From Kondratieff to Chaos: Some Perspectives on Long-Term and Short-Term Business Cycles

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FROM KONDRATIEFF TO CHAOS: SOME PERSPECTIVES ON LONG-TERM AND SHORT-TERM BUSINESS CYCLES

by

Charles Dale

AUTHOR'S NOTE: The nature of short- and long-term business cycles is a topic of considerable interest to futurists, since the state of the economy affects the possibilities for dealing with so many other areas of interest, from pollution control to child care. In this article, which is based on a talk that the author gave at the World Future Society's Sixth General Assembly in July 1989, he discusses the most recent ideas in both long- and short-term business cycle theory, and describes some of their interrelationships. One of the key connections between short- and long-term cycles is through industry, and the paper begins with a discussion of an industrial quality control issue.

THE DEFECTIVE YARDSTICKS

One of the most important issues facing the US economy today is its industrial competitiveness. Much has been written on this complex topic, and there is still no general agreement on the causes or cures for US industry's problems. Yet I believe that I discovered the major causes of our industrial problems in one afternoon at a local hardware store, when I bought a yardstick. When I looked at it I noticed that the 1/8 yard mark was at 4 inches, instead of 4 1/2 inches. The whole stack of yardsticks had the same defect. My initial reaction was the indignation felt by an adjunct business school professor at such poor quality control, but I quickly realized that I had a wonderful teaching device in my possession. If even one person had checked before the yardsticks were made, the defect would never have made it into production. It wouldn't even require a mathematical expert--anyone can see quite easily that the 1/8 marks are unequally spaced. The final irony is that a short distance away from the incorrect mark is printed "Made in USA". Those yardsticks illustrate more than just some badly made low-tech products, they are examples of poor quality control and the well known myopic vision so prevalent in businessmen. We will return later to a discussion of how muddled thinking and an inappropriate worldview can exacerbate movements in both short- and long-term economic cycles.

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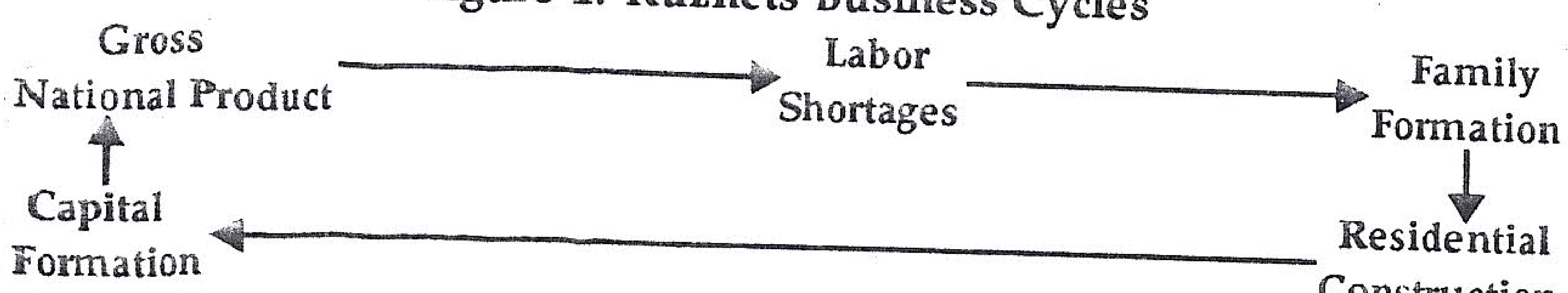
TYPES OF BUSINESS CYCLES

There are numerous ways to classify business cycles. One common taxonomy is shown in Table 1. "Business Cycles" usually mean 4 to 5 year swings in economic activity. In recent years some short-term business cycles have been both longer and shorter than that, but 4 to 5 years is a good average to use. These short-term swings have the greatest interest to policymakers, and we will discuss them in greater detail later.

Table 1: Hypothesized Cycles	
* Business Cycles	4-5 Years
* Kuznets Cycles	20-25 Years
* Kondratieff Cycles	50-60 Years

Economist Simon Kuznets detected 20 to 25 year cycles of economic activity, as shown in Figure 1. If an economy starts, for example, below full employment and there is an increase in business investment, or capital formation, this will lead to an increase in Gross National Product (GNP). The higher GNP will, in turn, increase labor market demand, put upward pressure on wages and encourage immigration. Those conditions in turn lead to more family formation and residential construction. The increase in construction leads to more spending for associated goods and thus to increased business investment, typically over-investment. When the over-investment is eventually reduced it causes a decrease in GNP (a recession) and reverses the entire process. Eventually some factor such as very low interest rates at the bottom of a recession causes business investment to increase again, and the process repeats, typically about 20 to 25 years from the original, below full employment starting point.

Figure 1: Kuznets Business Cycles



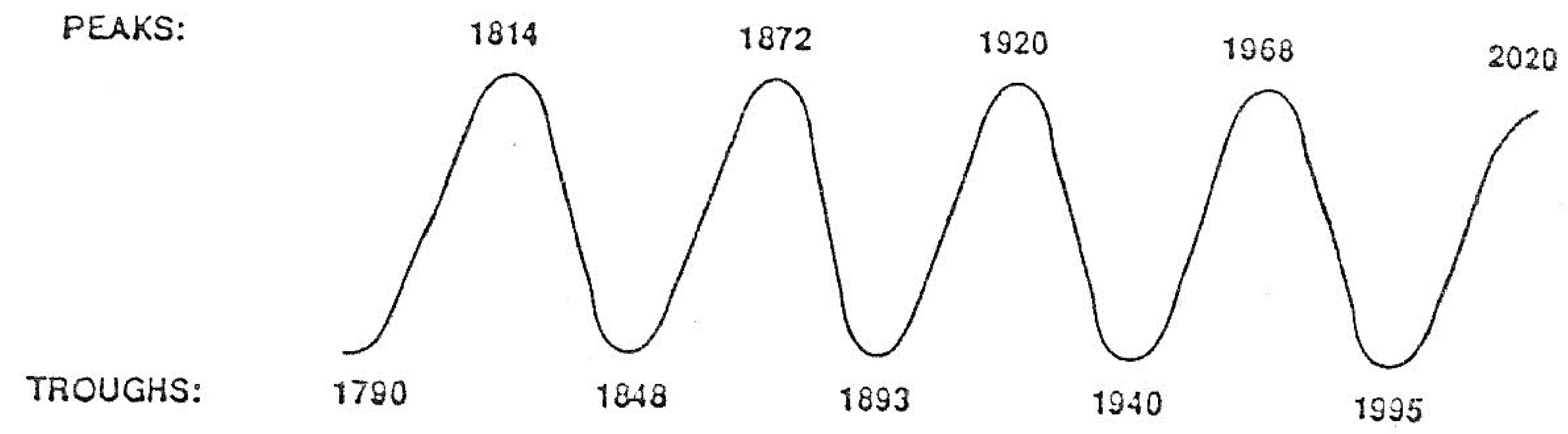
(Source: Van Duijn, 1983)

Kuznets cycles (also called construction cycles) gave a good description of construction cycles in 19th century America, but they have not worked as well in the mature America that emerged after World War I. Most economists, therefore, do not accept the current validity of Kuznets cycles. They do serve as a cautionary lesson that

business cycle theories may not be applicable to the future in spite of the fact that they have worked well in the past and have been supported by empirical data.

The Russian economist Kondratieff (also spelled "Kondratiev") hypothesized 50 to 60 year "long cycles" in economic activity. Figure 2 shows the Kondratieff cycles, or "long waves", that he discovered for the period 1790 to 1920 and which have been extrapolated by others (Goldstein, 1988; Berry, 1990). Those cycles have been applied, with mixed results, to movements in overall economic activity, to industrial production, and to prices.

Figure 2: Kondratieff economic cycles



Considerable research has been done on Kondratieff waves. There is a great deal of disagreement as to whether or not long waves even exist, and theories abound to explain their causes. Table 2 summarizes some of the most popular theories. Marxists have asserted that long waves are caused by factors outside the economy. Wars and revolutions are the causes of long waves, and are manifestations of the self-generating laws of capitalism (Trotsky, 1923).

Table 2: Sources of Long Waves
External Factors: Wars & Revolutions * Marxists
Internal Factors: Capital Investment * Forrester
Internal Factors: Innovations * Schumpeter * Mensch * Marchetti

More mainstream explanations of long cycles are provided by those who hypothesize that long waves are generated by changes in either capital investment or innovations. Forrester (1985) believes that changes in capital investment are the primary cause of long waves, an explanation similar to those used to explain Kuznets cycles.

Schumpeter (1939), Mensch (1979), and Marchetti (1988), on the other hand, believe that new product innovations are the key to explaining long cycles. Schumpeter in particular is frequently invoked in defense of those economic policies that would encourage entrepreneurs. Mensch wrote that basic innovations occur in clusters, as a result of necessity in a stagnating economy. He predicted that two-thirds of all basic innovations to be achieved in the period 1950-2000 would occur in the decade 1984-1994. Leaving aside debates over the definition of "innovations" (a typical measure is the number of patents issued), Mensch's prediction at this point appears to be very impressive. Marchetti, too, predicted a rush of innovations over the period 1984-2002, as new product innovations grow like a biological species filling a habitat that had been filled by a previously dying-off species.

Questions naturally arise as to whether policies can be devised to smooth movements in long cycles. Table 3 summarizes the suggested policies. To capital investment theorists like Forrester, since over-investment is the main cause of long cycles, the problem is primarily a management one. If managers can learn to understand their markets better, they might avoid overextending themselves.

Innovation theorists, on the other hand, believe that encouraging entrepreneurs to produce a continuous flow of new innovations is the key to smoothing long waves. Marchetti in particular says of entrepreneurs: "Give them money, make them heroes, detax them" (in Goldstein, 1988, p. 55).

Table 3: Policies to Smooth Long Waves
CAPITAL INVESTMENT THEORISTS * Better **Management** Is Needed to Avoid Overcapacity
INNOVATION THEORISTS * More Stimulus to **Innovation** Is Needed

A logical question that now arises is whether or not there is a connection between long waves and short-term business cycles. Thus, we turn next to a discussion of those short-term cycles.

CHAOS THEORY

Economists today have a rare opportunity: the chance to make a genuine scientific breakthrough. Researchers all over the world are testing economic systems to see if they are governed by the new

theory of "chaos". Chaos theory states that even small changes in the initial state of a seemingly simple system can lead to large and unpredictable changes in the subsequent behavior of the system (Baumol and Benhabib, 1989). The next section surveys the work being done in attempting to apply chaos theory to economics. If theories of chaos do apply to economic systems and financial markets, profound changes will be needed in our worldview of how economic systems work.

Futurists such as Hazel Henderson (1985) have long criticized economists for relying too heavily on abstract mathematical models and ignoring other disciplines such as scenario building and general systems theory. I am largely in sympathy with that view, but believe that a central problem with economics has been not reliance on mathematics but emphasis on the wrong kind of mathematics. Recent years have seen the development of new ideas that can describe complex and turbulent systems.

This following section also provides my personal view of what it is like to participate in an exciting scientific undertaking. Future economic historians will probably remember only the winners (if in fact there will be any), and will probably describe the discovery of chaotic economic systems in a logical, chronological fashion. In reality the researchers hunting for chaotic economic systems are in a constant state of confusion and bewilderment about exactly where to search and how to proceed, and are forever wondering who else is currently working on similar paths, what blind alleys are being pursued that have already been tried by others, etc. I will attempt to convey here those simultaneous feelings of excitement and frustration.

THE IMPORTANCE OF CHAOS

Chaos theory states that a simple, deterministic system can evolve in such a way as to appear to be random in nature. For example, if the growth in GNP is determined by a chaotic system, then GNP changes might appear to fluctuate wildly and randomly, when in fact if the internal generating mechanism were known then changes in the GNP would be predictable. Also, a characteristic of chaotic systems is sensitivity to initial conditions, i.e, very small policy changes could cause very large changes in the subsequent development of the system so that it appears the system is governed not by internal mechanisms but by external, random shocks.

The question naturally arises as to why economists or anyone else should care whether or not economic systems are chaotic in nature (Brock and Malliaris, 1987). One major reason is that there are significant differences in policy implications depending upon the nature of the underlying causes of business cycles in particular, as shown in Table 4.

Table 4	
Possible Causes of Business Cycles	**Effects of Government Policies**
INTERNAL FACTORS: (Inventories, Manufacturing Capacity)	
* Not Chaotic * Deterministic Chaos	* Government Can Help Economy * Government May Hurt Economy
EXTERNAL SHOCKS: (Oil Prices, Drought)	
* Not Chaotic By Definition	* Government Intervention Will Probably Make Things Worse
MIXTURE OF INTERNAL AND EXTERNAL FACTORS:	
* Not Chaotic * Noisy Chaos	* Government May Help Economy * Government Effects Uncertain

If business cycles are caused primarily by nonchaotic, internal factors such as excessive inventory buildups or shortages of manufacturing capacity, then many economists make a case for strong government fiscal and monetary stabilization policies. In this view, the economy is similar to the mechanism of a clock--it is basically stable, and just needs oil or fine tuning-occasionally to keep it running smoothly. For example, if the government sees that manufacturing capacity constraints are causing inflationary pressures due to excessive demand from an overheated economy, it could act to slow the economy by adopting a restrictive monetary policy, such as raising interest rates. A slower growing economy would restrain demand and also give manufacturers time to expand capacity.

If business cycles are, on the other hand, the product of deterministic chaos, then business cycles will always occur, apparently at random. If this is the case, then the government might apply a stabilization policy at the wrong time, making the economy worse. For example, the government might raise interest rates to slow the economy at about the time the economy is falling into a recession, and the result would be a much worse recession.

Suppose now that business cycles are caused instead mainly by external factors, such as changes in world oil prices or a severe drought. In this case governmental stabilization policies might make things worse. It would not be a good policy to try to hold down prices by slowing the growth of the economy through reducing demand, when the real problem is a shortage of supply.

Finally, suppose business cycles are caused by a mixture of internal and external factors. If the causes are nonchaotic in nature, then the government might possibly help if it could determine and sort out the internal and external causes. But if the causes are primarily chaotic, with relatively small external random shocks ("noisy chaos"), then once again the government easily can make things worse.

On balance, the discovery of a chaotic generating mechanism for business cycles would give strong support to adherents of minimal

governmental intervention in the economy, and economists also have a continuing interest in trying to understand the nature and causes of recessions and depressions.

EXCITEMENT AND FALSE STARTS

There are frequently debates about priority in scientific advances, but I have not seen anything that introduces chaos into economics earlier than the work of Richard Day and his collaborators at the University of Southern California (USC). In the early 1980s I began reading about chaos (also called "turbulence" or "nonlinear dynamics") in the literature I receive as a member of the American Physical Society. Early in 1984 I decided to try to search for business cycles in GNP data using a commonly used engineering technique called spectral analysis. While doing the research, I accidentally came across an article by Richard Day (1982) that described the possibility of chaotic price movements in GNP and in industrial production. The most amazing thing was the early date on the article. I had myself in the past waited for over two years between acceptance and publication in the same journal, so here was a researcher who had preempted my work by at least four years. At the same time, Day gave only a theoretical framework, so there was as yet no empirical verification of the existence of chaos. I thus continued my search for business cycles, fascinated by the work but with mixed emotions from the thought that I might eventually just be one of many people who helped win a Nobel Prize for Richard Day.

My search for business cycles would lead ultimately to inconclusive results (Dale, 1984). The results were consistent with theories of chaos but also with several competing theories of business cycles. Unbeknownst to me, at the same time, two researchers at the University of Wisconsin were developing theoretical arguments to show that my results were exactly what could be expected (Brock and Chamberlain, 1984). The methods I was using were not powerful enough to detect chaotic movements, so new techniques would have to be developed.

A number of other researchers were also trying to detect chaos. Brock and Sayers (1987) looked unsuccessfully for chaos in business cycles. Chera Sayers of the Universities of Wisconsin/North Carolina/Houston tried to find evidence of chaos in data on strikes (Sayers, 1988), but could not do so. An important advance was made by New York University (NYU) economists Ramsey, Sayers, and Rothman (1988). They used statistical tests developed for the physical sciences to replicate and test the work of others. Their test criteria (hereafter the "NYU meat grinder") would send several studies that attempted to find chaos, including the Sayers work on strikes and a few others to be mentioned later, to the scrap heap.

THEORETICAL ADVANCEMENTS AND EMPIRICAL FAILURES

While empirical work proceeded rapidly in the US, Grandmont (1985) in France developed a rather arcane theoretical model of how business cycles could be generated internally. In West Germany, Gabisch and Lorenz (1987) surveyed business cycle theories and discussed the possibility of finding chaos. Lorenz (1987, 1989) developed an interesting model in which he showed specifically how business cycles could be chaotic under a set of very reasonable assumptions.

Armed with the possibility of theoretical support, empirical researchers continued searching for chaotic systems. Scheinkman and LeBaron (1987) at the University of Chicago looked for chaotic returns in stock market prices, which would be a major finding. They concluded tentatively that they might have discovered chaos, but their results did not survive the NYU meat grinder (Ramsey, et al., 1988), so the question of whether stock prices are truly random or actually chaotic remains an open one. In the light of the research done thus far, the actions of New York Stock Exchange officials who, after the October 1987 crash, decided to install "circuit breakers" and halt trading when the Dow Jones Industrial Average moves more than 50 points up or down, cannot be criticized by invoking theories of chaos.

A big surprise came when I learned of a paper by Barnett and Chen (1986) that searched for chaos in money supply figures. The title of their paper amounted to a claim of victory in the search for chaos. Since they did their work at the University of Texas, where some of the most important research on chaos in the physical sciences had been done, it had to be taken seriously. Their work did not survive the NYU meat grinder, however, as Ramsey, et al. (1988) debunked their results and robbed them of their place in economic history.

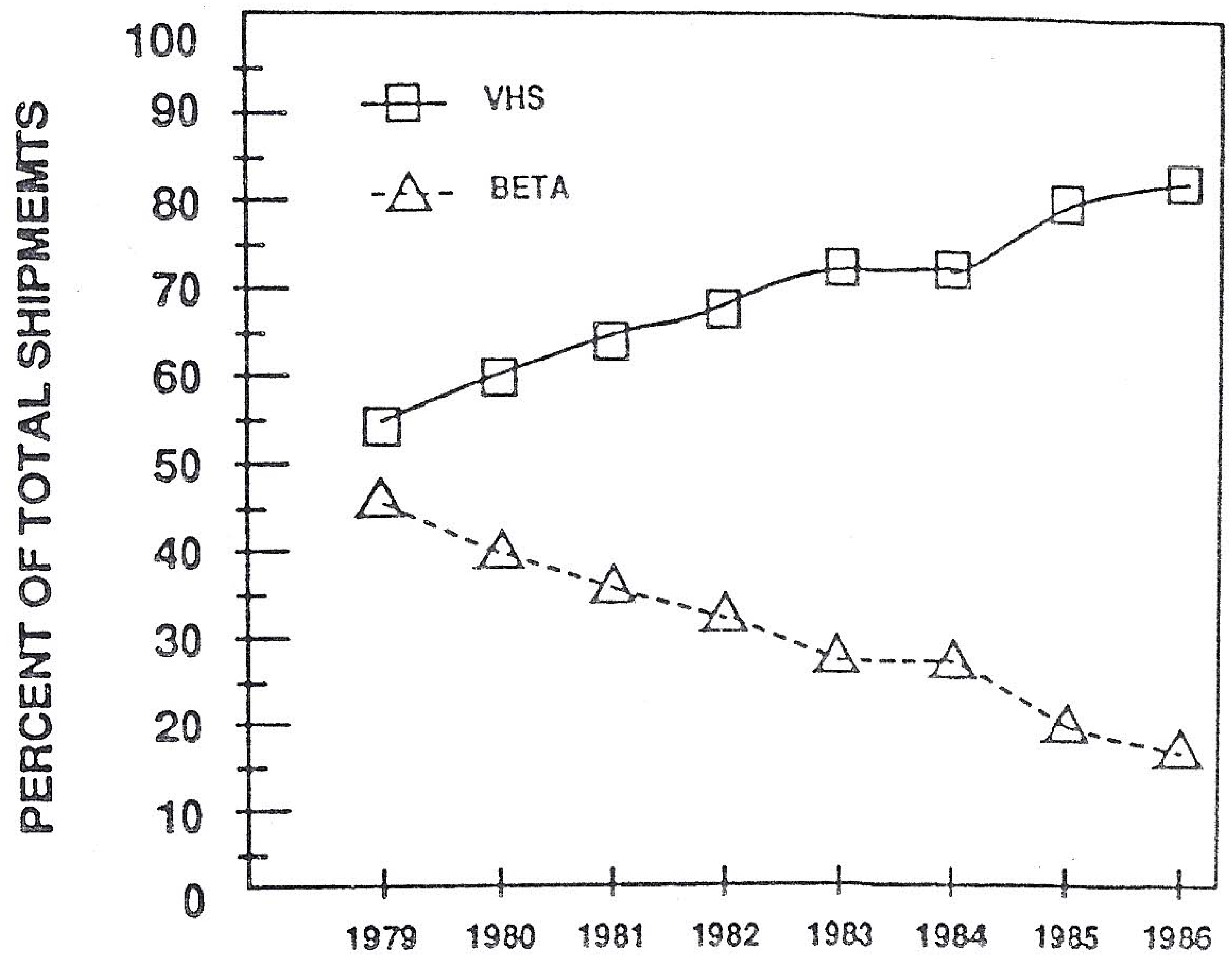
Other researchers besides those at NYU tried to develop mathematical tests for chaos. Brock, Dechert, and Scheinkman (1987) in particular have developed a statistical method (the "BDS Test") which appears to have value not only in testing for chaos but in analyzing other complicated types of models. But a staggering blow to researchers in the area came when both Christopher Sims and C.W.J. Granger concluded that chaos is highly unlikely to occur in most economic areas of interest (Brock, 1988), and even if it does it would take many human lifetimes for it to be manifested. Thus, chaos theories, even if true, may be irrelevant. This conclusion from two of the most respected members of the profession--both have statistical tests for causality named after them--seems to have been followed by a marked slowdown in research in the field. Setbacks in searching for chaos have not deterred all economists (Barnett and Hinich, 1990; Chen, 1989), and many are still searching for chaotic results that will ultimately withstand either the NYU meat grinder or the Wisconsin BDS test, preferably both. A successful finding of a chaotic system would have such a tremendous impact on the economics profession that the huge potential rewards outweigh what currently appears to be a relatively small probability of success. Thus the search for chaos in economic systems continues and, as of today (March 1990), it is still a game that anyone can win.

BEYOND CHAOS

One result of the great interest in chaos theories has been that it has caused many economists to reexamine both their long- and short-term models and assumptions. In Austria, Cesare Marchetti (1988), of the long wave innovation school, concluded that innovations in technologies follow predictable patterns. W. Brian Arthur (1988) at Stanford examines chaos in the much more general context of what he calls "self-reinforcing mechanisms" in economics.

Figures 3 through 6 are done in the spirit of the work of Marchetti and Arthur. Marketing literature is replete with studies of product substitution and changing market shares, and those ideas are applied here. Beta competed with VHS videotapes for market share early in the development of videocassette recorders (VCRs), as shown in Figure 3, but VHS ultimately dominated.

Figure 3: Market share of VHS versus Beta videotapes



Why did VHS win, when Beta was widely held to be of higher quality? I believe a critical point may have occurred in early 1985 when Sony introduced a portable camera that used a format different from Beta. VHS users could thus use the same format in their portable cameras and VCRs, so the simplicity of VHS ultimately led to its inevitable success. Arthur calls this inevitability "lock-in".

An example of a victory of a higher quality product is shown in Figure 4, which shows the rapidity with which compact discs (CDs) have been replacing vinyl long playing records (LPs). If Marchetti's ideas of technological substitution are correct, then the relative proportions of the winning product to the losing product, when subjected to his mathematical transformation, would be nearly straight lines, as shown in Figures 5 and 6.

Figure 4: Market share of compact discs versus vinyl LPs

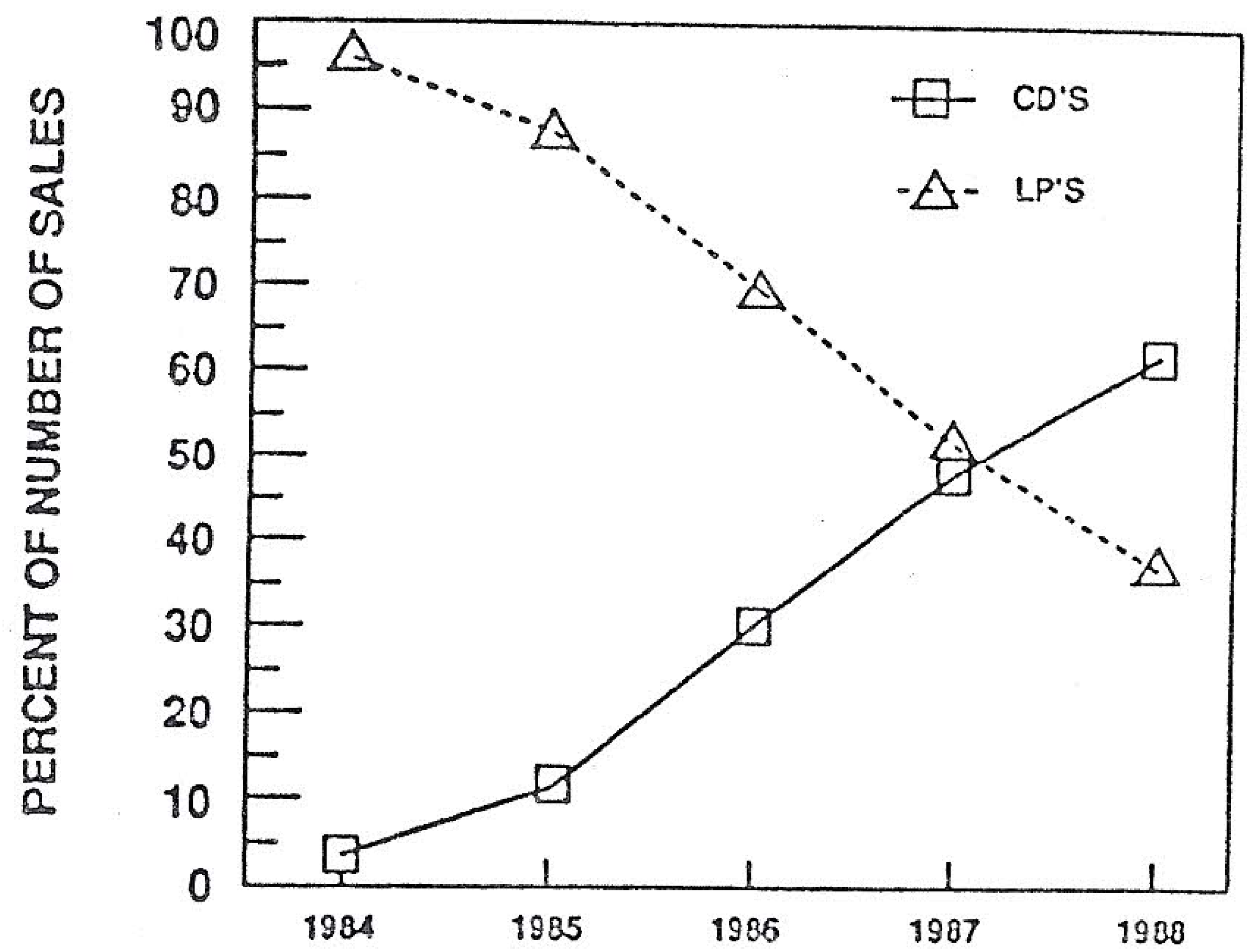


Figure 5: Substitution of VHS versus Beta videotapes

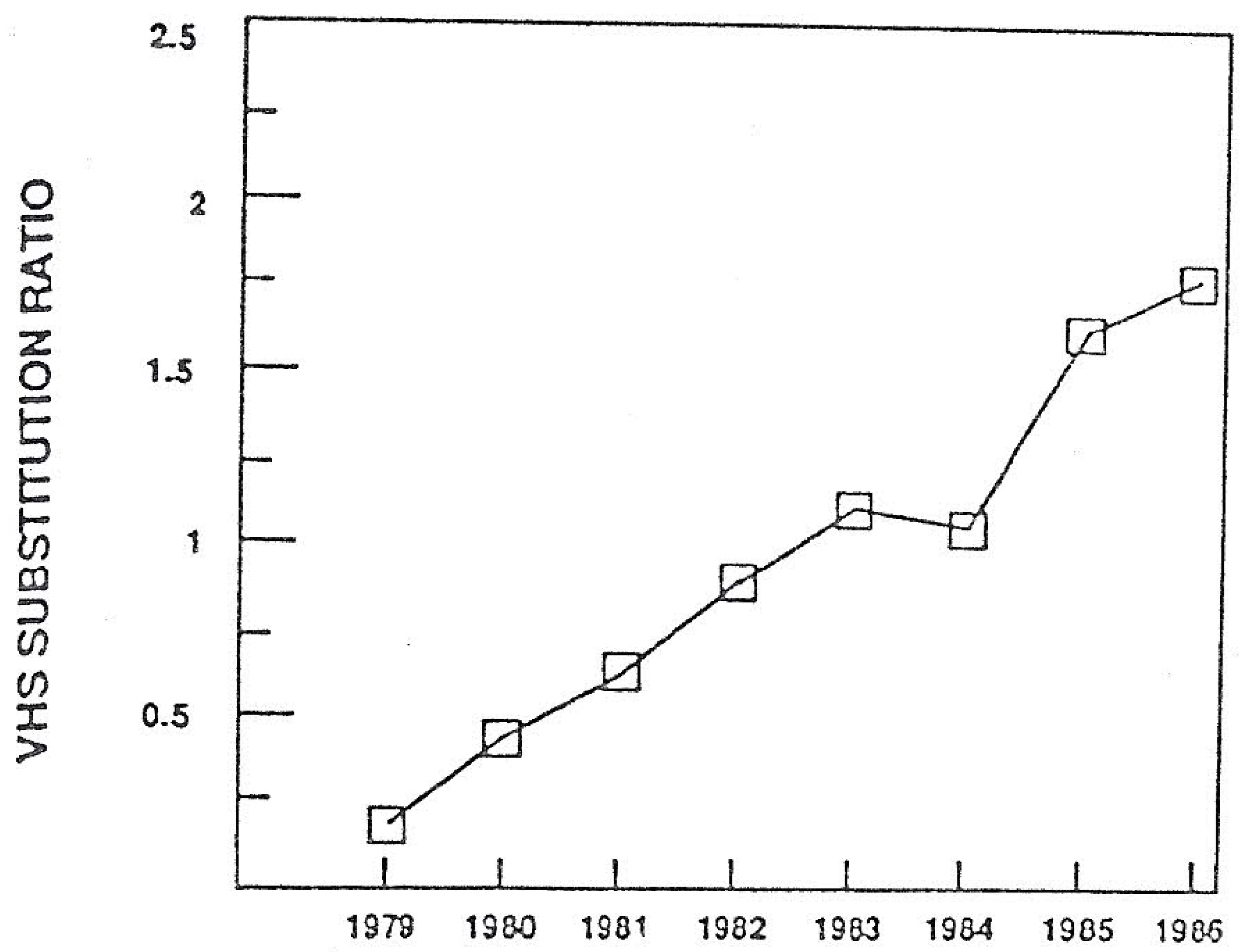
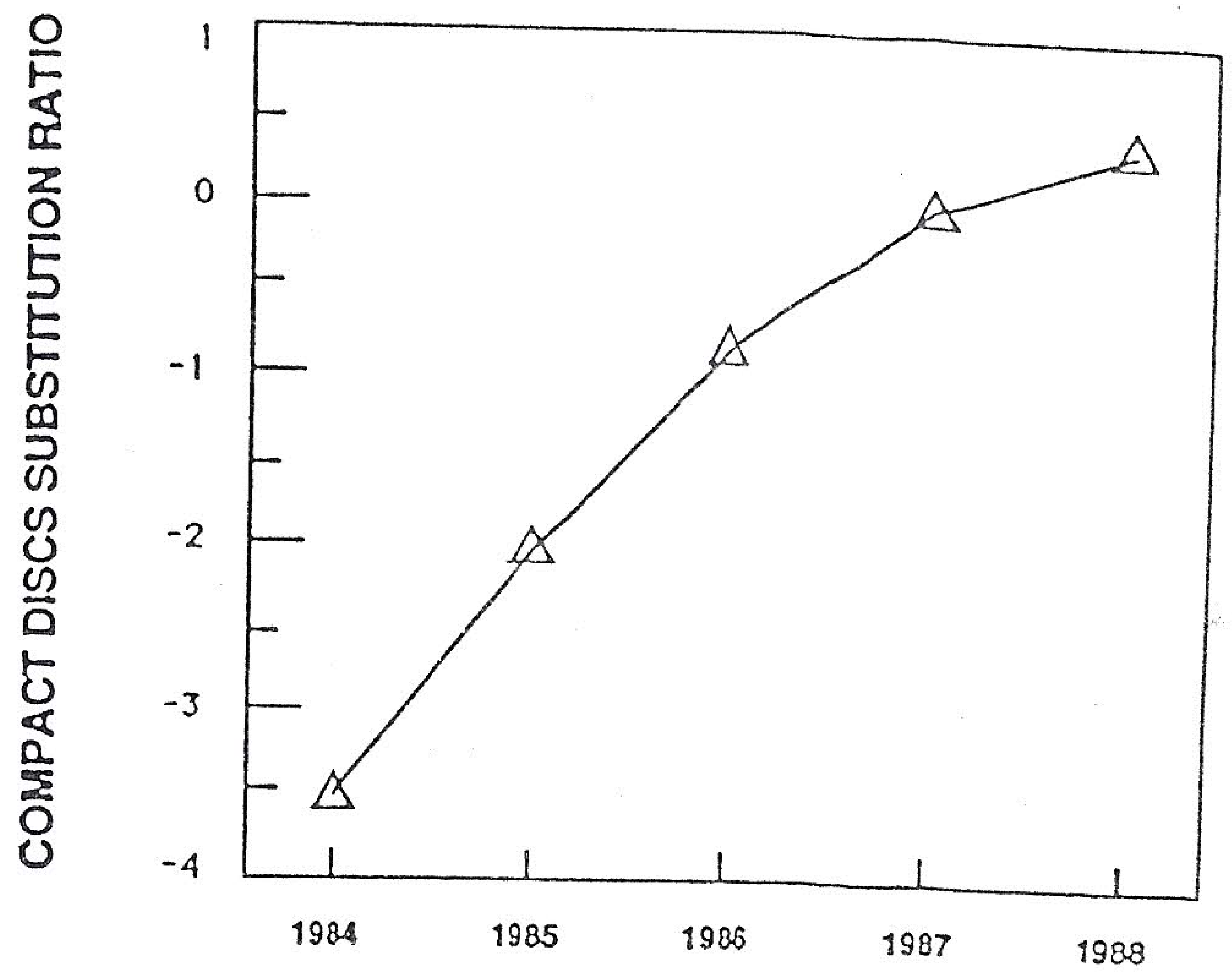


Figure 6: Substitution of compact discs for vinyl LPs



I believe that the accelerated pace of technological developments exemplified by the success of compact discs offers tremendous opportunities for future economic growth. Even if there have been long waves of growth in the past, technology may enable an economy to accelerate out of a decline much faster than in the past, if ways can be found to implement new technologies rapidly. Recent emphasis in graduate business schools on teaching production and operations management is one recognition of their increasing importance.

CONCLUSIONS

This paper began with a discussion of some defective yardsticks. It is not stretching a point to say that those yardsticks are a paradigm for a problem with a way of thinking in Western culture. In the East, the philosophy for thousands of years has been to look at entire systems, to examine interconnectedness, to recognize the importance of literally everything. In the West, general systems approaches date only from the middle of this century. Instead, in the West the adage has been to "worry about the big things, and the little things will take care of themselves". That type of thinking produces defective yardsticks--and also produces sophisticated electronic systems in which all the individual components work separately but don't work when put together--and also creates subway systems that cost many hundreds of millions of dollars to build but break down when it snows, because no one decided to spend about one million dollars for a device to clear ice and snow from the rails that are above ground. The reader can probably find his or her own examples of cases where ignoring "the little things" led to catastrophic results.

If policy-makers in the West can learn to adopt some of the holistic thinking of the East, then perhaps eventually they will recognize the importance of the "little" entrepreneurs. As noted above, product life-cycles are now so relatively short that new innovations might help smooth both short- and long-term business cycles. If futurists can help convince policy-makers of the importance of adopting a general systems view of the economy (Hunter, 1989), then we can be optimistic about the future.

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