PART ONE

Technological Revolutions as Successive Great Surges of Development

1. The Turbulent Ending of the Twentieth Century

On a day like any other in November 1971, a small event in Santa Clara California was about to change the history of the world. Bob Noyce and Gordon Moore launched Intel's first microprocessor, the precursor of the computer on a chip. It was the big-bang of a new universe, that of all-pervasive computing and digital telecommunications. Chips were powerful, they were cheap and they opened innumerable technological and business possibilities.

At that time not many people had heard of venture capital or 'angels'. Though many common citizens in the USA had stocks and bonds, few followed the daily changes in the stock market. The word 'derivative' was generally confined to mathematics. Most middle-class people kept their money in the bank or in the savings and loan society and the self-made millionaires, although a core element of the American dream, were few and far between. In the decades to follow, all this was to change radically. Millionaires would abound and finance was to become the central concern of people with old and new wealth. By the end of the 1990s, even people with modest salaries had turned into hopeful 'investors'.

Henry Ford had been the central character in a similar event in 1908. The low-cost Model-T, with its internal combustion engine powered by cheap gasoline, was the *big-bang* opening the world of the automobile and of mass production and mass consumption.

By the mid-1920s, the New York Stock Market was perceived as the engine moving the American economy and even the world's. As was to happen later, in the 1980s and 1990s, financial geniuses appeared by the dozens and investment in stocks or real estate seemed almost guaranteed to grow and grow in an unending bull market. Great wealth for the players was the result; irrational exuberance was the mood. By the end of the 1920s even widows, small farmers and shoe-shine boys were putting their money into that glorified casino. The crash was unexpected; the following recession and depression were exceptionally deep and prolonged.

This sequence had happened three times before in a similar – though each time specific – manner. A decade after the first industrial revolution opened the world of mechanization in England and led to the rapid extension of the network of roads, bridges, ports and canals to support a growing flow of trade, there was canal mania and, later, canal panic. About 15 years after the Liverpool–

Manchester rail line inaugurated the Age of Steam and Railroads, there was an amazing investment boom in the stock of companies constructing railways, a veritable 'railway mania' which ended in panic and collapse in 1847. After Andrew Carnegie's Bessemer steel mill in 1875 gave the big-bang for the Age of Steel and heavy engineering, a huge transformation began to change the economy of the whole world, with transcontinental trade and travel, by rail and steamship, accompanied by international telegraph and electricity. The growth of the stock markets in the 1880s and 1890s was now, not only in railways but also in industry, not mainly national but more and more truly international. The crashes happened, in different forms, in the USA and Argentina, in Italy and France and in many other parts of the world.

Each technological revolution has led to the massive replacement of one set of technologies by another, either by outright substitution or through the modernization of existing equipment, processes and ways of operation. Each involved profound changes in people, organizations and skills in a sort of habit-breaking hurricane. Each led to an explosive period in the financial markets.

New actors, usually young, burst into action shaking a firmly established and complacent world. Investment in the new industries is carried out by new entrepreneurs while the young financial tycoons create a whirlpool that sucks in huge amounts of the world's wealth to reallocate it in more adventurous or reckless hands: some for speculation in real estate or in whatever is amenable at the time, some for buying existing assets and some for new investment. A part of this goes to new industries, another to expand the new infrastructure, another to modernize all the established industries, but most of it is moved about in a frenzy of money-making money, which creates asset inflation and provides a gambling atmosphere within an ever-expanding bubble. Eventually it has to collapse. But when it does, the changeover has been made. New industries have grown, a new infrastructure is in place; new millionaires have appeared; the new way of doing things with the new technologies has become 'common sense'. One crucial thing is still missing: a systematic articulation of the new regulatory framework and of the appropriate institutions, capable of steering and facilitating the functioning of the new economy in a socially and economically sustainable manner.

Each time around, what can be considered a 'new economy' takes root where the old economy had been faltering. But it is all achieved in a violent, wasteful and painful manner. The new wealth that accumulates at one end is often more than counterbalanced by the poverty that spreads at the other end. This is in fact the period when capitalism shows its ugliest and most callous face. It is the time depicted by Charles Dickens and Upton Sinclair, by Friedrich Engels and Thorstein Veblen; the time when the rich get richer with arrogance and the poor get poorer through no fault of their own; when part of the population celebrates prosperity and the other portion (generally much larger) experiences

outright deterioration and decline. It is certainly a broken society, a two-faced world. But while the poor can usually see the conspicuous consumption of the ostentatious members of the new 'leisure class', to these, the poor are often hidden from view. In the globalized world of the information economy, this is all the more true, given that the cleavage between the excessively rich and the extremely poor is basically international. Were it not for satellite TV and mass illegal migrations, the invisibility could be almost total.

When the financial breakdown comes, the party is over and the time comes for analyzing what went wrong and how it can be prevented from happening again. Though the debate about the causes and the culprits can go on forever, the more practical task of setting up an adequate regulatory system and a set of effective safeguards is soon undertaken. Thanks to the crash and the recession, there is a newfound readiness to accept such rules on the part of the – until recently arrogant – financial wizards, now sobered up.

If, at this turning point, the institutional adjustment is successfully achieved, what follows may be a golden age. It can be a period of full employment and widespread productive investment, a period when *production* is at center stage, when at last the benefits of the system begin to spread down and an era of 'good feeling' sets in. The best face of capitalism can then be seen. It is the face of progress and of relative coincidence between individual and collective interests. Financial capital goes out of public sight into boardrooms and offices. It increasingly supports big production companies that are generating real wealth, and grows *with* them and at the pace they set. By this time, the main companies may already be the result of mergers and would have become what in each period would be considered *big* corporations, often operating as oligopolies.[3] This reduces the previous ferocity of competition and leads to a common interest in having comfortable profit margins and in enlarging the target markets by widening the consumer base. As the improvement in income distribution allows, consumption grows and expands. The new style of living, just established by the *nouveaux riches*, begins to diffuse down from one social stratum to another in more 'popular' versions. These are the times when capitalism is identified with progress and the idea that it can achieve social justice becomes more credible. Hope grows high. In the next phase, though, the unfulfilled expectations will lead to frustration and protests.

This book holds that the sequence *technological revolution–financial bubble–collapse–golden age–political unrest* recurs about every half century and is based on causal mechanisms that are in the nature of capitalism. These

3. In the first and second revolutions personal or family firms were still typical and their size, though seen as large by contemporaries, was typically small in relation to the industry as a whole. The truly giant corporations and the formation of oligopolies and cartels only became a feature of the system with the third revolution, from the end of the nineteenth century.

mechanisms stem from three features of the system, which interact with and influence one another:

1. the fact that technological change occurs by clusters of radical innovations forming successive and distinct revolutions that modernize the whole productive structure;
2. the functional separation between financial and production capital, each pursuing profits by different means; and
3. the much greater inertia and resistance to change of the socio-institutional framework in comparison with the techno-economic sphere, which is spurred by competitive pressures.

Obviously the recurring sequence is hidden under many layers of unique factors, events and circumstances. These layers happen to be some of the most important aspects in the history of any country and of the world: culture, politics, leading personalities, wars, gold discoveries, natural catastrophes and so on. In addition, because of uneven development, itself an outstanding feature of capitalism, such regularities are mainly visible in the core countries of the world system, which also change over time (as when the USA took the lead from Britain in the twentieth century).

Yet the dynamic regularities presented in this model can be identified from many angles. When A.C. Pigou, Alfred Marshall's successor in Cambridge, observed the changing views about money in the first half of the twentieth century he was precisely picking up the sequence in question:

> In the years preceding the First World War there were in common use among economists a number of metaphors … 'Money is a wrapper in which goods come'; 'Money is the garment draped round the body of economic life'; 'money is a veil behind which the action of real economic forces is concealed'…
> During the 1920s and 1930s … money, the passive veil, took on the appearance of an evil genius; the garment became a Nessus shirt; the wrapper a thing liable to explode. Money, in short, after being little or nothing, was now everything …
> Then with the Second World War, the tune changed again. Manpower, equipment and organization once more came into their own. The role of money dwindled to insignificance …[4]

However, this effort at identifying the recurrent phenomena is not aimed at simplifying history or at applying mechanistic models to its infinite complexity and unpredictability. It is mainly aimed at serving two useful purposes in relation to policy, growth and development:

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4. Pigou (1949) pp. 18–19.

1. To help recognize the dynamic and changing nature of capitalism in order to avoid extrapolating any particular period – be it good or bad – as 'the end of history' or as the final crisis of capitalism or as the arrival of unstoppable progress or as any 'new' and permanent nature of the system, from then on.
2. To help see ahead to the next phase of the sequence, in order to design timely actions to make the best of the impending opportunities.

According to the model that will be presented here, achieving this second purpose also requires a deep understanding of the nature of the particular technological revolution being deployed. One of the main ideas to be put forth is that each of these revolutions is accompanied by a set of 'best-practice' principles, in the form of a *techno-economic paradigm*, which breaks the existing organizational habits in technology, the economy, management and social institutions. The particular manner in which these principles are applied each time and in each case is strongly influenced by all the layers mentioned above. Therefore, the modes of growth adopted, while formally applying similar structural principles, can be profoundly different in their social content.[5]

The world is once again at a crossroads where explanations and guiding criteria are sorely needed. The twentieth century left a turbulent legacy that after chanting the advent of a 'new economy' has to cope with unraveling the meaning of the implosion of the Internet bubble and its aftermath. Comprehending some of the underlying causes of the stagflation and debt crises of the 1980s and of the financial boom of the 1990s, could be helpful for overcoming the consequences of the collapse that began in 2000. It is hoped that the model to be presented will provide a contribution to such an understanding. The possibilities open are very different: it can be a world for the few or a world for the many. Perhaps a fruitful debate about the structural causes of such changing conditions can guide positive action towards constructing the next golden age, and maximizing its social benefits in the core countries and globally.

Technological revolutions and the unfolding of their potential play a central role in the model. The following chapter is devoted to defining them and identifying the five revolutions that have shaped the last two centuries. It will also define the two associated concepts that play a major role in the model to be presented. One is *techno-economic paradigm*, which stands for the new 'common sense' guiding the diffusion of each revolution. The other is *great surge of development*, which represents the process of installation and deployment of each revolution and its paradigm in the economic and social system.

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5. The mass-production revolution, which marked most of the institutions of the twentieth century, underlay the centralized governments and massive consumption patterns of the four great modes of growth that were set up to take advantage of those technologies: the Keynesian democracies, Nazi-fascism, Soviet socialism and State developmentalism in the so-called 'Third World,' each with very wide-ranging specificities.