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PROFESSIONAL PAPER

ON A FIFTY YEARS PULSATION IN HUMAN AFFAIRS: Analysis of Some Physical Indicators

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PREFACE

Why should economic cycles (or "long waves" or "long-term pulsations in social behaviour") have a place in the Core Concepts project? Such cycles, surely, are a familiar concept, neither newly emergent nor in need of clarification. In this paper, Marchetti, questions these assumptions.

They are called economic cycles, he argues, because they were first discussed by economists but, in fact, economic indicators are not nearly as successful in establishing the existence and nature of such cycles as are "physicals". So the concept is not so clear after all, but does it have some emergent quality? Does it threaten to change the conversation of applied systems analysis?

Yes, says Marchetti, it changes the way in which we see our client--*the decision maker*. At present, we tend to see the decision maker as the Great Controller, the Great Initiator, but, as we clarify the cycles by using physical rather than economic indications, so we begin to see him more as the Ribbon Cutter. Decision makers are downgraded and become only "the active tendrils of Big Brother, the System".

Michael Thompson
Leader, Core Concepts Project

ON A FIFTY YEARS PULSATION IN HUMAN AFFAIRS: Analysis of Some Physical Indicators

INTRODUCTION

That human affairs have a cyclical course is an ancient observation. Not unexpected where nature is so cyclical: the day, the moon, the seasons, the planets, all move around in never ending repetitions.

The facts were so dominating that the idea of cyclicity came into philosophy and the general conception of the world. All cycles had a hierarchical order terminating in a universal cycle of great length, just a billion years for the Hindus controlling the eternal repetition of the beautiful play.

Christian theologians of the third century, for reasons of internal consistency, declared time open, with a beginning and presumably an end, an objective and a program. The idea has been of immense stimulus to western activism. They did not have the interest, however, of shooting at lower levels. So we are still entangled in the concept, with astronomers, geologists, geophysicists, climatologists, ecologists, sociologists, and, finally, economists all chasing around to find some. Open-end processes are fearful, and the cycle protective. Even in Vico's spiral form: a little new, a lot of deja vu.

The cycles we are dealing with in this workshop I would more precisely define as pulsations, as there is a lot of new and little

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Workshop on Long Waves, Depression and Innovation: Implications for National and Regional Economic Policy. Siena and Florence, 26-28 October 1983.

deja vu. They were originally discussed by economists and for that reason they were called economic cycles. I think they go beyond economics, so a better definition could be "Long-term pulsations in social behaviour". To sit on the safe side I measured all sorts of physical indicators, but excluded money indicators. My work should then be considered complementary to that of economists. The results are fascinating, the signals which are so fumbled in economy to leave the discussions alive for a century, are crystal clear when "physicals" are analyzed. And it is also fascinating in the philosophical induction that human society behaves like a homeostatic body, a concept perceived since antiquity (see Menenius Agrippa) but never really proved quantitatively.

THERE IS A TIME FOR INFRASTRUCTURES...

Infrastructures are usually built through the superior decisions of decision makers. In any case they are unfailing there to cut the ribbon and deliver the speech. Decision makers, however, seem to be only one rung in the hierarchical system, with lots of wires going somewhere else. If we actually analyze a certain type of infrastructure, e.g. the underground "Metros" we find an extraordinary regularity, I would even dare the word coordination, in the way they are implemented. Fig.1 reports the "starts" for the first line of each of all the Metros of the world.

These starts coalesce into three groups. Each group can be organized into a logistic if we measure the cumulative number of starts vs time. The centerpoints of the logistics are 54 years apart. The first one has only two elements, so I just took the middle date, and the third one appears to be halfway. I am

perfectly aware that fitting three-parameter logistics is a tricky job when they are only halfway, but it can be instructive to check in the next few years how well the facts follow the implications. If they fit, it will be a great victory for the constraints and a suggestion for modesty on the decisionmakers. They are only the active tendrils of Big Brother, the System. The 54 years are an obvious reminder of the Kondratieff cycle with no real cycle involved, but pulsation in activity.

Metros are a type of innovation in the infrastructure that keeps flourishing again and again, others are for one season only, at least as starts. Canals were the craze around 1750-1850, but people seem to have lost interest in building canal grids since then. Railways were the following wave and filled the nineteen century from around 1825. The "starter" dates for about 40 grids world-wide are reported in Fig.2. The organizing function is again a logistic. The centerpoint coincides, year more year less, with that of the first wave of Metros. Curiously enough, practically all railway grids now present in the world are there. No grid was started after 1900. These starter dates cover a period of about 50 years. If we examine the grids one by one they also took one or two pulses to develop with about 50 years to go from 10% to 90% of thei final length. Then they slowly contracted in a well documented dimensional and functional decay. With all their intrusion and confusion Italian railways now carry 10% of total ton-kilometer traffic for goods and 5% of passenger kilometers.

Fig. 3 shows the development for Italian railways. The two main thrusts are spaced 55 years, and as we will see, anti-cyclical. Fig. 4 describes the development of paved roads in the United States; Fig. 5 the telegraph lines in the United States.All

have a time constant of around 50 years. What I find most puzzling is that the saturation parameter or the size of the niche--using biological terminology--seems to be held constant during all the growth period, which implies some sort of implicit knowledge of it. How the signals operate is a perfect mystery to me.

If we take the series canals-railways-paved roads, the natural following term is air-ways. These are a bit deceiving for decision makers because they cannot cut the ribbon, but they can always deliver a speech in these modern trivia called airports.

Putting all US transportation infrastructures in a single graph (Fig. 6), we see that they reasonably organize as a sequence of pulses spaced 50 years, so we can conclude that building transportation infrastructure is a resurgent activity, but the particular technology changes from pulse to pulse. At this point I am biting my nails trying to guess what will be the technique for the next round. Vacuum tunnels plus magnetic suspension? Watch the Japanese for the hint. The "starters" should begin around the year 2000, which is in tune with Japanese intentions for magnetically suspended railways.

The energy system can be considered a form of infrastructure. By putting on the same graph the market shares of primary energy for the world, during the last two hundred years, we find four starters in the game, coal, oil, gas and nuclear, one about every fifty years. The time constant for penetration, however, this time is in the range of 100 years, covering two pulses, so only coal and oil are in their phase-out configuration, with gas and nuclear still penetrating. A new start for 2025 fits very well the hope of the physicists trafficking with fusion. Alles in Schritt!

....A TIME TO INVENT AN INNOVATE....

Some years ago I made an analysis of innovation waves whose main result is reported in Fig.7. The lines give the cumulative number of innovations at a certain date and for a certain wave expressed as percentages or fractions of the total number in that wave. The midpoints are spaced about 50 years although there is a reduction in time constants, i.e. a sharpening of the wave, when proceeding in time. These basic innovation waves represent the starters of new products and new industries, and they are of the utmost importance in determining the level and the pulsation of economic activity.

An example of the complex interlinkage is reported in Fig.8, where also invention, world market shares for primary energy consumption, energy prices and detrended energy and electricity consumption in US, are all reported together on the same time scale. The tuning is remarkable pointing to causal links, or common causation.

....A TIME TO KILL....

After having sifted hundreds of graphs, and meditated on causes, I strongly lean toward the second position. As artists finely perceive and express, society is moody, protective, aggressive, enthusiast, depressed and the individual behavior is strongly linked to that. A first hint in that direction comes from an exploration in societal aggressivity I recently made. For indicators I took causalities in murder and suicides, with the argument that statistics should be better than usual as death is accounted with care. I took US for its long and homogenous time series. Zooming into the details, I also looked at the techniques for murder, and at the ratio male-female for the victims. The results are reported in Fig.9 for murders and in Fig.10 for suicides. On top of each figure, the 54-year sinusoid of the detrended energy consumption for US is reported, to serve as a

kind of reference clock and as an indicator of societal activism.

The tuning appears very good with phases advanced or retarded. The maximum of homicides, e.g., occurs at the center of the recession branch of the energy wave, together I must add, with maximum mortality rates for entreprises, banks and stock exchanges. The use of firearms for killing as a ratio to knives, shows only a slight phase retardation with the energy or activity indicator. When business is flourishing people shoot, when it is so so, they stab. And the signal is not a tiny ripple, the ratio between maximum and minimum is a factor of three!

Coming to suicides, the really curious result is the 25 years pulsation in the ratio female/male. This pulsation, in phase with tops and bottoms of the activity cycle corresponds to periods of high societal and international aggressivity. Wars and revolutions tend in fact to pack around these points. One should look at the situation in countries where women are drafted!

....AND TO CONSTRUCT....

The detrended oscillation in energy and electricity consumption which appears incorporated in Fig. 8, is an important indicator of societal activity and it is reported alone in Fig. 11, with the schematic version to be used for checking the phases of some of the activities described before.

Fig. 12 reports again the case of the construction of Italian railways. It happened basically during recessive periods, although the starts are still into the booms. This makes much sense, because recession means capital and manpower in search of employment, and the times were favorable to such capital intensive and slow profit entreprises. The very intense spurt at the end of the recession could be, perhaps, considered as a planned move against the strong unemployment at the end of the century. Keynes before Keynes!

Fig. 13 reports the position of the centers of Metro's starter waves against the skeleton energy wave. Also here there is a tendency to start underground railways during recessive periods, including some part of the end of the boom. This means construction should be mainly anticyclical, a question I still have to check in detail.

For what concerns the US transportation infrastructure, the centerpoints of the deployment are right at the bottom of recession. This means as their time constants are about 50 years, the starts are at the end of a boom and construction is shared between recession (first half) and boom (second half).

CONCLUSION

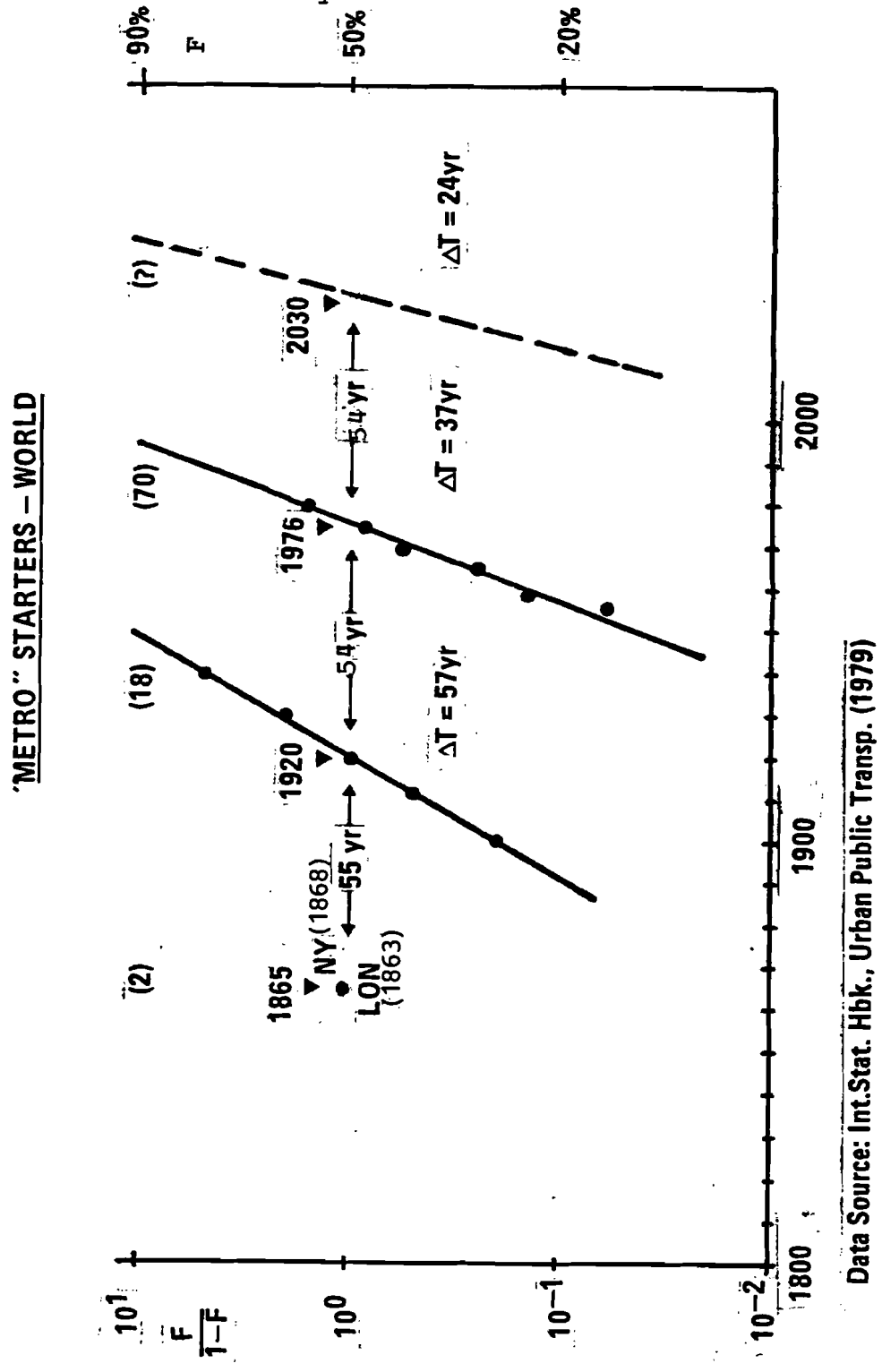
A pulsation of about 50 years seems to pervade all sorts of human activity and I have the impression that the social communication system is mediator of the signal, which seems to have a cooperative character, with no outstanding "decision centers".

I think this deemphasizes the role of central cause for economic activity making it one of the many manifestations of social information trading. As I tried to prove in a previous paper, this trade follows strict biological rules. In this frame of thought, a car is the transcodification of a conceptual structure in the same way an animal can be seen as the transcodification of a DNA structure. Incidentally car populations grow exactly like animal populations.

I hope this de-emphasis, fitting it into a broader frame and getting out of the quicksands of money indicators, may help provide a simple description of economics as a social phenomenon. I am aware that what I presented is exploratory in character and this may excuse for the numerous shortcomings.

Figure 1.

The graph organizes the dates when the first Metro line was inaugurated in various cities in the world (starters). These starter dates come in heaps, and the lines give their cumulative number vs. time expressed as a fraction of the total number of starters in the heap. The first "heap" has only two starters, London and New York. The second has 70. For the third one, the total number (saturation point) has been calculated from the partial data (three parameter logistic). The distance between the centerpoints of the "starter" waves is about 54 years.



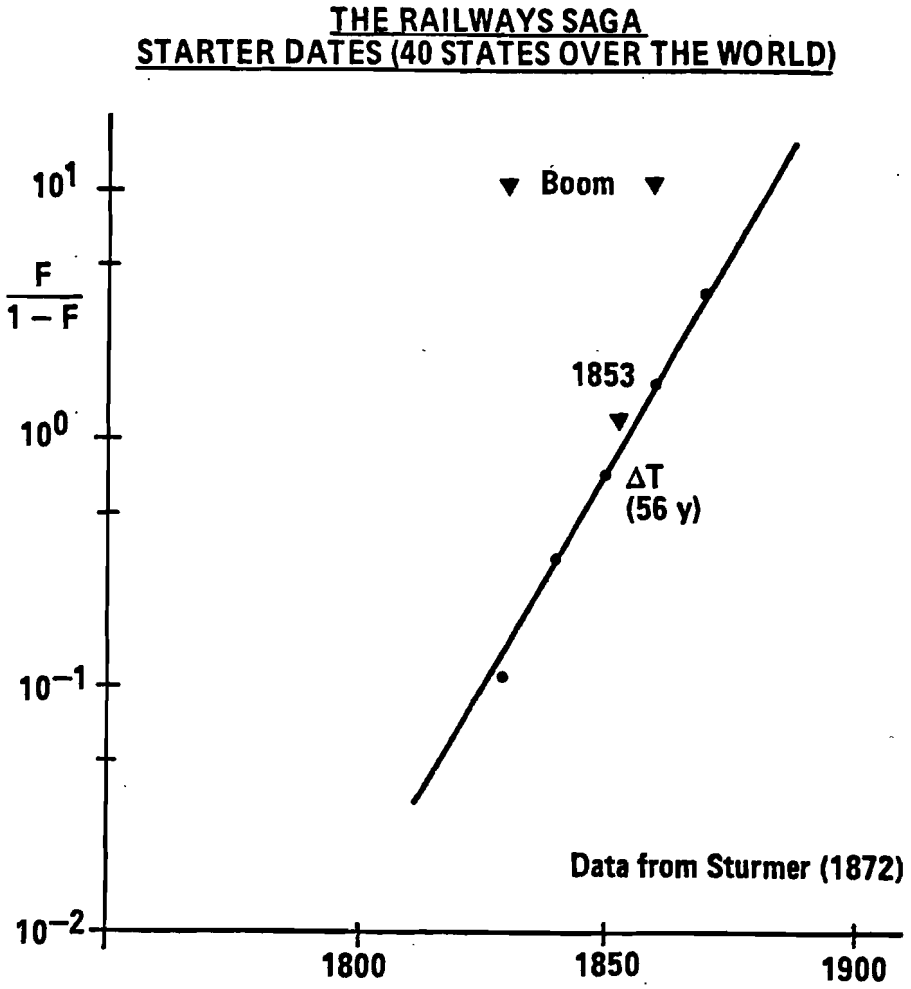


Figure 2.

This figure reports the "starters" for railway grids at world level. In this case, we have only one wave. The time constant is 55 years. This means all railway nets in the world were started during a single long economic cycle.

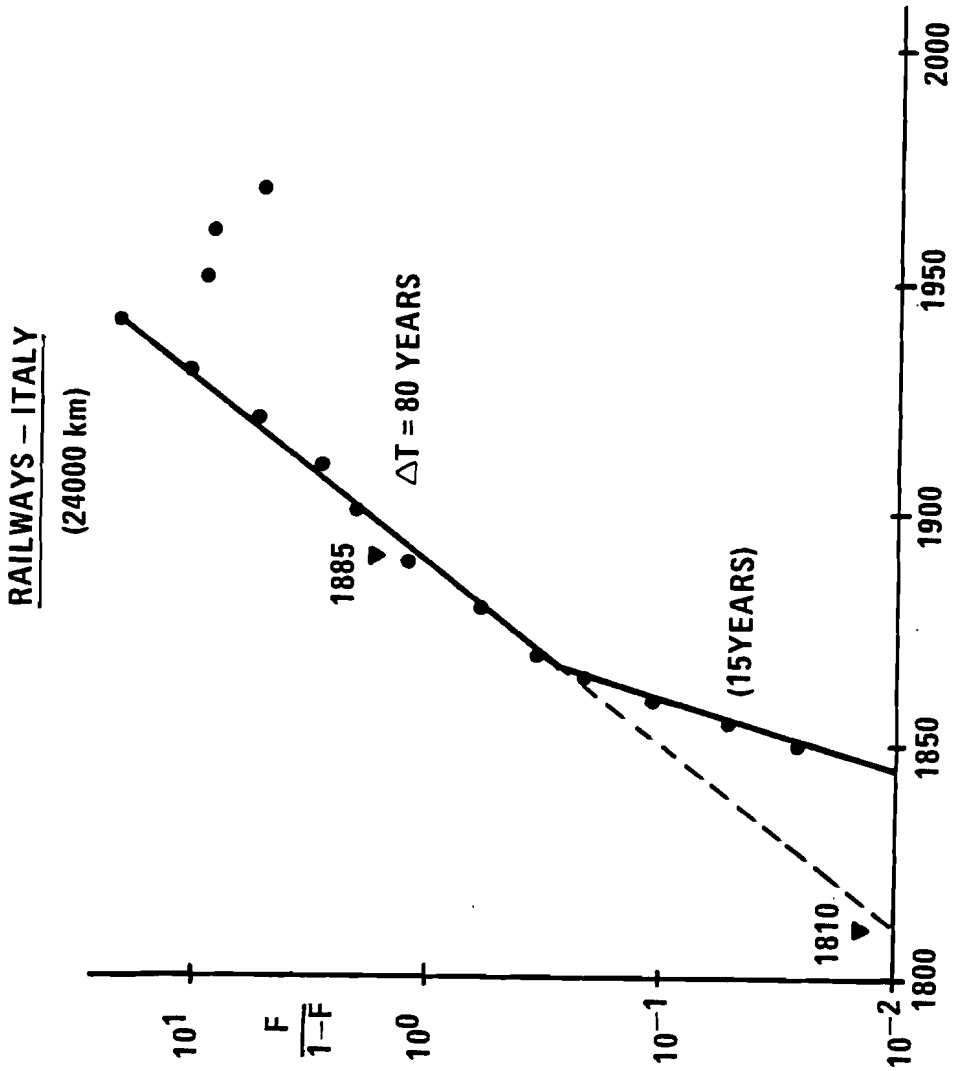


Figure 3a.

The development of the Italian railway system is reported here in logistic form. The kink indicates mismatching logistics. A finer analysis is made in the following figures.

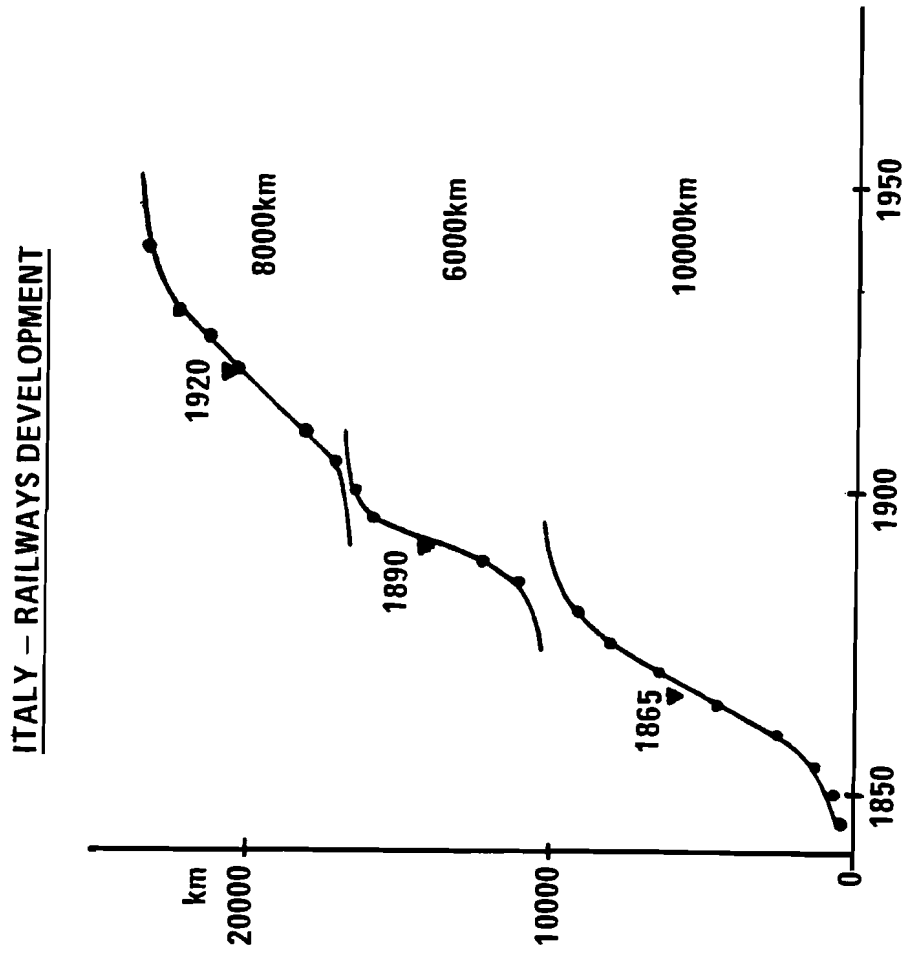


Figure 3b.

Here the growth of Italian railways is reported in linear terms. The presence of three different logistics spurts is visible.

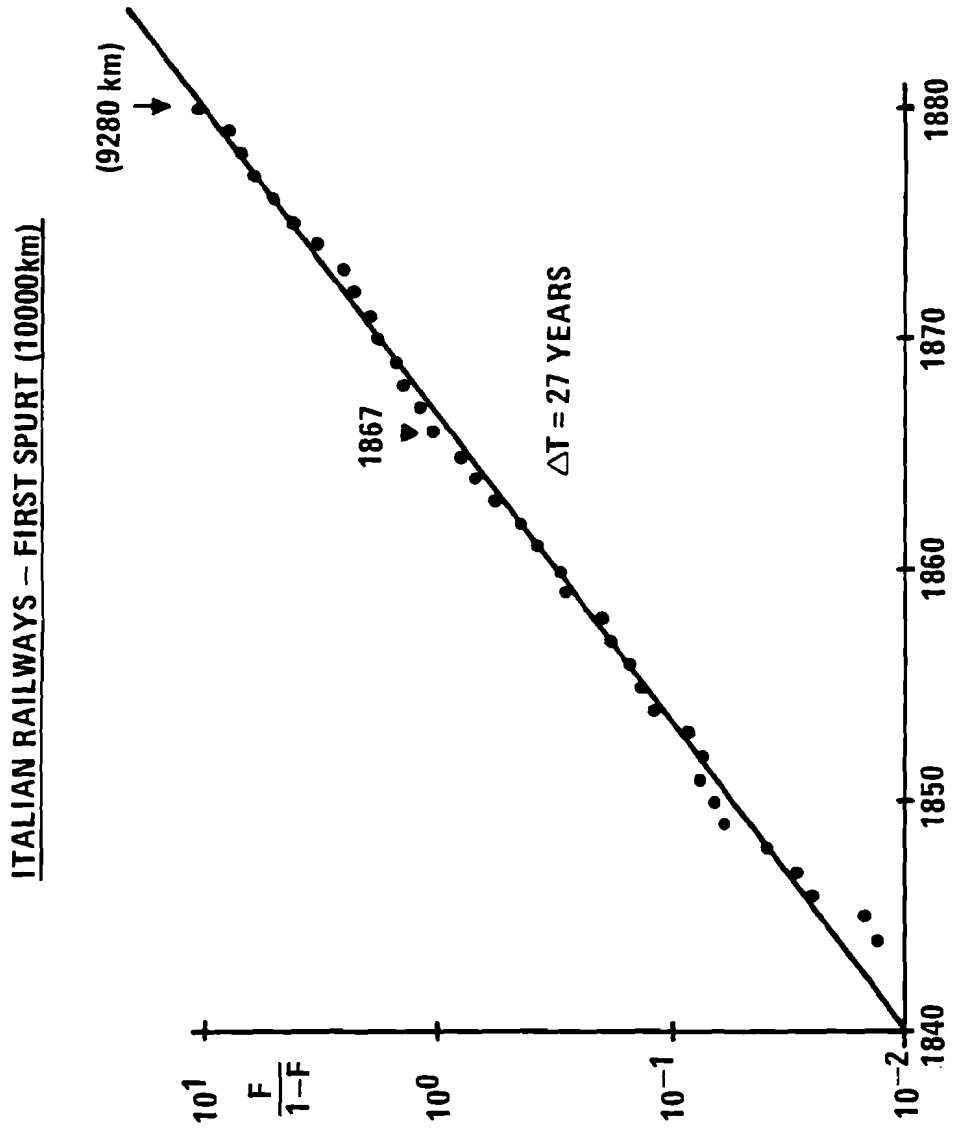


Figure 3c.

The first spurt of railway construction is analyzed logistically.

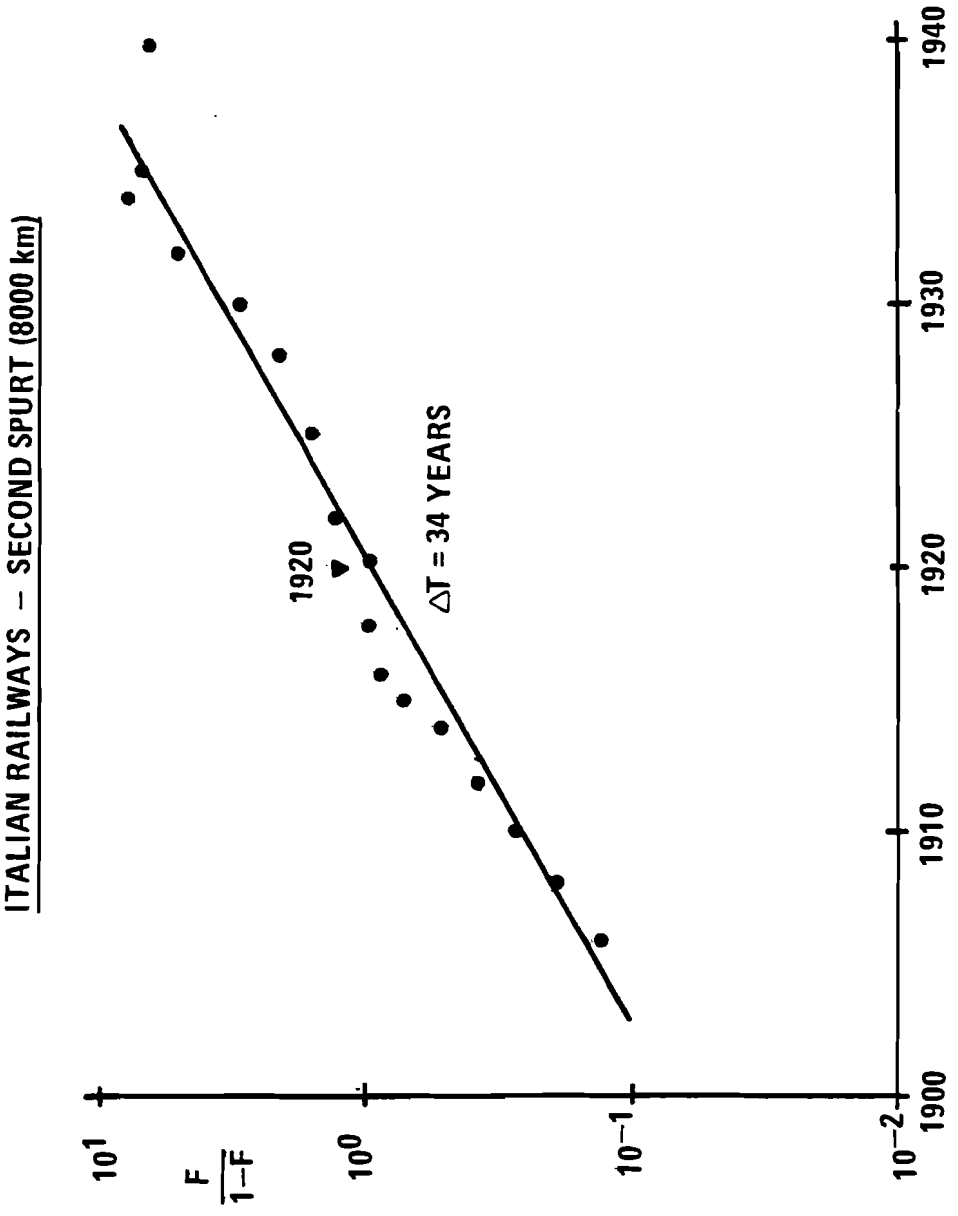


Figure 3d.

The last spurt of railway construction is analyzed logistically.

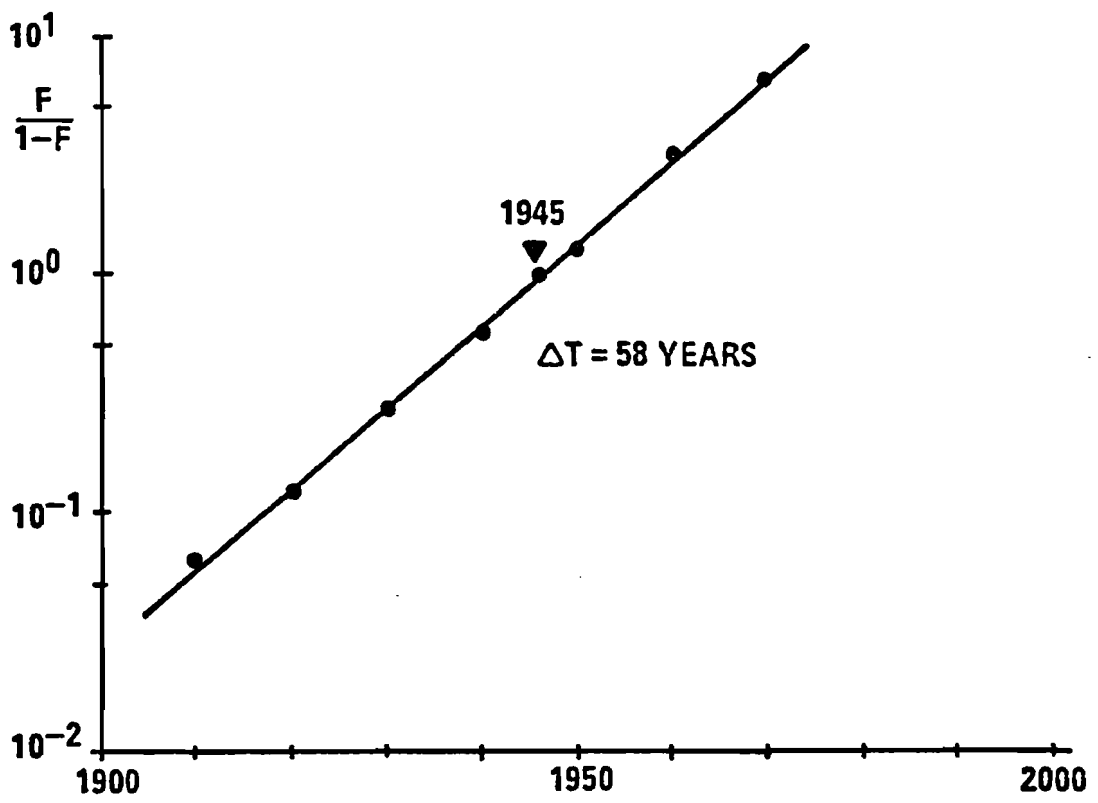


Figure 4.

The development of paved roads length in the US is reported here in the usual logistic coordinates. The "perceived" saturation length is about 3 million miles.

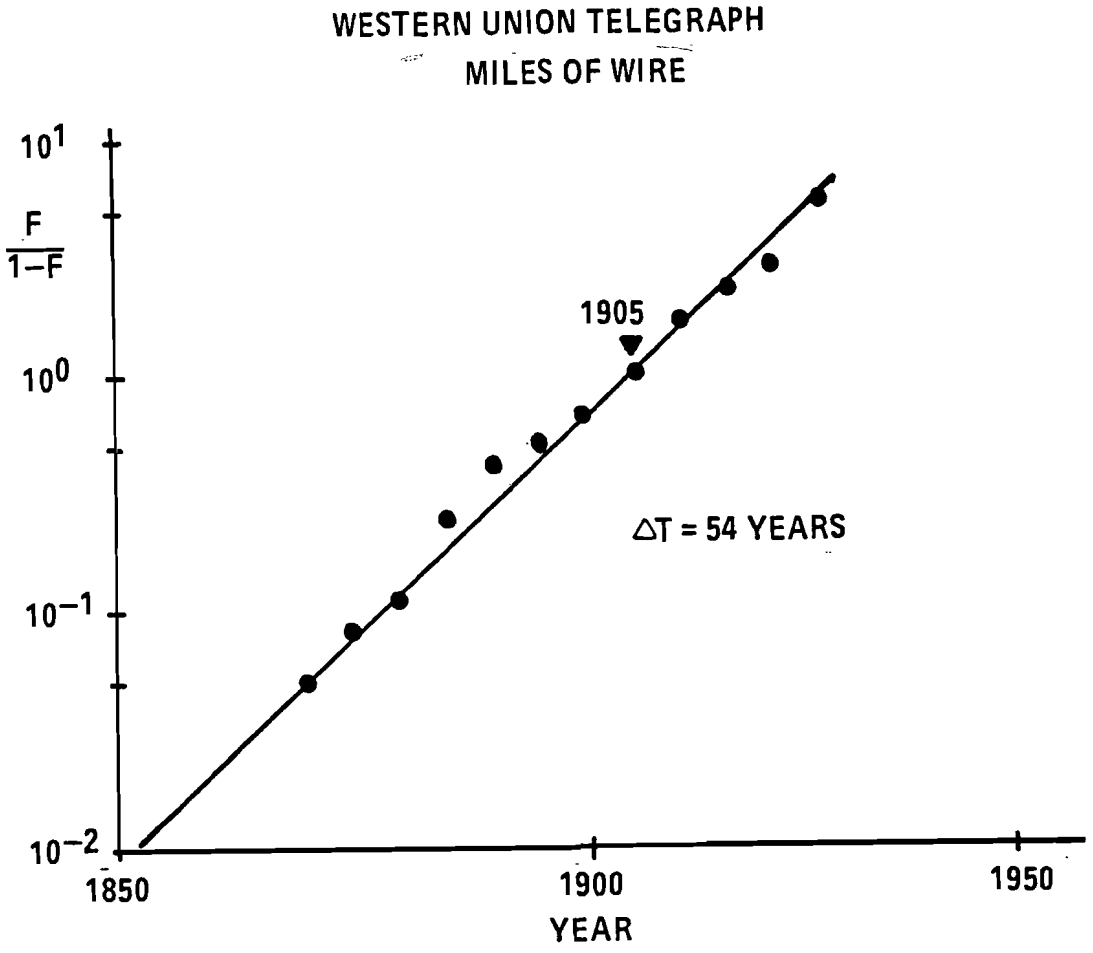


Figure 5.

The development of telegraph lines in the US is reported here in the usual three-parameter logistic form. The "perceived" saturation length is about 3 million miles, but this length was never reached. Perceived ceiling is the asymptote, and usually competition stops penetration before that. In the case of telegraph lines in the US maximum reached length was 2300 miles.

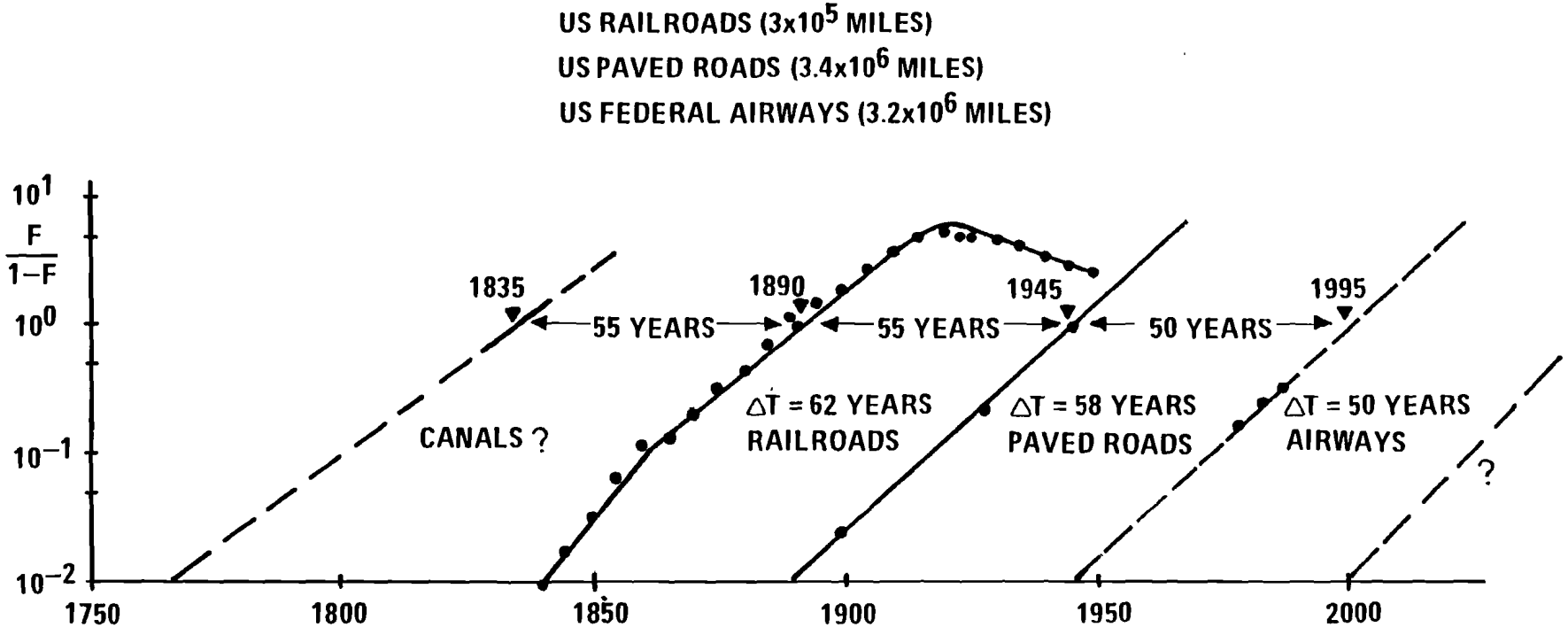


Figure 6.

Four waves of transportation infrastructure are here reported. The first and the last on very incomplete data, but with centerpoints quite firm. These centerpoints are about 54 years apart which calls for a fine tuning with long cycles. The kink in railways calls for a more detailed analysis.

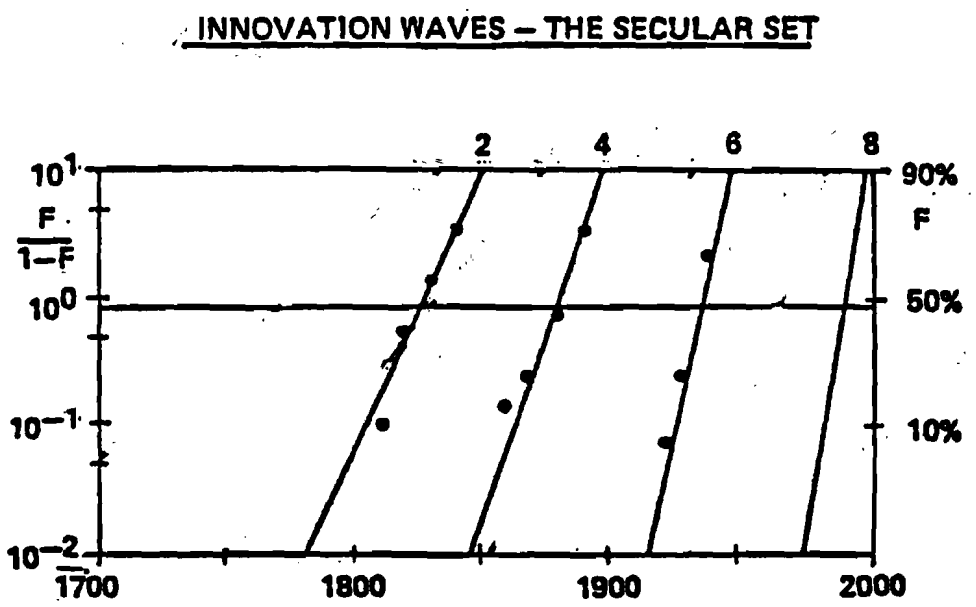


Figure 7.

Basic innovation also comes in waves and can be organized with logistics. The mid-points are spaced by about 54 years.

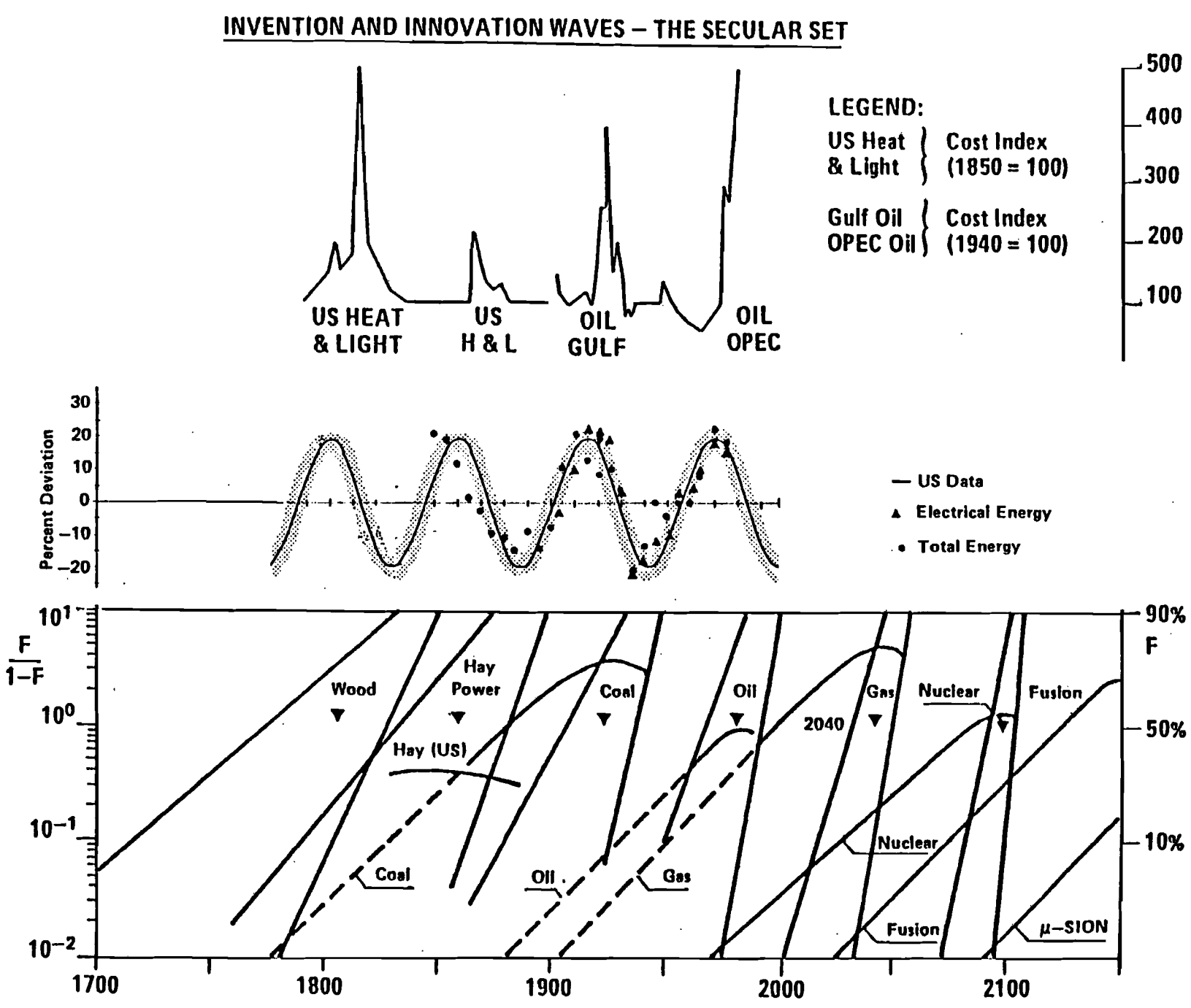


Figure 8.

Interlinking between inventions, innovations, market shares of primary energies, detrended energy consumption (primary and electrical, for US) are reported to show their meshing periods and phases.

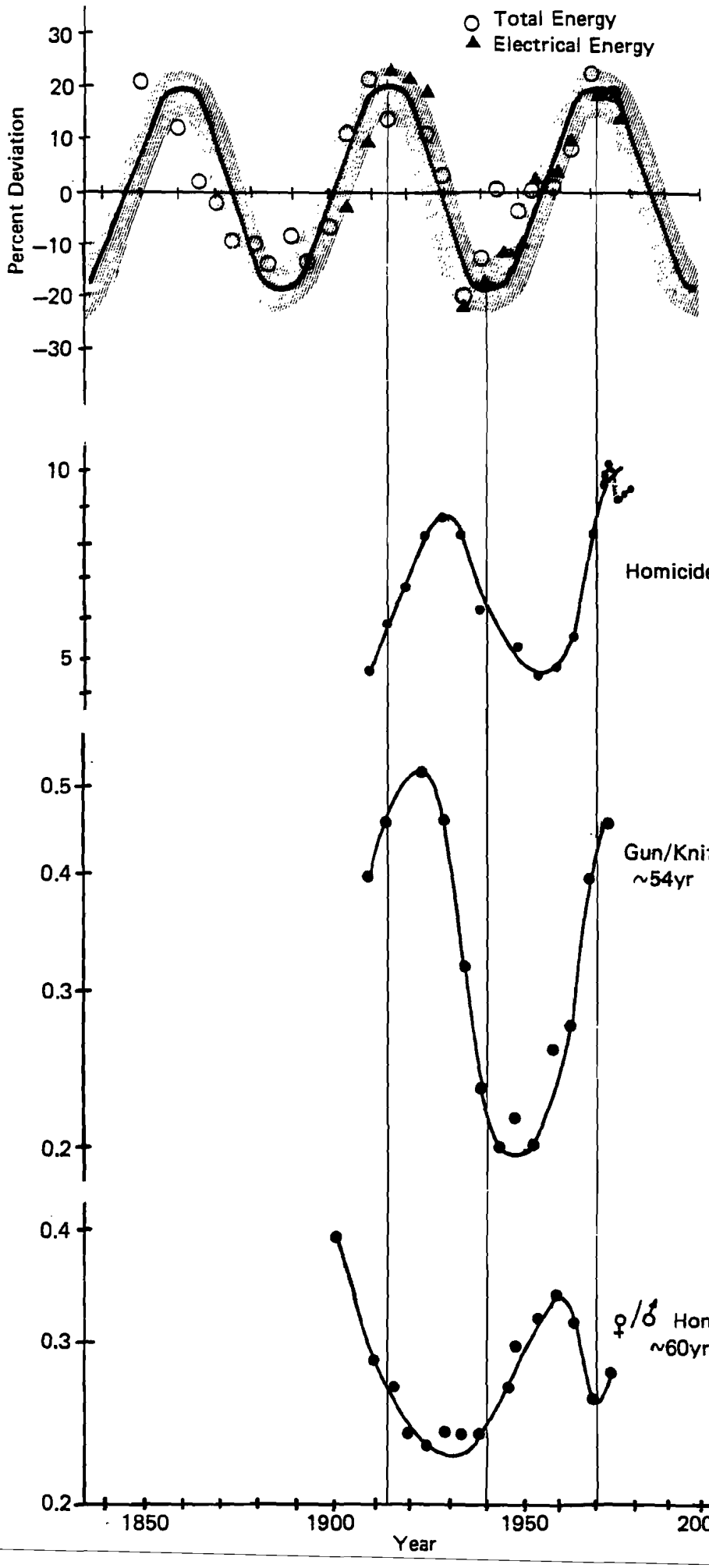


Figure 9. As an example of modulation of social activity the case of murder is analyzed in detail for the US. The total murder index (per 100.000 population), the ratio of women to men killed, and the ratios of guns to knives used to kill, are reported. The 54 year modulation is evident in all three cases, although the phases are quite different.

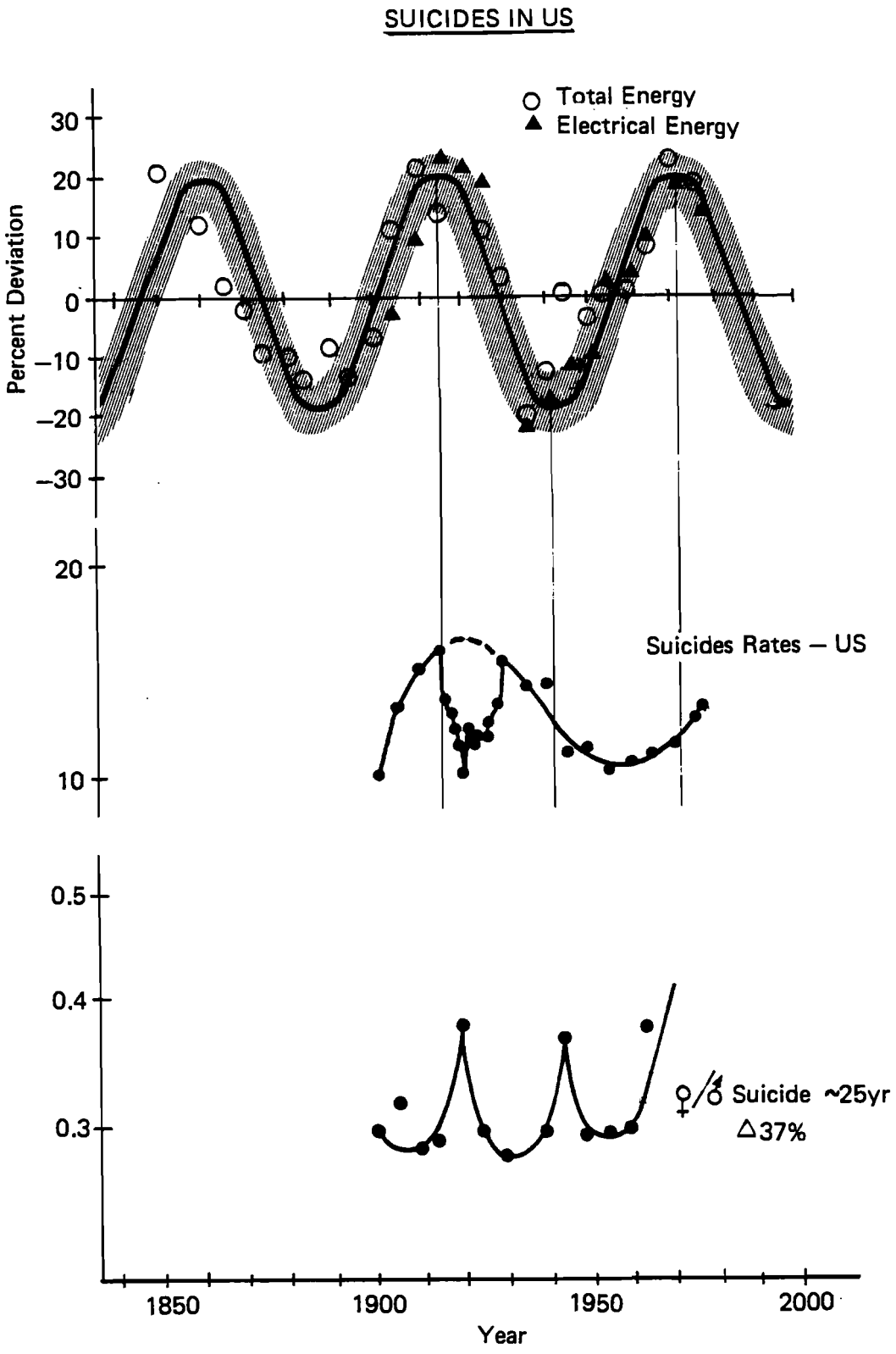


Figure 10.

As an example of modulation of social activity the case of suicides is analyzed here. The total suicides index (per 100.000 population) and the ratio women to men committing suicide are reported. The period of suicide appears somehow longer than 54 years, and the period for women to men almost one half, i.e. about 25 years.

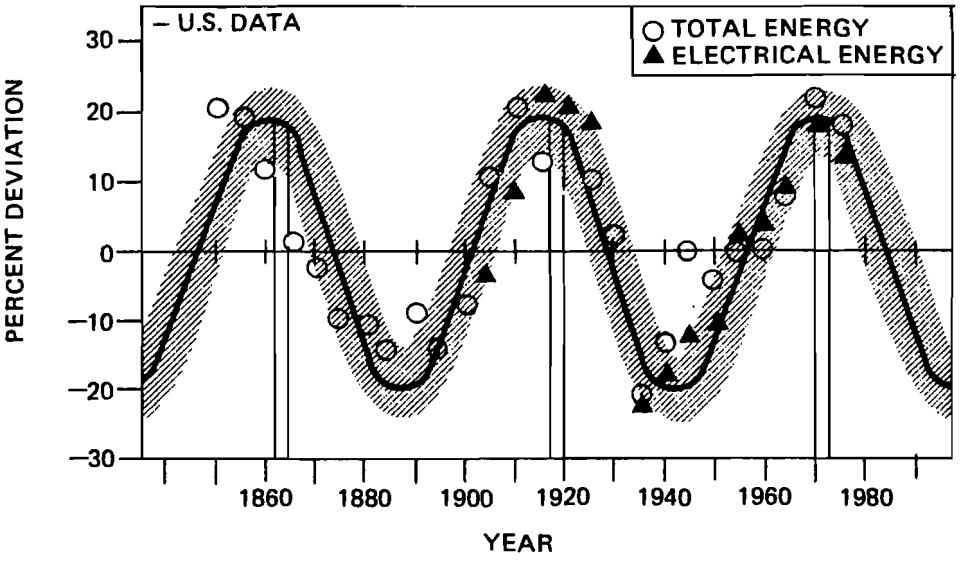


Figure 11.

Detrended oscillation in primary energy and electrical energy for the US. The curve to fit the trend has been a logistic. Deviations expressed as percentages from actual trend values.

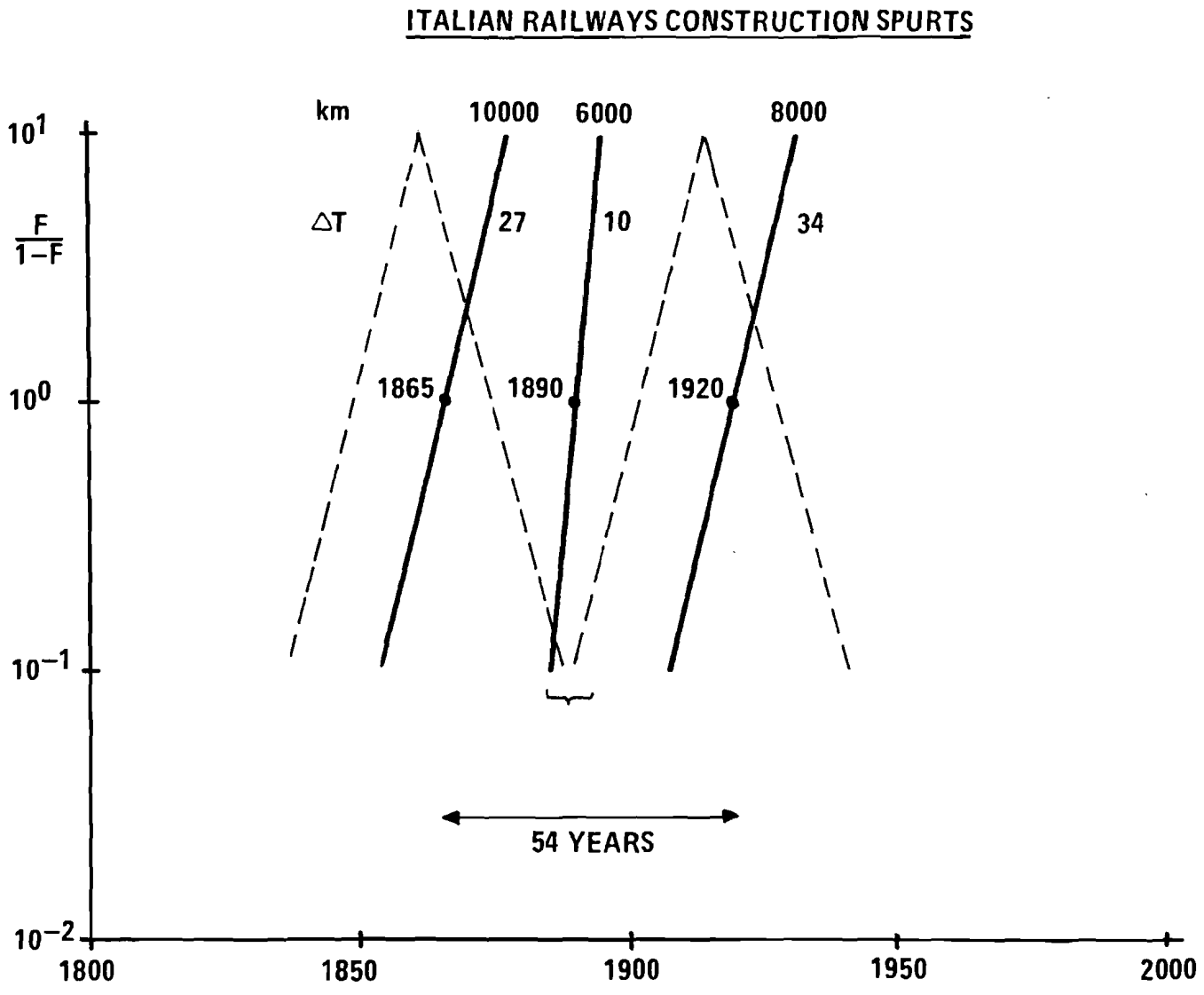


Figure 12.

The spurts in construction for Italian railways are here reported again, against a skeleton of the primary energy oscillation in the US. All construction was basically performed anticyclically, i.e. during recession periods.

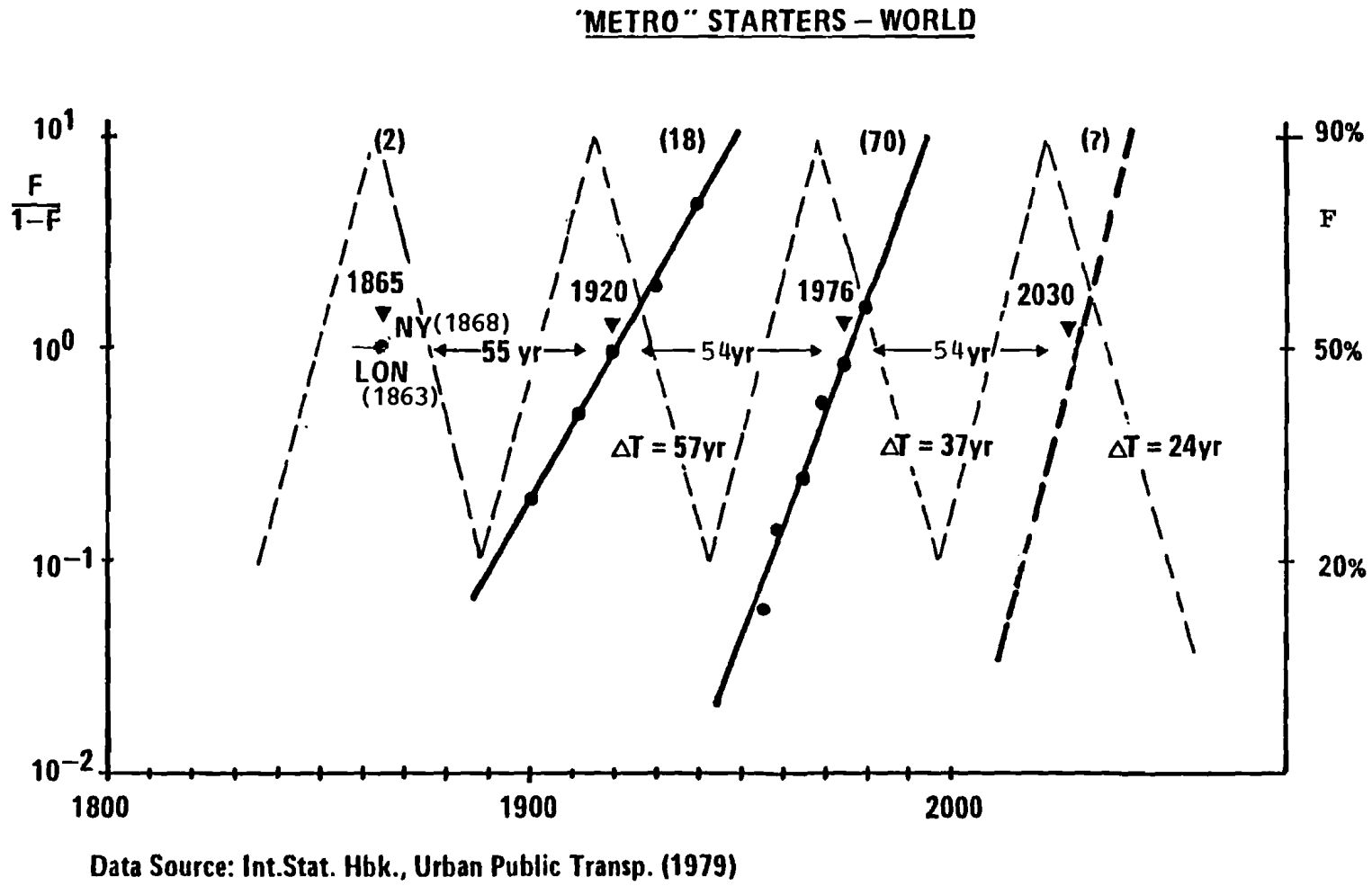


Figure 13. To the graph of Fig.1 organizing the "starters" for subway construction in the world, a skeleton version of Fig.12 has been added to show the interlinkages. It appears that most of the subways were started anticyclically, i.e. during recession periods. The decrease in the time constants, which means a sharpening of the derivatives of these curves, representing the actual starts, makes the case more and more evident.