"FORECASTING: ITS ROLE AND VALUE FOR LONG-TERM PLANNING AND STRATEGY"

by

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FORECASTING:
ITS ROLE AND VALUE FOR LONG-TERM PLANNING AND STRATEGY

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The most important lesson we have learned in the field of forecasting over the last two decades is that models which best fit available data are not necessarily the most accurate ones in predicting beyond this data. In this paper I show that such a lesson has serious implications for other areas and notably management which is still based on the notion that future success can be attained by imitating "excellent" companies or best practices, that is past success or the equivalent of model fitting. In this paper I demonstrate that future success can only be achieved by correctly recognizing emerging changes in the business environment and accurately predicting future ones. Recognizing and predicting such changes brings forecasting to the forefront of management and ironically turns its biggest weakness (the fact that the best model fit does not guarantee the most accurate post-sample forecasts) into a much needed strength as recognizing and predicting changes is becoming one of the most critical factors for formulating corporate strategies, planning effectively and in general succeeding in business.

What Can We Learn from "Excellent" Companies?

The book *In Search of Excellence* was published in 1982. It became an instant success, selling millions of copies. Through research conducted between 1961 and 1980, its authors, Tom Peters and Robert Waterman, identify 36 excellent companies and present the factors that brought about their "success". The objective of the book and its intended value for other companies can be best captured by its subtitle, *Lessons from America's Best-Run Companies*. Could others have learned, however, from America's best?

Figure 1 shows the 1980 (the latest figures available when the study leading to the book was completed) price/earning ratios, in comparison to the average, of as many of the 36

FIGURE 1

EXCELLENT COMPANIES: THEIR P/E RATIOS IN COMPARISON TO THOSE OF ALL FIRMS IN 1980

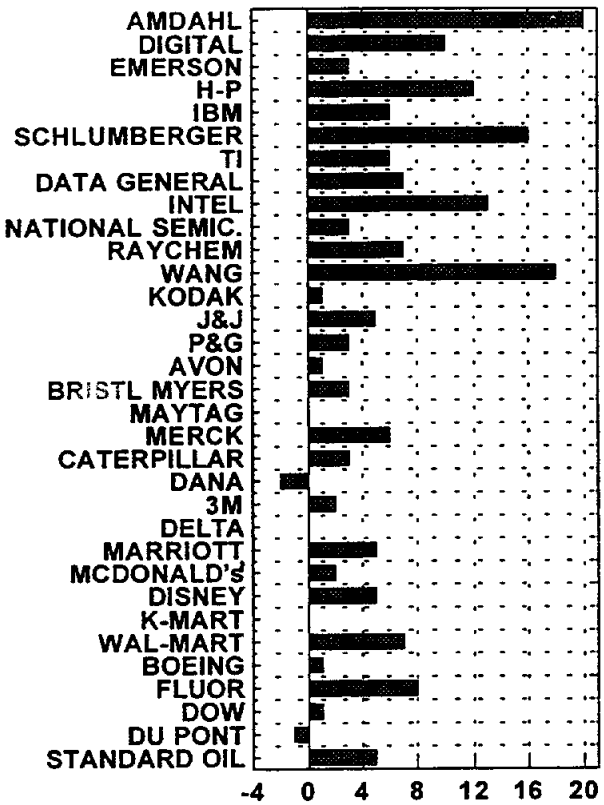


FIGURE 2

"EXCELLENT COMPANIES": THEIR P/E RATIOS IN COMPARISON TO THOSE OF ALL FIRMS IN 1992

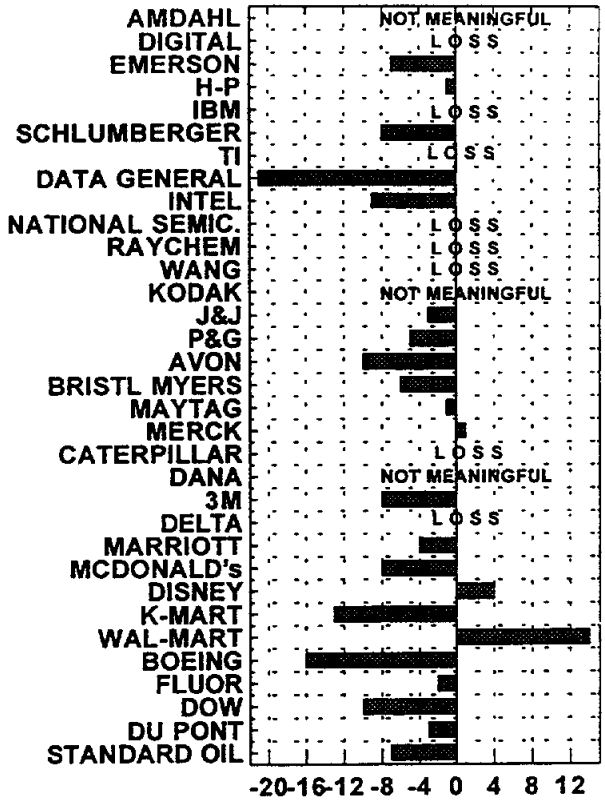


FIGURE 3

"EXCELLENT COMPANIES": THEIR RETURN TO INVESTORS IN COMPARISON TO FORTUNE's 500 MEDIAN

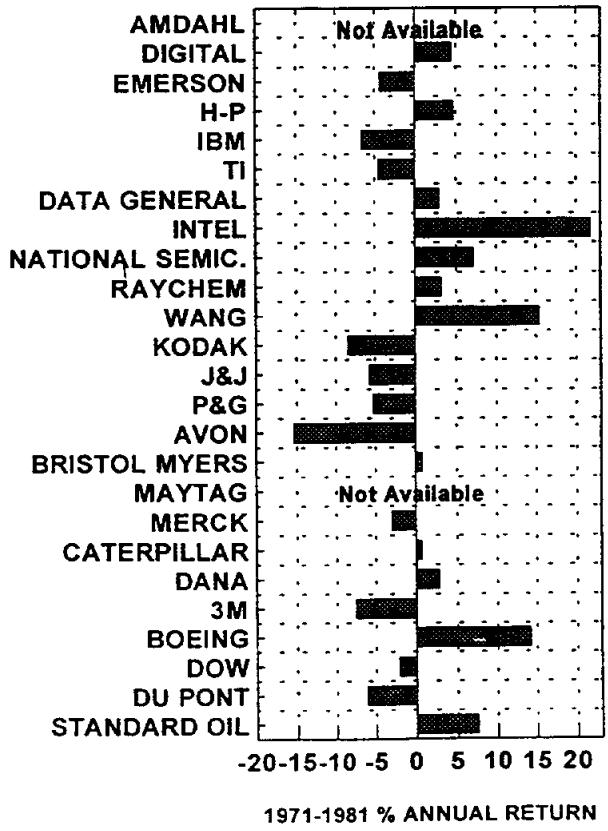
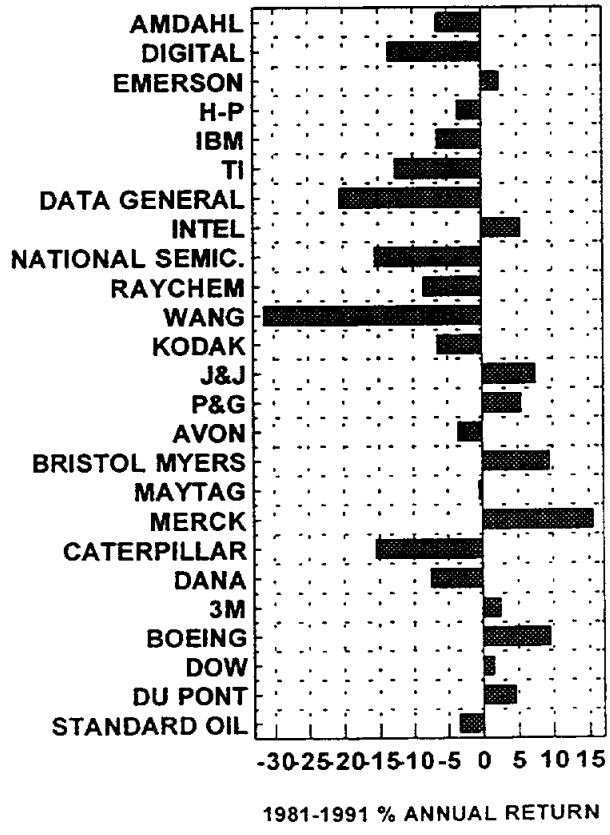


FIGURE 4

"EXCELLENT COMPANIES": THEIR RETURN TO INVESTORS IN COMPARISON TO FORTUNE's 500 MEDIAN



"excellent" companies identified by Peters and Waterman for which published data was available, while Figure 2 shows the same ratios ten years after the book was published. Figure 1 reveals that the price/earning ratios of the "excellent" companies were, with a couple of exceptions, well above the average. However, the opposite is true in Figure 2 which shows losses in eight of the 33 firms and only three with above average price/earning ratios.

Some people rightly argue that price/earning ratios reflect psychological factors as well as real financial performance and might not be appropriate for drawing conclusions about the "excellent" firms identified in *In Search of Excellence: Lessons from America's Best-Run Companies.* To provide a more objective basis for comparisons, Figure 3 shows the average annual rate of return to investors (ROI) for the decade before the book was published while Figure 4 shows the same rates for the decade after.[1] Interestingly the "excellent" firms did not perform significantly above the average during the 1971/81 decade, at least as far as the return to investors was concerned (Figure 3). However, they did considerably worse than average for the 1981/91 decade.

The obvious conclusion from the above discussion is that if the "excellent" companies could not even manage to stay average ten years later, how can they teach lessons to other firms? Figures 2 and 4 even suggest that there is a regression of the "excellent" firm to below average as it is highly unlikely that the results of Figures 2 and 4 are due to pure chance. In forecasting terms best fit does not guarantee the most accurate post-sample predictions.

The firms of *In Search of Excellence* are not the exception of successful and admired companies that found themselves getting into serious trouble. GM and IBM were considered textbook examples of best managed companies. Yet today they are thought of as dinosaurs unable to adapt to the changing business environment. The same was true of Digital Equipment, Du Pont, Polaroid, Xerox and even Apple. Yet these firms have found

[1] Taken from various issues of *Fortune*.

themselves getting into serious difficulties, performing below average, a fact that can be seen in their stock prices which have declined considerably. At the same time other firms like Microsoft, Intel, Compaq or Virgin have become examples of successful companies and Wall Street favorites. The obvious challenge, therefore, is to discover future success stories and even more importantly help management to make their firms successful by helping them to predict forthcoming opportunities while avoiding future dangers.

What Can We Learn from Management Theories on Long Range and Strategic Planning

Corporate planning and strategy has become a popular management area since the early 1960s (Gilmore and Brandenburg, 1962; Ansoff, 1964) as the size of corporations as well as their complexity and competition were increasing. Although the early attempts concentrated on long range planning, later there was a shift towards corporate strategy (Ackoff, 1970; Ansoff, 1979; Lorange and Vancil, 1977; Malmlow, 1972; Steiner, 1979) as it was recognized that trends can change and unexpected events can occur rendering long range plans useless. Prominent among these methods, assuming that past patterns will also hold true in the future, has been the Product Life Cycle Planning approach (Smith, 1980), the Portfolio Matrix of the BCG (The Boston Consulting Group, 1972), and Competitive Analysis (Porter, 1980). Porter, for instance, in 1980 wrote:

> "Also, some firms persistently outperform others in terms of rate of return on invested capital. IBM's return has consistently exceeded that of other mainframe computer manufacturers, for example. General Motors has persistently outperformed Ford, Chrysler and AMC." (p.126-127)

Needless to say today, 15 years after the book was published, after IBM and GM lost $16 and 8 billions respectively and after Chrysler became the star of the automobile industry, Porter's statement seem outdated, if not ludicrous. Competitive analysis is useless unless the strength of **future** competition can be predicted. The same is true with the Portfolio Matrix and PIMMS (Schoeffler et al., 1974) approach which assumed that the bigger the competitor and the higher his or her market share the more important his or her advantages (Wensley, 1982).

Such thinking failed to see the bureaucratic disadvantages associated with bigness, or alternatively the value of being small and therefore more entrepreneurial and flexible (Kiechel, 1981). The recent excellent performance of smaller firms and their ability to outperform their giant competitors point out to the impossibility of drawing conclusions about the future by simply extrapolating what has worked well in the past. Again best model fit does not guarantee most accurate predictions for the future.

Mintzberg (1994) in a recent book entitled *The Rise and Fall of Strategic Planning* concludes that "'strategic planning' did not work, that the form (the 'rationality' of planning) did not conform to the function (the needs of strategy making)" (p. 415). He also mentions the findings of a study conducted among Japanese firms (Hayashi, 1978) which shows that Japanese firms distrust formal strategic planning which they use instead for "identifying major problems and of creating an atmosphere conducive to the development of creative ideas and hard work within the company" (p.217).

Some form of accurate forecasting is indispensable in all approaches to long range or strategic planning. The problem is that the need and importance for such forecasting is neither made explicit nor utilized. In the Portfolio Matrix approach, for instance, a product is defined as a "star" when its industry is growing at a fast pace while it holds a small market share at present. The idea is, therefore, to invest in such a "star" to increase its market share, and production volume, and gain the economies of scale and scope, as well as increase profits, that go together with being a high volume producer in a fast growing market. Such reasoning, however, assumes that one can predict high growth industries and that competitors will not attempt to also invest in their own "stars" -- in which case the result will be overcapacity, high competition and low profits, or losses, even in the case that the high growth industries can be correctly identified. Moreover, it assumes that economies of scale and scope outweigh the bureaucratic and other disadvantages associated with "bigness" which recent experience has shown to outweigh such economies.

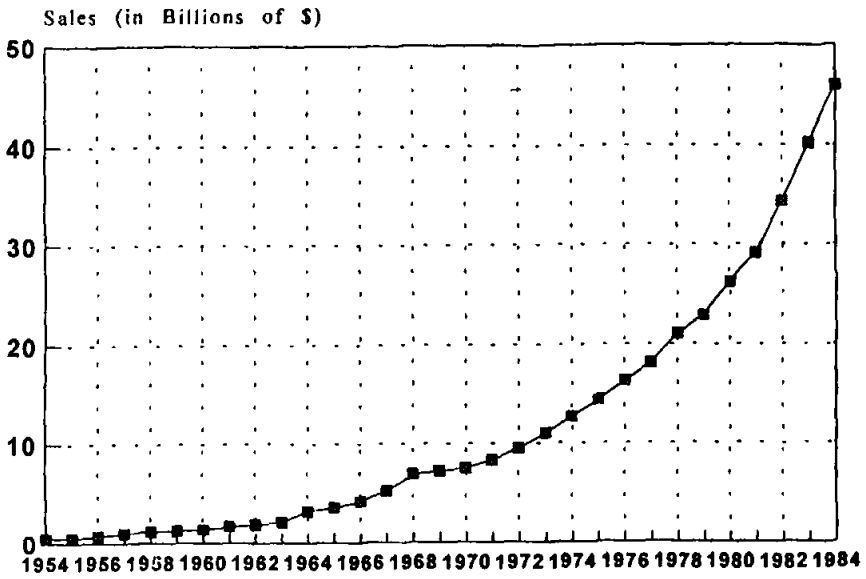
Successful strategy must be based on realistic assumptions about what can and cannot be forecasted as well as the uncertainty involved in all types of future predictions. In addition, it must take into account competitive actions and reactions which cannot be known in advance as they involve learning and attempt to guess and outsmart the behavior and actions of competition. The futility of any type of analytic strategy is that it is based on principles and assumptions well known to everyone. It must be obvious, therefore, that competitors will predict the consequences of the actions of firms using these strategies and take whatever steps are necessary to render such strategies obsolete.

In the remainder of this paper I will discuss the value, as well as limits, of forecasting and its potential contribution to long range planning and strategy. My approach is consistent with the quote about the Japanese firm. The value of forecasting can be used to identify potential opportunities as well as dangers in the business environment. In addition, it must be used to appreciate the extent of future uncertainty while assessing its impact on the firm. This is where forecasting can provide real benefits of strategic importance to firms and where much can be done to improve its value and relevance to executives. Identifying opportunities and dangers as well as appreciating uncertainty realistically are areas of **common** interest between forecasters and strategists, requiring cooperation and joint work between the two.

Past vs Future Success

In 1984 John Opel, IBM's chairman, announced that the sales of his firm, $50 billion at the time, would double to $100 billion by 1990 while its profits would continue their exponential growth. Figure 5 shows IBM's sales between 1954 and 1984, the time of the announcement, while Figure 6 displays its profits. Extrapolating the historical growth of IBM's sales for 1990 results in $110 billion sales, $10 billion less than Opel's forecast which could, therefore, be considered conservative as it underestimated the straightforward extrapolation of IBM's past sales.

IBM's ACTUAL SALES: 1954-1984



IBM's PROFITS: 1954-1984

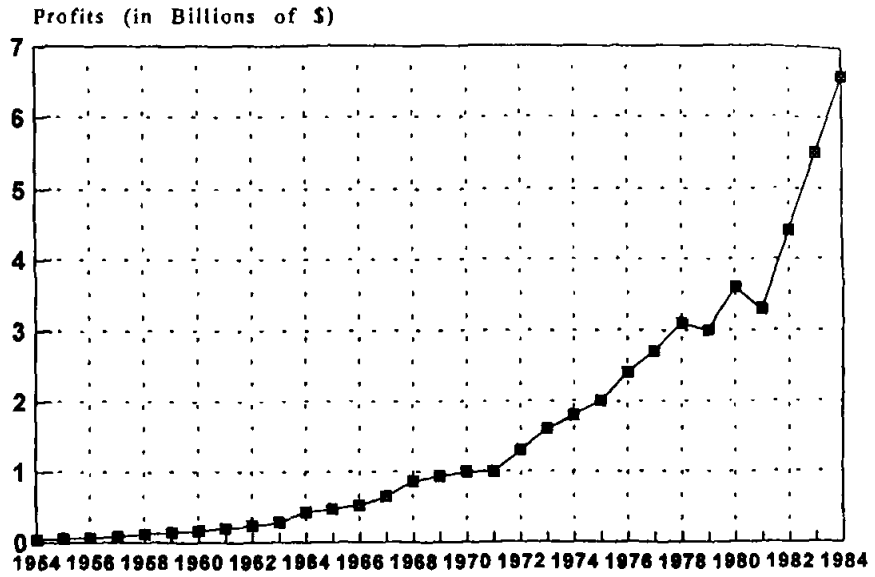


FIGURE 7

IBM: SALES AND 1984 FORECASTS

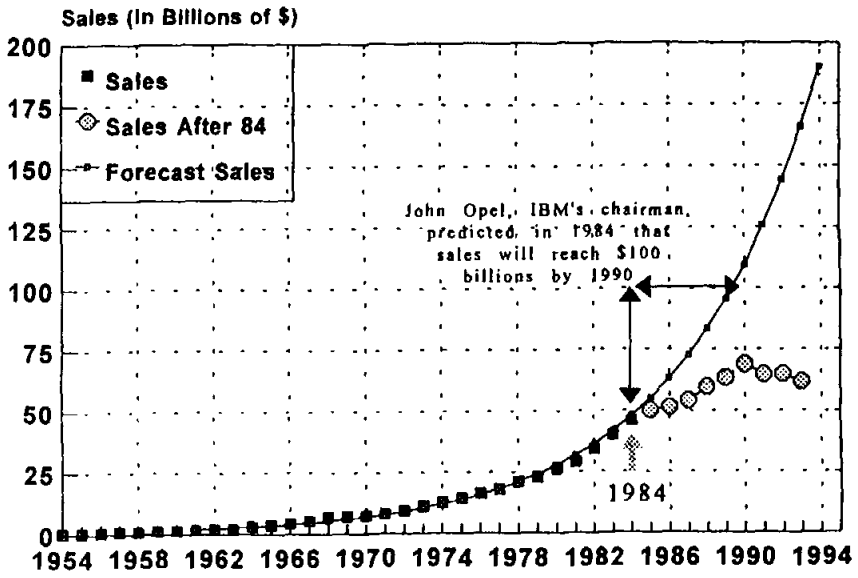
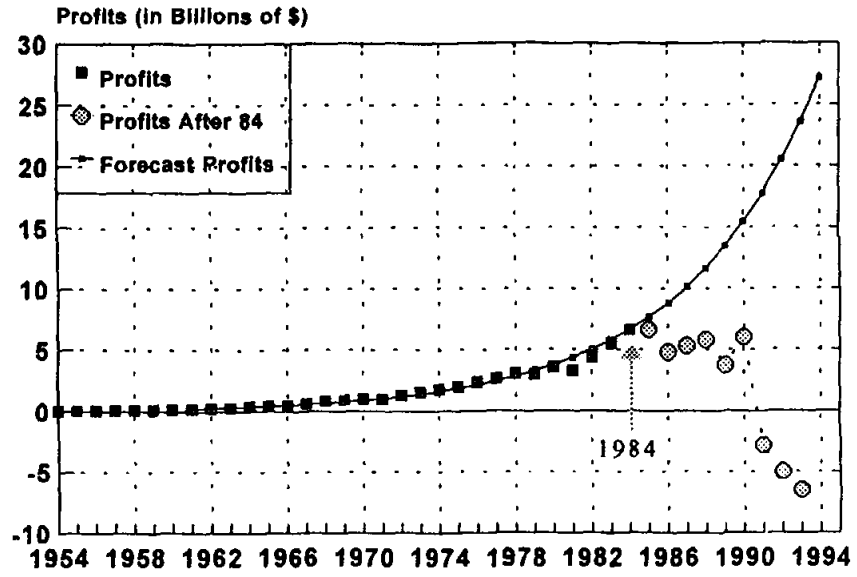


FIGURE 8

IBM: PROFITS AND 1984 FORECASTS



Based on such forecasts IBM hired more than 100,000 new personnel to be capable of providing its existing and new customers with the high quality service it was much acclaimed for. However, things did not turn out as **expected**. Figures 7 and 8 show, in addition to the 1954 to 1984 era, IBM's sales and profits since 1984. In 1993, ten years later, its sales were only $62 billion while it has incurred losses of more than $16 billion over the last three years. Moreover, its work force will be, by the end of 1994, at about half its 1986/87 peak of 430,000.

Should a firm like IBM, renowned for its high calibre, professional management, have made such a monumental mistake in forecasting? IBM's management assumed that the business environment and IBM itself would **not** change during the following six years and felt, therefore, justified in extrapolating historical patterns and basing its overall strategy and expansion plans on the forecasts from such extrapolation. This belief, however, that best model fit guarantees the most accurate forecasts is not a good business practice for three reasons. First, if nothing changes, the future will be deterministic as straightforward extrapolation is trivial and can be done by everyone, including all of IBM's existing as well as new competitors who would also make plans to expand and take for themselves as high part of the growing pie as possible. But inevitably the lure of high growth and big profits creates overcapacity, intensifies competition and results in price wars that diminish profits or even bring losses. Second, yearly growth rates in the 15% to 20% range may be possible for a small or medium size company but become exceedingly difficult for a $50 billion giant as a 16% growth meant an $8 billion yearly increase, more than the revenues of all but a few dozens of 1984's largest firms. Finally, even if IBM had managed to grow in revenues it would have been highly unlikely to have grown equally well in profits.

History has shown that no large, bureaucratic firm has managed to maintain the growth in its profits at the level when it was smaller, more flexible and entrepreneurial. Bureaucracy and the associated diseconomies of scale inevitably take their toll. These types of historical observations seem to have held since modern firms appeared and are not likely to change as

they are a direct consequence of the economic and market system based on free competition and capitalism.

Major Changes in the Business Environment

Many firms and whole industries (e.g., steel and automobile) have found themselves in similar situations to IBM, being unable to recognize that the environment has or is about to change and that it does not suffice to continue doing well what has brought them success and high profits in the past. Table 1 summarizes the major changes in the business environment which have resulted in much stronger, and global, competition, more demanding consumers, willing to only accept high value products/services, and fundamental shifts in the way firms are managed and operate. These changes have and will continue to fundamentally affect the business environment requiring a forward looking perspective for identifying both opportunities and dangers and formulating effective strategies to deal with these opportunities/dangers.

Table 1: Major Changes in the Business Environment

TYPE OF CHANGE	YESTERDAY	TODAY	TOMORROW	CONSEQUENCES
MARKETS	Growing	Stagnant	Declining Except !!	
				Stronger Competition
INDUSTRY BOUNDARIES	Well-Established	Falling Down	Non-Existant	
			⇔	More Demanding Customers
TECHNOLOGICAL CHANGES	Slow	Fast	Super-Fast	
				Fundamental Changes in Firms and Management
RULES OF GAME	Accepted	Disregarded	New/Changing	

There is one certainty about the future: Firms are to expect continuous changes in the business environment. They must embrace, therefore, a new attitude that accepts that future success will be directly linked to identifying the opportunities opening up through these changes while steering clear of the dangers that forthcoming changes will inevitably bring. The role of forecasting is central in providing two tasks: as accurate and relevant predictions as possible, **and** assessing the uncertainty that the future holds as realistically as possible. As no long range planning or strategy is possible without these two tasks, the role of forecasting is critical for the future success or failure of firms, making the cooperation of forecasters and strategists an absolute necessity.

Uncertainty in the Business Environment: Cycles vs Long-Term Trends

Figure 9 shows the monthly copper prices (in constant 1993 dollars), for 28 months. The downward trend is obvious. Constant prices were about $5.5 at the beginning of the graph and $2.5 at the end, a decrease of more than 50%. Moreover, as the R^2 is 0.974 we can feel pretty comfortable, according to prevalent statistical thinking, about extrapolating such a downward trend to future periods. Moreover, our uncertainty, based on these 28 data points, is low as R^2 is close to 1 and the variance of the model fitting errors is small. For instance, the forecast for month 36 is $2 a kilo while the 95% confidence interval around such a forecast is in the $1.8 to $2.2 range.

Figure 10 shows real copper prices for 14 years. Figure 10 indicates that copper prices are constant, not decreasing. Which of the two, Figure 9 or 10, is correct? According to the prevalent statistical thinking, Figure 9 is to be preferred to Figure 10. Its R^2 is 0.974 versus 0.007 for Figure 10. Moreover, the model implied in Figure 9 is based on 28 points while Figure 10 uses 14 points only. However, the prices shown in Figure 9 are monthly, and consist of a small part (that shown between the two arrows) of the yearly data displayed in Figure 10. Logic dictates, therefore, to set aside the traditional statistical thinking and instead conclude that real copper prices are constant.

REAL 1994 MONTHLY COPPER PRICES

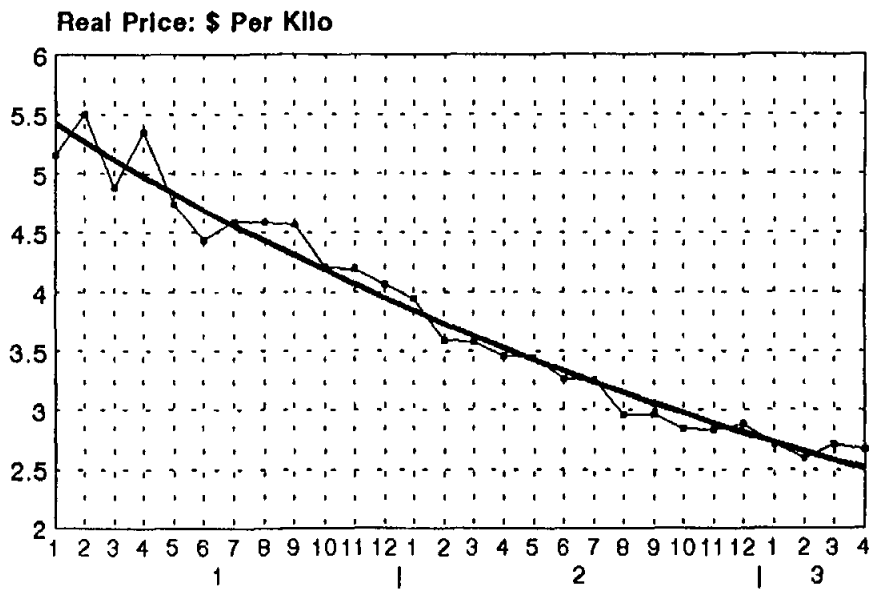


FIGURE 11
REAL YEARLY COPPER PRICES

REAL YEARLY COPPER PRICES

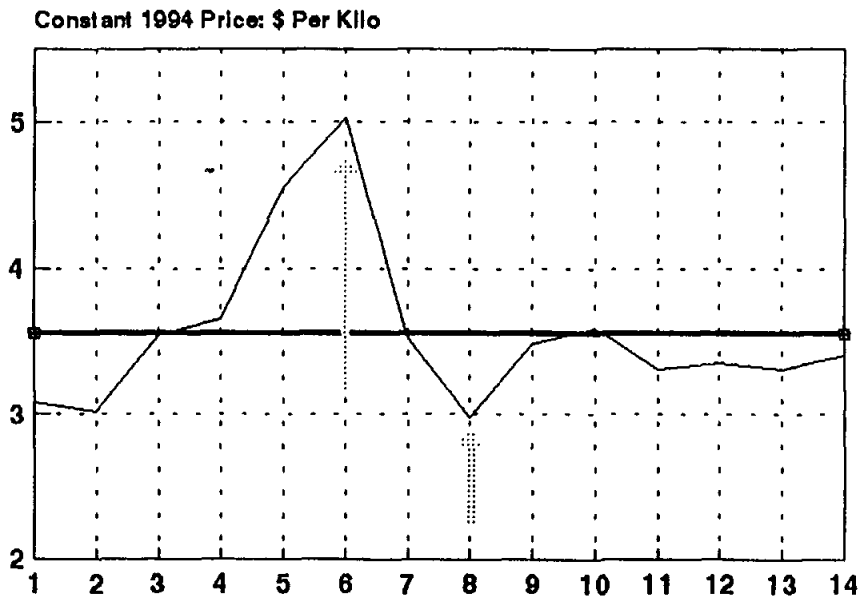
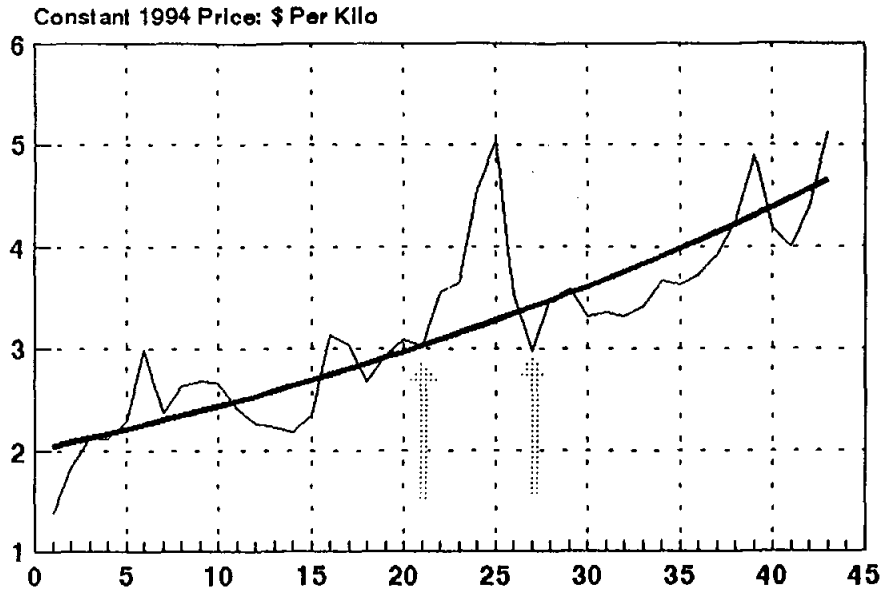


FIGURE 12
REAL COPPER PRICES IN CONSTANT 1994 $



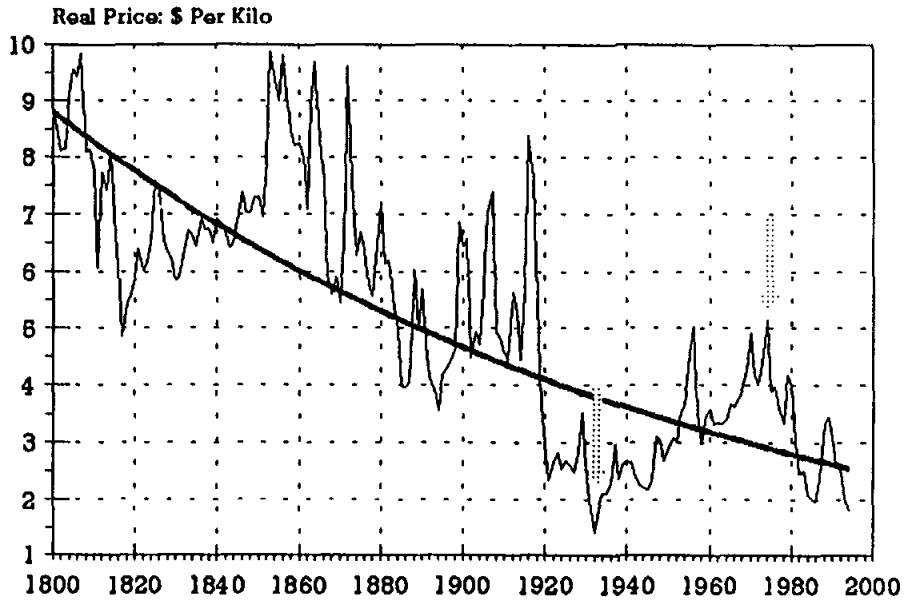


Figure 11, which contains 42 years of data, suggests a different picture: increasing copper prices (the 14 yearly data of Figure 10 are simply the part shown between the two arrows of Figure 11). The R^2 of the data shown in Figure 11 is 0.724. What can a copper firm conclude from these graphs? As the highest R^2 is found in Figure 9, traditional statistical thinking dictates that the best model is the one shown in that figure. Logic dictates, however, that yearly data should be trusted more than monthly ones, irrespective of the value of R^2.

But even if we assume that the best model is that related to Figure 11, can its increasing trend be used as the basis on which to make an investment decision for opening a new copper mine that will cost more than $1 billion? After all, 42 years is a very long period (most executives complain that their data does not go back more than five to ten years) and the fit of the model shown in Figure 11 is pretty good -- its R^2 is 0.724. Our confidence, therefore, about extrapolating the exponential trend of copper prices to future years should be pretty good.

In real life, 42 years of data does not represent a long enough period to draw any conclusions about the long-term trend in copper prices. Long wave cycles, also called kondradieff, can last for more than 60 years. It is possible, therefore, that what seems to be an upward trend for 42 years is, in effect, the rising part of a kondradieff cycle. This is the case of the data shown in Figure 11 which includes the upward increase of the long-wave cycle that started in 1932 and ended in 1973. The full cycle that started in 1932 can be seen in Figure 12 which shows copper prices since 1800 (an appropriate starting time since the effects of the industrial revolution started at about this time) and which displays both an exponentially decreasing trend and many cycles of various durations and lengths (the 42 years of Figure 11 are simply the part of Figure 12, shown between the two arrows, from 1932 to 1973 -- the downward decline of such a cycle has not ended as yet).

Even though the R^2 relating to Figure 12 is 0.618, smaller than the 0.724 of Figure 11, we will have to conclude that real copper prices are not increasing in the long run as Figure 11 suggests. On the contrary, they are decreasing in an exponential fashion. This means that Figures 9, 10 or 11 have no value beyond illustrating the dangers of making long-term forecasts without an appropriate starting period. In fact, any conclusion drawn from them can be misleading and must not be used for basing real-life decisions and notably strategies that require anticipating correctly long-term copper prices on which to base capital expansion decisions. Such a conclusion implies a fundamental change in our approach to forecasting as well as its use for long-term planning and strategic decisions. Unless we are certain that we use the right starting period (as with Figure 12), we cannot be confident about our extrapolations or our ability to distinguish long-wave cycles from long-term trends.

Successful strategy and effective long-term planning (e.g., capital budgeting) require figuring out the implication of long trends and distinguishing such trends from the various cycles associated with them. As a matter of fact, the further the copper prices go away from the long-term trend, as is the case of the data shown in Figure 11, the higher the chance that there will be a regression towards, and possibly below, the long-term trend. This has happened in Figure 12 which shows that copper prices, well above the long-term declining trend in 1973, have fallen below such a trend in 1993 and 1994.

Uncertainty in the Business Environment: Unusual and Unexpected Events

In addition to cycles of various durations and depths, unusual and unexpected (or little expected) events can also occur that add to the uncertainty of future predictions. The 1991 Gulf War, for instance, brought air travel to a standstill and caused huge losses to airlines and the travel industry as people, afraid of terrorist attacks, avoided or cancelled practically all travel abroad. Similarly, new competitors like the Japanese entering the US Automobile Industry when the conventional wisdom of that time was that such a move was bound to fail (Magaziner and Patinkin, 1989); new technologies like personal computers that substantially decreased the demand for mainframe ones because of their lower cost and versatility,

including their user friendliness; and changes in consumer attitudes like the acceptance of superdiscount stores, warehouse clubs, or greater concerns about health or the environment as well as fads and fashions can and do bring unexpected consequences which firms must be capable of withstanding, or at least be capable of reacting as soon as possible.

Although it is not possible to plan for unusual events, or anticipate unexpected ones, the fact remains that such events will occur again and again in the future and some type of strategy must exist to deal with them once they occur. Contingency planning and scenarios (Wack, 1985) are possible ways for dealing with unusual and unexpected events. Most importantly, however, such events require a fundamental change in executive thinking away from the reassuring belief that the future can be predicted to accepting that it is impossible to eliminate future uncertainty. In such a case one of the most valuable aspects of strategy is to provide adequate responses or the necessary slack to allow the organization to smoothly adjust to temporary changes (e.g., in the case of war, or a competitive move) or successfully adapt to permanent ones (e.g., new, improved technologies or fundamental changes in consumer tastes and attitudes). But whatever the response uncertainty cannot be ignored. The possible negative consequences of doing so can be devastating for the health or long-term survival of the firm.

Even though there are no "recipes" or precise rules of how to deal with unusual or little expected events, forecasting can contribute a great deal to long range planners and strategies by compiling a list of such past events, related to specific industries, together with their impact and possibility of future occurrences either in the same or some modified form. Moreover, since unexpected events are also bound to influence firms, they must allow for flexibility and finance slack in their strategy so that the negative consequences of such events do not cause permanent setbacks.

Can forecasting be relevant and useful with the type of huge cycles, lasting for many decades, shown in Figure 12 or the unusual and unexpected events discussed in this section? The answer is yes. Any long-term planning, strategic or otherwise, must take into account the various types of uncertainty associated with the future. Otherwise it will not be realistic, as the great majority of series in the economic and business environment exhibit cyclical behavior similar to that of Figure 12 and are affected by crisis brought by unusual and unexpected events. It is not possible, therefore, to pretend that long-wave cycles, and threatening events do not exist or that they will never occur simply because they increase the uncertainty surrounding the future, making strategy and planning more difficult. Estimating the influence of cycles and unusual events for planning purposes and the possibility of even unexpected events into strategy presents as great a challenge for the field of forecasting as its normal task of providing predictions based on extrapolating past patterns and/or relationships. Confidence intervals and other measures of uncertainty must be modified to take into account the cyclical behavior of series and the influence of unusual and even unexpected events.

The Long-Term Trends in Real Prices, Income and Buying Power

Most prices, when inflation is excluded, decrease in the long run. The decrease started with agricultural products and has continued with most commodities and standardized manufacturing products and services. Figure 13 displays real wheat prices since 1264 and clearly shows their considerable decrease since around 1800 through the impact of the industrial revolution which greatly increased agricultural productivity and yields. Since 1800, real wheat prices behave very much like copper ones and both are declining in real terms because supply has increased above demand (although population has increased six-fold between 1800 and 1994, and diet improved considerably).

The long-term decrease in real prices means that supply is higher than demand. Moreover, it implies continuous productivity improvements on the part of firms to decrease their costs and maintain their profits even when prices are declining. As long-term price decreases cover practically all standardized products and services (Figures 14 to 16 display the long-term

FIGURE 13

WHEAT PRICES IN CONSTANT 1993 £

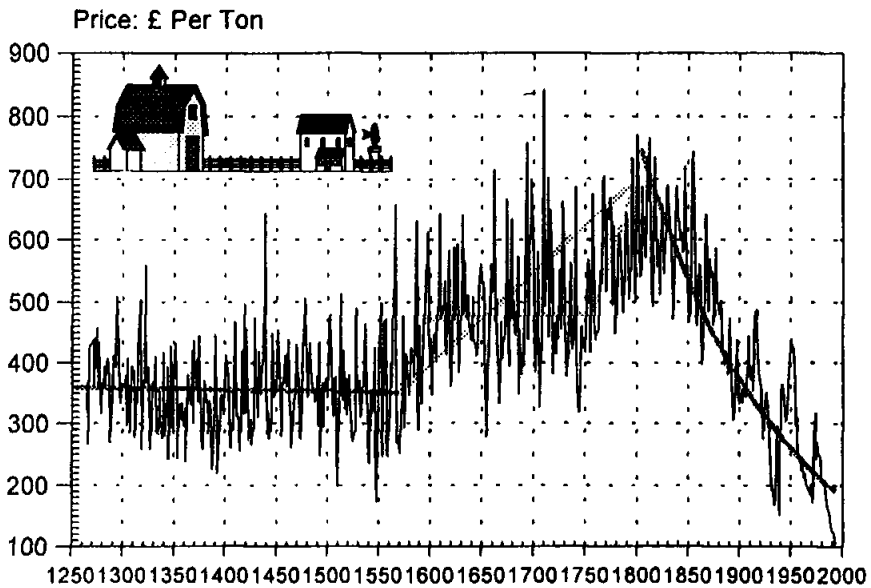


FIGURE 14

NAIL PRICES IN CONSTANT 1993 $

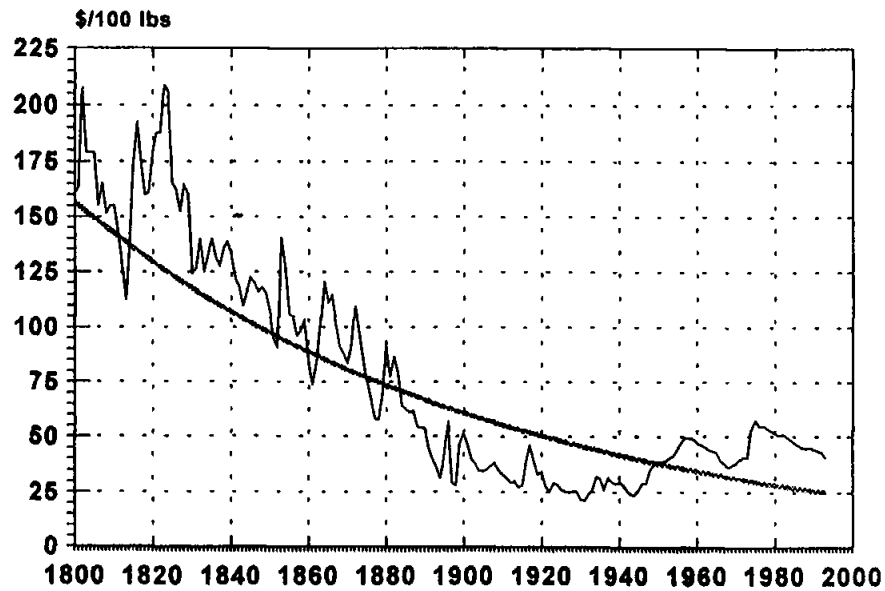


FIGURE 15

TELEPHONE COST: NEW YORK-SAN FRANCISCO

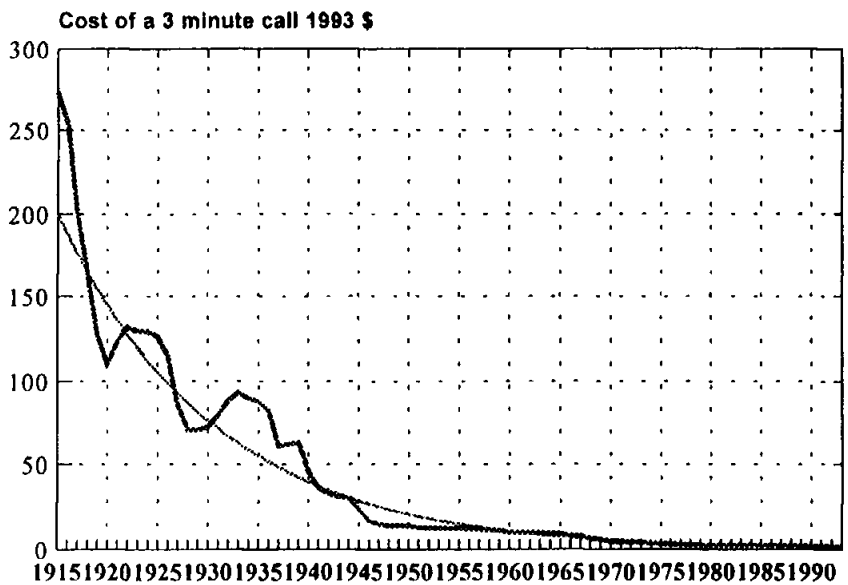
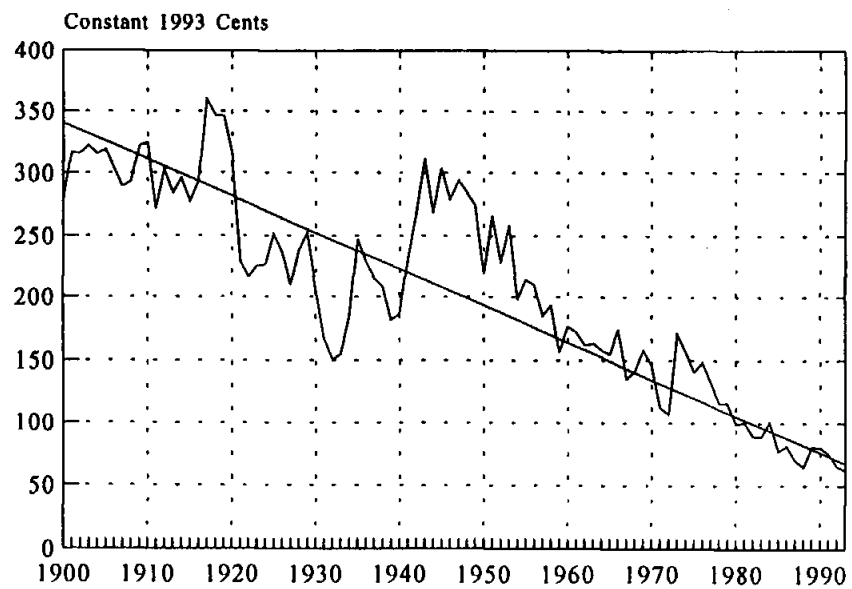


FIGURE 16

CONSTANT PRICE OF A DOZEN EGGS: USA



behavior of real prices of additional products/services), they necessitate a long-term view of the firm that must be centered around continuous improvements and innovations, both technological and organizational. In addition, this long-term view requires identifying and exploiting emerging opportunities in the business environment while steering clear of forthcoming dangers (see below).

In the long run, real income increases too, although its increase is also characterized by cyclical fluctuations. Figure 17 shows real wages in England since 1264 and clearly indicates that real income has been increasing exponentially, first from around 1625 until 1725 under the impact of the agricultural revolution, and second since about 1800 under the impact of the industrial revolution. As real wages increase, so does real GNP or wealth. Figure 18 displays the real Gross National Product (GNP) of several countries, going as far back as reliable data has been available, and also shows a substantial increase over time.

The combined effect of diminishing constant prices and increasing real income improves people's buying power in an accelerated fashion, and results in more material possessions. For instance, Figure 19 shows, since 1264, the percentage of a day's wages needed to buy two kilos of wheat (about what is needed to feed an average family which used wheat as its major source of food) in England. Such a percentage has both decreased substantially and has been fluctuating much less around its long-term trend since about 1800. As buying power improves, the great majority of people in industrialized countries can buy all necessities required for living and also have a part of their income left for acquiring durable and luxury goods, or spend it on services, including entertainment, and housing. Today, practically all families in industrialized countries possess refrigerators, ovens and similar electrical appliances while the great majority own telephones, TVs and cars. There is no doubt that in the future material possessions will increase even more as prices go down and income increases.

FIGURE 17

REAL DAILY WAGES IN £: ENGLAND

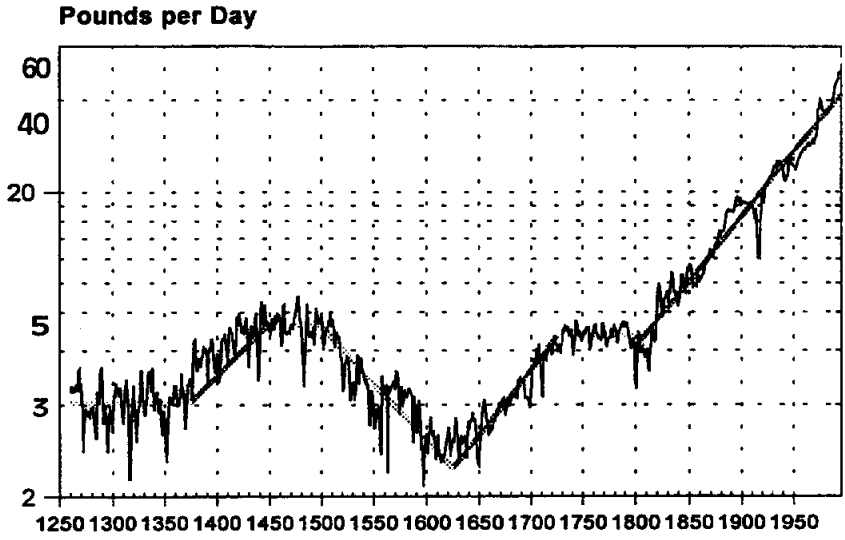


FIGURE 18

GNP: USA, JAPAN, FRANCE, HOLLAND AND UK

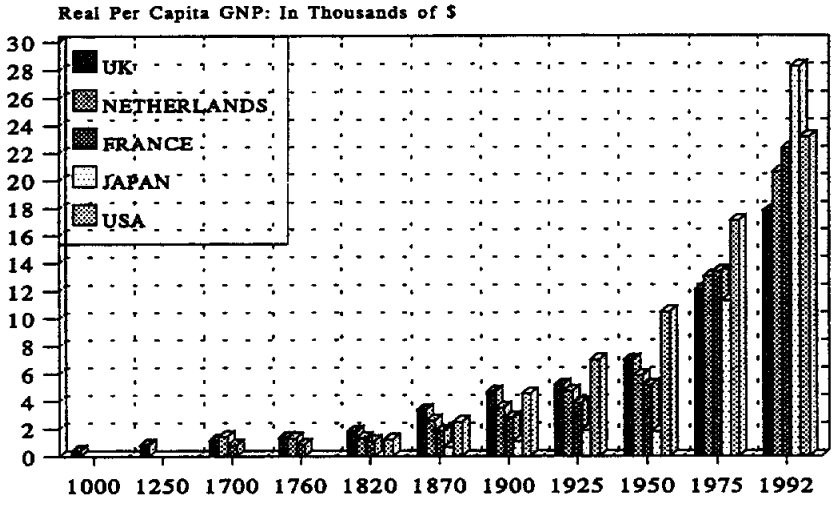
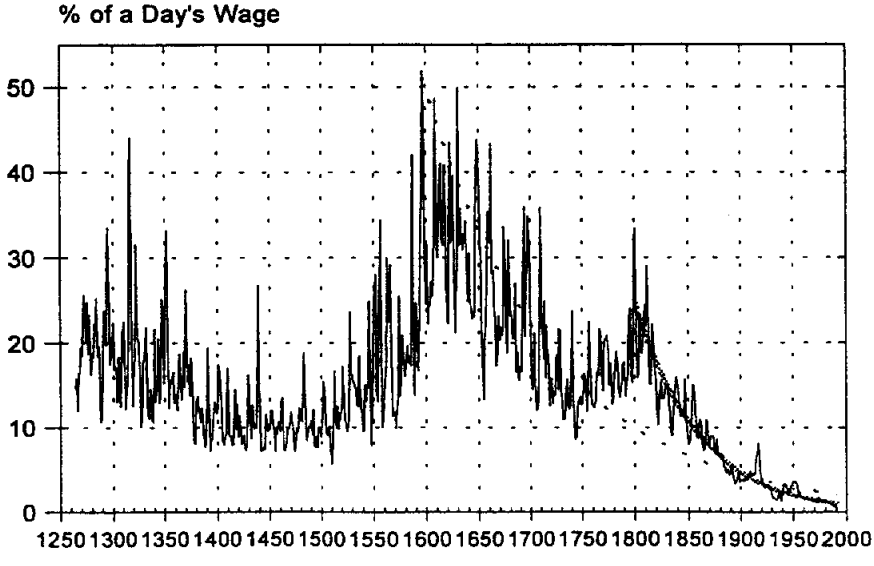


FIGURE 19

% OF A DAY's WAGE TO BUY TWO KILOS OF WHEAT



Cycles of Various Durations and Depths

The prices, income and buying power graphs displayed in Figures 12 to 19 exhibit strong deviations around the long-term trend. As was mentioned, these deviations, or cycles, can last for many decades and present a considerable challenge to forecasting. Unfortunately, however, cycles cannot be predicted quantitatively, as their length and depth is not constant (this observation can be confirmed in Figures 12 to 19). As Slutsky (1937) has pointed out, cycles are the outcome of cumulative random errors of the following form:

$$Y_t = \Sigma e_t \tag{1}$$

where e_t are independent, normally distributed error terms, with a mean of zero and a constant variance.

Figure 20 shows four graphs generated by (1). Figure 20(a), 20(b) and 20(c) were selected from a total of ten tries to illustrate extreme cases of applying equation (1). Figure 20(d) includes two graphs. One is the cycles of copper prices (the difference between the actual copper prices and their long-term trend from Figure 12), the other is the series, among ten ones generated by (1), that has the highest correlation to the copper price cycles shown in Figure 12. The obvious resemblance between the copper price cycles and the series generated through expression (1) in Figure 20(d) is striking, proving that copper cycles are the outcome of random factors whose influence is being accumulated over time. The shapes of Figure 20 suggest that the cumulative effect of random fluctuations can result in strong cyclical patterns that can make us believe, in an illusory manner (Langer, 1975), that there are underlying factors behind them.

Y_t, as presented by equation (1), is called a random walk and it is characterized by our inability to predict its next turning point. Many economic and business series behave like random walks, making the most appropriate forecast, for any future value of $\hat{Y}_t$, the latest one available, or

FIGURE 20(a)
A GENERATED SERIES THROUGH A RANDOM WALK

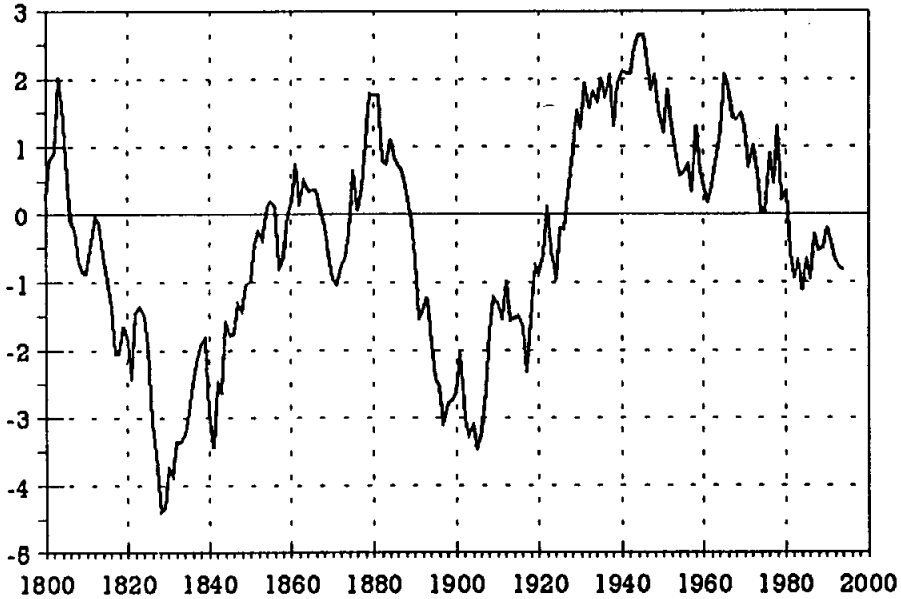


FIGURE 20(b)
A GENERATED SERIES THROUGH A RANDOM WALK

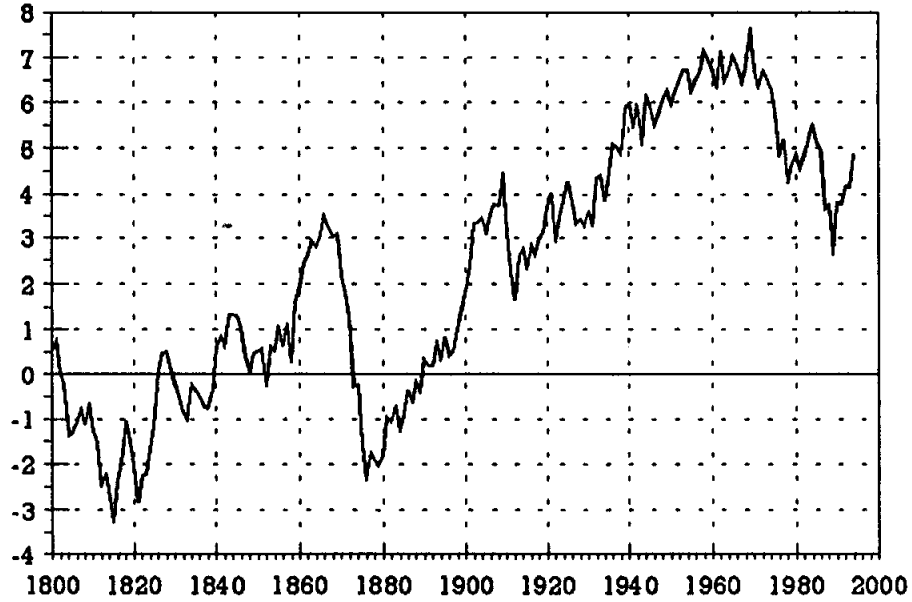


FIGURE 20(c)
A GENERATED SERIES THROUGH A RANDOM WALK

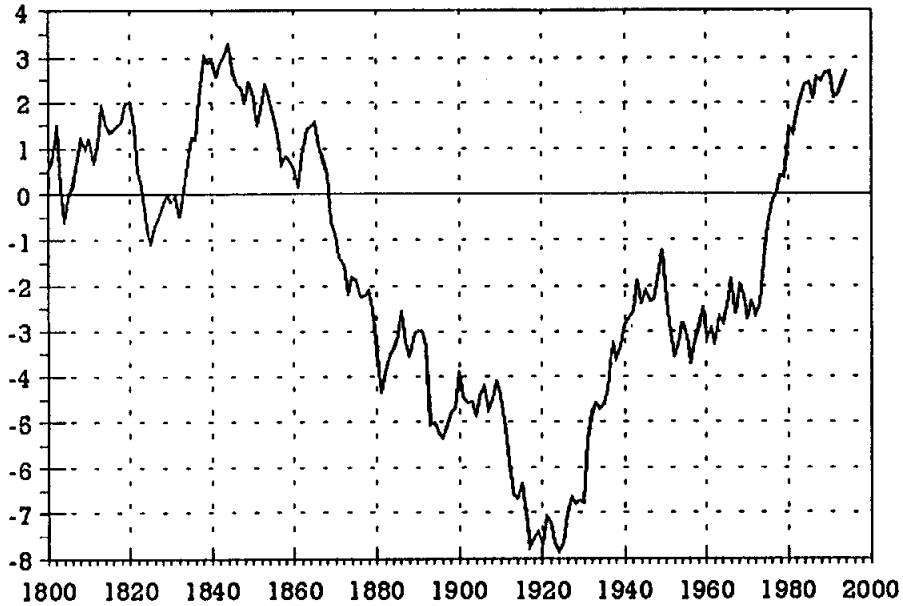
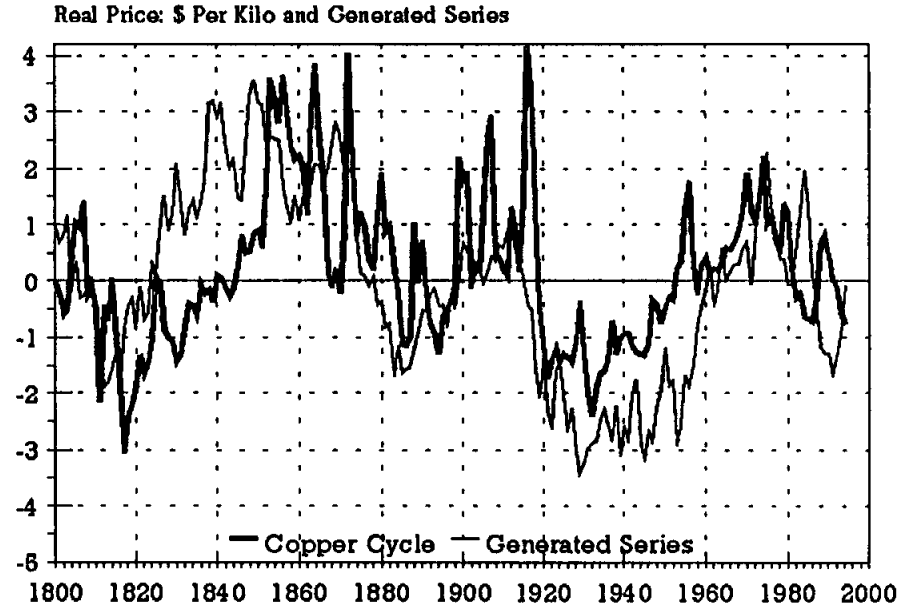


FIGURE 20(d)
CYCLES IN REAL COPPER PRICES AND A RANDOM WALK



$$\hat{Y}_{t+i} = Y_t$$

Figure 20(d) suggests that copper prices, once the long-term trend has been excluded, are random walks which cannot be predicted, unless additional non-quantitative information is available (e.g., inside information about capacity utilization rates, cartels, etc.). The random walk character of economic and business series explains the conclusions (Fildes and Makridakis, 1993) of why sophisticated models, which identify and extrapolate trends, are not more accurate than methods which assume no trend (e.g., single exponential smoothing) or which slow down its continuation (e.g., dampen exponential smoothing).

The fact that cycles are random walks increases the uncertainty in long range planning and strategy and necessitates taking into account such uncertainty when planning and formulating strategies for firms. Like chaos theory in physics (Gleick, 1987) random walks as expressed in (1) indicate that random factors, and their cumulative effects, are sometimes responsible for huge cyclical swings which are not therefore predictable as they are determined by initially small perturbations.

The Long-Term Trends in Population, and Wealth Inequalities

Human population has grown exponentially since homo sapiens appeared 50,000 years ago. However, absolute growth had been small until about 700 BC when the population of earth stood at about 200 million and has been increasing at a strong exponential rate since the fifteenth century when population was about 375 million. Since then it has doubled in 1740, and again in 1875, and 1955. It is expected to double again to 6 billion people before the end of this century.

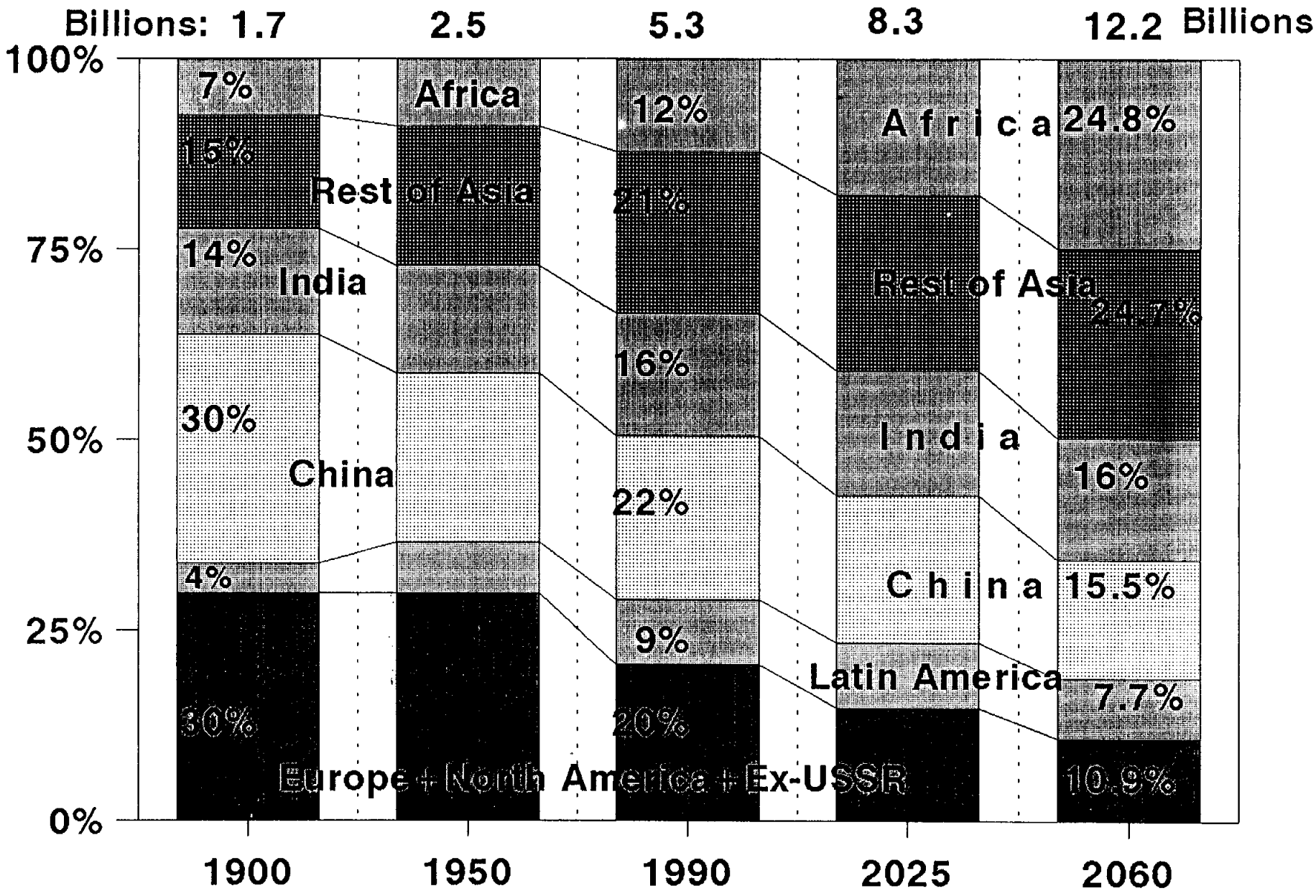
Population growth in developed nations has slowed down since the 1970s, or has even become negative in certain countries, while those of the developing world are still growing at a fast pace. If the population growth of the developing countries follows the same pattern of

slowing down as that of developed ones, then it is estimated that the population of earth will stabilize around the year 2060 at about 12.2 billion, more than double today's population size of about 5.7 billion. Sustaining a population of 12.2 billion does not seem as difficult as it was a few decades ago (e.g., see *The Limits to Growth*, 1972). Agricultural and manufacturing production can support an even bigger population size. Instead, serious problems are bound to come from the growing differences in the population size and wealth inequality between the rich and the poor, and the social and environmental problems associated with high consumption levels as well as wealth inequalities.

Figure 21 shows the percentage of population living in various countries/regions over time. These percentages confirm the substantial increase in the population of developing countries and the corresponding decrease in that of developed ones. In 1950 Europe, North America and the ex-USSR constituted 30% of the population of earth. In 1990 it stood at 20% and it is expected to drop to 11% by the year 2060, when it is expected that the population of earth will stabilize at around 12.2 billion.

Today, the top seven richest countries in the world with 14.6% of the population hold 87.9% of the world's GNP. The USA alone with 4.7% of the world population generates 25.8% of its wealth. Its average yearly growth rate of about 3.1% is 183 billions, a number which exceeds the combined GNP of the 37 poorest countries with a per capita GNP of less than $550 a year. Moreover, this 3.1% yearly increase of $183 billion is higher than the total GNP of India with a population of 885 million people. Worst of all, the gap between the rich and poor will continue to increase if left to its own devices encouraging crime, pollution, illegal immigration and social unrest. If the poor see no opportunities and chances for advancement, by following the established rules imposed upon them by the rich nations, they will search for alternatives including cultivating and selling drugs, deforesting the Amazon, or other forests, polluting the environment, resorting to crime, or illegally entering countries where they can find work.

WORLD POPULATION



Growth in sales and opportunity for expansion is bound to shift to the developing countries of the third world, and in particular those of South and South East Asia which, in addition to the high population growth, are developing economically at a fast pace. The population of China and India alone will, by the year 2015, be 2.7 billion, more than twice as much as the combined population of Europe, North America and Japan. Moreover, the inhabitants of developing countries own few material possessions, at present guaranteeing a huge demand from household appliances and cars to computers and medical equipment. The only difficulty will, of course, be that they will need enough income to be able to afford these products. However, if history is a guide, developing countries will improve their economies and achieve a take-off as today's developed nations have done since the beginning of this century. There are encouraging signs with many Asian countries that such an economic take-off is well under way. This means that European, North American and Japanese firms will be obliged to operate in developing countries if they want to grow and through their investment and managerial know-how contribute to a faster economic growth for these developing nations. In such a case an important role for forecasting will be to accurately predict the countries and the timing of their take-off to help entering their market with appropriate investments.

Extrapolating Long-Term Trends: Implications

Table 2 shows the effects of a 1% decline in real prices, a 2.8% increase in the Index of Industrial Production (IIP), a 1.8% increase in the per capita GNP and the corresponding improvement in buying power as well as earth's population assuming that its growth in developing countries will follow the same pattern as that of developed ones. Table 3 shows the same variables except for prices which are assumed to decline by an average of 2% a year instead of the 1% used in Table 2.

The effects of the cumulative growth are phenomenal. Buying power, 6 in 1890, becomes 100 in 1990, 133 in 2000, 200 in 2015, and 2158 in 2090. When average price decreases are assumed to be 2% (see Table 3), the effects are even more profound as buying power will be 146 in 2000, 260 in 2015 and 6473 in 2100. If the trends shown in Table 2 or 3 continue,

TABLE 2

THE CUMULATIVE EFFECT OF GROWTH RATES
Per Capita IIP=2.8%, GNP=1.8%, Prices=-1%

	1885 to 1895	1985 to 1995	2000	2015	2050	2100
IIP	6	100	132	200	524	2086
Real GNP	17	100	120	156	292	712
Real Prices	270	100	90	78	55	33
Buying Power	6	100	133	200	530	2158

TABLE 3

THE CUMULATIVE EFFECT OF GROWTH RATES
Per Capita IIP=2.8%, GNP=1.8%, Prices=-2%

	1885 to 1895	1985 to 1995	2000	2015	2050	2100
IIP	6	100	132	200	524	2086
Real GNP	17	100	120	156	292	712
Real Prices	270	100	82	60	30	11
Buying Power	6	100	146	260	973	6473

excluding unforeseen disasters, we are about to enter into an era of full material abundance where the buying of goods and services, at least the standardized ones, will be done with a very small percentage of people's income. The obvious implications of this are that people will easily own everything they need and will be looking for **new** products or services on which to spend their increasing real revenue. In such an environment the biggest challenge for firms will be to identify and quickly bring to market novel products/services to satisfy the needs of consumers who already own practically everything they want. Success and high profits will then have to come from technological or other innovations, and from using these innovations to satisfy **new** customer needs, as practically all existing ones will have already been satisfied. Success will therefore have to come from identifying emerging or future customer needs, thus requiring forecasting, and from creativity and new thinking to come up with new or improved products/services rather than from past success or imitating what others have been doing well.

A concern when extrapolating for more than 100 years is whether or not the trends assumed in Tables 2 or 3 will continue, or alternatively flatten out or even reverse themselves. Today we know that the agricultural revolution brought considerable improvements in yields and productivity which have allowed the reduction in real prices and the increase in real income since the beginning of the nineteenth century. Moreover, the effects of industrial revolution in increasing manufacturing productivity and reducing costs is unquestionable. However, as agricultural productivity has reached a plateau and as manufacturing productivity is slowing down and as their contribution produces diminishing returns (the price decreases being brought are becoming smaller and smaller in absolute terms because of the exponentially decreasing behavior of prices shown in the figures being displayed) the big question is how to achieve continuous price decreases of non-diminishing magnitudes. Furthermore, increases in real income will also slow down unless alternative ways to improve productivity beyond agriculture and manufacturing are found.

As it has been indicated, the major reason that real prices have been dropping in the long run is because supply exceeds demand, which fuels competition and productivity improvements. Today there is overcapacity in practically all industries. Moreover, whenever any scarcities develop, eliminating them takes little time for three reasons. First, scarcities mean that demand exceeds supply, allowing high prices and good profit margins. However, the expectation of high profits attract competition searching for opportunities of above average profits, which adds to existing supply. Second, as competition is global, local inefficiencies are easily eliminated with products or services from other parts of the world. Finally, adding to existing capacity or building a new one takes little time because both capital and technologies are readily available. This means that for products or services that can be reproduced demand would rarely exceed supply, or do so for any long periods of time. Consequently, strong competition will continue the pressure towards lower real prices.

There must be a shift towards services and white-collar employees as well as the distribution system if the contribution of productivity improvements is to continue. The forthcoming challenge for firms will, consequently, be devising ways of getting the maximum amount of productivity gains from their office workers and managers while reducing their distribution costs as much as possible, as the bulk of the employment in the service sector is in offices, and distribution adds considerably to the overall price consumers pay. This productivity challenge has already been under way but it will have to be accelerated substantially to provide for the continuation of trends shown in Tables 2 or 3 and it will have to mainly come from using computers and communications (C&C) to achieve substantial productivity gains in offices and white-collar work as well as the distribution system.

Trends in Computers and Telecommunications: The Information Revolution

Figure 22 shows the trend in the speed of personal computers, Figure 23 that of their memory, Figure 24 that of the dollar cost per Million of Instructions Per Second (MIPS) while Figure 25 shows the speed and capacity of telecommunications. If current trends continue, experts estimate that by the year 2015 the speed of computers will be approaching that of the human

FIGURE 22
SPEED OF PERSONAL COMPUTERS

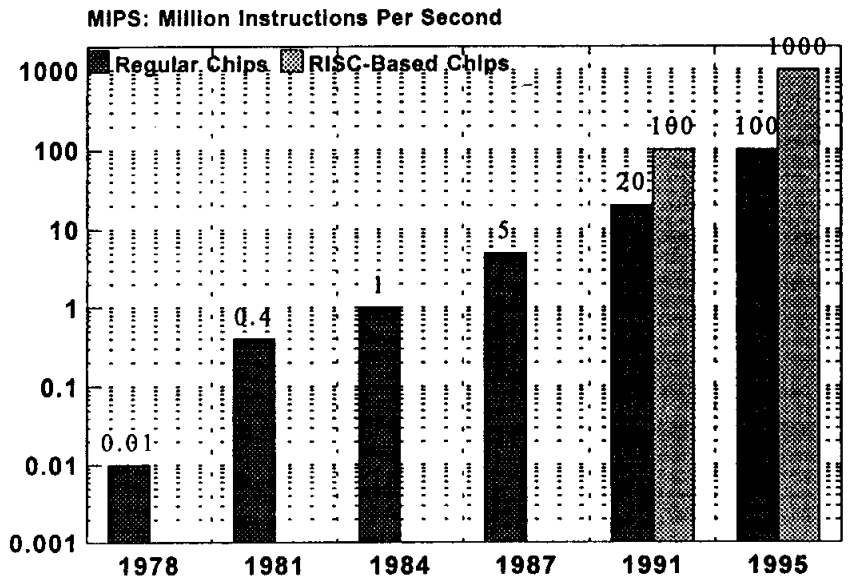


FIGURE 23
NUMBER OF TRANSISTORS IN EACH CHIP

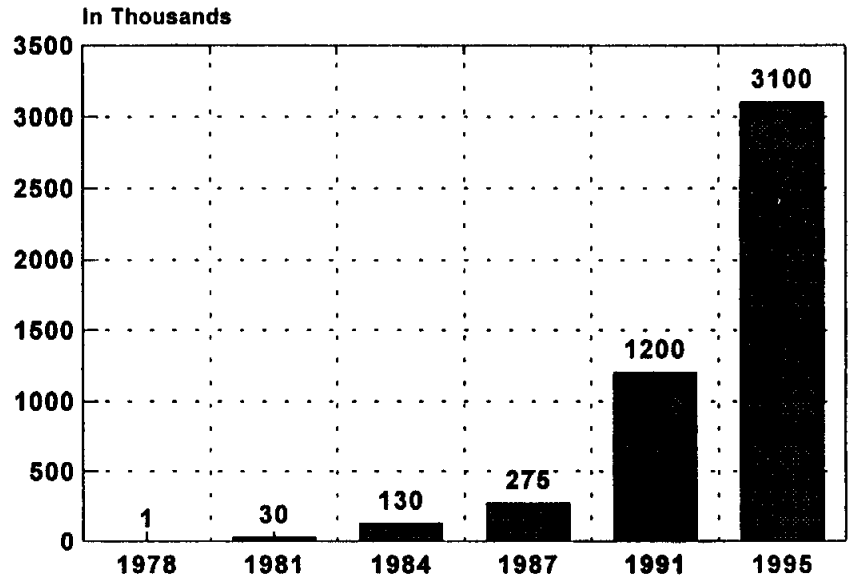


FIGURE 24
REAL COST OF PERSONAL COMPUTING: $/MIPS

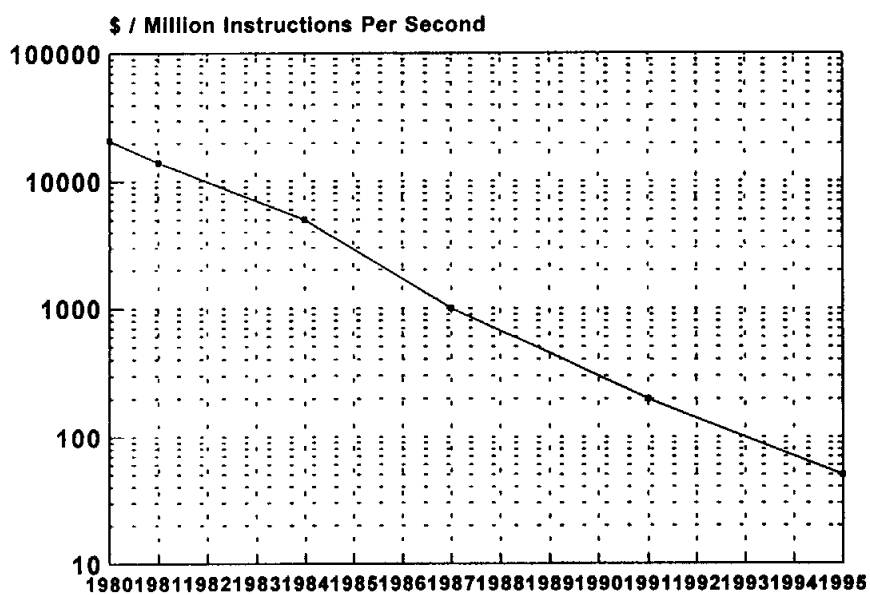
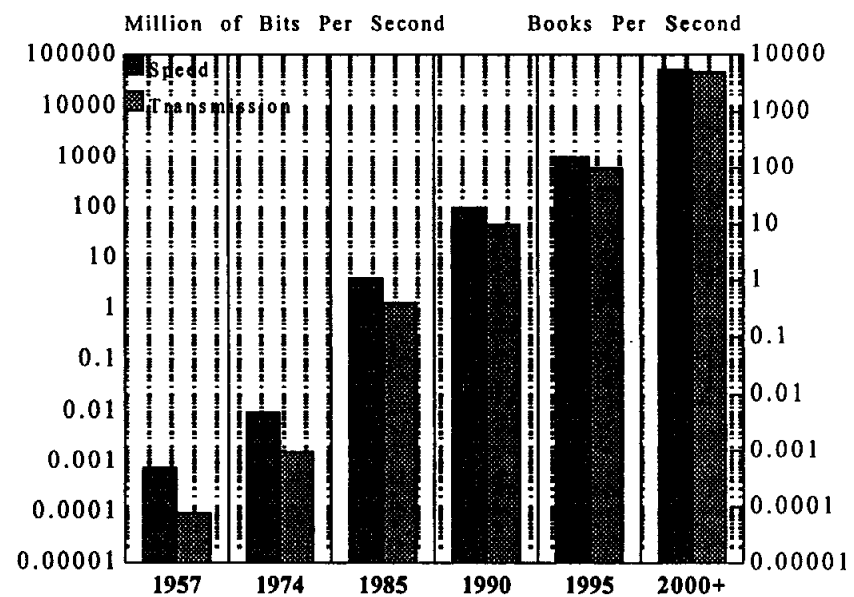


FIGURE 25
TRANSMISSION SPEEDS/CAPACITIES



brain, the density of memory chips will be approaching that of the human memory, while the speed of computer transmissions will approach that of our visual system (Corcoran, 1991; Keyes, 1993; Stix, 1993; Weiser, 1991). Moreover, these experts see no limits to reaching and surpassing these speeds or capacities. This would mean that by the year 2015 the fastest supercomputers will be at the computational speed level and the communication power of our brain. Moreover, computers will be able to store infinite amounts of information as their memory size will not be limited to that of a cranium, as is the case with our brain. At the same time, personal computers costing a few thousand dollars will provide users with the power and memory of many times that of today's fastest supercomputers.

The above mentioned trends in computers and telecommunications will have critical implications in how information is processed, communicated and used, and the type of tasks that computers will be capable of performing more productively than humans. As machines substituted, supplemented and amplified all standardized manual tasks previously done through the use of human muscles, computers will similarly substitute, supplement and amplify all standardized mental tasks currently performed using our brain. Computers will, in the near future, be able to read handwritten text without major mistakes, understand and speak a limited vocabulary of natural languages and by the end of this century acquire some elementary vision. In the long term, 2010 to 2020, they will be capable of reading and speaking as well as humans and probably "seeing". This means they will be able to perform, in addition to practically all repetitive manual tasks, practically all standardized mental ones currently performed by people while also helping to substantially increase the productivity of all tasks performed by humans, even those requiring high level of skills and/or creativity. Humans will have to concentrate on non-standardized tasks involving imagination, creativity, new or creative problem-solving and quality personal services. Alternatively, humans will have to perform tasks requiring talents, experience and/or expertise that computers will not be capable of acquiring.

There are a lot of complaints that white-collar productivity has not increased at all despite the huge investments made in computers and other office equipment (Roach, 1988, 1991). Thus, there is skepticism as to whether or not computers will be capable of providing the substantial productivity improvements required so that the long-term trends in prices, income and buying power mentioned above can continue. I believe that another major role of forecasting is to provide objective information to deal with important concerns such as the role and potential value of computers and communications, or similar types of forthcoming technologies. This can be done by studying similar analogies, for instance the one between mechanical and computer power.

Newcomen developed the first workable steam engine in 1707. It took more than 200 years before Henry Ford used such an invention for the practical purpose of building a useful car that the majority of people could afford to buy. Furthermore, it took another half a century before cars could substantially change our mode of life by permitting people to move to the suburbs and by allowing them to decide where they would work and do their shopping. Similarly, it took more than 90 years between the time electricity was invented and its use by firms to substantially improve productivity. It has been estimated that it took more than 20 years at the beginning of our century before the considerable investments in electricity paid off (David, 1993). It cannot be expected, therefore, that computers will produce immediate results. After all, they were invented less than half a century ago and they are still used mainly as number crunchers, text editors, data banks and in general for doing more efficiently tasks done without computers beforehand (the same was true of engines and electricity before the mid 1920s). Table 4 shows analogous events concerning machines and computers and demonstrates that the information revolution is not late. If the trends in C&C shown in Figures 23 to 25 continue, and if the analogies displayed in Table 4 are valid, we will be entering by the end of this century, or the beginning of the next, into a period where major productivity improvements from the computer revolution will be achieved. By 2015 the information revolution should have provided firms with as much productivity improvement as those of the industrial revolution today.

FROM STEAM ENGINES TO UNATTENDED FACTORIES AND FROM THE ENIAC COMPUTER TO EXPERT SYSTEMS

MECHANICAL POWER		COMPUTER POWER	
1712	Newcomen's Steam Engine	1946	ENIAC Computer
1784	Watt's Double Action Steam Engine	1950's	IBM's Business Computers
1830	Electricity	1971	Time Sharing
1876	Otto's Internal Combustion Engine	1973	Microprocessor
1914	Continuous Production Line	1970's	Electronic Data Processing (EDP)
1890	Cars	1977	Apple's Computer
1901	Electricity in Homes	1980's	Computers with Modems
1919	" in 1/3 of "	1993	Personal Computers in about 1/3 of Homes
1925	" in 1/2 of "	1999?	Widespread Use of Computer/Mobile Tele-communication Devices
1928	Cars in 1/2 of "	200?	Widespread Use of Tele-shopping/Services
1950's	Widespread Use of Cars	200?	Expert Systems
1950's	Widespread Use of Electrical Appliances		
1990's	Unattended Factories		

The biggest change as the information revolution takes off will be in the way people communicate with each other, shop and obtain services, entertain themselves and work. All these tasks can be done through computers and communications opening up the possibility, for those who want to take it, of a tele-society where work, education, shopping and, of course, entertainment can be done from the comfort of one's home. In addition, the information revolution is bound to bring fundamental changes in the way firms are organized, managed and run. Information could be shared and meetings could be held over computer networks among people who will not have to be physically present in the same location. Consumers could buy, or get whatever service they need through computer networks that would allow unlimited access to information (prices, quality, consumer surveys, delivery time etc.) as well as freedom of choice. Such changes in the way firms could be organized and buying/selling could be done would force firms to reengineer themselves to exploit the availing advantages that C&C could be capable of providing.

By the beginning of the next century unattended factories using robots and CAM (Computer Aided Manufacturing) will be common, further reducing the number of blue-collar workers. Moreover, the appropriate use of computers in offices and service firms will do for the repetitive white-collar jobs what machines have done for the blue-collar ones since the beginning of 1800. Finally, C&C will do for all buying or the obtaining of services what computer and telephone lines have already done for airline and other reservations: open up a global market place where information is instantly disseminated and where consumers themselves can avoid all intermediaries if they possess a personal computer and connected in a computer network.

The above means that firms will employ fewer people who will add value through their creativity, talents, experience, expertise or interpersonal skills. In order to be useful, employees will have to use their heads, instead of being told what to do, and their intelligence and imagination for doing as well as or better than their competitors as technology, including

computers, will be available to everyone. A valued and critical contribution of forecasting would be to identify the opportunities opening up by C&C and explore the analogy between the industrial and information revolutions in order to figure out the impact and value of the information revolution.

Information Revolution: Major Changes and their Implications

Table 5 shows the five most important technologies of the industrial revolution. Each of them contributed significantly in changing the way people lived and the organization, management and running of firms. Electricity brought mechanical power everywhere, whether in factories or homes, and allowed the effective use of power tools. Electrical appliances, in particular those for home use, freed women from household work, thus giving them the opportunity of entering the labor market. Cars provided people with mobility and unlimited freedom to go wherever they wanted and when they wanted in a comfortable way. Cars permitted people to move away from cities, where the majority of the jobs were located, to the suburbs, and go to shop far away from their homes in search of bargains. Telephones allowed people to talk to relatives or friends, obtain information or services, or do business from their homes or offices. As long distance calls become cheaper and cheaper, communications over telephone wires become more and more popular affecting both consumers and firms. Television, finally, brought entertainment to every home and reduced the need to physically go out.

The five technologies shown in Table 5 have achieved practically 100% penetration rate in most developed countries. The obvious reason is that people want them and are willing to pay to obtain them. It is interesting to consider the five industrial revolution technologies shown in Table 5 and their correspondence in terms of the information revolution.

Electricity: Computer networks will take computer power everywhere so that everybody can use it. Portable notebook, or smaller size computers, will be part of these networks allowing unlimited access to the network. Information can, therefore, become instantly available anytime and place anyone needs it.

TABLE 5

FIVE INVENTIONS THAT HAVE CONTRIBUTED TO THE MOST SIGNIFICANT CHANGE IN OUR LIVES

- Electricity
  - Batteries
- Electrical Appliances
  - Programmable, Rechargeable
- Automobiles
  - Greater Choice, Better Quality
- Telephones
  - Cordless, Mobile
- Television
  - Remote Control, Cable, VCR

Electrical Appliances: Software and grouper will become easy to use providing high value in ways that are not clear yet as the value of electrical appliances was not obvious 100 years ago. As they will be available over computer network they can be used anywhere increasing their usefulness and value.

Automobiles: Of the five technologies of the industrial revolution shown in Table 5, cars are the most problematic. Their success has clogged up roads, made parking in popular places impossible and has increased their prices. Computers can provide an alternative by permitting people to work, shop or obtain services and entertain themselves anywhere they wish, including in their own homes. Network and software/groupware will provide such opportunities.

Telephones: Computers can augment telephone communications in many ways including bringing images, permitting multiple connections, and allowing the simultaneous transmission of voice, data and images. As all information can be digitalized, computers will provide unlimited possibilities for all sorts of communications and unlimited freedom of choice of where to work and shop or get services. Cheap teleconferencing over personal computers will become as affordable and popular by the beginning of the next century as telephones are today. High quality images brought to one's computer at cheap prices will also affect buying and obtaining services over C&C.

Television: The information superhighways will allow the carrying of images, sound, data and any other type of information (books, magazines, newspapers, teaching material, etc.) to any home. The possibilities are limitless, not only for entertainment, but also for all kinds of related leisure activities, from reading a rare book to viewing the entire work of Picasso or seeing any movie or theater play anywhere in the world. In addition, the integration of communications and computers will provide a high degree of interactivity.

Is the information revolution a dream with few practical implications? Another important role for forecasting is to determine the right timing that specific communication and computer technologies will become practical and economically useful. In addition its role must also be to educate executives about forthcoming technologies and the advantages/drawbacks of doing nothing versus adopting them. These are important roles that must be further explored if forecasting, as a profession, is to become more useful and relevant. This means that forecasting must move beyond its emphasis on short-term predictions to identifying emerging and forthcoming changes and figuring out their implications in terms of various time spans. Most interestingly it will have to help managers identify and exploit the opportunities that C&C will be availing while providing them with advice about the dangers involved if they do not "informatize" their firms. This is where its contribution and value to long range planning and strategy are of critical importance and where forecasters must work together with strategists in order to devise the most useful way of providing relevant predictions.

Conclusions

Human history has shown a clear tendency towards achieving more with less effort, doing more interesting and challenging tasks, having more free time to spend as people wish, living longer and healthier lives, in addition to being able to feed, clothe and shelter ourselves as well as possible. These objectives are natural, part of our intelligence and purposeful behavior. They are built into our economic, social, cultural and political systems. They are related and bring what we can call "progress" of our human civilization. Given the structure of our economic system and people's needs, objectives and expectations we can assume, with a reasonable degree of certainty, that the long-term trends described in this paper will continue into the future. The implications of such continuation is that continuous ways of improving productivity must be found which would require exploiting the availing potentials of computers and communications to improve services, white-collar work and the distribution system. Another challenge for firms in industrialized countries will be to continue growing while their population is stagnant and already possesses practically everything, while that of developing nations will be increasing at a fast pace and be in need of practically all the goods

and services enjoyed by the citizens of affluent nations. This challenge will mean either trying to operate in developing countries, whose income is a small fraction of developed ones, and where uncertainty is high or alternatively compete in the safety of developed economies whose markets are saturated and whose population has stopped increasing.

Business firms need to identify additional, more specific trends applicable to their own industries, markets or interests. For strategic purposes the critical question is not whether the long-term trends will continue because, barring natural or man-made catastrophes, they will. Rather what should be of utmost importance is first the length and extent of deviations around the long-term trends, as some of these deviations can last for many decades and result in considerable fluctuations away from the trend, and second in identifying and figuring out the influence of the various trends and the associated uncertainty to specific industries, markets or firm-related areas. The role of forecasting is critical as is its task to identify the specific long-term trends relevant for given firms or industries and to extrapolate them to assess their strategic implications. I believe that forecasters and strategists will have to work closely together to bring success to tomorrow's firms. In such a collaborative effort, forecasters must concentrate their efforts on identifying long-term trends as well as the uncertainty surrounding the business environment, specific industries and/or firms. Strategists, on the other hand, must consider the implications of such trends and uncertainty and find ways of exploiting the opportunities while minimizing the dangers from the available forecasts.

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