

Chapter 2

Theory

Abstract Technical progress and economic growth occur mainly in cycles of efforts and tensions, with breaks of various scales and intensity. Economic history shows how relativistic these movements are: they are not necessarily to be found in all economic systems nor in all countries. Some characterise a period, others an economy. Hence the nature of each cycle depends on the socio-economic systems which generate it, although their causes and periodicities might vary through history, depending on the economic structures of the countries in question. However, without a theory or a combination of theories, the study of economic cycles is both impractical and sterile.

Keywords Business cycles • Cliometrics • Economics • Economic growth • Economic history • History • History of economic thought • Methodology

Technical progress and economic growth occur mainly in cycles of efforts and tensions, with breaks of various scales and intensity. Economic history shows how relativistic these movements are: they are not necessarily to be found in all economic systems nor in all countries. Some characterise a period, others an economy. In fact each cycle derives part of its specifics from a more fundamental underlying movement. Hence the nature of each cycle depends on the socio-economic systems which generate it, although their causes and periodicities might vary through history, depending on the economic structures of the countries in question.

However, without a theory or a combination of theories, the study of economic cycles is both impractical and sterile. Obviously there is no need to endorse the fundamental causes identified by one theory or another but it is necessary to understand the effects these causes have on economic life as well as the repercussions of the various elements on one another.

In this chapter, we do not aim to repeat the comprehensive work of the great economists of the past such as Haberler (1937) or Schumpeter (1939, 1954). We will start with a selection of results which we consider as accepted, which come from various studies' experience-based conclusions and their confrontation with economists' essential hypotheses, investigating causes and analysing the economic cycle, to contribute some additional elements to the most recent theoretical, statistical and econometric developments.

In line with our statement on the relativity of economic fluctuations, we should specify that we do not again mean here to discuss in extenso Schumpeter's distinction (1939) between cycles of the Kitchen, Juglar and Kondratieff types, with their respective periodicities. We will mainly deal with the shorter cycle, which can also be called the "classical" cycle.

2.1 The "Old Decennial Cycle" and Its Theorizations

Economic fluctuations existed already before the Industrial Revolution and in many cases they could be explained by the alternation of good and bad harvests. However, no regular pattern could be observed in this alternation, as exogenous events obviously came to blur the graph of a possible endogenous rhythm, inherent in the very nature of economic dynamics.

2.1.1 *Industrial Crises*

During the 19th century, fluctuations were more frequent and more regular. At the same time, the harvests had a lower impact, both because of the growing importance of manufacturing industries and because the opening up of the world market made it possible to compensate for the shortage of agricultural products. Moreover, the importance of technical and particularly financial factors increased. Crises had a tendency to become industrial. One of their main characteristics was that they were affected by a general overproduction. Ricardo (1821, ed. Sraffa, p. 265), when he published the first edition of his *Principles* in 1817, had the example of the English crisis of 1815 right under his nose and he made sure he stressed the phenomenon: "The commencement (...) of peace after a long war, generally produces considerable distress in Trade. It changes in a great degree the nature of the employments to which the respective of countries were before devoted;; and during the interval while they are settling in the situations which new circumstances have made the most beneficial, much fixed capital is unemployed, perhaps wholly lost, and labourers are without full employment".

The 1815 crisis, which was followed by another one in 1818–1819, was to raise fierce controversies about possible general overproduction and Say's law, between

Sismondi (1827) and Malthus (1820) on the one hand and Ricardo (1821) and Say (1815–1821) on the other.

However, economic historians, such as Bairoch (1997, pp. 401–402) generally agree to date the first real “modern” crisis back to 1825. According to Hicks’ interpretation (1989, Chap. 11; also 1981), this first crisis was followed by others in 1836–1837 (which hit mainly the United States), 1848, 1857 and 1867; later the phenomenon weakened, at least in Great Britain. When one looks at this succession of dates, the notion of cycle comes immediately to mind as these crises seemed to happen at 10-year periodicities. This is the “classical cycle”, the “old” cycle to use the terminology of Hicks (1989).

Two authors, Stuart Mill (1848, book III, Chap. 12) and Marx (1894, book III, Sect. 5), although they did not have much experience of crises, produced a good analysis of this classical cycle and particularly of its critical point, namely the crisis. For the two of them, the explanation focused on England and stressed the influence of credit mechanisms as well as the role of the Bank of England. For Marx (1894, book III, volume 7, p. 151): “(...) the whole crisis seems to be merely a credit and money crisis”; for Stuart Mill (1848, p. 528): “the fall, as well as the rise, originating not anything affecting money, but in the state of credit”.

Here in fact is the underlying explanatory scheme of these two authors. In the early days of economic depression, prices and interest rates were low compared to the values observed during the prosperous period. Progressively, the recovery of economic activity induced a rise in some prices, while the interest rates remained low. The financing of an increasing price level was rather unproblematic, using bills of exchange. However there came a time when trade credit was not sufficient anymore; firms turned then to bank credit, which meant that bank rates were pushed up. In the long run, the accumulation of bills of exchange in the banks’ portfolios, as well as speculation encouraged by a lasting price increase, resulted in a mistrust of bank notes. This distrust resulted in a sudden increase of the basic currency, i.e. gold. Second-rank banks which did not have sufficient reserves to face the demand for gold would turn towards the Bank of England, which, when its metal reserves started to dwindle, made credit more expensive and in so doing plunged the economy in a crisis.

Hence it was the Bank of England which triggered the crisis and the resulting bankruptcies of banks and firms as well as the fall in prices when it tried to protect its gold reserves. To curb the further collapse of prices and put the economy back on the road to prosperity, the Bank of England had to restore the banks’ and firms’ confidence by lowering its bank rate at the appropriate time. This is what Hicks called Thornton’s precept (Bagehot’s lender of last resort comes immediately to mind, but in fact Thornton came much earlier as his *Paper Credit* dates back to 1802!).

Actually the Bank of England was to make this concept its own progressively and to learn to handle its bank rate wisely. It thus acquired the means to avoid major crises so that in the 1860s, cyclical fluctuations became less marked, at least in Great Britain.

2.1.2 Classical Business Cycles

Nevertheless the long series of quasi-decennial cycles which started in 1825 was bound to raise questions among economists. Two of them, William Stanley Jevons and Clément Juglar, decided to look into the issue. In some ways they followed similar approaches, especially as they were much more interested in cycles than in crises: this was a major break with their predecessors. Furthermore they made extensive use of the available time series. However, they differed on two main points: the strict periodicity of the fluctuations and the analysis of their causes.

Jevons really started to do research on cycles in the 1870s, after he had already a solid reputation as a theoretician, in particular with the publication in 1871 of his *Theory of Political Economy*, which ranked him—together with Walras and Menger—among the initiators of marginalism. In a 1875 writing (1884, pp. 194–205), he first formulated the hypothesis that sunspot cycles (of a duration of 11.1 years) implied a temperature cycle which in turn caused a harvest cycle and in fine a cycle of grain prices. It was however difficult for Jevons to connect the periodicity of sunspots with that of grain prices, a series which did not provide identifiable variations. He therefore turned to the analysis of credit cycles between 1825 and 1867, which, according to him, presented a periodicity of 10.8 years. There remained a gap between both durations which Jevons was unable to explain. In the end, in his publication *The Periodicity of Commercial Crises and its Physical Explanation* written in 1878—Jevons (1884, pp. 206–220)—he concluded, on the basis of new calculations, that there was a credit cycle which had an average length of between 10.3 and 10.46 years. Since a new study of sunspots made it possible to date the periodicity of the corresponding cycle to 10.45 years, Jevons (1884, p. 215) was in a position to assert that “it becomes highly probable that the two periodic phenomena (...) are connected as cause and effect”.

Juglar, whose book *Commercial Crises* was first published in 1862 with a second edition in 1889, studied the course of crises in France, England and the United States. Schumpeter (1954) considered him as “one of the greatest economists of all times”. His method was comparative and was based on the empirical study of long series. In short, his approach was supposed to be scientific: “if we rely not only on statistical data, but also on large numbers, long periods in three big countries, we consider that we have met the main conditions of a scientific demonstration better than arguable assertions.” (1862, p. XII).

For Juglar, there was almost no doubt about the fundamental cause of crises and hence of cycles: once accidental causes or specific events had been discarded, the cause of crises was to be found in the modifications of credit conditions, especially the development of discounts and he therefore assumed that the evolution of currency flows played a major role.

It should be mentioned that in his second edition (1889), Juglar’s approach remained identical, but at the same time he specified that he used more numerous statistical data and he considered a longer period of time. Moreover he differentiated himself from Jevons by refusing any strict periodicity of the cycle and

he just noted that crises occurred “over a period of 5 to 10 years”. In this second edition, Juglar also proposed an analysis of the cycle phases, which is still used today: prosperity duration of 5 to 7 years, crisis duration from a few months to some years; depression duration some years.

2.2 The Years of High Theory

The Great Depression of the 1930s was without precedent, utterly different from the 19th century classical crises in both form and scale, and was to produce abundant theoretical literature. Out of this crop, well analysed by Haberler (1937), in spite of his close proximity to these debates, two names emerged: Hayek, the best-known representative of the Austrian economics school, and Keynes.

2.2.1 Austrian Theory

The Austrian theory of the business cycle fits into a more general context of economic literature’s between-the-wars interest in questions of economic conjuncture, which was accentuated by the 1929 crash. From a different angle, the theory is linked to a traditional subject for the Austrians, the mode of integration of money to real phenomena. Although theirs is not the only work in the Austrian theory of the cycle, Mises and Hayek are its two main authors.

Mises initiated a theoretical representation of the channels of influence of money on the real economy in *The Theory of Money and Credit* (1912); it explains economic disturbances as the effects of money creation on the relative prices structure. He developed this analysis between the wars (see the section of *Money, Method and the Market Process* (1990) on monetary questions (pp. 55–109)) and *Human Action* (1966).

Hayek’s first economic research was on trade cycle theory in the middle of the 1920s. Following a research trip to the USA (1923–1924), he wrote several articles on the problems of fluctuations in the market economy (1925–1929), the most important of which were translated into English and were published in a 1985 collection, together with later texts, entitled *Money, Capital and Fluctuations, Early Essays*. Hayek’s first full length book, in a similar vein, was entitled *Monetary Theory and Trade Cycle* (1928b). He especially developed his ideas during a cycle of four conferences at the London School of Economics, on Lionel Robbins’ invitation. They were immediately published under the title *Prices and Production* (1931). This is undoubtedly at the very centre of Hayek’s theories—and the most stylistic—on the subject. It unleashed a barrage of arguments from such illustrious figures as Keynes, Sraffa and Hicks; but even today is the work of reference on Austrian cycle analysis.

Prices and Production stressed the issue of agents' success in their expectations, or in other words, coordination of their plans. Hayek thus concentrates his analysis of modes of interaction between the producers/entrepreneurs and the employees in the shape of consumers/savers, studying procedures of finding compatibility and adjustment between the producer/entrepreneurs' plans and the employees' inter-temporal consumer choices. Coordination requires consumers' plans and producers' strategies to be mutually compatible so that the saved part of consumers' incomes will equal the volume of investments generated by firms. Conversely, crisis is described in theoretical terms as the expression of generalized discoordination between, firstly, entrepreneurs' choices in factor allocation for producing consumer and investment goods and secondly, employees' preferences in directing income to consumption or saving.

The theory presents a trilogy between interest rates, relative prices and capital seen as a structural, heterogeneous whole. Money plays a sustained, central role. The distribution of credit initiates the cycle—with an expansion phase—and ends it by producing depression. The creation of liquid assets separates technical processes from subjective choices: it makes the organisation of the production structure incoherent with regard to agents' inter-temporal preferences in terms of orientation of resources.

Sudden adjustments by quantity occurs when credit distribution and its consequence, raised income, dissipates monetary illusion and empowers consumers to once again make their point of view heard when production choices are being made. However, the inevitable move from boom to bust is based on a concept of the rapport between reality and the monetary; it requires the thorough application of a strict timetable.

Hayek does not try to determine a relation between the general price level and an aggregate production level. He studies the consequences of monetary expansion on the distribution of resources between the sectors of investment goods and consumption goods. For him, money enters the real system at specific points, in a sequential way, and has an impact on the structure of production through the interest rate. This relation between capital and interest is one of the characteristics of the Austrian approach. The fall of the monetary interest rate below the natural rate (or equilibrium rate, reflecting the inter-temporal preferences of the wage-earners-consumers) starts the cycle. Considering the strong sensitivity to interest rates of the relatively more capitalised sectors upstream of the production structure, investment there is artificially stimulated ("mal-investment").

The Austrian theory of cycles tells a story of linked distortions; distortion between the equilibrium rate and the monetary rate, distortion of investment within the production structure, distortion of the relative prices between investment goods and consumption goods, distortion between monetary credit supply and real savings supply. But in the development of the Austrian cycle, chronology is of major importance. The dialectics of money and capital, governed by the game of relative prices, is organised around certain time-lines, characterised by the notions of sequence, lag and, above all, rigidity. The expansion of credit leads to time bugging, not only because it produces false information (money illusion) but

also by encouraging specific forms of rigidity: rigidity of interest, as during the boom phase the pursuit of monetary expansion prevents the money rate from reaching the rate balance; price rigidity, for if errors are made and it takes time to correct them, this is due to prices not adapting immediately to the subjective data and not performing their informative and predictive function¹; rigidity of inter-temporal agent-preferences, considered as given and constant from the beginning to the end of the cycle. If agents were to change their inter-temporal consumption choices during the period of analysis, the second phase of the cycle, the crisis, would not occur.

2.2.2 The Keynesian Revolution

Keynes' *General Theory* (1936) is of course not devoted to studying or explaining the cycle. However, Chap. 22 provides a precise idea of the problematic raised by the author. The analysis uses the complete set of Keynesian conceptual tools: propensity to consume, the multiplier effect, the principle of effective demand, liquidity preference and above all the marginal efficiency of capital. For Keynes (1936, pp. 313–311), the latter is the main explanatory factor of trade cycles. We should recall here that for a given type of capital good, marginal efficiency is defined as “that rate of discount which would make the present value of the series of annuities given by the returns expected from the capital-asset during its life just equal to its supply price” (Keynes 1936, p. 135). The supply price of a capital good could also be called its “replacement cost”, i.e. the fair price high enough to incite the manufacturer to produce an additional unit of this good. This price is determined during the current period. This does not apply to expected returns which by definition are calculated by taking the near and distant future into account. The new investment results from a comparison between global marginal efficiency and the actual interest rate; it takes place only if the former is higher than the latter.

One point should be made about the “subject” who calculates the expected efficiency of various types of capital. This subject does not actually exist, according to Keynes; it is in fact the stock exchanges which assess (and re-assess) daily the value of most investments. To use the *General Theory*'s words (1936, p. 151), “certain classes of investment are governed by the average expectation of those who deal on the Stock Exchange as revealed in the price of shares, rather by the

¹Hicks noted: “When the market rate is reduced below the natural rate, what will happen to the quantities of inputs and outputs? The correct answer, on these assumptions, is very simple: the effect will be nil. Prices will rise uniformly; and that is that. When the Wicksell model is taken strictly (as it was being taken strictly), it is in Neutral equilibrium ... Thus there is no room for a prolonged discrepancy between market rate and natural rate if there is instantaneous adjustment of prices. Money prices will simply rise uniformly; and that is that” (Hicks 1967, p. 206). Hicks (1967, p. 206).

genuine expectations of the professional entrepreneur". It should be added that this average expectation relies on a pure convention, the essence of which is to assume that the present state of affairs will continue indefinitely unless there are very good reasons to expect a change. Keynes states that such a conventional assessment basis is "the outcome of the mass psychology of a large number of ignorant individuals". But the essential task of professionals and speculators active on the financial markets is to anticipate modifications of the conventional assessment basis before the general public does. Consequently these markets function in a rather hectic way and with great volatility, as they are subject to unreasonable waves of optimism and pessimism.

All this said, let us turn now to Keynes' explanations of economic cycles and consider the question from the viewpoint of the economic boom's last stages. As is well known, the interest rate is in upward trend as a consequence of an increased demand for money to meet both commercial and speculative needs. This is not, however, the main point: what actually characterises the end of the boom is the traders' expectations and their estimations of the stock market yields being so optimistic that they neglect the increasing production costs and the increasing interest rates which characterise this phase of the cycle. The crisis then coincides with a sudden collapse of the marginal efficiency of capital. It is easy to explain why this reversal has to be large scale and brutal, since financial markets, as noted by Keynes (1936, p. 316), are under the double influence "...of purchasers largely ignorant of what they are buying and of speculators who are more concerned with forecasting the next shift of market sentiment than with a reasonable estimate of the future yield of capital-assets". Uncertainty about the future and the collapse of the marginal efficiency of capital leads to an increase of the preference for liquidity and hence a new rise of the interest rate, which in turn further damages confidence levels. The drop of the interest rate would certainly later constitute a prerequisite to economic recovery during the recession phase but once the crisis has started, the drop in marginal efficiency continues and is sustained.

Time is therefore needed (three to five years according to Keynes) before trust is restored and marginal efficiency of capital recovers, a period during which the decrease in interest rates may—in extreme cases—even prove insufficient to revive an anaemic marginal efficiency. All the more time to recover is needed as the collapse of marginal efficiency has a negative impact on the propensity to consume, through the simultaneous collapse of stock markets and of speculators' income. Demand as a whole falls off.

The recession only really ends when capital marginal efficiency curves upwards once again, a phenomenon objectively linked to the fact that capital has become sufficiently rare; a best left new cycle can then begin.

It is to Keynes to conclude this analysis (1936, p. 320), "...in conditions of *laissez-faire* the avoidance of wide fluctuations in employment may, therefore, prove impossible without a far-reaching change in the psychology of investment markets such as there is no reason to expect. I conclude that the duty of ordering the current volume of investment cannot safely be left in private hands."

2.3 Keynesianism and Around

Keynes' analysis of the cycle was in line with the public works policies of the 1930s, the New Deal etc., all of which were attempts to get out of the Great Depression by stimulating effective global demand. As for Hayek's theory of economic fluctuations, it was much less in line. Lawrence R. Klein's appreciation—a future Nobel Prize laureate—clearly explains this difference: (1949, p. 52) “Hayek's description of the economic process just does not fit the facts”. It is therefore not surprising that the economists who were studying the cycle turned to Keynes' theory and that Hayek's analyses comparatively disappeared from the public eye for a long while.

2.3.1 *The Keynesian School*

Applying Keynesian policies to support economic activity was to prove very efficient, as the period of the Thirty Glorious Years did not experience any significant general recession. Full employment seemed to have become a permanent state of the economy. Moreover, as noted by Hicks (1981, p. 344), the few recessions which occurred in some specific countries, resulted most of the time from “political pressure”.

These *post festum* findings were anticipated by Kalecki (1943b) who talked of a “political business cycle” which would substitute the traditional cycle. His main argument is that it is technically impossible for the State to bring the economy to the point of full employment and to maintain it there. Industrial leaders in fact opposed such a level since “their class instinct tells them that lasting full employment is unsound from their point of view”. And Kalecki therefore devised the typical political cycle²: during recessions, under the pressure of the workers, governments used to increase public investment based on loan in order to avoid mass unemployment. The consequence was economic recovery which led to full employment. Should public authorities use the same “Keynesian” techniques to maintain a high employment level, the pressure and opposition from the business circles would become so strong that they would lead governments to revert to budgetary orthodoxy. As a result, recession would be back and would require new state intervention, etc.

Moreover, the Cambridge economist's conceptual system, as soon as the *General Theory* was published, was taken up and developed by several authors. Alvin Hansen's book published in 1941 is important not so much on the theoretical level as on the economic policy level: it is a true manifesto in favour of a Keynesian full employment policy. It is therefore not surprising that Hansen's

²Later on the meaning of the term “political cycle” evolved and was used for a purely electoral cycle: see for instance Nordhaus (1975).

objective (1941, p. 292) was for instance “to minimize the cycle movement by a system of fluctuating tax rates.” Generally speaking, he favoured a budget policy as a means to compensate for the impact on employment of private investment variations, as well as to ensure the boosting of the economy: this is the “pump-priming”.

However, several authors, often young ones, will try to think the cycle anew basing their theorizations on the foundations of *General Theory*. The first one to do so was R.F. Harrod, who published his *Trade Cycle* in 1936. Harrod (1936, p. 102) considered that the cycle could be explained by the interactions between the Multiplier and the “Relation” (author’s capitals). By “Relation”, he meant nothing else but the acceleration principle, i.e. the influence of spending or income variations on investments. This principle as such was nothing new as one can date back its origins to Aftalion (1913), or even Marx. It gave rise to numerous discussions after World War I: J.M. Clark, A. Spiethoff, S. Kuznets, A.C. Pigou, W.C. Mitchell, D.H. Robertson are some of the names which come to mind in that respect. What was new with the author of *Trade Cycle*, is on the one hand his really dynamic concept of the effects of acceleration and on the other the study of interconnections between the multiplier and the accelerator: Harrod (1936, p. 70) even claimed that with this study he had “revealed the secret of the trade cycle”. It should be noted however that although Harrod really dynamized the acceleration effect, like Keynes he continued to conceive the multiplier as an instantaneous—hence static—relation between investment and income.

The second author was the Polish economist, Michal Kalecki. Strictly speaking, Kalecki (1936) was not Keynesian, as evidenced by his criticism of the *General Theory*. However, if he criticized Keynes for not properly modeled investment demand, he acknowledged that he had exhaustively analyzed the relationship between the variations in investment and the general movement of production and employment. Indeed, independently of Keynes, Kalecki (1935a, b, 1943a, 1954) developed a model with a remarkably stable nucleus even if it gave rise to different kinds of interpretations. We will focus here on one single interpretation, that given in 1935. We will however modify Kalecki’s notations and we will neither take up his assumption that workers’ savings were non-existent nor his distinction between capitalists and workers.

Kalecki reasoned within a closed economy, in which the income or product could be split into consumption C , investment (net expenditure) I and autonomous expenditure A . Since A is constant and $C = cY$, income is determined, via the instantaneous multiplier, by

$$Y(t) = (I(t) + A)/(1 - c). \quad (2.1)$$

Orders of equipment goods at time t , denoted by B , generate corresponding deliveries and finally investment outlays $I(t)$, defined net of replacement, after a fixed lag θ . In mean, we have:

$$I(t) = \frac{1}{\theta} \int_{t-\theta}^t B(t)dt. \quad (2.2)$$

Denote by $K(t)$ the capital stock at the instant t . Its derivative with respect to time $K'(t)$ is the rate of deliveries of new capital goods, so that

$$\frac{d}{dt}K(t) = B(t - \theta). \quad (2.3)$$

By assumption $B(t)$ is positively related to the saving rate and negatively to the current capital stock³:

$$B(t) = a(1 - c)Y(t) - kK(t), \quad a, k > 0. \quad (2.4)$$

The relations (2.1), (2.2), (2.3) and (2.4) form a system of four equations with four unknowns: $Y(t)$, $I(t)$, $K(t)$ and $B(t)$. After some substitutions, we obtain a mixed difference-differential equation:

$$\frac{dK(t)}{dt} = \frac{a}{\theta}K(t) - \left(k + \frac{a}{\theta}\right)K(t - \theta). \quad (2.5)$$

The mathematical treatment of Eq. (2.5) has been given by Frisch and Holme (1935). It yields the following conclusions: the model admits as unique solution a sinusoidal function; the period of oscillation is several times the length of the lag θ ; the oscillations may be regular or damped according to the values of coefficients a and k .

2.3.2 The Samuelson-Hicks Model

Samuelson (1939), although he would not acknowledge it, was totally in keeping with the Harrodian analysis.⁴ His contribution was twofold: on the one hand he explicitly included governmental expenses in global demand; on the other he developed a dynamic cycle model which can be expressed in three equations:

$$\begin{cases} Y_t = C_t + I_t + G_t \\ C_t = \alpha Y_{t-1} \\ I_t = \beta(C_t - C_{t-1}). \end{cases} \quad (2.6)$$

The notations are explicit enough; hence we will only specify that I represents exclusively private investment, α the marginal propensity to spend and β the acceleration coefficient.

³One could insert an additional variable in function (2.6) which would represent a trend, possibly a variable trend in the long run.

⁴Samuelson (1939) claimed the merit for the study of multiplier-accelerator interactions was all Hansen's, who was also his PhD supervisor. A quick reading of Samuelson's article shows the obvious influence of Harrod, although Samuelson mentioned it not once. For instance he used repeatedly the typically "Harrodian" term "relation" to name the acceleration principle.

If we assume that governmental expenditure G is exogenous to the model, we have the difference equation of second order

$$Y_t = G_0 + \alpha(1 + \beta)Y_{t-1} - \alpha\beta Y_{t-2}. \quad (2.7)$$

The solution to (2.7)—which remains simple since its coefficients are constant and there are only two lags to take into consideration—depends on the roots of the characteristic equation $x^2 + \alpha(1 + \beta)x + \alpha\beta = 0$, themselves functions of the parameters α and β . The set of possible values of α et β is divided into four areas, each of which gives different sample paths for the national revenue⁵: in synthesis, there are cyclical fluctuations (damped, regular or explosive) when the roots of characteristic equation are complex conjugate numbers, i.e. when $\alpha < (4\beta/(1 + \beta)^2)$. In other terms, national revenue swings temporally if the marginal propensity to consume is weak and the acceleration coefficient is large or vice versa.

Samuelson's model makes it possible, under specific circumstances, to create fluctuations which differ from real cycles from three points of view: (1) the oscillations of the model are regular only in a very specific case, i.e. when the marginal propensity to spend equals the reversed coefficient of acceleration; (2) as opposed to the observed cycles, these oscillations are perfectly symmetrical; (3) their magnitude depends on the initial conditions of the model whereas, the magnitude of real cycles varies and should at least be explained. (Samuelson's model was long-lasting; we should note Selten and Guth's (1982) contribution to it, their originality being to introduce Nash's bargaining solution in the frame of a simple multiplier-accelerator model.)

In 1950 Hicks took up again the issue of the oscillator to which he added his personal touch, so that soon one started talking about the 'Samuelson-Hicks model'. However, although Hicks (1950, p. 83) considered the case where the model experienced explosive oscillations, the Oxford economist modified Samuelson's analysis on three major points:

1. He substituted the framework of a "progressive" economy—and hence growth at a constant rate—for that of a stable economy.
2. He introduced a cyclical ceiling in that at each period, the national income could go beyond a certain level defined by full employment of production factors.
3. Finally he introduced also a cyclical floor which limited the downward variations of revenue; the existence of such a floor is plausible since the disinvestment following this drop is at any time necessarily limited by the tempo of throwing out equipment; in other words, the accelerator stops releasing these effects from the moment the floor is reached.

All in all, Hicks provided an overview of economic dynamics which showed that economies experiencing a cyclical growth movement and fluctuations were

⁵For a comprehensive analysis of the model and its solutions, see Chiang et al. (2005, pp. 578 sq).

constrained by the full employment ceiling and the very progressive disuse of capital goods. As such his model is much closer to real life than the simple multiplier-accelerator model.

2.3.3 “Non-linear” Contributions of Goodwin and Allais

Samuelson’s and Hicks’ approaches are based formally on linear equations systems; however, it is possible to introduce nonlinearities in the analysis while keeping the same conceptual framework. One of the first to explore this path was Nicholas Kaldor. In fact, he supposed that the values of the marginal propensity to consume and the accelerator were not stable but varied with the production level. It was therefore possible to generate a cycle endogenously—Kaldor (1940, especially pp. 89–92)—so that the magnitude of the fluctuations would not depend on the initial conditions or random shocks.

The method used by Kaldor was mainly graphic. This was not true of the two other economists who both constructed a true mathematical model, namely Goodwin and Allais.

Goodwin (1951) has developed a model which combines dynamic multiplier and non-linear accelerator. As in Kalecki, there is a fixed-time delay θ in the accelerator; then θ is an average lag between investment decisions and outlays, i.e. $I(t) = B(t - \theta)$. The accelerator is defined as a relation between total outlays $B(t)$ and the rate of variation of national product $dY(t)/dt$:

$$B(t) = \varphi(dY(t)/dt), \quad (2.8)$$

where $\varphi(\cdot)$ is a non-linear function. Furthermore this accelerator is restricted by upper and lower limits, respectively denoted by U and L .

In fine, the Goodwin model also yields a mixed difference-differential equation; its solution consists of a stable limit-cycle, not of sinusoidal form, depending on the U and L values.

The future Nobel Prize-winner Maurice Allais (1953, 1955, 1956) also conceives a very original non-linear model of the cycle. It differs from Kalecki’s or Goodwin’s in that it is founded on essentially monetary dynamics. In fact, the whole effort of the French theorist consists of explaining stable cycles’ autogeneration on the basis of interactions between preferences for cash, defined as the opposite of the speed of money’s circulation, and the quantity of bank money.

The model’s fundamental equation is⁶:

$$D(t + T) - D(t) = \frac{1}{T} [M(t) - M_D(t)], \quad (2.9)$$

⁶All the notations used are Allais’s (1955).

where $D(t)$ represents global expenditure at the instant t , T is the time lag between revenue and spending, $M(t) - M_D(t)$ is the difference between actual money balances and desired money balances in t .

Then it is supposed that the money supply is a positive monotonically increasing function, denoted by g , of what Allais called “the psychological expansion rate”, noted as $v(t)$:

$$M(t) = g(v(t)). \quad (2.10)$$

In the same way, the desired reception is by hypothesis in the form

$$M_D(t) = D(t)f(u(t)), \quad (2.11)$$

where f is a positive monotonically increasing function of $u(t)$, i.e. of the rate of economic expansion. Taking into account (2.10) and (2.11), (2.9) then becomes:

$$T[D(t + T) - D(t)] = [g(v(t)) - D(t)f(u(t))]. \quad (2.12)$$

This mixed difference-integral equation is only dependent on $D(t)$ and permits us to determine the path of the global spending (equal to revenue) in time. Its analysis shows that the model may have two types of solution: either converging towards stable or unstable equilibrium, or else towards a limit-cycle, the properties of which must be numerically computed.

In the end, as Allais indicated (1947, 1998, p. 124), “The longer past memory is, the stronger is the tendency to stability and the longer the limit-cycle period.”

2.4 The Statistical and Econometric Approaches

If we can date back to Juglar and Jevons the use of long series to characterise the economic cycle, the credit for the first really statistical analysis of these series has to go to Moore and Persons.

2.4.1 The First Steps

Moore (1914) used the periodogram to detect two cycles of a respective duration of eight and 33 years in the rainfalls in the Ohio Valley. As for Persons (1919), he seems to be the first economist to have proposed to split time series into four components: the trend, the cycle, seasonality and a purely accidental hazard. We will return to the other great contribution of Persons to the analysis of fluctuations: the construction of the “Harvard barometer”.

However, as early as 1913, Wesley Clair Mitchell published the first book totally devoted to the study of economic oscillations (business cycles). He developed a new methodological approach which he summed up as follows: “To observe, analyze, and systematize the phenomena of prosperity, crisis, and

depression is the chief task” (Mitchell 1913, p. 20). From this position, there was no need to decide between the different cycle theories; they need only be used to select the relevant facts.

In 1920, Mitchell became the Director of the National Bureau of Economic Research, an institution which in 1921 launched a statistical research programme on economic cycles. This programme resulted in another book by Mitchell called *Business Cycles: The Problem and its Setting* (1927). In it, Mitchell criticised the use of statistical techniques—periodogram or decomposition of time series—applied by Moore and Persons; he considered that these techniques did not directly measure the business cycle. Moreover *Business Cycles* presented a synthesis of research works on the cycle undertaken in the 1920s and ended with a proposed plan for measuring economic fluctuations. Hence, as Morgan (1990, p. 50) wrote, the book “fully established Mitchell’s reputation as the preeminent figure in statistical business cycle research of the interwar period”.

Another book resulted from Mitchell’s research programme, *Measuring Business Cycles*, written in collaboration with A.F. Burns, published in 1946. In addition to a definition of the cycle, which we will come back to later, the two authors proposed—among others—a series of measures of fluctuations, or more precisely of what he called the reference cycle on the one hand and the specific cycles on the other. The latter were connected with specific variables and were obtained by dating turnaround points of the variable under study. The reference cycle is the global, aggregated economic cycle defined on the basis of a set of relevant variables.

However, in the 1920s, Mitchell was not the only economist preoccupied by the statistical analysis of swings. The aforementioned Persons was entrusted by the Harvard Committee for Economic research in 1917 with initiating a study of the “methods for collecting and interpreting economic statistics”. Two years later he published the results of his work as a monthly business barometer in the *Review of Economic Statistics*, created in 1919 by the Harvard Committee and which became in 1949 the *Review of Economics and Statistics*. This barometer relied on three cycle indicators representing the movement of the economy and covering respectively the stock market, industry and the monetary conditions. These indicators led to the famous curves called Harvard A-B-C which were supposed to represent the dynamics of economic fluctuations and therefore to forecast crises. Harvard barometers did not survive the Great Depression; however, see Samuelson (1987) for a reappraisal of the Harvard work.

During the 1920s there was a real blossoming of institutions dedicated to research on the cycle and the economic situation. In 1920 the Moscow Institute, chaired by Kondratieff, was created; one in Stockholm in 1922, in Paris and London in 1923, Berlin in 1925, etc. In January 1927 the Austrian Research Institute on Business Cycles (Österreichische Konjunkturinstitut) was created at Ludwig von Mises’ behest. Thanks to his support, Hayek was its director until he left Vienna for London in 1931, when he was hired by the London School of Economics. Morgenstern succeeded him until 1938, when he immigrated to the United States after *Anschluss*.

Mitchell and Persons' intellectual influence on most of these new institutions is quite obvious, yet their futures turned out to be diverse: the Moscow institute was closed in 1928 and Kondratieff was banished to Siberia; the European institutes as well as Harvard's lost their credibility, as they had been unable to predict the 1929–1930 crisis.

2.4.2 The “Tinbergen Moment”

The decline of economic research institutes paved the way for attempts at modeling cycles. The most obvious name which comes to mind in that respect is that of Jan Tinbergen, the first Nobel Prize winner in economics in 1969, together with Ragnar Frisch. The Dutch economist's research, considerable as it is, did not come out of the blue, it was directly prepared by the work of three authors, namely Yule, Slutsky and Frisch.

Yule (1926) had showed that one had to be very careful when calculating correlations (in a statistical sense) between chronological series: these might prove to be nonsense correlations. Of course such a criticism implicitly questioned the works of the cycle analysts which were based on the calculation of high correlation coefficients to provide evidence of the relations between variables. The following year, Yule published another article in which he compared the cycle to a “pendulum bombarded with green peas”, the swings being due to random shocks, represented by the green peas.

The Russian economist Slutsky (1937), in an article written in 1927 but which was published in English only in 1937, stressed even more strongly the importance of random shocks, as, by accumulating, they might produce series which could be compared to a combination of sinusoidal swings. Kuznets (1929, p. 274), who might have read Slutsky's article in its original version, came to the conclusion that “if cycles arise from random events, (...), then we obviously do not need the hypothesis of an independent regularly recurrent cause”.

Ragnar Frisch, the first Nobel Prize winner in economics together with Tinbergen, is the third author who had a significant influence on the Dutch economist. In 1933 in the paper written for the book to pay homage to Cassel, he proposed a small dynamic macro-economic model of the cycle: from a mathematics perspective it was a mixed system of recurrence equations and differential equations. The attempt was completely in the *Zeitgeist*, as the 1929 crisis had focused economists' attention somewhat.

Without going into details, we can say that Frisch's model combines deterministic dynamic relations and random shocks. We could almost call it an econometric model, except that its structural parameters were not evaluated but “calibrated”. Nevertheless with this type of calibration, Frisch's system proposed solutions for the three main variables and these solutions were composed of a trend and three cycles, one of which—primary—had a 8.57 year duration. This matched reality quite well.

Following up on these three authors, Jan Tinbergen designed and assessed the first econometric model of the cycle. He did it at the request of the *Vereniging voor de Staathuishoudkunde en de Statistiek*, the association of Dutch economists which convened in October 1936 a congress on the topic “Out of Depression”. Tinbergen (1936), addressing an audience not very knowledgeable in quantitative methods, left out the most technical aspects of his presentation. However, one year later he published with Hermann in Paris a complete presentation of the “Dutch econometric model” and identified the quantitative effects of a large scope of measures of economic policy. Plainly, it was for the time both a major intellectual and numerical performance: the model used 31 variables and 22 equations; among the latter 16 were behavioural or technical relations which Tinbergen evaluated for the period 1923–1935 (Tinbergen 1937, pp. 14–15).

The Dutch economist took an early interest in the issue of economic fluctuations, as evidenced in particular by his contribution to *Econometrica* (Tinbergen 1935). It is therefore not surprising that the future Nobel laureate was asked in 1936 by the League of Nations to test empirically the business cycle theories as they were to be presented in Haberler (1937). Tinbergen worked two full years on this issue and published the result of his work in 1939 as two volumes entitled *Statistical Testing of Business-Cycle Theories*. The first one contained a methodological part in Chaps. 2 and 6 as well as three case studies (investment swings, residual construction and net investment in the railways); the second volume proposed an econometric model of the American economy aimed at assessing the various analyses of the business cycles.

This dynamic macro-economic model, even more than the Dutch model of 1936, was a real achievement: it contained 71 variables, 48 equations and covered the period 1919–1932; moreover it was of a higher empirical interest as Tinbergen was able to express in equations a series of theories expressed in purely verbal terms and to test them later following a three-step procedure. Of course the assessment of these various models depended on the data used (it was not very good) as well as on the specific character of the period under study (the “great depression”). But Tinbergen could not be held responsible for those.

What is more interesting from a present-day point of view is the first volume considered from its methodological dimension. The method used was called by Tinbergen “correlation analysis” (1939, vol. I, p. 15). In fact the aim was simply to assess the coefficients of a multiple linear regression (possibly with lagged variables) by minimising residual sum of squares. This estimated equation is then characterized by the correlation coefficient—the famous R^2 of modern econometricians—whose value varies from 0 to 1. The closer to unity the correlation coefficient, the better the statistical fit.

The last step in this approach consists of testing the statistical significance of coefficients. From that viewpoint, Tinbergen (1939, vol. I, p. 28) did not refer to the Neyman-Pearson theory but to what he called the “classical method”, the “final formula (of which) was provided by R.A. Fischer”. In practice, the method amounts to applying a t -test to each coefficient divided by its standard error. Tinbergen used also another testing method created by Frisch (1934) the method

of the *bunch maps*, which has since not been used for a very long time and which we will therefore not comment on here. (The interested reader can check Tinbergen 1939 vol. I, pp. 29–31, or Valavanis 1959, pp. 146–150 for further information.)

Tinbergen's work raised different types of comments. Allen (1940), for instance, was a strong supporter but Milton Friedman (1940) was much more critical, although his review of *Statistical Testing* concerned only volume II. The severest review is without doubt Keynes' (1939). In addition to divergences on the epistemological value of Tinbergen's work, the author of the *General Theory* raised six points of criticism of the econometric methodology used: the need to determine all "causes", i.e. all explanatory variables present in a multiple regression; the inability to take into account non measurable qualitative variables; the possibility of connecting explanatory variables, which we would call today multicollinearity; the non-checking of the linearity assumption; the difficulty to correctly determine the number of lags in the assessed equations; the dependence on these estimates on the time coverage.

Tinbergen (1940) replied to the Cambridge economist; however the true reply came later with the development of the econometric theory and practice, which made it possible to solve the—real—problems raised by Keynes. For instance, it is nowadays usual to estimate non-linear equations or models with qualitative variables.

2.4.3 Towards Large Scale Models

This Keynesianism was bound to permeate in the end the whole macro-economic field. We have already mentioned above that the author of the *General Theory* was very critical of the pioneering work of Tinbergen. In the 1940s however, Haavelmo (1944) gave a new direction to econometrics by encouraging a "probabilistic revolution". The word "revolution" was used, among others, by Morgan (1990), because his approach provided a frame, a theoretical (probabilistic and statistical) structure which made it possible to test competing economic theories. It is worth noticing that Haavelmo (1943) defended Tinbergen against Keynes. In fact Haavelmo's programme was to take shape in the work of the Cowles Commission, in particular in Koopmans' (1950) and Hood and Koopmans' (1953) monographs.

Hence, when Lawrence R. Klein prolonged Tinbergen's work (1939) for the United States, he did it under different conditions characterised by the hegemony of Keynesian macro-economics and the "probabilistic revolution". His *Economic Fluctuations in the United States*⁷—Klein (1950)—developed the first Keynesian macro-economic model. It was followed by many others, in particular Klein-Goldberger's (1955) and large-scale ones, such as Brookings'.

⁷Here is Klein's (1966, pp. 227) description of the origin of his *Fluctuations*...: "(...) I was stimulated by J. Marschak to build a Tinbergen type model for the United States economy, just after completing the original version of the *Keynesian Revolution*."

However, this type of model did not succeed in endogenously creating an oscillatory behaviour of the economy. As Adelman and Adelman (1959) showed using the example of Klein-Goldberger's system of equations, it is only by introducing random shocks that one could generate cycles, the characteristics of which could be compared to those of the American economy.

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Aimar, T.; BISMANS, F.J.; Diebolt, C.

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