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# Time Scales and Mechanisms of Economic Cycles: A Review of Theories of Long Waves<sup>1</sup>

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## Abstract

This paper explores long wave theory, including Kondratieff's theory of cycles in production and relative prices; Kuznets' 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 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 reexamination is warranted and timely.

**JEL classification codes:** B16; B23; C65; E20; D90; G01; N20

**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

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## **1. Introduction**

After a thirty 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’ theory of cycles arising from infrastructure investments; Schumpeter’s theory of cycles due to waves of technological innovation; Keynes – Kaldor – Kalecki 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 analyzes varying time scales and mechanisms of economic cycles prevalent in economic theory. Section 4 examines a Minsky-type of 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.<sup>2</sup>

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 nine 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 (*i.e.*, inventions and process modifications requiring fifty 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.

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<sup>2</sup> There are antecedents to Kondratieff's work and he cites some earlier empirical efforts aimed at systematizing the cyclicity of economic crises by van Gelderen (1913), Buniatian (1915), and de Wolff (1924).

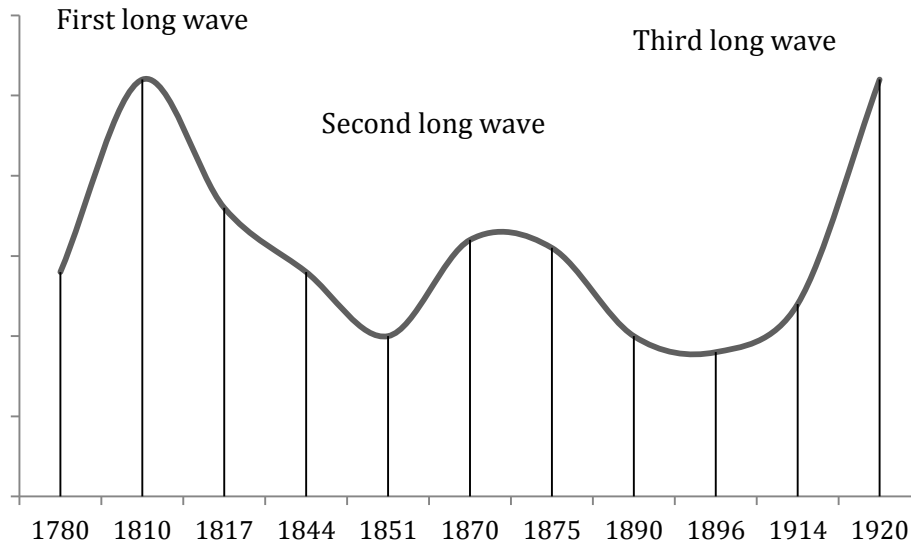


Figure 1a: An illustration of Kondratieff’s long wave – cycles.<sup>3</sup>

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 both 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 transition to the logical next stage of socialism, which was the then a dominant interpretation of Marx’s *Capital* (1867). 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).

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.<sup>4</sup>

## 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

<sup>3</sup> Source: authors’ approximation based on Kondratieff (1935)

<sup>4</sup> For more information see Korotaev and Tsirel, 2010; Kondratieff et al. 2002; and Akaev, 2009.

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 (e.g. Korotaev 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 cyclicity 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 Korotaev 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 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.



Figure 1b. Kuznets curve

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 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); 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-19th 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 19th century, which Marx and other classical economists also contributed to 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<sup>5</sup>. 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 nonlinear 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

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<sup>5</sup> A review of the mechanisms of cycles on a shorter time scale is given in Semmler (1986).

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 cycle (1971) 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, e.g., 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 triggering 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 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, and 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 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, Semmler and Gong (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 are 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” (Schumpeter, 1970, 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 (Schumpeter, 1970, 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” (Schumpeter, 1970, 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.”

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<sup>6</sup>:

- The water-powered mechanization of industry in the 18th and early 19th centuries.
- The steam-powered mechanization of industry and transport in the middle of the 19th century (railways, steam engines, machine tools)
- The electrification of industry, transport, and homes at the end of the 19th 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<sup>7</sup>.

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<sup>6</sup> For details see Reati and Toporowski (2004).

<sup>7</sup> For details of the subsequent dynamic modeling, see Semmler (1986).

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 and causes wage growth to increase, thereby causing the profit share to start falling. Using nonlinear 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

$$\begin{aligned}\dot{x} &= P(x, y) = (a - by)x \\ \dot{y} &= Q(x, y) = (cx - d)y\end{aligned}$$

or as

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

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

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

$$\begin{aligned}\frac{\dot{x}}{x} &= b(1 - y) - (m + n) \\ \frac{\dot{y}}{y} &= cx - (e + m)\end{aligned}$$

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, 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  $\xi_1, \xi_2$  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 nonlinear 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 nonlinear 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 nonlinear model of business cycles. That model has since been reformulated in the light of mathematical advances in the theory of nonlinear 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 nonlinear 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, i.e. 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 nonlinear differential equations as follows (Chang and Smyth, 1971):

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

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

where  $\alpha$  is a reaction coefficient,  $\dot{Y}$  the rate of change of income,  $\dot{K}$  the rate of change of the capital stock,  $I$  = investment and  $S$  = saving as functions of the level of income and capital stock. According to the assumptions underlying the model, there is a unique singular point (Chang and Smyth, 1971, 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 abnormal high or abnormal low levels of income;
- c) The stationary state equilibrium has a normal level of income.

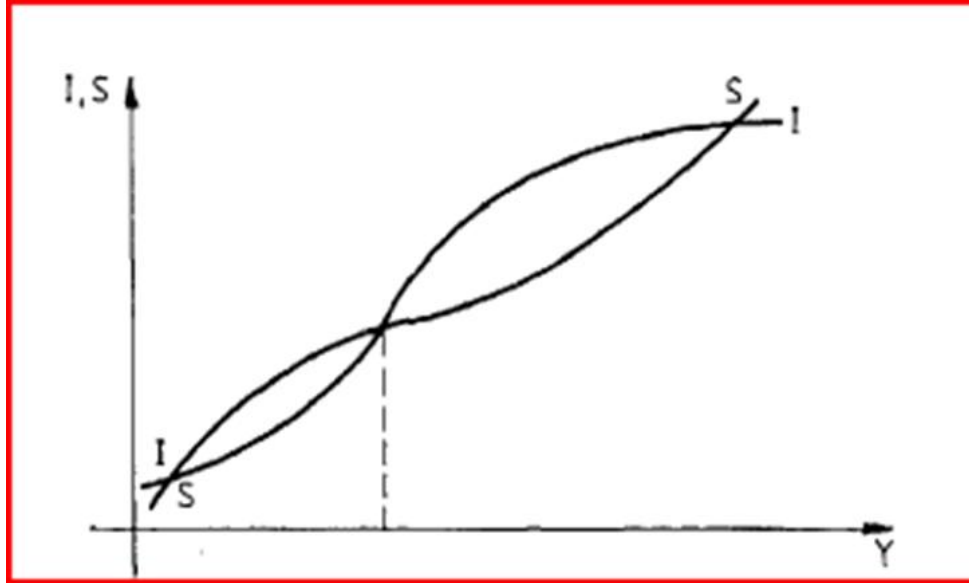


Figure 2: Kaldor's graph of nonlinear investment and saving functions.

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.

### 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  $\Pi^8$  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:

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

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:

<sup>8</sup> This conversion seems permissible as long as there are no savings out of workers income and thus workers income is completely spent on consumption.

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

(a) when  $\Pi > \Pi_2$ , the sensitivity of investment falls because of rising construction cost for plants, rising material and wage cost (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 with 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 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  $\Pi(t)$ ,  $\dot{\Pi}$  turns negative and for large enough  $K(t)$ ,  $\dot{K}$  turns negative and vice versa.

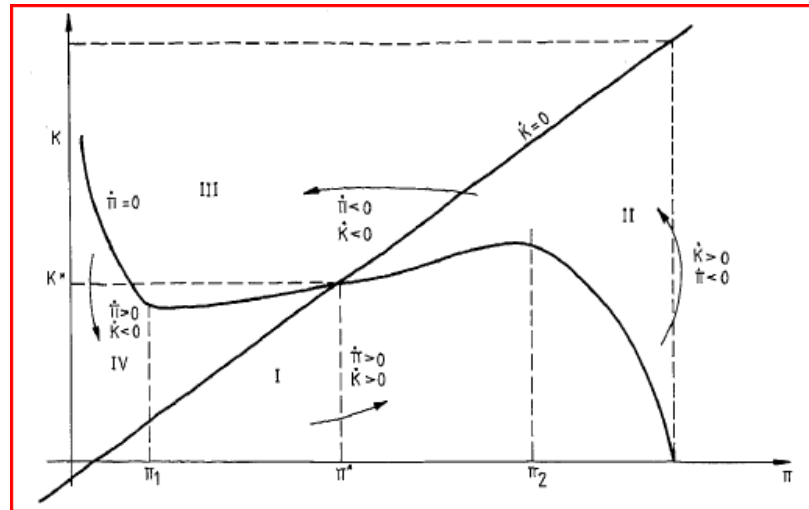


Figure 3: Phase Diagram

#### 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; while Goodwin cycles are based on changes in the functional distribution of income arising from changed bargaining power conditions in period 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 is increasing 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 stages of development perspective has been further elaborated by Whalen (1999) and Wray (2009).

Recently, Palley (2010, 2011) has argued 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 it 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 can be labeled the "Minsky super cycle".

The basic cycle is driven by evolving patterns 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 they rely on capital gains to meet their obligations.

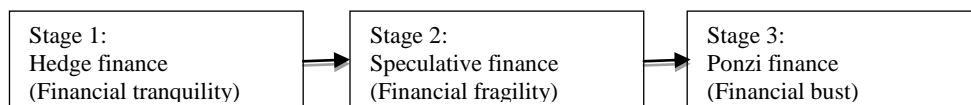


Figure 4: Minsky financing practices

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 willingness to take on increasing risk in 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 text book 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 U.S. 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.

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, decision-making 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 when 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 twenty-five 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 forgetting of earlier financial crisis, 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 easily travel 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 U.S. 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 increasingly more 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, chapter 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 U.S. 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 (i.e 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 the thwarting institutions become sufficiently weakened and financial excess becomes sufficiently deep that the economy experiences a cyclical downturn that is uncontrollable and becomes a crisis.

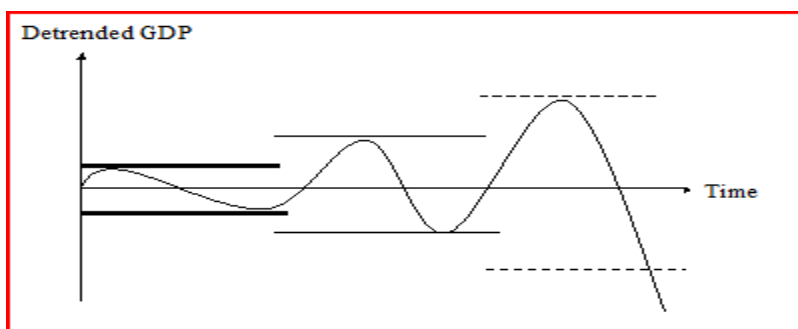


Figure 5: De-trended GDP - Symmetric Fluctuations

Figure 5 shows the case where 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.

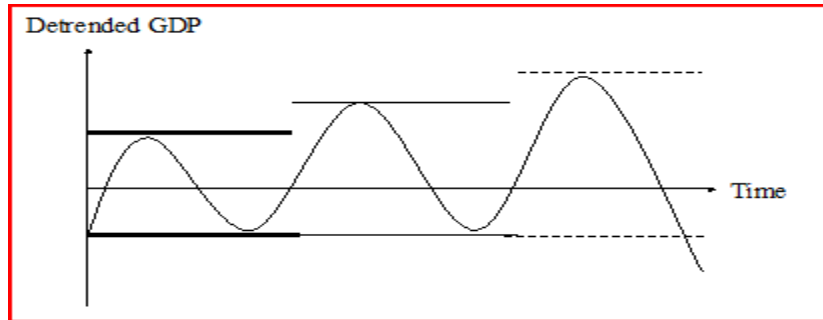


Figure 6: De-trended GDP - Asymmetric Fluctuations

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' (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 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". 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 the gradual 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 last thirty years that ended with the financial crisis of 2008. The Kondratieff cycle seems relevant for understanding the on-going 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.<sup>9</sup> 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 two hundred years, a repeated sequence of structural changes have transformed the economy from one dominated by agriculture to 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 decision making 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,” Palley (2011) This 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 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 (e.g. 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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<sup>9</sup> 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.

## References

- Akaev, A. A. (2009), 'Soveremennyj finansovo-ekonomicheskij krizis v svete teorii innovatsionno-tekhnologicheskogo razvitiya ekonomiki i upravleniya innovatsionnym processom', In D.A. Khalturina and A.V. Korotaev (eds.) *Sistemnyj monitoring. Global'noe i regional'noe razvitie*. In Russian. Moscow: Librokom, pp 141 – 162 .
- Bernanke, B. (2004), 'The Great Moderation', Remarks at the meetings of the Eastern Economic Association, Washington DC, February 20.
- Bernanke, B., Gertler, M., and Gilchrist, S. (1999), 'The Financial Accelerator in a Quantitative Business Cycle Framework', in Taylor & Woodford (eds.), *Handbook of Macroeconomics*, Volume 1, Elsevier Science, p. 1341 – 93, Amsterdam, The Netherlands .
- Bernanke, B., M. Gertler, and S. Gilchrist (1996), 'The Financial Accelerator and the Flight to Quality', *Review of Economics and Statistics*, **78**, 1 – 15.
- Buniatian M. A. (1915), '*Ekonomicheskie krizisy. Opyt morfologii i teorii periodicheskix ekonomicheskix krizisov i teorii kon'juktury*', In Russian. Moscow: Mysl'.
- Chang, W. and D. L. Smyth (1971), 'The existence and persistence of cycles in a non-linear model: Kaldor's 1940 model re-examined', *Review of Economic Studies* 38, 37-46.
- De Wolff, S. (1924), *Prosperitats- und Depressionsperioden. Der Lebendige Marxismus* / eds. by O. Janssen. Jena: Thuringer Verlagsanstalt. S., pp 13–43.
- Delli Gatti, D., M. Gallegati, and H. Minsky (1994), 'Financial institutions, economic policy, and the dynamic behavior of the economy,' Working paper No. 126, The Jerome Levy Economics Institute of Bard College, New York.
- Ferri, P. and H. Minsky (1992), 'Market Processes and Thwarting Systems', Working Paper No.64, The Jerome Levy Economics Institute, Bard College, Annadale-on-Hudson, NY and published in *Structural Change and Economic Dynamics*, **3**, 79 – 91.
- Flaschel, P. (1984), 'Some stability properties of Goodwin's growth cycles', *Zeitschrift fuer Nationaloekonomie*, **44**, 281-285
- Flaschel, P and W. Semmler (1987), 'Classical and Neoclassical Competitive Adjustment Process', *Manchester School of Economic and Social Studies*, **55** (1), 13-37.
- Gallegati, M., J. Ramsey and W. Semmler (2011), 'Forecasting output using interest rate spreads: a wavelet decomposition analysis', submitted.
- Garvy, G. (1943), 'Kondratieff's Theory of Long Cycles', *The Review of Economics and Statistics*, **25** (4), 203-220.
- Gevorkyan, A.V. (2011), *Innovative Fiscal Policy and Economic Development in Transition Economies*, Oxford, UK: Routledge.
- Gevorkyan, A.V. and Ar. Gevorkyan. 2012. Redefined fundamental uncertainty, fiscal rules, fiscal net, fiscal sustainability and emerging markets scenarios, *Aestimatio, the IEB International Journal of Finance*, Vol (5): 126-161.
- Goodwin, R., (1967), 'A growth cycle' in: C.H. Feinstein, ed., *Socialism, Capitalism and Economic Growth*, Cambridge University Press, Cambridge, pp. 54-58.
- Greiner, A, W. Semmler and G. Gong (2005), *The Forces of Economic Growth*, Princeton, NJ, USA: Princeton University Press.
- Grossman, G. M., and A. B. Krueger (1995), 'Economic growth and the environment', *Quarterly Journal of Economics*, **110**, 353–377.
- Guckenheimer, J and P. Holmes (1983), *Nonlinear Oscillations. Dynamical Systems and Bifurcations of Vector Fields*, Berlin/New York: Springer.
- Hicks, J.R. (1950), *A Contribution to the Theory of the Trade Cycle*, Oxford, U.K.: Clarendon Press.
- Hirsch, M.W. and S. Smale (1974), *Differential Equations, Dynamical Systems and Linear Algebra*, New York, NY, USA: Academic Press.

- Juglar, C. (1862), *Des Crises commerciales et leur retour periodique en France, en Angleterre, et aux Etats-Unis*, Paris, France: Guillaumin.
- Kaldor, N. (1940), 'A Model of the Trade Cycle', *Economic Journal*, **50**, 78-92, republished in: N. Kaldor, *Essays in Economic Stability and Growth* (G. Duckworth, London, 1960).
- Kaldor N. (1971), 'A comment', *Review of Economic Studies*, **38**, 45-46.
- Kalecki, M. (1937), 'A Theory of the Business Cycle', *Review of Economic Studies*, **4**, 77-97.
- Kalecki, M. (1971), *Selected Essays on the Dynamics of the Capitalist Economy*, Cambridge, UK: Cambridge University.
- Kitchin, J. (1923), 'Cycles and Trends in Economic Factors,' *Review of Economics and Statistics*, **5** (1), 10–16
- Kiyotaki, N., and J. Moore (1997), 'Credit Cycles', *Journal of Political Economy*, **105**, 211-248.
- Kondratieff, N. (2002), *Big Cycles of Conjunction and Theory of Prevision*, Selected Works, Yakovets, Y.V., and L.I. Abalkin, editors, In Russian (Bol'shie cikly kon'junktury i teoriya predvideniya. Izbrannye trudy). Moscow: Ekonomika.
- Kondratieff, N. (1922), *The World Economy and its Conjunctions During and After the War*. Republished in English (2004), Yakovets, Y.V., Makasheva, N.A., editors, translated by Wolfson, Moscow: International Kondratieff Foundation.
- Kondratieff, N. (1935), 'The Long Waves in Economic Life.' *Review of Economics and Statistics*, **18** (6), 105-15.
- Korotaev, A. and S. Tsirel (2010), 'A Spectral Analysis of World GDP Dynamics: Kondratieff Waves, Kuznets Swings, Juglar and Kitchin Cycles in Global Economic Development, and the 2008–2009 Economic Crisis.' *Structure and Dynamics*, Vol. 4 (1), pp 1-55. Available online: <http://www.escholarship.org/uc/item/9jv108xp> [accessed April 14, 2011].
- Kuznets, S. (1973), 'Modern Economic Growth: Findings and Reflections.' *The American Economic Review*, **63** (3), 247-258.
- Kuznets, S. (1971), *Economic Growth of Nations: Total Output and Production Structure*, Cambridge, UK: Belknap Press of Harvard University Press.
- Kuznets, S. (1966), *Modern Economic Growth: Rate, Structure, and Spread*, New Haven: Yale University Press.
- Kuznets, S. (1955), 'Economic Growth and Income Inequality', *The American Economic Review*, **45** (1), 1-28.
- Kuznets, S. (1949), 'National Income and Industrial Structure', *Econometrica*, **17**, 205-241.
- Kuznets, S. (1937), *National Income and Capital Formation, 1919–1935*, New York: National Bureau of Economic Research.
- Kuznets, S. (1934), 'National Income, 1929–1932.' U.S. Senate document no. 124, 73d Congress, 2d session.
- Marx, K. 1867 (2003). *Capital: A Critique of Political Economy, Vol.I, The Process of Capitalist Production*, Reprint. New York: International Publishers.
- Minorsky, N (1962), *Nonlinear Oscillations*, D. Van Nostrand Co., New York.
- Minsky, H.P. (1957), "Monetary Systems and Accelerator Models, American Economic Review, 47 (December), 859 – 83.
- Minsky, H.P. (1959), "A Linear Model of Cyclical Growth," Review of Economics and Statistics, 41 (May), 133 – 45.
- Minsky, H. P. (1983), Financial structure, indebtedness and credit, Paper prepared for the conference 'Keynes Today: Theories and Policies', Paris.
- Minsky, H. P. (1992a), 'The Financial Instability Hypothesis', Working paper No. 74, The Jerome Levy Economics Institute of Bard College, New York, 1992 and published in Arestis P. and Sawyer M. (eds), *Handbook of Radical Political Economy*, Aldershot: Edward Elgar, 1993

- Minsky, H. P. (1992b), 'Schumpeter and finance,' in S.Biasco, A. Roncaglia, and M Salvati (eds.), *Market and Institutions in Economic Development: Essays in Honor of Paulo Sylos Labini*, New York: Macmillan Press, 103 – 115.
- Palley, T. I. (2010), 'The Limits of Minsky's Financial Instability Hypothesis as an Explanation of the Crisis', *Monthly Review*, April, 28 - 43.
- Palley, T. I. (2011), 'A Theory of Minsky Super-Cycles and Financial Crises', *Contributions to Political Economy*, vol. 30, issue 1, pp 31 – 46.
- Palley, T. I. (2012), *From Financial Crisis to Stagnation: The Destruction of Shared Prosperity and the Role of Economics*, Cambridge University Press, New York, NY.
- Reati, A. and J. Toporowski, An economic policy for the fifth long wave, *BNL Quarterly Review*, vol. 57 n. 231, December 2004, pp. 395-437.
- Rostow, W.W. (1975), 'Kondratieff, Schumpeter, and Kuznets: Trend Periods Revisited.' *The Journal of Economic History*, **35** (4): 719-753.
- Samuelson, P.A., (1939), 'Interactions Between the Multiplier Analysis and the Principle of Acceleration', *The Review of Economic and Statistics*, **21**, 75 – 78.
- Schumpeter, J.A. (1970), *Capitalism, Socialism and Democracy*, New York: Harper & Row.
- Schumpeter, J.A. (1939), *Business Cycles: A Theoretical, Historical and Statistical Analysis of the Capitalist Process*, New York, NY, USA: McGraw-Hill.
- Semmler, W. (1986), 'On Nonlinear Theories of Economic Cycles and the Persistence of Business Cycles', *Mathematical Social Sciences, Elsevier-North Holland*, **12**, 47-76.
- Stern, D.I. (2004), 'The Environmental Kuznets Curve,' *International Encyclopedia of Ecological Economists*, available online: <http://www.ecoeco.org/pdf/stern.pdf> (accessed April 15, 2011).
- Van Gelderen, J. (1913), 'Springvloed: Beschouwingen over industriele ontwikkeling en prijsbeweging' ('Spring Tides of Industrial Development and Price Movements'). *De nieuwe tijd* 18.
- Velupillai, K. (1979), 'Some Stability Properties of Goodwin's Growth Cycle', *Zeitschrift für Nationalökonomie*, **39**, 245-257.
- Whalen, C. J. (1999), 'Hyman Minsky's theory of capitalist development,' Working Paper No. 277, The Jerome Levy Economics Institute of Bard College, New York.
- World Bank (WB), (1992), *World Development Report*, Washington, D.C., USA: The World Bank
- Wray, L. R. (2009), 'Money manager capitalism and the global financial crisis,' in E.Hein, T. Niechoj, and E. Stockhammer (eds.), *Macroeconomic Policies on Shaky Foundations: Whither Mainstream Economics?*, Marburg: Metropolis-Verlag, p.283-306.