studies at the Milken Institute, was conducted by Henri Lepage of the University of Paris IX-Dauphine and translated by Nancy J. Overholt of the University of California at Santa Barbara. An expanded version appeared in the French periodical *Politique Internationale.*

HENRI LEPAGE: *The book you are editing with Bruce Bueno de Mesquita,* Governing for Prosperity *[Yale University Press], analyzes the institutional conditions needed for economic development. What is the message you want to get across?*

HILTON ROOT: That there is no longer any fundamental disagreement about the means by which economic development occurs: the remaining hurdles slowing growth are essentially political.

HL: *Have we actually solved the riddle of economic development? If so, why are there still so many failures?*
HR: Until the 1980's, reasonable people could claim that the path to development could be achieved through collective means. It was not unusual to believe in central planning over blind market forces. Today, there is scarcely anyone who would disagree; the countries that chose a centrally planned approach have all gone bankrupt. Economists are now largely in accord about the basic building blocks of development. And few people claim that the advantages of capitalism can be obtained without the institutions that underpin it – private property, competition, the rule of law.

HL: *Except, of course, in France, where the consensus in favor of the market found among Anglo-Saxon economists – indeed, among most of our European neighbors – is far from being unanimous.*
HR: The historical record speaks for itself. We know that the absence of natural resources does not impede growth – the rise of the Asian Tigers demonstrates this. And the subsequent emergence of the Southeast Asian economies shows that economic failures can no longer be explained by so-called cultural biases. Finally, these countries illustrate the importance of what economists call human capital – investment in education.

The Asian experience also illustrates that in order for there to be growth, benefits must be shared in a way that society judges equitable. Stable growth can happen only when there is political consensus. The exterior threat from China was a big help, forcing East Asians to put aside their differences about distribution and to focus on the means to put into place a society focused on economic growth. But the Communist risk disappeared and Asian societies are now more divided.

HL: *If economists are mainly in agreement, how is it that economic inequality continues to grow? How can you explain that humanity continues to fight hunger, poverty and sickness?*
HR: We can no longer treat these tragedies as natural evils beyond the reach of human influence. Nor can we treat them as the result of our ignorance concerning the mechanisms of economic growth. The huge differences in growth rates are clearly the consequence of whether political institutions support or undermine economic freedom.

HL: *The key to success depends not so much on the knowledge of economists as it does on our understanding of the ways political institutions order individual incentives?*
HR: Exactly. We must stop representing the state as the product of some mythic general good pursued by people who, even when they are misguided, have nothing but disinterested service to their citizens in mind. In both democracies and authoritarian regimes, all political decision-making is driven by the personal incentives of those in power. Certain institutional arrangements lead officials to make good decisions; others encourage them to become predators. We are trying to identify not just the economic solutions to poverty but also the political solutions.

HL: *Can you give us a concrete application of your approach?*
HR: The Asian crisis. Many are persuaded that the principal cause was hot money – excessive movement of capital across national boundaries. So the news media are generally favorable to the reintroduction of currency controls. Economists know that the crisis originated in the persistence of mercantilist and

corporatist policies that, in a world with a free flow of capital, made a meltdown inevitable.

Go back a step. There's a link between the policies and the authoritarian nature of these countries. Without a civil society, the survival of political leaders is based less on the satisfaction of the greatest number than on the use of the state's power to direct the spoils of growth toward groups whose support keeps the leader on top. In societies with democratic governments, politicians can maintain their hold on power only by building large coalitions – which limits their ability to use state structures to distribute favors. Democracy is thus more likely to support growth, since the gains from individual initiative are protected by the state.

For some time before the crisis, it was evident that Asia was going to hit the wall. But even if they knew of the danger, the reigning leaders, democratic and autocratic alike, could do nothing; they would have had to agree to reforms that deprived them of financial control, which was critical to maintaining political power. Since the crisis, these countries have still been reluctant to open their financial systems because political power is grounded in financial power.

The crisis is not limited to the economy. What has happened is both more serious and more profound: Asian societies haven't adapted to conditions for durable growth in a world of free markets, a situation that, for the historian that I am, recalls the contradictions that led to the French Revolution.

HL: *You say there is no longer any doubt about the universality of market-based solutions. Yet recent history gives us several counterexamples: Start with Russia.*
HR: This "counterexample" is, in fact, not one. The Russians have tried to build a capitalist society. But they have preserved many of the institutions of central planning. An omnipresent state still exists, whose propensity for predatory taxation and capricious regulation is a disincentive to growth. Since the owners of privatized firms have uncertain property rights, they plunder, rather than invest in, the companies they control.

HL: *How about the IMF's "structural adjustment" programs? They are examples of liberal economic orthodoxy that have failed to bring about growth to a number of countries.*
HR: It's not enough to introduce a macroeconomic policy that is well designed if the institutions in place do not generate good choices.

HL: *What does this entail?*
HR: Increasing the legal and political constraints that guarantee the sanctity of private contracts; guaranteeing citizens that the state will respect its own contracts; creating a fiscal system that collects taxes in a transparent manner based on clear principles. This may appear rather simple. But macroeconomists tend to forget the malevolent capacity of the state in the third world. Without institutional changes, good macro policies will be in vain.

HL: *How do you explain the institutional weaknesses that led to the East Asian crisis?*
HR: Take Korea. Its growth was anchored on a mercantilist strategy in which the state controlled all financing and distributed credit to companies that appeared to have the most dynamic export strategy. That concentrated economic and financial power in the hands of a few large conglomerates – the chaebols – that collaborated closely with the administration.

It is never good for decisions concerning the allocation of capital to come from a closed group, acting in concert. It is not good for either democracy or the economy. When 15

families control practically all the capital in a country – as in Indonesia, the Philippines and Thailand – it is difficult to have rule by law. It is difficult to have effective laws when those who control the capital can buy judges and politicians. The powerful take what is available and leave only crumbs for other businesses. Capital is thus rarely used most efficiently. And the banking system remains ignorant of modern risk-management techniques: why make the effort to learn when it will not be the banker who chooses the portfolio?

HL: *What is the solution?*

HR: The prerequisite to stable growth is the destruction of industrial and financial oligarchies, accompanied by the development of stock and bond markets and supported by a gamut of banking and financial institutions. When these countries have competitive capital markets, with stockholders who demand results, the problem will solve itself. Competition – at first from foreign firms, which are more efficient – will compel domestic firms and banks in these countries to align their accounting practices with the modern norms. For this reason, it is most important that borders be opened to global financial institutions. It is still very difficult for a foreigner to buy a bank in Korea – and difficult for anyone to introduce a new financial product.

HL: *You believe in the virtues of general competition in banking when the media and politicians see it as a destabilizing force. What do you expect to get from more competition?*

HR: More transparency in accounting, greater expertise in lending decisions, a better understanding of risk – and thus, more efficient intermediation between investment and savings; better returns on assets; reduced market instability; stronger, more regular growth.

HL: *A fashionable idea is that achieving this goal would require the establishment of a worldwide super-administration.*

HR: A super-government would only bring about a super-disaster. What is needed is the sort of decentralization driven by the Internet.

HL: *Are Asian countries willing to follow this path of decentralization?*

HR: The new South Korean president, Kim Dae Jung, certainly understands the problem. He has promised to break the iron triangle that links government, finance and big business, and a majority of Koreans are behind him. But he is only the head of a minority party in a new democracy, whose institutions retain the influence of martial law. Moreover, reforms will be effective only if Koreans introduce more flexibility in their employment practices – and unions do not want to hear of that.

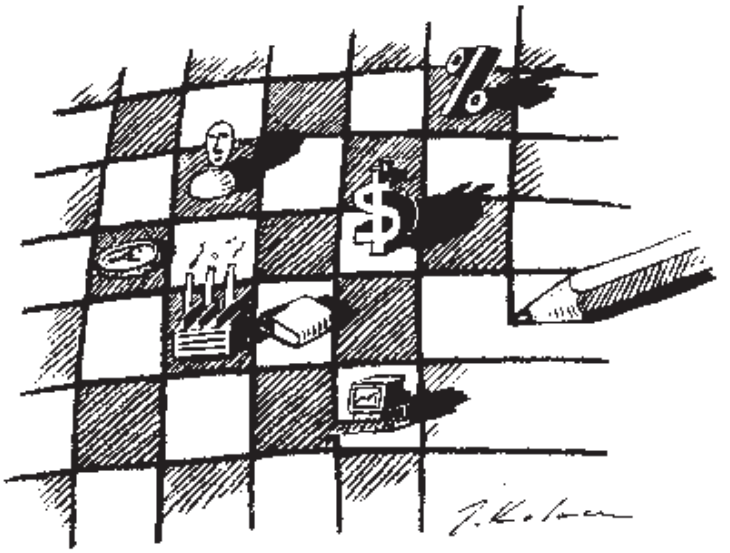
South Korea, a prisoner of contradictory interests, lacking a democratic culture mature enough to settle interest-group conflict through compromise, deprived of the unifying influence of a credible Communist menace, faces a double blockage – both political and institutional. And with few exceptions, the situations of other countries victimized by the financial crisis of 1997 are identical.

HL: *How do you explain in retrospect the remarkable success of these nations in the last 20 years?*

HR: Today's impasse is an outcome of the peculiar institutions of Asian capitalism. Whatever cultural virtues they possess, Confucian or other, it would not have mattered. Nevertheless, we must recognize that

the system worked well for the people of that region for 20 years. The Asian model of development had three winning cards:

- A high-quality civil service. The absence of a rule of law was counterbalanced by a professional cadre of economic advisers: a bureaucracy copied from Japanese law, which was in turn inspired by the German civil service. For a very long time, the result was economic management that was adequately independent from moneyed powers.
- The use of the bounty of growth to create a social consensus in support of economic development. In exchange for the promise of social peace (relatively easy to obtain in times of Communist menace), the state made huge investments in education, housing and health. Governments fostered the feeling that citizens really benefited in the construction of the economy.
- Investments in human capital and low tax rates allowed individuals to cash in on their own productivity. The climate in the Asian Tigers is very different from that of India, Vietnam or Algeria – countries where professional competence does not insure social mobility and confiscatory taxes undermine incentives for self-improvement. This is why savings rates are so high in the Asian Tigers, why everyone sacrifices today in order to benefit later. But the Asian growth strategy led to a fatal concentration of financial power. The Asian miracle is over, and the model that launched these economies must be significantly reformed.



JERZY KOLASCZ

HL: *Will they come out of it?*

HR: The historian in me observes that even severe economic crises rarely yield the needed institutional change. It is only at the edge of the abyss, when events degenerate into open political crisis, that leaders settle down to reform. But it is often too late. That is why France at the end of the 18th century was unable to save itself from a bloody revolution.

HL: *One last question. Can you explain why, over the past 10 years, a gulf has developed between America and old Europe?*

HR: America has just taken a big lead by promoting the democratization of capital. This is supported by two interdependent elements: on the one hand, the wide distribution of equity ownership – 40 percent of Americans own stock – and, on the other, the decline of banks and the enhanced role of securitized credit markets, which more effectively link borrowers with savers.

This is a largely unnoticed revolution. The growth of capital markets helps democratize and decentralize risks, which gives the United States an edge in efficiency. And with so many citizens owning equity, politicians are under pressure to produce economic policies that generate growth. M