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Time scales and mechanisms of economic cycles: a review of theories of long waves*

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This paper explores long wave theory, including Kondratieff's theory of cycles in production and relative prices; Kuznets's theory of cycles arising from infrastructure investments; Schumpeter's theory of cycles due to waves of technological innovation; Goodwin's theory of cyclical growth based on employment and wage share dynamics; Keynes–Kaldor–Kalecki's demand and investment-oriented theories of cycles; and Minsky's financial instability hypothesis whereby capitalist economies show a genetic propensity to boom–bust cycles. This literature has been out of favor for many years but recent developments suggest a re-examination is warranted and timely.

Keywords: *cycles, production cycles, infrastructure cycles, accelerator-multiplier mechanism, innovation cycles, financial crisis, booms and busts, Goodwin, Kalecki, Minsky, asset price-leveraging cycles, Kaldor, Kuznets, Kondratieff*

JEL codes: *B16, B23, C65, E20, D90, G01, N20*

All things come in their due seasons – Heraclitus
To everything there is a season, and a time to every purpose … – Ecclesiastes 3:1

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1 INTRODUCTION

After a 30-year period of relative global economic tranquility – the so-called period of 'Great Moderation' – the US economy suffered a financial meltdown in 2008 that triggered the 'Great Recession.' These events have generated new interest in theories that can explain long periods of expansion that end suddenly with deep recessions. One approach, which has been intellectually unfashionable for many years, is the theory of long economic waves.

This paper examines long wave theory and demonstrates the continuing relevance of the theoretical constructs developed by Nikolai Kondratieff and Simon Kuznets, both for modern macroeconomics and for assessing possible future scenarios. The paper also shows the difficulty of modeling long waves as they pose significant challenges to the equilibrium method which dominates shorter period economic analysis.

Business cycles of shorter duration can be explained by economic mechanisms that generate cyclical fluctuations in activity. However, the mechanical view of long waves is more problematic and challenging. Whereas there is solid evidence for shorter business cycles and the endogenous dynamics of shorter cycles appears clear and distinct, long wave cycles are more controversial and involve different theoretical mechanisms that are harder to verify empirically – in part because data is inevitably more limited owing to the reduced frequency of such cycles.

Several different theories of the long wave exist. These include Kondratieff's theory of cycles in production and relative prices; Kuznets's theory of cycles arising from infrastructure investments; Schumpeter's theory of cycles due to waves of technological innovation; Keynes–Kaldor–Kalecki's demand and investment oriented theories of cycles; Goodwin's theory of cyclical growth based on employment and wage share dynamics; and Minsky's financial instability hypothesis whereby capitalist economies show a genetic propensity to boom–bust cycles. The notion of a financially based long wave Minsky super-cycle, which has been largely overlooked by contemporary economists, appears to have become more relevant in the wake of the financial crisis and the end of the 'Great Moderation.'

The paper is organized as follows. Section 2 examines the long wave theories of Kondratieff and Kuznets. Section 3 builds on the preceding discussion and analyses varying time scales and mechanisms of economic cycles prevalent in economic theory. Section 4 examines Minsky-type long-period cycles. Section 5 concludes the paper. The focus is on theory. In a subsequent paper, we plan to explore the empirical challenges of detecting long duration cycles and the evidence for them.

2 THE LEGACY OF KONDRATIEFF AND KUZNETS

2.1 Kondratieff and the theory of long waves

Writing in the early 1920s, Nikolai Kondratieff advanced the idea of the probable existence, in capitalist economies, of long waves with 48- to 60-year cycles. He argued that economies progress through a long period of accumulation of material wealth in which productive forces move the economy to a newer and higher level of development. However, beyond a certain point, a long decline in economic activity commences,

before faster growth again sets in (Kondratieff 1922 [2004]). This mechanism has been labeled the Kondratieff cycle.[1]

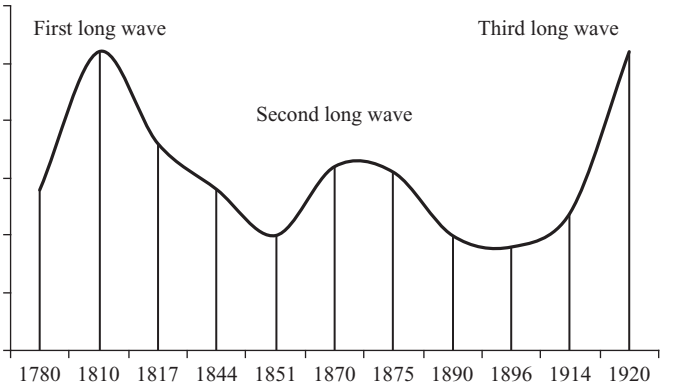
Although Kondratieff's ideas were not well accepted by official Soviet economists, he persisted with his investigations and followed up his original claims with more rigorous publications. Despite few English language translations being available (most notably, Kondratieff 1935), his ideas were recognized and quickly entered the work of subsequent economists (some reviewed below).

The core of Kondratieff's argument rested on his empirical analysis of the macroeconomic performance of the USA, England, France, and Germany between 1790 and 1920. That analysis examined wholesale price levels, interest rates, production and consumption of coal and pig iron, production of lead, and price movements (Kondratieff 1935). De-trending the data and then using an averaging technique of 9 years to eliminate the trend as well as shorter waves of the Kitchin type, Kondratieff claimed he had identified long wave regularity in the data combined with intermediate waves within. He concluded that such a pattern reflected a process of continuous development, and possible explanations for such long wave cycles included (a) changes in technology; (b) wars and revolutions; (c) appearance of new countries on the world map; and (d) fluctuations in the production of gold (Kondratieff 1935; and Kondratieff 2002).

While these four mechanisms appeared valid, he also argued that external factors could not be the sole determinants of regular cycles. The missing part, Kondratieff postulated, was the accumulation of preceding events and the development of economic, social, and political relationships that helped endogenize these external factors. In this regard, Kondratieff pointed to the large-scale 'accumulation' of innovative activity (that is, inventions and process modifications requiring 50 or more years before being absorbed into the productive process) as an important endogenizing mechanism. Figure 1a illustrates an approximation of Kondratieff's original timeline for long wave cycles.

Schumpeter (1939) was one of the first to accept Kondratieff's logic and he pointed out the distinction between short (Kitchin cycles of 3–4 years), medium (Juglar cycles of 8–10 years), and long (Kondratieff cycles of 54–60 years) cycles in his analysis of economic development. We discuss some of this below. However, other western economists and Soviet economists were sharply critical of Kondratieff's claims. On the western side, Garvy (1943) argued there was not sufficient statistical evidence to warrant any claim of cyclical regularity. On the Soviet side, several economists writing around the time of Kondratieff's original publications and shortly after (for example, Studensky, Oparin, Pervushin, Bogdanov, Sukhanov, and others – see Garvy 1943 for concise discussion and references) rejected the term 'cycle' in reference to the capitalist production mode since that implied some type of capitalist system perpetuity. This was directly contrary to then-held socialist beliefs of a gradual phasing out of capitalism and a transition to the logical next stage of socialism, which was then a dominant interpretation of Marx's *Capital* (1867 [2003]). Ironically, this belief in rapid phased successions, acquired from simplistic interpretations, would feed into initial enthusiasm for shock therapy reforms in post-socialist economies in the early 1990s (Gevorkyan 2011).

1. There are antecedents to Kondratieff's work and he cites some earlier empirical efforts aimed at systematizing the cyclicality of economic crises by van Gelderen (1913), Buniatian (1915), and de Wolff (1924).



Source: Authors' approximation based on Kondratieff (1935).

Figure 1a An illustration of Kondratieff's long wave cycles

Recently, working within Kondratieff's original methodological scope, researchers have tried to extend his analysis across the twentieth century with a focus on near-term predictive capabilities. Using spectral analysis, some report that the current global economic slow-down fits calculations of a fifth Kondratieff long wave.[2]

2.2 Kuznets's novel analysis of development

Simon Kuznets received the Nobel Prize in Economics in 1971 for his empirical analysis of economic growth, in which he identified a new era of 'modern economic growth.' Like Kondratieff, Kuznets relied on empirical analysis and statistical data to formulate his theory in his pioneering research. The first step involved constructing national income series for industrial nations using the abstract categories of the national income decomposition, which at that time was still being formulated. Thereafter, Kuznets proposed the concept of long swings that, though disputed, are now referred to as Kuznets cycles or Kuznets swings (for example, Korotayev and Tsirel 2010).

Kuznets swings have a periodicity of 15–25 years and Kuznets initially connected them to demographic cycles. In that first analysis, he linked the cyclicality of production and prices to immigrant population flows and construction cycles. Subsequently, researchers tried to connect these cycles with fixed capital investment and infrastructure investment (see Korotayev and Tsirel 2010, for a literature review). Focusing on the developed economies of North America and Western Europe, Kuznets computed national income from late 1860 forward, along with structural breakdowns by industry and final products. He also provided measures of income distribution between rich and poor population groups.

Kuznets was critical of theoretical work built on over-simplified assumptions and he criticized the idea that capital and labor were the sole factors sufficient for economic growth. Instead, he said, explaining growth requires recognizing the effects of information on technology, population and labor force skills, trade, markets, and government

2. For more information, see Kondratieff (2002); and Akaev (2009); Korotayev and Tsirel (2010).

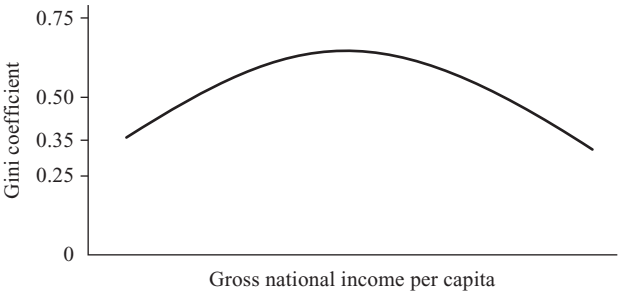


Figure 1b Kuznets curve

structure. In developing measures of national income, Kuznets introduced categories of consumption, savings, and investment (see Kuznets 1949; 1937; 1934), eventually creating today's system of national income accounting.

Additionally, as part of his work on income inequality, Kuznets was one of the first to look at economic growth measurements (see Kuznets 1971; 1966; 1955). His well-known inverted U-shaped curve measuring inequality on the y-axis, and economic development expressed as change in GNP on the x-axis, was an intellectual breakthrough (see Figure 1b). His conclusion was that income inequality among different groups is low when an economy is agrarian. However, with the onset of industrialization, inequality initially rises and then falls.

This pattern roughly describes the experience of the developed economies in Western Europe and North America. Upon reaching a critical saturation point, inequality subsides while economic growth continues. This happens through the emergence of a 'middle class' and improved education facilities, health care, and governance. On a speculative note, based on evidence from the US economy since 1980, further structural change and the shifting of resources to services and the financial sector may again increase inequality. This would render the Kuznets curve wave-shaped.

A variant of the Kuznets curve is also utilized in environmental economics. This application suggests an immediate deterioration in air quality and intensification of environmental problems with the onset of industrialization, which is then reversed with the emergence of middle-class affluence that drives legislative and other controls on hazardous production (WB 1992; Grossman and Krueger 1995; and more recently Stern 2004).

The Kuznets curve's implied prediction of declining inequality provided strong intellectual appeal for the earlier mentioned shock therapy reforms of the early 1990s in Eastern Europe and the former Soviet Union (Gevorkyan 2011). However, shock therapy failed to recognize the necessity of the proper sequencing of market liberalization reforms and the important role of the state in efficient market economies. Consequently, it failed to deliver on the promise of lower income inequality, and income inequality remains a critically important issue two decades after the 'transition.'

A common theme in the work of Kondratieff and Kuznets was to identify the mechanisms of economic growth and development, and to systematize core tendencies driving economic transformation. Those mechanisms render development cyclical. In this regard, Kuznets (1973) identified six key features of modern economic growth: (1) increases in per capita growth and population in developed economies; (2) increasing productivity rates; (3) increasing rates of structural transformation; (4) rising urbanization

and secularization; (5) spread of technology and infrastructure improvements (communications); and (6) limits to wide-scale spread of economic growth and benefits.

3 DURATION AND MECHANISMS OF ECONOMIC CYCLES

As mentioned in Section 2, the work of Kondratieff and Kuznets fostered a systematic approach to understanding long-period economic swings. Numerous authors have proposed additional mechanisms for explaining cycles as well as identifying cycles of different duration. An early theory of cycles was put forward by Robert Owen in 1817, who stressed wealth inequality and poverty resulting from industrialization, generating the under-consumption that can cause an economic crisis. In the mid-nineteenth century, Sismondi took a similar view and also developed a theory of periodic crises due to under-consumption. This led to the discussion of the 'general glut' theory of the nineteenth century, to which Marx and other classical economists also contributed extensively.

Juglar (1862) proposed a mechanism for cycles of a shorter duration, 8–10 years, based on waves of fixed investment. Kitchin (1923) introduced an inventory cycle of 3–5 years. Schumpeter (1939) made an important contribution with his idea of the 'bunching' of innovations, the diffusion of which causes long waves in economic activity.

Samuelson (1939), influenced by the Spiethof accelerator and the Keynesian multiplier principle, developed the first mathematically oriented cycle theory using difference equations.[3] Others, such as Rostow (1975), had proposed the theory of stages of growth. Simultaneous with Samuelson, Kalecki (1937) developed his theory of investment implementation cycles where he saw significant delays between investment decisions and investment implementations, formally introducing differential delay systems as a tool for studying cycles.

Kaldor (1940) developed his famous Keynesian non-linear investment-saving cycles, which take account of the evolution of aggregate demand. Later, Goodwin (1967) proposed a model of growth cycles, which incorporates elements of classical growth theory via its focus on the profit share–accumulation relation. This section explores these contributions, beginning with discussion of long-duration cycle theories, followed by discussion of the Goodwin and Keynes–Kaldor cycles. It also includes a brief discussion of Kalecki's (1971) cycle theory and how it might relate to Kondratieff's.

3.1 Kondratieff long swings

Kondratieff's work, as represented in Figure 1a, was substantially empirical. That raises the question of the causes of cycles, which in turn suggests the gradual exhaustion of endogenous and exogenous factors. In the long upswing, the exhaustion process is driven by rising prices, interest rates, and wages. Raw materials and non-renewable resources may also become exhausted, causing prices and wages to rise further. There are also market limits – for example, export limits – which restrict further expansions, as Kondratieff's data on French exports showed. In the long downswing, new technologies are discovered, which contribute to the triggering of

3. A review of the mechanisms of cycles on a shorter time scale is given in Semmler (1986).

a new upswing. New natural resources may also be discovered, causing resource prices to fall and setting up supply-side conditions favorable for supporting a long upswing. All of these mechanisms are indicated by Kondratieff, but not specifically modeled.

3.2 Kuznets long swings

Kuznets's theory of development and fluctuations can be seen as an interesting intersection of two traditions in the economics of his time. On the one hand, he was interested in cyclical movements in numerous time series data, such as the volume of all types of production and prices, seasonal and secular movements in industry income and national income and its components, long swings in economic activities, and business cycle analysis. On the other hand, he saw development as a time-irreversible process of industry and national income development, which evolves in stages of economic growth, characterized by significant structural change. Each stage may have its own particular saving rate, consumption pattern, unevenness and disequilibrium as well as income inequality. Kuznets's conceptual framework can be seen as a mixture of cycle theory based on the accelerator principle applied to infrastructure investment, and stages of economic growth theory similar to that advanced by Rostow (1975). Greiner et al. (2005) present a stages-of-growth approach based on the ideas of Kuznets and Rostow. Overall, Kuznets was ambiguous as to whether there are regular mechanisms generating cycles. Instead, he conjectured that cycles may be visible in economic data solely as a result of certain historical 'occurrences.'

3.3 Schumpeterian innovation cycles

Schumpeter's concept of competition deviates from the neoclassical conception in some essential aspects. First, competition is not limited to price or quantity adjustments. It is described as an evolutionary process, as a process of 'creative destruction.' The engine of this process is capitalist enterprises (Schumpeter 1970, p. 83). The incentive for developing this technical change is transient surplus profits. What is taken as automatically given in neoclassical general equilibrium analysis – in which price and quantity adjust – is the very thing Schumpeter seeks to explain: adjustment is actually driven by process innovation, product innovation, new forms of organization of the firm, and new forms of financial control.

Second, Schumpeter stresses that competition is not necessarily an equilibrating force. When referring to the existence of entrepreneurial firms and their rivalry, Schumpeter maintains that 'there is in fact no determinate equilibrium at all and the possibility presents itself that there may be an endless sequence of moves and counter-moves, an indefinite state of warfare between firms' (ibid., p. 79). Indeed, for Schumpeter, it is product and process innovation, undertaken by the entrepreneur, which disturbs initial economic stasis, triggering long waves and business cycles. Furthermore, Schumpeter seems little interested in a theory of centers of gravitation for market forces as developed by the classical economists.

Third, for Schumpeter, competition is an evolutionary process, one of rivalry between firms motivated by the search for surplus profit. He calls this surplus profit the transient 'monopoly profit' of new processes and new products (ibid., p. 102). 'The transient surplus profit does not appear as deviation from the perfectly competitive state of the economy and as a waste in the allocation of resources, but as a reward

for the innovator and a gain for the capitalist society. On the contrary, the perfectly competitive economy, where every market agent behaves in the same way under the condition of parametrically given external conditions seems to imply a waste of resources … working in the conditions of capitalist evolution, the perfect competitive arrangement displays wastes of its own. The firm of the type that is compatible with perfect competition is in many cases inferior in internal, especially technological, efficiency. If it is, then it wastes opportunities' (ibid., p. 106). Thus, in Schumpeter's view, entrepreneurial firms are powerful engines of progress and 'in particular of the long-run expansion of total output' (ibid., p. 106).

Subsequent literature in the Schumpeterian tradition has distinguished between radical and incremental innovation. The major waves of radical innovations, which were followed by the diffusion of this new technology and incremental innovations are:[4]

- The water-powered mechanization of industry in the eighteenth and early nineteenth centuries.
- The steam-powered mechanization of industry and transport in the middle of the nineteenth century (railways, steam engines, machine tools).
- The electrification of industry, transport, and homes at the end of the nineteenth century.
- Motorization of industrial production, transport, civil economy, and war machinery (from ~1914 onward).
- Computerization and information technology from the 1960s and 1970s onward.

According to Schumpeterian long wave theory, not only did each of these radical innovations trigger a long wave of economic development within the originating country, they were also diffused worldwide.

3.4 Goodwin growth and income distribution cycles

Another type of cycle that has been discussed, particularly in the post-World War II period, is Goodwin's growth cycle theory that postulates an interaction of employment and wage share. When first proposed, it was interpreted as a business cycle model but it seems to operate empirically on a medium-run time scale.[5]

Goodwin (1967) postulates cycles driven by growth and income distribution. Low growth, generated by low profits and investment, generates unemployment, which in turn limits wage growth as compared to productivity. This lowers the wage share, which raises the profit share and slowly raises investment. That increases employment, and the cycle reaches a turning point once higher employment causes wage growth to increase, thereby causing the profit share to start falling. Using non-linear differential equations, originally developed by Lotka and Volterra for models of interacting populations, the Goodwin model of wage–employment dynamics can be written as follows:

$$\dot{x} = P(x, y) = (a - by)x$$

$$\dot{y} = Q(x, y) = (cx - d)y$$

4. For details, see Reati and Toporowski (2004).
5. For details of the subsequent dynamic modeling, see Semmler (1986).

or as

$$\frac{\dot{x}}{x} = a - \mathrm{by}$$

$$\frac{\dot{y}}{y} = cx - d,$$

where $\dot{x}$ represents the time rate of change of the ratio of the employed to the total labor force and $\dot{y}$ is the change of the wage share. Both variables depend on the level of x and the constants $a, b, c, d > 0$. The coefficient a denotes the trend of employment if all income is reinvested ($y = 0$) and d is the fall in real wage if ($x = 0$). The symbol by denotes the influence of the wage share on the employment ratio, and cx the positive influence of employment on the wage share. The interaction of the variables prevents the employment ratio from rising and the wage share from falling without limit.

Viewed as a growth model with trends, the coefficients can be interpreted as follows: $a = b - (m + n)$ where b is the output/capital ratio *(Y/K)*, m is the growth rate of productivity, and n is the growth rate of the labor force. All of these are taken as constant. Assuming a linearized wage function, $\frac{\dot{w}}{w} = -e + cx$, with m the growth rate of productivity, we obtain the following expression for the growth rate of the wage: $\frac{\dot{y}}{y} = \frac{\dot{w}}{w} - m$, with $m = d - e$. Thus the second pair of differential equations can be written as:

$$\frac{\dot{x}}{x} = b(1 - y) - (m + n)$$

$$\frac{\dot{y}}{y} = cx - (e + m).$$

This is equivalent to the first equation of the (above) system, except that it is written in terms of growth rates. The core of the last system shows that the change of the employment ratio depends on the profit share $(1 - y)$ and that the change of the wage share depends on the employment ratio. This form has been used to explain the fluctuation of the employment ratio and the fluctuation of the industrial reserve army in Marx (Marx 1867 [2003], vol. I, ch. 23; see Goodwin 1967). The basic structure of this model represents the interacting variables of the employment ratio and wage share as dynamically connected.

The last system has two equilibria: (0,0) and $(\frac{d}{c}, \frac{a}{b})$. The linear approximation of the system is with ξ_1, ξ_2 as small deviations from the equilibrium values:

$$\begin{pmatrix} \dot{\xi}_1 \\ \dot{\xi}_2 \end{pmatrix} = \begin{bmatrix} J_{11} & J_{12} \\ J_{21} & J_{22} \end{bmatrix} \begin{pmatrix} \xi_1 \\ \xi_2 \end{pmatrix}.$$

The calculation of the Jacobian for the first linear approximation gives for the equilibrium $(\frac{d}{c}, \frac{a}{b})$:

$$J = \begin{bmatrix} 0 & -bd/c \\ ca/b & 0 \end{bmatrix}.$$

The real parts of the eigenvalues are zero and the linear approximation of the equilibrium point represents the dynamical structure of a center (Hirsch and Smale 1974, p. 258). With real parts of the eigenvalues zero, the linear approximation of the system through the Jacobian does not allow conclusions regarding the behavior of the dynamical system in the neighborhood of the equilibrium. Yet, as can be shown, by constructing a Liapunov function for the above system, which is constant in motion and hence has time derivatives $\dot{V} = 0$, the wage share–employment dynamics results in closed solution curves (Hirsch and Smale 1974, p. 258 and Flaschel and Semmler 1987).

The closed trajectories of the system are, however, only closed curves and the wage share–employment dynamics does not allow for persistent cycles, such as limit cycles (Hirsch and Smale, 1974 p. 262; Flaschel 1984). In addition (see Flaschel and Semmler 1987), the dynamical system is structurally unstable, since small perturbations can lead to additional interaction of the variables J_{11}, or J_{22} can become nonzero. This leads to a qualitatively different dynamical behavior of the system, hence it can become totally stable or unstable. Under certain conditions, the above system can also become globally asymptotically stable. This can occur if the conditions for Olech's theorem are fulfilled (see Flaschel 1984).

Equivalent results are obtained when, in place of a linear wage function, a non-linear wage function is substituted in the system (see Velupillai 1979). The wage share–employment dynamics worked out originally by Goodwin for a model of cyclical growth and then applied by him to explain an endogenously created unemployment of labor depict a growing economy, whereas often models of non-linear oscillations refer only to a stationary economy.

Since the change of the wage share and the change of labor market institutions such as bargaining and other protective legislature are slow, this model of economic cycles, however, does not really model business cycles but, rather, medium-run cycles. On the other hand, for a theory of longer cycles, the dynamical interaction over time of other important variables (such as waves of innovations, changes of capital/output ratio, productivity, relative prices and interest rates) and demand factors are neglected.

3.5 Two important shorter-term cycle theories

In this section we present two important shorter-term cycle theories: the Keynes–Kaldor Demand-Driven Cycle and Kalecki's Profit and Investment cycle. Keynes–Kaldor is interesting because of its use of non-linear functions, which produce endogenous cycles. Thus, it is the starting point for many other, later non-linear cycle models. As an important example of that, we present some introductory material on Kalecki's model, which is, actually, only a specification of Keynes–Kaldor's model. Both of these models are important, intellectually, for any discussion of cycle theories. However, as they both consider cycles of shorter periods than the long-period models we focus on in this paper, much of the discussion on them has been relegated to a future paper. Interested readers will find more information there, as well as references to further discussion.

3.5.1 Keynes–Kaldor demand-driven cycles

The Keynes–Kaldor model operates on a shorter time scale. It centers on the role of demand as defined by the relationship of investment to savings. In his 1940 article, Kaldor introduced a non-linear model of business cycles. That model has since been reformulated in the light of mathematical advances in the theory of non-linear

oscillations which take into account demand changes (Kaldor 1940; 1971; Chang and Smyth 1971; Semmler 1986).

Kaldor uses a geometric presentation of a business cycle model which is driven by the non-linear relationship between income changes and capital stock changes. The model seems to generate self-sustained persistent cycles without rigid specifications for the coefficients, time lags, and initial shocks. The dynamic interaction between income changes and accumulation and dissolution of capital also allows for the possibility of limit cycles – that is, asymptotically stable cycles regardless of the initial shocks and time lags.

His ideas are formulated for a stationary economic system and can be represented by non-linear differential equations as follows (Chang and Smyth 1971):

$$\dot{Y} = \alpha(I(Y,K) - S(Y,K)$$

$$\dot{K} = I(Y,K),$$

where α is a reaction coefficient, $\dot{Y}$ the rate of change of income, $\dot{K}$ the rate of change of the capital stock, I is investment, and S is saving, as functions of the level of income and capital stock. According to the assumptions underlying the model, there is a unique singular point (ibid., p. 40). This type of Keynes–Kaldor model can give rise to persistent cycles (see Semmler 1986) and does not rely on a specific role for growth and income distribution, in contrast to the Goodwin model. Instead, it relies on endogenously changing demand conditions.

According to Kaldor's presentation, it is assumed (see Kaldor 1940) that:

(a) $I_Y > S_Y$ for a normal level of income;
(b) $I_Y < S_Y$ for abnormally high or abnormally low levels of income;
(c) The stationary state equilibrium has a normal level of income.

The Kaldor model is illustrated in Figure 2, with Y denoting the level of output. Figure 2 shows that the normal level of Y is unstable and the extreme values of Y are stable. According to Kaldor (1940), what is actually necessary for cycles is only that $I_Y > S_Y$ at some level of Y. Moreover, the singular point at the normal level of Y does not have to be unstable as a necessary condition for a limit cycle. The critical point can be stable (see Minorsky 1962, p. 75). In addition there also is the possibility that the system is globally asymptotically stable.

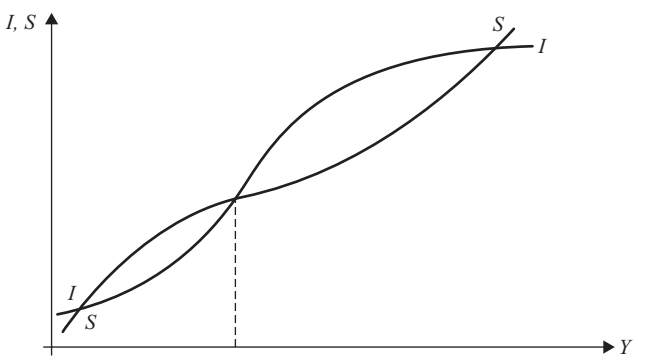


Figure 2 Kaldor's graph of non-linear investment and saving functions

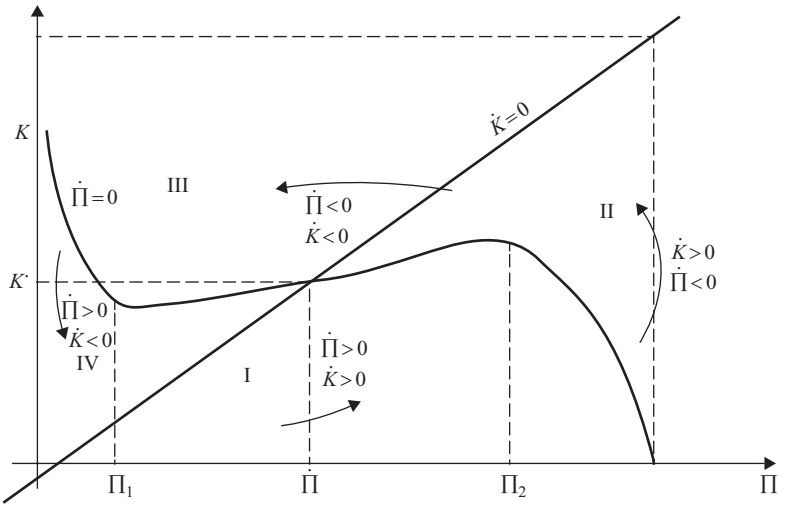


Figure 3 Phase diagram

3.5.2 Kalecki profit and investment cycles

To draw some similarities to the Kondratieff long wave theory, we can follow Kalecki (1971) and replace the income, Y, by profit flows Π[6] and allow $J_{11} = \alpha(I_\Pi - S_\Pi)$ to change sign during the cycle. Now, investment and saving are driven by profits, which links analytically to Goodwin's model that was discussed above.

Suppose that:

$$\frac{\partial I}{\partial \Pi} > \frac{\partial S}{\partial \Pi}, \text{for profit income in an interval such as } \Pi_1 < \Pi < \Pi_2 \text{ (see Figure 3).} \quad (1)$$

Thus, there is a region in which investment is more sensitive than saving to changes in profit. This may be due to previous decreases in production and employment costs which lower current new plant construction costs, continuing low interest rates relative to profit rates that have recovered, and easy access to credit. Together these factors promote a surge of investment in response to improved profit conditions.

In other regions the relative sensitivity is:

$$\frac{\partial I}{\partial \Pi} < \frac{\partial S}{\partial \Pi}, \quad (2)$$

(a) when $\Pi > \Pi_2$, the sensitivity of investment falls because of rising construction costs for plants, rising material and wage costs (relative to productivity), rising interest rates and falling actual and expected profits. Profits and expected profits may fall due to increased costs and wages – that cannot be passed on. This pattern has similarities to the mechanisms invoked in Kondratieff long cycles that eventually choke off the cycle (see Sections 2.1 and 3.1).

(b) when $\Pi < \Pi_1$, the sensitivity of investment also falls, owing to recessionary or slow recovery conditions. In such conditions, firms invest in financial funds

6. This conversion seems permissible as long as there are no savings out of workers' income and thus workers' income is completely spent on consumption.

instead of real capital (Minsky 1983) and the rate of saving is relatively high due to economic insecurity induced by recessionary conditions. Profit expectations may also be subdued, due to the onset and persistence of recessionary conditions. Again, this resembles the Kondratieff scenario of a long downswing and recessionary or stagnation period.

Although the economic logic behind the Kalecki business cycle appears similar to that of the Kondratieff long wave cycle, the time scales are different: the former is a short period cycle whereas the latter is a long period cycle. Moreover, in long period cycles much of the economic structure and many relationships are also likely to change.

The existence of self-sustained cycles is illustrated in Figure 3. The trajectories of $\Pi(t)$ and $K(t)$ are bounded in absolute values. For large enough $\Pi(t)$, $\dot{K}$ turns negative, and for large enough $K(t)$, $\dot{K}$ turns negative, and vice versa.

4 THE MINSKY FINANCIALLY DRIVEN BASIC CYCLE AND SUPER CYCLE

Long cycles have historically been interpreted as an interaction of real forces with cost and prices. Kondratieff cycles emphasize secular changes in production and prices; Kuznets cycles are associated with economic development and infrastructure accumulation; Schumpeterian cycles are the result of waves of technological innovation; Goodwin cycles are based on changes in the functional distribution of income arising from changed bargaining power conditions in periods of high growth rates; and Keynesian theories express demand factors.

The work of Hyman Minsky provides an explicitly financially driven theory of business cycles. Minsky's own writings were largely devoted to exposition of a short-run cycle and a very long-run analysis of stages of development of capitalism. The short-run analysis is illustrated in two articles (Minsky 1957; 1959) that present a financially driven model of the business cycle based on the multiplier–accelerator mechanism with floors and ceilings. A later formalization is Delli Gatti et al. (1994), in which the underlying dynamic mechanism increases leveraging of profit flows, which roughly captures Minsky's (1992a) hedge–speculative–Ponzi finance transition dynamic that is at the heart of his famous financial instability hypothesis. The very long-run analysis of stages of development of capitalism is illustrated in Minsky's (1992b) essay on 'Schumpeter and Finance.' That stage of development perspective has been further elaborated by Whalen (1999) and Wray (2009).

Recently, Palley (2010; 2011) has argued that Minsky's (1992a) financial instability hypothesis also involves a theory of long cycles. This long cycle explains why financial capitalism is prone to periodic crises and it provides a financially grounded approach to understanding long wave economics. A long cycle perspective provides a middle ground between short cycle analysis and stages of development analysis. Such a perspective was substantially developed by Minsky in a paper co-authored with Piero Ferri (Ferri and Minsky 1992). Unfortunately, Minsky entirely omitted it in his essay (Minsky 1992a) summarizing his financial instability hypothesis, leaving the relation between the short and long cycle undeveloped.

Minsky's financial instability hypothesis maintains that capitalist financial systems have an inbuilt proclivity to financial instability that tends to emerge in periods of economic tranquility. Minsky's framework is one of evolutionary instability and can be thought of as resting on two different cyclical processes (Palley 2010; 2011).

The first is a short cycle and can be labeled the 'Minsky basic cycle.' The second is a long cycle and can be labeled the 'Minsky super cycle.'

The basic cycle is driven by evolving patterns (Figure 4) of financing arrangements and it captures the phenomenon of emerging financial fragility in business and household balance sheets. The cycle begins with 'hedge finance' when borrowers' expected revenues are sufficient to repay interest and loan principal. It then passes on to 'speculative finance' when revenues only cover interest, and the cycle ends with 'Ponzi finance' when borrowers' revenues are insufficient to cover interest payments and rely on capital gains to meet their obligations.

The Minsky basic cycle embodies a psychologically based theory of the business cycle. Agents become progressively more optimistic in tranquil periods, an optimism which manifests itself in increasingly enthusiastic valuations of assets and associated actual and expected revenue streams, and a willingness to take on increasing risk in the belief that the good times are here forever. This optimistic psychology affects credit volume via the behavior of both borrowers and lenders: not just one side of the market. That is critical because it means market discipline becomes progressively diminished. Leveraging is increased but the usual textbook scenario of corporate finance, whereby higher leverage results in higher risk premia, is not visible in the cost of credit. Instead, credit remains cheap and plentiful because of these psychological developments.

This credit dynamic is illustrated in the recent long financial cycle starting in the 1990s. Initially, it was a real cycle driven by information technology (IT). This IT bubble burst around 2000/2001. However, expansion resumed, owing to Minsky's financial cycle of overoptimism, high leverage, underestimation of risk, and expansion of new financial practices. The data show a high degree of leveraging during this period, an optimistic view of profit expectations, low risk premia, low credit spreads, and few credit constraints. Thus, contrary to corporate finance textbooks, the market generated high leveraging with low risk premia.

This process of increasing optimism, rising credit expansion and low risk perception is evident in the tendency of business cycle expansions to foster talk about the 'death of the business cycle.' In the US, the 1990s saw talk of a 'new economy' which was supposed to have killed the business cycle by inaugurating a period of permanently accelerated productivity growth. That was followed in the 2000s by talk of the 'Great Moderation' which claimed central banks had tamed the business cycle through improved monetary policy based on improved theoretical understanding of the economy. Such talk provides *prima facie* evidence of the operation of the basic Minsky cycle.

Moreover, not only does the increasing optimism driving the basic cycle afflict borrowers and lenders, it also afflicts regulators and policymakers. That means market discipline is weakened both internally (weakened lender discipline) and externally (weakened regulator and policymaker discipline). For instance, Federal Reserve Chairman Ben Bernanke (2004) openly declared himself a believer in the Great Moderation hypothesis.

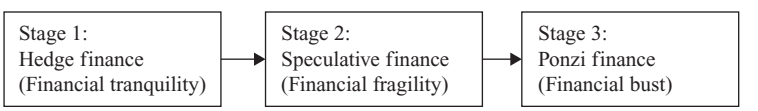


Figure 4 Minsky financing practices

The Minsky basic cycle is present every business cycle and explains the observed tendency toward increased leverage and increased balance sheet fragility over the course of standard business cycles. However, it is complemented by the Minsky super cycle that works over a longer time scale of several business cycles. This long cycle rests on a process that transforms business institutions, decisionmaking conventions, and the structures of market governance including regulation. Minsky (Ferri and Minsky 1992) labeled these structures 'thwarting institutions' because they are critical to holding at bay the intrinsic instability of capitalist economies. The process of erosion and transformation of thwarting institutions takes several basic cycles, creating a long phase cycle relative to the basic cycle.

The basic cycle and long cycle operate simultaneously so that the process of institutional erosion and transformation continues during each basic cycle. However, the economy only undergoes a full-blown financial crisis that threatens its survivability when the long cycle has had time to erode the economy's thwarting institutions. This explains why full-scale financial crises are relatively rare. In between these crises the economy experiences more limited financial boom–bust cycles. Once the economy has a full-scale crisis it enters a period of renewal of thwarting institutions during which new laws, regulations, and governing institutions are established. That happened in the Great Depression of the 1930s and it is happening again following the financial crisis of 2008.

Analytically, the Minsky long cycle can be thought of as allowing more and more financial risk into the system via the twin developments of 'regulatory relaxation' and 'increased risk taking.' These developments increase both the supply of and demand for risk.

The process of regulatory relaxation has three dimensions. One dimension is regulatory capture whereby the institutions intended to regulate and reduce excessive risk-taking are captured and weakened. Over the past 25 years, this process has been evident in Wall Street's stepped-up lobbying efforts and the establishment of a revolving door between Wall Street and regulatory agencies such as the Securities and Exchange Commission, the Federal Reserve, and the Treasury Department. A second dimension is regulatory relapse. Regulators are members of and participants in society, and like investors they are also subject to memory loss and reinterpretation of history. Consequently, they too forget the lessons of the past and buy into rhetoric regarding the death of the business cycle. The result is willingness to weaken regulation on grounds that things are changed and regulation is no longer needed. These actions are supported by ideological developments that justify such actions. That is where economists have been influential through their theories about the 'Great Moderation' and the viability of self-regulation. A third dimension is regulatory escape whereby the supply of risk is increased through financial innovation. Thus, innovation generates new financial products and practices that escape the regulatory net because they did not exist when current regulations were written and are therefore not covered.

The processes of regulatory capture, regulatory relaxation, and regulatory escape are accompanied by increased risk-taking by borrowers. First, financial innovation provides new products that allow investors to take more risky financial positions and borrowers to borrow more. Recent examples of this include home equity loans and mortgages that are structured with initial low 'teaser' interest rates that later jump to a higher rate. Second, market participants are also subject to gradual memory loss that increases their willingness to take on risk. Thus, the passage of time contributes to a forgetting of earlier financial crises, which fosters new willingness to take on risk, The 1930s generation were cautious about buying stock in light of the

experiences of the financial crash of 1929 and the Great Depression, but baby boomers became keen stock investors. The Depression generation's reluctance to buy stock explains the emergence of the equity premium, while the baby boomers' love affair with stocks explains its gradual disappearance.

Changing taste for risk is also evident in cultural developments. For example, home ownership became seen as an investment opportunity as much as providing a place to live.

Importantly, these developments concerning attitudes to risk and memory loss also affect all sides of the market, so that market discipline becomes an ineffective protection against excessive risk-taking. Borrowers, lenders, and regulators go into the crisis arm-in-arm.

Lastly, there can also be an international dimension to the Minsky long cycle. That is because ideas and attitudes travel easily across borders. For instance, the period 1980–2008 was a period that was dominated intellectually by market fundamentalism which promoted deregulation on a global basis.

The twin cycle explanation of Minsky's financial instability hypothesis incorporates institutional change, evolutionary dynamics, and the forces of human self-interest and fallibility. It appears to comport well with developments in the US economy between 1981 and 2008. During this period there were three basic cycles (1981–1990, 1991–2001, and 2002–2008). Each of those cycles was marked by developments that had borrowers and lenders taking on increasing amounts of financial risk in a manner consistent with Minsky's 'hedge to speculative to Ponzi' finance dynamic. The period as a whole was marked by erosion of thwarting institutions via continuous financial innovation, financial deregulation, regulatory capture, and changed investor attitudes to risk, all of which is consistent with the idea of a Minsky long cycle.

Wray (2009) and Palley (2012, ch. 5) provide detailed historical analyses of the period 1970–2007 that show the changing institutional structure of financial markets, the changing face of regulation, and the changing behaviors of investors, borrowers, and lenders. Particularly compelling in favor of the Minsky long cycle hypothesis is recent behavior of US household debt and house prices.

The Minsky long cycle enriches long wave theory. In addition to adding financial factors, the Minsky cycle has different implications for the pattern of long waves compared to conventional long wave theory. Conventional theories see a separate long wave on top of which are imposed shorter waves. In contrast, the Minsky long cycle operates over a long time scale to gradually and persistently change the character of the short cycle (that is, the Minsky basic cycle) until a crisis is generated.

This pattern of evolution is illustrated in Figure 5, which shows a series of basic cycles characterized by evolving greater amplitude. This evolution is driven by symmetric weakening of the thwarting institutions which is represented by the widening and thinning of the bands that determine the system's floors and ceilings. Eventually

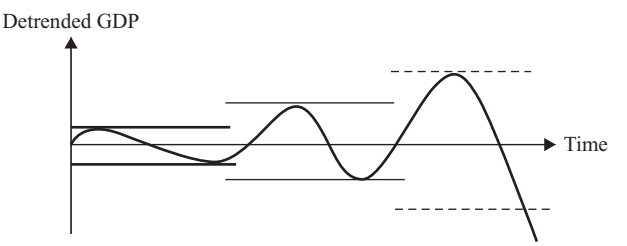


Figure 5 De-trended GDP – symmetric fluctuations

the thwarting institutions become sufficiently weakened and financial excess becomes sufficiently deep that the economy experiences a cyclical downturn that is uncontainable and becomes a crisis.

Figure 5 shows the case where the economy undergoes basic cycles of symmetrically widening amplitude prior to the crisis. However, there is no requirement for this. Another possibility is that cycles have asymmetrically changing amplitude. This alternative case is shown in Figure 6 which represents Minsky's endogenous financial instability hypothesis as having an upward bias. In this case, thwarting institution ceilings are less durable than the floors, giving rise to stronger and longer booms before crisis eventually hits. A third possibility is a long cycle of constant amplitude and symmetric gradual weakening of thwarting institutions that eventually ends with a financial crisis. This richness of dynamic possibilities speaks to both the theoretical generality and historical specificity of Minsky's analytical perspective. The dynamics of the process are general but how the process actually plays out is historically and institutionally specific.

Analytically, the full Minsky system can be thought of as a combination of three different approaches to the business cycle. The dynamic behind the Minsky basic cycle is a finance-driven version of Samuelson's (1939) multiplier–accelerator formulation of the business cycle. This dynamic is essentially the same as that contained in new Keynesian financial accelerator business cycle models (Bernanke et al. 1996; 1999; Kiyotaki and Moore 1997). Thwarting institution floors and ceilings link Minsky's thinking to Hicks's (1950) construction of the trade cycle. Those can also be present in the coefficients of the multiplier–accelerator model which determines the responsiveness of economic activity to changes in such variables as expectations and asset prices. The long cycle aspect is then captured by shifting and weakening of floors and ceilings and changing of behavioral coefficients. This connects Minsky to long wave theory, with the role of financial innovation linking to Schumpeter's (1939) construction of an innovation cycle.

Despite these commonalities with existing cycle theory, formally modeling Minsky's financial instability hypothesis is difficult and can be potentially misleading. Though models can add to understanding, they can also mislead and subtract.

One problem is that formal modeling imposes too deterministic a phase length on what is in reality a historically idiosyncratic process. Adding stochastic disturbances jostles the process but does not adequately capture its idiosyncratic character which Minsky described as 'One never steps in the same stream twice' (Palley 2011). A second modeling problem is that the timing of real-world financial disruptions can appear almost accidental. This makes it seem as if the crisis is accidental when it is in fact rooted systematically in prior structural developments.

A third problem is viewing the financial instability hypothesis as a quintessentially non-equilibrium phenomenon, one in which the economic process is characterized by

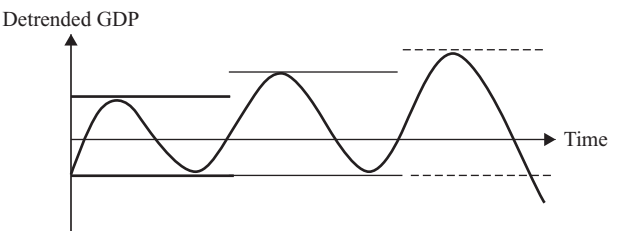


Figure 6 De-trended GDP – asymmetric fluctuations

the gradual and inevitable evolution of instability that agents are blind too, even though it is inherent in the structure and patterns of behavior – and agents may even know this intellectually. This problematic of non-equilibrium is explicitly raised by Minsky (1992b, p. 104) in his 'Schumpeter and Finance' essay: 'No doctrine, no vision that reduces economics to the study of equilibrium seeking and sustaining systems can have long-lasting relevance. The message of Schumpeter is that history does not lead to an end of history.'

5 CONCLUSION

Economic theory is split on the issue of economic cycles, and differences intensify with distinction between short, medium, and long cycles. In reviewing the contributions of Kondratieff, Kuznets, Schumpeter, Goodwin, Kaldor, Kalecki, and Minsky, this paper emphasizes the value of these analytical frameworks for understanding capitalism and the current economic situation. The Goodwin cycle and Minsky super cycle seem particularly appropriate to understanding current macroeconomic circumstances: the former captures the long boom effect of rising profit shares, while the latter explains financial aspects of the boom climate of the 30 years that ended with the financial crisis of 2008. The Kondratieff cycle seems relevant for understanding the ongoing IT revolution associated with computers, the microchip, and mobile telephony. It would also seem to have relevance for understanding the consequences of climate change and the emerging bio-technology and nano-technology revolutions, as these developments promise to have significant long-lasting effects on economic activity that will take decades to fully work out.

Empirically detecting the mechanisms of long cycles, and thereby calibrating policy to the real economy, is difficult. There are technical challenges associated with filtering and spectral methods.[7] Economies are characterized by continuous change that is ever more significant as the period of analysis lengthens. For instance, long waves of 25 to 50 years would inevitably include a period of significant structural change. Over the last 200 years, a repeated sequence of structural changes have transformed the economy from one dominated by agriculture to one that is manufacturing-based, and then on to service sector dominance. More recently, the financial component has advanced as a dominant factor of change, globally, as emphasized in the above analysis.

Economies are also characterized by institutional changes that alter decisionmaking processes, introduce new players and interest groups, and change the balance between market and government. Technological change has promoted a trend towards economic activity that involves less physical production and resource use, and is more intensive regarding knowledge-based production activity. As a result, the character and forces of growth are likely to change. From that perspective, in the immortal words of Heraclitus, 'one can never step into the same river twice.' The existence of so much historically idiosyncratic material makes it empirically difficult to detect cycles of fixed periodicity and amplitude based on time invariant cycle generating mechanisms. Adaptations of wavelet methods may prove a suitable means for empirically identifying economic relationships over cycles of different duration. It also seems

7. In the literature there are three standard methods used to empirically study detect cycles. These are spectral analysis (Fourier`s theorem), filtering methods (HP-filter, BP-filter, and penalized splines), and wavelet theory. Interested readers may see Flaschel (1984), Flaschel and Semmler (1987), Korotayev and Tsirel (2010), and Gallegati et al. (2011) for more information.

reasonable to talk of stages, or phases, regarding the economic dynamics of developed and emerging market economies.

Persistence of long wave-like tendencies on a global scale, a feature of maturing globalization, allows one to advance a concept of redefined fundamental uncertainty (see, for example, Gevorkyan and Gevorkyan 2012). This is consistent with the risk and destabilizing factors of the cycle theories reviewed in this essay; it suggests the possibility of extending this methodology to emerging markets and to questions of economic and social stability. Collectively, the world is capable of widespread technological advance and innovation. Viewed through the lens of long cycle theory, this gives hope that the global economy may be advancing to a newer stage.

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